

PROJECT MANUAL
INCLUDING CONSTRUCTION SPECIFICATIONS

for

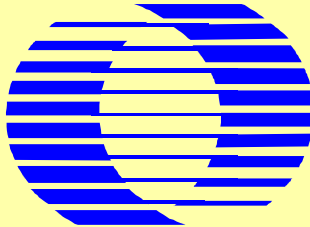
BP-S00195
TERMINAL C, PHASE 1X – AIRSIDE CONCOURSE

CONTRACT DOCUMENTS

Addenda Book 3 OF 5
(Addendum No. 4 Part 2)

ORLANDO INTERNATIONAL AIRPORT

Orlando, Florida 32827



GREATER ORLANDO AVIATION AUTHORITY

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Item C-102 Temporary Air and Water Pollution, Soil Erosion, and Siltation Control

DESCRIPTION

102-1. This item shall consist of temporary control measures as shown on the plans or as ordered by the ~~Resident Project Representative (RPR)~~ **Owner Authorized Representative (OAR)** during the life of a contract to control pollution of air and water, soil erosion, and siltation through the use of silt fences, berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

Temporary erosion control shall be in accordance with the approved erosion control plan; the approved Construction Safety and Phasing Plan (CSPP) and AC 150/5370-2, *Operational Safety on Airports During Construction*. The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

Temporary control may include work outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.

Temporary control measures shall be designed, installed and maintained to minimize the creation of wildlife attractants that have the potential to attract hazardous wildlife on or near public-use airports.

Contractor shall prepare all required documentation, pay all fees and perform all services and work necessary to obtain all permits from appropriate local, state, and federal regulatory agencies for Contractor's staging, stockpile, blending and batch plant areas and operations. In compliance with the National Pollutant Discharge Elimination System (NPDES) permit issued or approved by U.S. Environmental Protection Agency (EPA) pursuant to 40CFR Part 122.6, the contractor shall prepare a project specific erosion control as part of a Stormwater Pollution Prevention Plan.

Contractor's Pollution Control Plan. The Contractor's pollution control plan shall address all measures to dispose of, control, or prevent discharge of solid, hazardous and sanitary wastes to the waters of the U.S. The plan shall include procedures to control offsite tracking of soil by vehicles and construction equipment; and procedures for cleanup and reporting of non-stormwater discharges (such as accidental spills). The Contractor shall adhere to the requirements set forth by the Florida Department of Environmental Protection (FDEP) document No. 62-621.300(4)(a), Florida Statute Section 403.0885, and Florida Administrative Code (F.A.C.) 62-62-4.050(4)(d). The pollution plan may be part of the Environmental Resource Permit review and approval process required by South Florida Water Management District (SFWMD).

Contractor shall adhere to all requirements set forth in the GOAA Master Water Use Permit No. 48-02319-W and must obtain a letter modification prior to commencement of any dewatering activities.

102-1.2 Coordination and Corrective Requirements. The installation of temporary erosion control features shall be coordinate with the construction of any permanent erosion control features to the extent necessary to assure economical, effective, and continuous control of erosion and water pollution throughout the life of the contract.

In cases of repeated failures on the part of the Contractor to control erosion and pollution, right is reserved by the OAR to employ outside assistance to provide such corrective measures and actions deemed appropriate by the OAR to correct the condition(s) and/or to direct the Contractor to perform other work as required by the circumstances. Such measures which may be ordered by the OAR may consist of reconstruction of berms, dikes, dams, drains, sediment basins, ditches, canals, or the use of fiber mats, woven plastic filter cloths, gravel, mulches, quick growing grasses, sod, bituminous spray, and other erosion control devices or methods deemed appropriate under the circumstance(s). The Contractor will be responsible for all costs associated with this requirement.

~~Such incurred costs, including related Engineering costs, will be charged to the Contractor and appropriate deductions made from the Contractor's progress payments.~~

102-1.3 Control of Water Pollution. The Contractor shall take sufficient precautions to prevent pollution of streams, canals, lakes, reservoirs, and other water bodies with fuels, oils, bitumens, calcium chloride, or other harmful materials.

Contractor shall also conduct and schedule operations in such a manner as to avoid or otherwise minimize pollution or siltation of such streams, lakes, and other water bodies, and to avoid interference with natural movements of migratory fish. No residue from dust collectors or washers shall be dumped into any water body whatsoever.

Contractor shall not cause runoff from water controls to exceed 29 Nephelometric Turbidity Units (NTU) above background values. Contractor shall take all necessary steps to meet this requirement.

Except as necessary for construction, excavated materials shall not be deposited in close proximity to waterways and/or water bodies to be washed away by high water and/or runoff.

The Contractor shall not disturb lands or waters outside of the limits of construction as staked, except as may be found necessary and authorized by OAR.

The location of and method of operation for borrow pits, material pits, staging and plant sites and disposal areas for wasted materials from the project (other than commercial operated sources) shall meet the approval of the OAR as being such that erosion during and after completion of the work will not result in the probability of detrimental siltation and/or water pollution.

MATERIALS

102-2.1 Grass. Grass that will not compete with the grasses sown later for permanent cover per Item T-901 shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover. Selected grass species shall not create a wildlife attractant.

102-2.2 Mulches. Mulches may be hay, straw, fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials per Item T-908. Mulches shall not create a wildlife attractant.

102-2.3 Fertilizer. Fertilizer shall be a standard commercial grade and shall conform to all federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

102-2.4 Slope drains. Slope drains may be constructed of pipe, fiber mats, rubble, concrete, asphalt, or other materials that will adequately control erosion.

102-2.5 Silt fence. Silt fence shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life. Silt fence shall meet the requirements of ASTM D6461 **and FDOT Standard Specifications Section 104-6.4.10.**

102-2.6 Baled Hay or Straw. *Baled hay or straw shall meet the requirements of FDOT Standard Specifications Section 104-6.4.9.*

102-2.7 Sand Bags. *Sand bagging shall consist of furnishing and placing sand bags in configurations and/or piles so as to effectively control erosion and siltation.*

102-2.8 Turbidity Barriers. *Turbidity barriers shall meet the requirements of FDOT Standard Specifications Section 104-6.4.11.*

102-2.9 Watering and Dust Control. *Watering of the site shall be as required to control blowing dust on open excavations, including subgrade and lime rock surfaces. The Contractor shall apply supplemental water to the areas as required and/or directed by the OAR to mitigate blowing dust and debris. This requirement shall be in addition to water required for compaction purposes. The Contractor shall obtain approval from the OAR and make all arrangements to obtain water from suitable sources on the site. Contractor shall also pay all costs for establishing and removing all apparatus required for watering*

102-2.10 Sock Pipe/Horizontal Wells. *Sock Pipe/Horizontal Wells shall include the installation of a pumping system or other approved methods of containing perforated plastic pipes, wrapped twice in filter fabric, in a horizontal fashion along the bottom of the excavation pit to be dewatered, as necessary. The Sock Pipe/Horizontal Well shall be used to remove excess surface water, if necessary. The excess surface water shall be filtered and discharged into the existing catch basins provided no visible sediment is discharged. If, in the opinion of the OAR, an excess of sediment is being discharged into the existing catch basin, pumping shall be halted until additional filtering methods can be exercised. Pumping of the water into existing stormwater treatment ponds will not be allowed without prior approval of the OAR.*

102-2.11 Catch Basin Filter Fabric. *Catch Basin Filter Fabric protection shall consists of placing approved filter fabric material underneath the grate or covering of existing catch basins, inlets, and manholes, as indicated within the plans. Filter fabric shall be placed in two separate layers, each running perpendicular to each other. The filter fabric layers shall be secured to the bottom of the grate or covering and shall extend at least 12 inches beyond the edge when the grate is placed in its sealed position. The fabric shall be neatly folded over and secured to each other with suitable fasteners.*

102-2.12 Other. All other materials shall meet commercial grade standards and shall be approved by the RPR **OAR** before being incorporated into the project.

CONSTRUCTION REQUIREMENTS

102-3.1 General. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

The ~~RPR~~ **OAR** shall be responsible for assuring compliance to the extent that construction practices, construction operations, and construction work are involved. ***Acceptance will be on the basis of visual inspection by the OAR.***

102-3.2 Schedule. Prior to the start of construction, the Contractor shall submit schedules in accordance with the approved Construction Safety and Phasing Plan (CSPP) and the plans for accomplishment of temporary and permanent erosion control work for clearing and grubbing; grading; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the ~~RPR~~ **OAR**.

The Contractor shall schedule operations such that the area of unprotected erodible earth exposed at any one time is not larger than that of the minimum area necessary for efficient construction operations and the duration of the exposed, uncompleted construction to the elements shall be as short as practicable.

“The erosion control plan identified in the plans is provided as a minimum requirement. Contractor is solely responsible for preventing turbidity and for conforming to SFWMD and NPDES permits. Contractor shall submit their erosion and turbidity control plan to the OAR at the Preconstruction Conference. The Plan shall include a maintenance schedule for rehabilitation of the items contained within the erosion control plan. The submitted plan shall be reviewed by the OAR and the Contractor shall incorporate comments received from the OAR.

102-3.3 Construction details. The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the plans and approved CSPP. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

Where erosion may be a problem, schedule and perform clearing and grubbing operations so that grading operations and permanent erosion control features can follow immediately if project conditions permit. Temporary erosion control measures are required if permanent measures cannot immediately follow grading operations. The ~~RPR~~ **OAR** shall limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current with the accepted schedule. If seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified as directed by the ~~RPR~~ **OAR**.

The Contractor shall provide immediate permanent or temporary pollution control measures to minimize contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment as directed by the ~~RPR~~ **OAR**. If temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or directed by the ~~RPR~~ **OAR**, the work shall be performed by the Contractor and the cost shall be incidental to this item.

The ~~RPR~~ **OAR** may increase or decrease the area of erodible earth material that can be exposed at any time based on an analysis of project conditions.

The erosion control features installed by the Contractor shall be maintained by the Contractor during the construction period.

Provide temporary structures whenever construction equipment must cross watercourses at frequent intervals. Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials shall not be discharged into any waterways, impoundments or into natural or manmade channels.

Typical methods of controlling dust and other air pollutants may include exposing the minimum of erodible earth, applying temporary mulch with or without seeding, using water sprinkler trucks, using covered haul trucks, using dust palliatives or penetration asphalt on haul roads, and/or using plastic sheet coverings.

102-3.3.1 Details for Temporary Erosion Control Features. Temporary erosion control features shall consist of, but not limited to: sand bagging, slope draining, sediment basins, sediment checks, artificial coverings and berms per Florida Department of Transportation standards. The OAR may direct use of temporary erosion control features or methods other than those included in the original contract.

- A. Slope Drains. Slope drains shall consist of constructing slope drains utilizing pipe, fiber mats, rubble, cement concrete, asphaltic concrete sheeting or other acceptable materials as may be approved by the OAR.***
- B. Sediment Basins. Sediment basins shall consist of constructing basins accordance with the details shown on the drawings or as may be approved by the OAR to adequately perform the intended function. Sediment basins shall be cleaned out whenever they are half full or as directed by the OAR.***
- C. Sediment Checks, Hay Bales, and Silt Fences. Sediment checks shall consist of constructing checks, dams, bales, and/or silt fences as may be approved by the OAR. Prior to the beginning of construction, the area immediately downstream of construction shall be cross-section surveyed to determine existing conditions. Once construction has been completed and just prior to project acceptance, the area shall be cross-section surveyed again. Any silt and washed materials deposited in these areas shall be removed.***

The upstream side of each installation shall be checked periodically throughout construction for siltation and deposits. Unless otherwise directed by the OAR, any sediment or deposits in excess of six (6) inches shall be removed.

The checks shall be maintained by the Contractor for the period of the contract. Just prior to the acceptance of the project, the checks shall be removed by the Contractor unless requested by the OAR that they are to be allowed to remain.
- D. Artificial Coverings. Artificial Coverings shall consist of furnishing and applying fiber mats, netting, plastic sheeting or other approved covering to the earth surfaces.***
- E. Berms. Berms shall consist of the construction of temporary earth berms to divert the flow of water from an erodible surface.***

F. Fertilizer. Fertilizer shall be a standard commercial grade material and shall conform to all Federal and State regulations in addition to the standards of the Association of Official Agricultural Chemists.

102-3.4 Installation, maintenance and removal of silt fence. Silt fences shall extend a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 m) on center. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 4 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. The trench shall be backfilled and the soil compacted over the silt fence fabric. The Contractor shall remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The fence shall be maintained in good working condition until permanent erosion control is established. Silt fence shall be removed upon approval of the RPR OAR.

102-3.5 Local Laws, Rules, and Regulations. *In the event of differences between these requirements and pollution control laws, rules or regulations of local agencies, the more restrictive laws, rules, and/or regulations shall apply.*

- A. *The Contractor shall file a Notice of Intent (NOI) for coverage under the State of Florida Generic Permit for Stormwater Discharge from Large and Small Construction Activities issued under the provisions of the National Pollutant Discharge Elimination System (NPDES). Guidance for and requirements of the NOI, Generic Permit and NPDES are available through the Florida Department of Environmental Regulation website at www.dep.state.fl.us .***
- B. *The Contractor shall furnish, as submittals to the OAR and Owner, hardcopy and digital documentation for the NOI, the Contractor's Stormwater Pollution Prevention Plan to be implemented for this project, and the Notice of Termination (NOT) filed upon completion of the project.***
- C. *A Construction Stormwater Pollution Prevention Plan Template is in the Florida Stormwater Erosion and Sedimentation Control Inspector's Manual, dated October 2018, or more current edition, available through the Florida Department of Environmental Protection regulation website at www.dep.state.fl.us .***

102-3.6 Maintenance of Erosion Control Features

- A. Routine Maintenance. *The Contractor, at his/her expense, shall provide routine maintenance of permanent and temporary erosion control features until the project is completed and accepted. If such erosion control features must be reconstructed due to the Contractor's negligence or carelessness or, in the case of temporary erosion control features, failure by the Contractor to install permanent erosion control features as scheduled, such replacement (labor, tools, equipment, materials, fines, etc.) shall be at the Contractor's expense.***
Routine Maintenance to control dust and other air pollutants shall include, in addition to other methods mentioned herein, using water sprinkler trucks and covered haul trucks.

- B. Mowing. The OAR may direct mowing of areas of permanent or temporary grass constructed on the project. The Contractor shall mow these designated areas within seven (7) days of receiving such order. Mowing of slopes which are steeper than four horizontal to one vertical will not be required.***
- C. Suspension of Contractor Operations. In the event that is necessary that the construction operations be suspended for any appreciable length of time, the Contractor shall shape the work in such a manner as to permit runoff of stormwater and shall construct earth berms along the top edges of the embankments to intercept runoff water. Temporary slope drains shall be provided to convey runoff from cuts and embankments which are located in the vicinity of rivers, streams, canals, lakes, ditches, improved water bodies, and/or water bodies. The slope drains shall be located at the intervals of approximately five hundred feet (500-FT) and shall be stabilized by paving or covering with water proof materials. Should such preventative measures fail, the Contractor shall immediately take other action necessary to effectively prevent erosion and siltation.***

The OAR may direct the Contractor to perform, during such suspensions of time, any other erosion control work deemed necessary. The Contractor shall monitor the project and maintain all erosion control features during any suspension of contract time or work.

102-3.7 Proposed Plan of Operation. At the Pre-Construction Conference, the Contractor shall be prepared to present the proposed plans and schedules for the project in accordance with the requirements of this section. The schedule shall be in written form and approved by the OAR prior to the processing of the first partial pay request. This requirement shall not be waived. This schedule shall specifically indicate the sequence of operations and construction of permanent erosion control features and the proposed uses of temporary erosion control features. It shall also include proposed methods to prevent pollution of the streams, lakes, ditches, canals, tidal waters, reservoirs, and other impoundments as the result of construction operations. The Contractor shall also outline his proposed methods of controlling erosion and preventing pollution on haul roads/routes and in borrow pits, material pits, staging and plant sites, and areas used for disposal of waste materials from the project.

No work shall be started until the aforementioned plans and schedules have been accepted by the OAR. The Contractor will be responsible for the accomplishment of the work in accordance with the accepted plans and schedules. The OAR may approve changes made necessary by unforeseen circumstances or conditions which are beyond the control of the Contractor.

102-3.8 Open Surface Area. The OAR shall limit the surface areas of unprotected erodible earth exposed by excavation operations and shall direct the Contractor to provide immediate permanent or temporary erosion/pollution control measures to prevent contamination of any river, stream, lake, tidal water, reservoir, canal or other impoundment or to prevent detrimental effects on property outside of the project limits and damage to the project. The limitation of area in which operations may be under way shall be commensurate with the Contractor's capability and progress in maintaining erosion control measures current in accordance with the approved schedule.

102-3.9 Coordination with Permanent Construction. Any permanent erosion control features shall be incorporated into the project at the earliest practical time. Except where future construction operations will damage slopes, the Contractor shall perform permanent seeding and mulching and other specific slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Use of temporary erosion control features will be authorized to correct conditions that develop during construction which were not foreseen at the time of design to control erosion prior to the time it is practical to construct permanent control features or to provide immediate temporary control of erosion that develops during the course of normal construction operations but is not associated with permanent erosion control features of the project. Temporary erosion control features may be authorized for use in controlling erosion in areas where stage construction or other conditions not under the control of the Contractor preclude completion of a section of airfield in a continuous manner and in areas where construction operations which must be performed subsequently will cause damage to permanent erosion control features.

102-3.10 Dewatering / Ground Water Control. The Contractor is completely responsible for the site conditions including but not limited to dewater the project site for groundwater and stormwater runoff conditions. A dewatering plan shall be submitted by the contractor to the OAR for review prior to the start of construction. ~~The Contractor shall file for any dewatering permits required, shall pay for all costs associated with dewatering and dewatering permits, and shall implement dewatering in compliance with local water management district, the Airport's SWPPP plan, and any FDEP and/or NPDES requirements simultaneously.~~ Contractor shall adhere to all requirements set forth in the GOAA Master Water Use Permit No. 48-02319-W and must obtain a letter modification prior to commencement of any dewatering activities. The type of methods of site dewatering will be by the Contractor (means and methods), and shall be included in the Contractor's bid. ~~If no specific pay item for dewatering is provided within the bid documentation (plans and specifications), the Contractor shall include enough money in one or more other pay items for dewatering.~~ Dewatering shall be deployed for the entire duration of the project. No additional compensation will be made to the Contractor for dewatering the project.

The Contractor's attention is directed to the geotechnical engineering report, the boring logs, the contract documents, and/or the plans for water table information. If no water table information is depicted within the contract documents, it is the Contractor's responsibility to request information during bidding. The Contractor should assume that dewatering will be necessary at all times. The requirements of this section are in addition to the General Provisions and Special Provisions requirements.

METHOD OF MEASUREMENT

~~**102-4.1** Temporary erosion and pollution control work required will be performed as scheduled or directed by the RPR OAR. Completed and accepted work will be measured as follows:~~

- ~~a. Temporary seeding and mulching will be measured by the square yard (square meter).~~
- ~~b. Temporary slope drains will be measured by the linear foot (meter).~~
- ~~c. Temporary benches, dikes, dams, and sediment basins will be measured by the cubic yard (cubic meter) of excavation performed, including necessary cleaning of sediment basins, and the cubic yard (cubic meter) of embankment placed as directed by the RPR OAR.~~

~~d. All fertilizing will be measured by the ton (kg).~~

~~e. Installation and removal of silt fence will be measured by the linear foot.~~

102-4.1 Temporary erosion and pollution control work required which is not attributed to the Contractors' negligence, carelessness, or failure to install permanent controls which is performed as scheduled or ordered by the OAR or as required to comply with SFWMD permits shall be measured as a lump sum item. Individual items of work shall not be measured separately but shall be considered subsidiary to the lump sum bid item "Erosion and Turbidity Control".

102-4.2 Control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the Contractor.

BASIS OF PAYMENT

~~**102-5.1** Accepted quantities of temporary water pollution, soil erosion, and siltation control work ordered by the RPR **OAR** and measured as provided in paragraph 102-4.1 will be paid for under:~~

~~Item C-102-5.1a — Temporary seeding and mulching — per square yard (square meter)~~

~~Item C-102-5.1b — Temporary slope drains — per linear foot (meter)~~

~~Item C-102-5.1c — Temporary benches, dikes, dams and sediment basins — per cubic yard (cubic meter)~~

~~Item C-102-5.1d — Fertilizing — per ton (kg)~~

~~Item C-102-5.1e — Installation and removal of silt fence per linear feet~~

~~Where other directed work falls within the specifications for a work item that has a contract price, the units of work shall be measured and paid for at the contract unit price bid for the various items.~~

~~Temporary control features not covered by contract items that are ordered by the RPR **OAR** will be paid for in accordance with Section 90, paragraph 90-05 *Payment for Extra Work*.~~

102-5.1 Accepted quantities of temporary water pollution, soil erosion, and siltation control work shall be paid for at the contract lump sum price bid for "Erosion and Turbidity Control". Payment will be made under:

Item P-102-5.1 Erosion and Turbidity Control – per lump sum

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5200-33 *Hazardous Wildlife Attractants on or Near Airports*

AC 150/5370-2 *Operational Safety on Airports During Construction*

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

TEMPORARY AIR AND WATER POLLUTION,
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ASTM International (ASTM)

ASTM D6461 *Standard Specification for Silt Fence Materials*

United States Department of Agriculture (USDA)

FAA/USDA Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM C-102

Item C-105 Mobilization

105-1 Description. This item of work shall consist of, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project **and the preparation and submittal of all permit applications and documentation to comply with the provision of this contract**, except as provided in the contract as separate pay items.

105-2 Mobilization limit. Mobilization shall be limited to 10 percent of the total project cost.

105-3 Posted notices. Prior to commencement of construction activities, the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor: Equal Employment Opportunity (EEO) Poster "Equal Employment Opportunity is the Law" in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL "Notice to All Employees" Poster; and Applicable Davis-Bacon Wage Rate Determination. These notices must remain posted until final acceptance of the work by the Owner.

105-4 Engineer/~~RPR~~ OAR field office. An Engineer/~~RPR~~ OAR field office is not required.

METHOD OF MEASUREMENT

105-5 Basis of measurement and payment. Based upon the contract lump sum price for "Mobilization" partial payments will be allowed as follows:

- a. With first pay request, 25%.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 40%.
- d. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation*, the final 10%.

BASIS OF PAYMENT

105-6 Payment will be made under:

Item C-105-6.1 Mobilization (Not To Exceed 10% of Total Project Cost)

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Office of Federal Contract Compliance Programs (OFCCP)

Executive Order 11246, as amended

EEOC-P/E-1 – Equal Employment Opportunity is the Law Poster

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MOBILIZATION
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United States Department of Labor, Wage and Hour Division (WHD)
WH 1321 – Employee Rights under the Davis-Bacon Act Poster

END OF ITEM C-105

ITEM C-106 SAFETY, SECURITY AND MAINTENANCE OF TRAFFIC

PART 1 - DESCRIPTION

- 1.1 The work of this item shall consist of all labor, material, equipment, work and operations necessary for Maintenance of Traffic both on, and off airport property. Such items include barricades, signage, pavement sweepers, flagmen, radio operators, gate security, worker and personnel transportation and general site security, etc., as required by the Drawings, these specifications, and State and local laws and regulations. Paramount in this item is that aircraft shall have the Right-of-Way at all times. The Contractor shall include all measures required to maintain the safe and orderly movement of Air Operations Area (AOA) traffic in and around the construction areas as shown on the Plans and as described in the Contract documents. The AOA is defined as all areas, used or intended to be used for aircraft operations including active runways, aprons, taxiways and taxilanes. The AOA is generally bounded on this project by 8' chain link fence with 3-strand barbed wire top, both on the ground and on jersey barrier defining the AOA limits. Maintenance of Traffic off airport property shall be in accordance with the FDOT Standard Specifications for Road and Bridge Construction, the FDOT Standard Index Drawings, and the Manual of Uniform Traffic Control Devices (MUTCD), most current editions.

1.2 GENERAL

This Section covers the Contractor's responsibilities for maintaining the optimum level of safety and the operating efficiency of the airport during construction. These responsibilities are based on criteria contained in the latest edition of Federal Aviation Administration Advisory Circulars 150/5370-2 "Operational Safety on Airports During Construction", and 150/5300-13, "Airport Design". The Contractor shall be responsible for all activities under his control, as specified in the above referenced Advisory Circulars, and in other referenced documents.

1.3 CONSTRUCTION ACTIVITIES

Construction activity, personnel, equipment, and materials shall be permitted only within the designated work areas as defined on the Plans or directed by the Owner's Authorized Representative (OAR).

1.4 MARKING AND LIGHTING OF CONSTRUCTION AREAS

The Contractor shall install, maintain, move and remove lighting, markings, lighted barricades, and other measures as shown on the plans, described in the Specifications, or directed by the OAR, to delineate access routes, closed areas, and hazardous areas during construction.

1.5 LOOSE MATERIAL AND DEBRIS

Loose materials shall be removed from the Project Limits on a daily basis to prevent dispersion into active portions of the AOA. The Contractor shall exercise care in the transportation of materials within the AOA to ensure that no material is tracked or spilled onto the AOA. Materials tracked or spilled in these areas shall be removed immediately. When hauling, loading, grading, or when any of the Contractor's activities are likely to cause the deposit of loose materials in the AOA or aircraft parking areas, it shall be immediately removed using powered vacuum sweepers which shall continuously patrol the affected areas. The vacuum sweepers shall be supplemented by power brooms with nylon bristles, hand sweepers, loaders, and trucks as necessary. Power brooms and sweepers with metal bristles shall not be used.

1.6 STOCKPILED MATERIALS

At no time shall materials be stockpiled within the Project Limits of the AOA. All materials that are not to be re-used shall be removed directly from the Project Limits or the AOA and hauled to a legal dump site off airport property.

1.7 VEHICLES AND MOBILE EQUIPMENT

All Contractor vehicles and mobile equipment operating in the AOA shall meet requirements of the Contract requirements.

1.8 RADIO COMMUNICATION

The Contractor shall provide and monitor a radio capable of receiving transmissions from the Air Traffic Control Tower (ATCT) and Airport Ground Control. The number of radios shall be as required for the Contractor's Superintendent and Flagmen to ensure safe and orderly movement of AOA traffic to, in, and around the construction areas. Flaggers shall be required to have a company walkie-talkie to communicate with each other.

1.9 CLOSURES

When the Contractor's operations require the closure of any portion of a runway, taxiway, apron, or taxilane the Contractor shall notify the OAR not less than 72 hours prior to need. No closures may occur without prior permission from the OAR and Airfield Operations.

1.10 LIGHTED BARRICADES AND TEMPORARY PAVEMENT MARKINGS

Temporary pavement markings, lighted barricades and other measures shall be provided, installed, relocated, and maintained as shown on the Plans on a 24-hour basis by the Contractor to delineate construction areas available to the Contractor and limits of aircraft operational areas.

On a daily basis, the Contractor shall verify that the temporary lighted barricades are in proper operating condition. Any necessary maintenance repairs shall be performed immediately by the Contractor. The proposed layout of temporary markings, fencing and other measures for each construction area are shown on the Plans. The actual field installation of lighted barricades, and other measures and attendant operational procedures shall be inspected by the OAR, and any necessary changes or modifications will be promptly implemented by the Contractor as directed at no additional cost to the Contract. The revised installation will be re-inspected and approved by the OAR and Airfield Operations before the Contractor may commence any construction or any other work which revises operational procedures in each affected area.

1.11 OPERATIONS SAFETY INSPECTION

The entire work site shall be inspected daily and more frequently if construction activities have potential to accumulate debris on AOA pavements. Special inspections shall be conducted for each work area prior to return to service for aircraft operation. The purpose of these inspections is to ascertain that areas being returned to aircraft service are in satisfactory condition and that the overall work site and its activities are within the safety criteria set forth in these Contract Documents and as set forth in the FAA Advisory Circulars. Inspections shall be conducted jointly by representatives of the Contractor, Airfield Operations, and the OAR. These inspections shall cover the several safety items noted in and referred by in this Section.

Any violations of the Safety Criteria found during these inspections shall be rectified immediately. If a violation cannot be corrected on an immediate basis by the Contractor, he shall immediately notify the OAR. No area shall be approved for aircraft operations while it is in violation unless specifically authorized in writing by Airfield Operations and the OAR.

1.12 OPERATIONAL EMERGENCIES

During periods of severe weather conditions or other operational emergencies, Airfield Operations or the OAR may direct the Contractor to relinquish areas under construction and to prepare the areas for severe weather or operational emergency. In this event, the OAR will so direct the Contractor to evacuate the area and the OAR will specify the limits of the area to be evacuated, the term of evacuation, and the conditions governing the restoration work necessary to prepare the area for aircraft operations. The Contractor shall promptly and fully comply with the OAR's directive. Should the directive entail extra work under the Contract, as determined by the OAR, the Contractor will be reimbursed for such extra work in accordance with the General Conditions of this Contract. Should the directive entail a delay in the completion of the Contract or any defined subdivision of the contract, as determined by the OAR, the Contractor may be granted an extension of time in accordance with the provisions of General Conditions of this Contract.

1.13 PROTECTION OF FAA FACILITIES

In areas where Contractor vehicles and equipment cross over FAA facilities, Contractor shall install steel plates to protect underlying utilities from damage as described in the electrical specifications and drawings.

1.14 CONSTRUCTION SAFETY AND PHASING PLANS (CSPP) AND SAFETY PLAN COMPLIANCE DOCUMENT (SPCD)

The Contractor shall review the Construction Safety and Phasing Plan (CSPP) provided by the Engineer. The CSPP has been developed for this project and is mandated by FAA AC 150/5370-2 "Operational Safety on Airports During Construction" (Latest Edition) for any projects funded by the Airport Improvement Plan (AIP) or the Passenger Facility Charge (PFC) Program when located on a Part 139 Airport. All FAA revisions to the CSPP have been incorporated in the CSPP.

The Contractor shall complete the SPCD. The SPCD must be submitted for approval from the Design Team, OAR, ATCT and Airfield Operations, prior to the issuance of the Contractor's Notice to Proceed (NTP). The SPCD will be used to supplement the CSPP document written to comply with the FAA AC 150/5370-2 "Operational Safety at Airports During Construction" (Latest Edition). The supplemental information in the SPCD should be written to match the format of the CSPP indicating each subject by corresponding CSPP subject number and title, per Chapter 2 of the CSPP. If no supplemental information is necessary for any specific subject, the statement "No supplemental information," should be written after the corresponding subject title. The SPCD should not suplicate information in the CSPP. All modification to the CSPP, due to construction activities, shall be highlighted in the SPCD.

PART 2 - MATERIALS AND CONSTRUCTION METHODS

2.1 DEACTIVATION OF AIRFIELD LIGHTS, SIGNS AND MARKINGS

The Contractor shall deactivate or cover lights, signs, and markings that lead into a construction zone, are in a construction zone, or are in a closed portion of a runway or taxiway, as directed by the OAR and/or described in the Contract Plans.

2.2 TEMPORARY FENCING AND BARRICADES

The Contractor shall install and maintain temporary fencing, with or without jersey barriers, at the locations shown on the Construction Safety and Phasing Plans, in accordance with the plan details, and as directed by the OAR. All temporary fencing shall be inspected daily and repaired or replaced immediately when damaged or not functioning. All temporary fencing shall include barbed wire as shown in the plan details. The temporary fencing shall be measured by the linear foot of fence or fence and barrier at the locations shown on the Plans and payment shall be made under Item C-106-1 – Temporary Fencing and Item C-106-2 – Temporary Fencing with Jersey Barrier.

2.3 TEMPORARY GATES

The Contractor shall install and maintain temporary double-swing type access gates at the locations shown on the Construction Safety and Phasing Plans. Each gate location shall include a double 15' wide swing gate to allow for construction traffic or Airfield Operations to pass through safely. All gates shall be inspected daily and repaired or replaced immediately when damaged or not functioning. During non-construction hours, all temporary gates leading to the construction work area shall be in the closed position and securely locked with an approved, Contractor-supplied combination lock. At no time shall the gates be left unattended in an open position. The Contractor shall provide an OAR-Approved gate guard at each gate. Payment shall be made per each 30' wide double swing gate under the Item C-106-3 – Temporary Swing Gate (30').

2.4 HAUL ROUTES

The Contractor shall stabilize existing areas that are to be used for haul routes utilizing Contractor provided materials at locations shown on the plan and as approved by the OAR. All haul routes shall be maintained throughout the construction period and shall be restored to original or better than original condition at the completion of the project. Haul routes specified in the Plans to become permanent segments of the Vehicle Service Road are to be constructed per the appropriate Plan Details at the conclusion of the project. Any portions of the permanent Vehicle Service Road that are used as temporary haul routes are to be restored to a "like new" condition at the conclusion of the project. Contractor shall water all unpaved haul routes and maintain paved haul routes as directed by OAR to minimize dust.

2.5 GUARDRAIL

The Contractor shall construct a guardrail with a shallow foundation at the locations shown on the plan in accordance with the plan details. All materials shall conform to the requirements of the plans. The guardrail is a permanent element of construction and shall not be removed at the conclusion of the project. Any defect or damage incurred to the guardrail during construction shall be removed and repaired at the Contractor's expense and to the satisfaction of the OAR.

2.6 SHALLOW FOUNDATION BOLLARD

The Contractor shall construct a bollard with a shallow foundation at the locations shown on the plans in accordance with the plan details. All materials shall conform to the requirements of the plans. All shallow foundation bollards are permanent elements of construction and shall not be removed at the conclusion of the project. Any defect or damage incurred to the bollards during construction shall be removed and repaired at the Contractor's expense and to the satisfaction of the OAR.

PART 3 - METHOD OF MEASUREMENT

3.1 TEMPORARY FENCE (WITHOUT JERSEY BARRIER)

The unit of measurement for Temporary Fence (without Jersey Barrier) shall be the total number of linear feet of temporary fence without jersey barrier, including barbed wire, as measured from the Construction Safety and Phasing Plans. No separate measurement shall be made for any fence or portion thereof removed and re-used for future construction phases.

3.2 TEMPORARY FENCE (WITH JERSEY BARRIER)

The unit of measurement for Temporary Fence (with Jersey Barrier) shall be the total number of linear feet of temporary fence with jersey barrier, including barbed wire, as measured from the Construction Safety and Phasing Plans. No separate measurement shall be made for any fence and barrier or portion thereof removed and re-used for future construction phases.

3.3 TEMPORARY SWING GATE

The unit of measurement for Temporary Swing Gates shall be each double swing gate consisting of 15' wide gate sections. No separate measurement shall be made for any swing gate or portion thereof removed and re-used for future construction phases.

3.4 No other items covered by this Specification section shall be individually measured for payment. Additional Maintenance of Traffic and Safety features include, but are not limited to temporary markings and subsequent removal, temporary haul route construction, sweeping and dust control and shall be considered incidental to other Pay Items. See Construction Safety and Phasing Plans for a detailed Maintenance of Traffic plan and additional requirements.

3.5 GUARDRAIL

The unit of measurement for Guardrail shall be the total number of linear feet of guardrail installed as measured on the Geometry and Joint Layout Plans. This pay item is inclusive of all labor, materials, equipment and incidentals required to construct the guardrail system as defined in the construction plans.

3.6 SHALLOW FOUNDATION BOLLARD

The unit of measurement for Shallow Foundation Bollard shall be each bollard as defined on the Geometry and Joint Layout plans. This pay item is inclusive of all labor, materials, equipment and incidentals required to construct the Shallow Foundation Bollards as defined in the construction plans.

PART 4 - BASIS OF PAYMENT

4.1 GENERAL

Payment for the work covered in this Section and as shown on the Plans shall be made at the unit prices bid for these items. The price and payment shall constitute full compensation for furnishing all labor, materials, equipment and incidentals required to complete the work under this Section.

4.2 PAYMENTS

Payments shall be made under:

Item C-106-4.1	Temporary Fence (without Jersey Barrier)	- per Linear Foot (LF)
Item C-106-4.2	Temporary Fence (with Jersey Barrier)	- per Linear Foot (LF)
Item C-106-4.3	Temporary Swing Gate (30' Total Width)	- per Each (EA)
Item C-106-4.4	Miscellaneous Maintenance of Traffic and Safety	- Lump Sum (LS)
Item C-106-4.5	Guardrail	- per Linear Foot (LF)
Item C-106-4.6	Shallow Foundation Bollard	- per Each (EA)

END OF ITEM C-106

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Item C-110 Method of Estimating Percentage of Material Within Specification Limits (PWL)

Spreadsheets for PWL calculations are available at the following website:
http://www.faa.gov/airports/engineering/design_software/.

Use Engineering Brief (EB) 57 Extended Q-Value Table for Estimating Percent of Lot Within Limits (PWL) and the MS Excel PWL Table when the number of samples (n) is greater than 10. The EBs are available at the following website:
http://www.faa.gov/airports/engineering/engineering_briefs/.

110-1 General. When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (PWL), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average ($\bar{X}$) and sample standard deviation (S_n) of the specified number (n) of sublots for the lot and the specification tolerance limits, L for lower and U for upper, for the particular acceptance parameter. From these values, the respective Quality index, Q_L for Lower Quality Index and/or Q_U for Upper Quality Index, is computed and the PWL for the lot for the specified n is determined from Table 1. All specification limits specified in the technical sections shall be absolute values. Test results used in the calculations shall be to the significant figure given in the test procedure.

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

It is the intent of this section to inform the Contractor that, in order to consistently offset the Contractor's risk for material evaluated, production quality (using population average and population standard deviation) must be maintained at the acceptable quality specified or higher. In all cases, it is the responsibility of the Contractor to produce at quality levels that will meet the specified acceptance criteria when sampled and tested at the frequencies specified.

110-2 Method for computing PWL. The computational sequence for computing PWL is as follows:

- a. Divide the lot into n sublots in accordance with the acceptance requirements of the specification.
- b. Locate the random sampling position within the subplot in accordance with the requirements of the specification.
- c. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.

d. Find the sample average ($\bar{X}$) for all subplot test values within the lot by using the following formula:

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

Where: $\bar{X}$ = Sample average of all subplot test values within a lot

$x_1, x_2, \dots, x_n$ = Individual subplot test values

n = Number of subplot test values

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

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

Where: S_n = Sample standard deviation of the number of subplot test values in the set

$d_1, d_2, \dots, d_n$ = Deviations of the individual subplot test values $x_1, x_2, \dots$ from the average value $\bar{X}$

that is: $d_1 = (x_1 - \bar{X}), d_2 = (x_2 - \bar{X}) \dots d_n = (x_n - \bar{X})$

n = Number of subplot test values

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

$$Q_L = (\bar{X} - L) / S_n$$

Where: L = specification lower tolerance limit

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

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

$$Q_L = (\bar{X} - L) / S_n$$

and

$$Q_U = (U - \bar{X}) / S_n$$

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

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

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

Where: P_L = percent within lower specification limit

P_U = percent within upper specification limit

EXAMPLE OF PWL CALCULATION

Project: Example Project

Test Item: Item P-401, Lot A.

A. PWL Determination for Mat Density.

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

$$A-1 = 96.60$$

$$A-2 = 97.55$$

$$A-3 = 99.30$$

$$A-4 = 98.35$$

$$n = 4$$

2. Calculate average density for the lot.

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

$$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$$

$$X = 97.95\% \text{ density}$$

3. Calculate the standard deviation for the lot.

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

$$S_n = [(1.82 + 0.16 + 1.82 + 0.16) / 3]^{1/2}$$

$$S_n = 1.15$$

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

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

$$Q_L = (97.95 - 96.30) / 1.15$$

$$Q_L = 1.4348$$

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

$$PWL = 98$$

B. PWL Determination for Air Voids.

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

$$A-1 = 5.00$$

$$A-2 = 3.74$$

$$A-3 = 2.30$$

$$A-4 = 3.25$$

2. Calculate the average air voids for the lot.

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

$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$

$$X = 3.57\%$$

3. Calculate the standard deviation S_n for the lot.

$$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$$

$$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$$

$$S_n = 1.12$$

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

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

$$Q_L = (3.57 - 2.00) / 1.12$$

$$Q_L = 1.3992$$

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

$$P_L = 97$$

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

$$Q_U = (U - X) / S_n$$

$$Q_U = (5.00 - 3.57) / 1.12$$

$$Q_U = 1.2702$$

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

$$P_U = 93$$

8. Calculate Air Voids PWL

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

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

EXAMPLE OF OUTLIER CALCULATION (REFERENCE ASTM E178)

Project: Example Project

Test Item: Item P-401, Lot A.

A. Outlier Determination for Mat Density.

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

$$A-3 = 99.30$$

$$A-4 = 98.35$$

$$A-2 = 97.55$$

$$A-1 = 96.60$$

2. From ASTM E178, Table 1, for $n=4$ an upper 5% significance level, the critical value for test criterion = 1.463.

3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

- a. For measurements greater than the average:

If (measurement - average)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-3, check if $(99.30 - 97.95) / 1.15$ is greater than 1.463.

Since 1.174 is less than 1.463, the value is not an outlier.

- b. For measurements less than the average:

If $(\text{average} - \text{measurement}) / (\text{standard deviation})$ is less than test criterion,
then the measurement is not considered an outlier.

For A-1, check if $(97.95 - 96.60) / 1.15$ is greater than 1.463.

Since 1.435 is less than 1.463, the value is not an outlier.

Note: In this example, a measurement would be considered an outlier if the density were:

Greater than $(97.95 + 1.463 \times 1.15) = 99.63\%$

OR

less than $(97.95 - 1.463 \times 1.15) = 96.27\%$.

Table 1. Table for Estimating Percent of Lot Within Limits (PWL)

Percent Within Limits (P _L and P _U)	Positive Values of Q (Q _L and Q _U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4717	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1192	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9671	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5582	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4355	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4030	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0793	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Percent Within Limits (P _L and P _U)	Negative Values of Q (Q _L and Q _U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4355	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5582	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM E178	Standard Practice for Dealing with Outlying Observations

END OF ITEM C-110

Item D-701 Pipe for Storm Drains and Culverts

DESCRIPTION

701-1.1 This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

701-2.1 Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

Reinforced Concrete Pipe (Class V)

Poly Vinyl Chloride (PVC – SDR 26)

701-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

American Association of State Highway and Transportation Officials (AASHTO) M167
Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches

AASHTO M190 Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches

AASHTO M196 Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains

AASHTO M219 Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches

AASHTO M243 Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

AASHTO M252 Standard Specification for Corrugated Polyethylene Drainage Pipe

AASHTO M294 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

AASHTO M304 Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter

AASHTO MP20 Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

AASHTO R73 Standard Practice for Evaluation of Precast Concrete Drainage Productions

ASTM A760 Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

ASTM A761	Standard Specification for Corrugated Structural Steel Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM C1479	Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
ASTM C1577	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
ASTM C1786	Standard Specification for Segmental Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
ASTM C1840	Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F667	Standard Specification for 3 through 24 in Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

701-2.3 Concrete. Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94.

701-2.4 Rubber gaskets. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the "RE" closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 Joint mortar. Pipe joint mortar shall consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

701-2.6 Joint fillers. Poured filler for joints shall conform to the requirements of ASTM D6690.

701-2.7 Plastic gaskets. Plastic gaskets shall conform to the requirements of ASTM C990.

701-2.8. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used, all joints shall have gaskets.

701-2.9 Precast box culverts. Manufactured in accordance with and conforming to ASTM C1433.

701-2.10 Precast concrete pipe. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association QCast Plant Certification program.

CONSTRUCTION METHODS

701-3.1 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactory jointing of the pipe and thorough compaction of the bedding material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade should be filled with granular material to form a uniform foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The ~~RPR~~ **OAR** shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

701-3.2 Bedding. The bedding surface for the pipe shall provide a foundation of uniform density to support the pipe throughout its entire length.

a. Rigid pipe. The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

b. Flexible pipe. For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

Flexible Pipe Bedding

Pipe Corrugation Depth		Minimum Bedding Depth	
inch	mm	inch	mm
1/2	12	1	25
1	25	2	50
2	50	3	75
2-1/2	60	3-1/2	90

c. Other pipe materials. For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 Laying pipe. The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

701-3.4 Joining pipe. Joints shall be made with (1) cement mortar, (2) cement grout, (3) rubber gaskets, (4) plastic gaskets, or (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

a. Concrete pipe. Concrete pipe may be either bell and spigot or tongue and groove. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Joints shall be thoroughly wetted before applying mortar or grout.

b. Metal pipe. Metal pipe shall be firmly joined by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

c. PVC, Polyethylene, or Polypropylene pipe. Joints for PVC, Polyethylene, or Polypropylene pipe shall conform to the requirements of ASTM D3212 when leak resistant joints are required. Joints for PVC and Polyethylene pipe shall conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M252 or ASTM M294. Fittings for polypropylene pipe shall conform to ASTM F2881, ASTM F2736, or ASTM F2764.

d. Fiberglass pipe. Joints and fittings shall be as detailed on the plans and in accordance with the manufacturers recommendations.

701-3.5 Embedment and Overfill. Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

701-3.5-1 Embedment Material Requirements

a. Concrete Pipe. Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

b. Plastic and fiberglass Pipe. Embedment material shall meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material shall be free of organic material, stones larger than 1.5 inches in the greatest dimension, or frozen lumps. Embedment material shall extend to 12 inches above the top of the pipe.

c. Metal Pipe. Embedment material shall be granular as specified in the contract document and specifications, and shall be free of organic material, rock fragments larger than 1.5 inches in the greatest dimension and frozen lumps. As a minimum, backfill materials shall meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material shall extend to 12 inches above the top of the pipe.

701-3.5-2 Placement of Embedment Material

The embedment material shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level, whichever is greater. Thoroughly compact the embedment material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under Item P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.

It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

701-3.6 Overfill

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be placed and compacted in layers as required to achieve compaction to at least 95 percent standard proctor per ASTM D1557. The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

701-3.7 Inspection Requirements

An initial post installation inspection shall be performed by the ~~RPR~~ **OAR** no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

For pipe sizes larger than 48 inches, a walk-through visual inspection shall be performed.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm.

METHOD OF MEASUREMENT

701-4.1 The length of reinforced concrete pipe shall be measured in linear feet of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The pipes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured. ***All necessary excavation, shoring, backfill, de-watering, pipe cradles, pipe bedding and other works required to install the pipe shall be considered incidental to the placement of the pipe.***

701-4.2 The length of PVC SDR 26 pipe shall be measured in linear feet of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, including connections to structures and inclusion of cleanouts, whichever is applicable. The pipes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured. ***All necessary excavation, shoring, backfill, de-watering, pipe cradles, pipe bedding and other works required to install the pipe shall be considered incidental to the placement of the pipe.***

BASIS OF PAYMENT

701-5.0 These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

701-5.1 Payment will be made at the contract unit price per linear foot for reinforced concrete pipe.

701-5.2 Payment will be made at the contract unit price per linear foot for PVC SDR 26 pipe.

Payment will be made under:

Item D-701-5.1	18-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.2	24-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.3	30-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.4	36-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.5	42-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.6	48-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.7	54-inch Reinforced Concrete Pipe - per linear foot

Item D-701-5.8	60-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.9	72-inch Reinforced Concrete Pipe - per linear foot
Item D-701-5.10	6" PVC SDR 26 Pipe - per linear foot
Item D-701-5.11	10" PVC SDR 26 Pipe - per linear foot

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3282	Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter

ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

National Fire Protection Association (NFPA)

NFPA 415	Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways

END ITEM D-701

Item D-705 Pipe Underdrains for Airports

DESCRIPTION

705-1.1 This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

705-2.1 General. Materials shall meet the requirements shown on the plans and specified below.

705-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

FDOT Standard Index 286 Type 1 Smooth High Density Polyethylene (HDPE)

705-2.3 Joint mortar. Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

705-2.4 Elastomeric seals. Elastomeric seals shall conform to the requirements of ASTM F477.

705-2.5 Porous backfill. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

Table 1. Gradation of Porous Backfill

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. *
1-1/2 inch (37.5 mm)	100
1 inch (25.0 mm)	90-100
3/8 inch (9.5 mm)	25-60
No. 4 (4.75 mm)	5-40
No. 8 (2.36 mm)	0-20
No. 16 (1.18 mm)	-
No. 50 (300 µm)	-
No. 100 (150 µm)	-

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

705-2.6 Granular material. Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

705-2.7 Filter fabric. The filter fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent.

Table 2. Fabric Properties

Fabric Property	Test Method	Test Requirement
Grab Tensile Strength, lbs	ASTM D4632	125 min
Grab Tensile Elongation %	ASTM D4632	50 min
Burst Strength, psi	ASTM D3785	125 min
Trapezoid Tear Strength, lbs	ASTM D4533	55 min
Puncture Strength, lbs	ASTM D4833	40 min
Abrasion, lbs	ASTM D4886	15 max loss
Equivalent Opening Size	ASTM D4751	70-100
Permittivity sec⁻¹	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

705-2.8 Controlled low-strength material (CLSM). CLSM is not used.

CONSTRUCTION METHODS

705-3.1 Equipment. All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the RPR before construction is permitted to start.

705-3.2 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the RPR. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the RPR and compacted to the density of the surrounding material.

The pipe bedding shall be constructed uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 inch when the bedding thickness is less than 6 inches, and 1-1/2 inch when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed, uncompacted material under the middle third of the pipe prior to placement of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

705-3.3 Laying and installing pipe.

a. Concrete pipe. The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and re-laid by the Contractor at no additional expense. Making adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it shall be prohibited. If the installed pipe section is not to grade, the pipe section shall be completely removed, the grade corrected, and the pipe rejoined."

b. Metal pipe. The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands that is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

c. PVC, fiberglass, or polyethylene pipe. PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321. Perforations shall meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Fiberglass per ASTM D3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

d. All types of pipe. The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the RPR.

Unless otherwise shown on the plans, a 4-inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe

outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

e. Filter fabric. The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with the AASHTO M288 Appendix, unless otherwise shown on the plans.

705-3.4 Mortar. The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 Joints in concrete pipe. When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches (75 mm) nor more than 6 inches (150 mm), unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2 (Table 1), as shown on the plans or as directed by the RPR.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the RPR.

705-3.6 Embedment and Backfill

a. Earth. All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The embedment material shall be select material from excavation or borrow and shall be approved by the RPR. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the RPR. The material shall be moistened or dried, as required to aid compaction. Placement of the embedment material shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The embedment material shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches (200 mm). Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the RPR, until the trench is completely filled and brought to the planned elevation. Embedment and backfilling shall be done to avoid damaging top or side of the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

b. Granular backfill. When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the RPR, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

c. Controlled low-strength material (CLSM). *CLSM is not used.*

705-3.7 Flexible Pipe Ring Deflection. The flexible pipe shall be inspected by the Contractor during and after installation to ensure that the internal diameter of the pipe barrel has not been reduced by more than 5 percent. For guidance on properly sizing mandrels, refer to ASTM D3034 and ASTM F679 appendices.

705-3.8 Connections. When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

705-3.9 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the RPR. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

METHOD OF MEASUREMENT

705-4.1 The length of 6" perforated or non-perforated pipe shall be the number of linear feet of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings (including cleanouts, frame/lids, concrete pads, wyes, tees, etc.) shall be incidental to the footage of pipeline being measured. The quantity of pipe underdrains shall include porous backfill and filter fabric for perforated sections.

BASIS OF PAYMENT

705-5.1 6-Inch Pipe Underdrains. Payment will be made at the contract unit price per linear foot for pipe underdrains of the type, class, and size designated.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D-705-5.1 6-inch Smooth High Density Polyethylene (HDPE) Pipe per linear foot

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals

ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M190	Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500- mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO	Standard Specifications for Highway Bridges

END OF ITEM D-705

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

PIPE UNDERDRAINS FOR AIRPORTS
ITEM D-705

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Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the ~~RPR~~ **OAR**.

MATERIALS

751-2.1 Brick. The brick shall conform to the requirements of ASTM C32, Grade MS.

751-2.2 Mortar. Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

751-2.3 Concrete. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

751-2.4 Precast concrete pipe manhole rings. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

751-2.5 Corrugated metal. Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.6 Frames, covers, and grates. The castings shall conform to one of the following requirements:

- a. ASTM A48, Class 35B: Gray iron castings
- b. ASTM A47: Malleable iron castings
- c. ASTM A27: Steel castings
- d. ASTM A283, Grade D: Structural steel for grates and frames
- e. ASTM A536, Grade 65-45-12: Ductile iron castings
- f. ASTM A897: Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

751-2.7 Steps. The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of asphalt paint, when directed.

751-2.8 Precast inlet structures. Manufactured in accordance with and conforming to ASTM C913.

CONSTRUCTION METHODS

751-3.1 Unclassified excavation.

a. The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, ~~or as staked by the RPR~~. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the ~~RPR~~ **OAR** may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the ~~RPR~~ **OAR**. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of **de-watering**, bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. All **de-watering equipment**, bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After excavation is completed for each structure, the Contractor shall notify the ~~RPR~~ **OAR**. No concrete or reinforcing steel shall be placed until the ~~RPR~~ **OAR** has **observed and** approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick structures.

a. **Foundations.** A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

b. **Laying brick.** All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze

out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and re-laid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. Joints. All joints shall be filled with mortar at every course. Exterior faces shall be laid up in advance of backing. Exterior faces shall be plastered or parged with a coat of mortar not less than 3/8 inch (9 mm) thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4 inch (6 mm) nor more than 1/2 inch (12 mm) wide and the selected joint width shall be maintained uniform throughout the work.

d. Pointing. Face joints shall be neatly struck, using the weather-struck joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing with water. If necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of water.

f. Curing and cold weather protection. The brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost on the brick or when the air temperature is below 50°F (10°C) unless the Contractor has, on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60°F (16°C) for the duration of the curing period.

751-3.3 Concrete structures. Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the ~~RPR~~ **OAR** before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

751-3.4 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another ~~RPR~~ **OAR** approved third party certification program.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow.

The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 Corrugated metal structures. Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base.

751-3.6 Inlet and outlet pipes. Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

751-3.7 Placement and treatment of castings, frames, and fittings. All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the **RPR OAR**, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the **RPR OAR**. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

751-3.8 Installation of steps. The steps shall be installed as indicated on the plans or as directed by the **RPR OAR**. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least seven (7) days. After seven (7) days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete structures they shall meet the requirements of ASTM C478. The steps shall be cast into the side of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches (300 mm).

~~Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the **RPR OAR**.~~

751-3.9 Backfilling.

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the ~~RPR~~ **OAR**.

b. Backfill shall not be placed against any structure until approved by the ~~RPR~~ **OAR**. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

751-3.10 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the ~~RPR~~ **OAR**. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

METHOD OF MEASUREMENT

751-4.1 Manholes catch basins and inlets shall be measured by the unit.

751-4.2 Cleanout shall not be measured and shall be incidental to other applicable elements of work.

751-4.3 The quantity of Adjust Existing Manhole, Inlet, Inspection Hole and Cleanout to grade shall be incidental to specification P-501 Portland Cement Concrete Pavement. This work shall consist of all materials and equipment needed to complete the item as shown on the plans and details.

BASIS OF PAYMENT

751-5.1 The accepted quantities of manholes, catch basins and inlets will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, de-watering, excavation, shoring, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item D-751-5.1	Manholes - per each
Item D-751-5.2	Inlets - per each

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

END OF ITEM D-751

Item D-756 Trench Drain and Forming System

DESCRIPTION

756-1.1 This item shall consist of trench drains and trench forming systems constructed in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Engineer.

MATERIALS

756-2.1a Forms (12' Trench) – Removable trench forms to be pre-manufactured using non-CFC EPS foam, wood product, FRP and or plastics. Each former segment shall have an 8" wide I.D. with means of deforming and provide a minimum of an 11.5" grate seat width. Appropriate form release for smooth interior walls and easy form removal is to be used. Form segments are to provide trench dimensional accuracy of .0625". Trench slope and depths are to be as specified on the drawings. Deviations from plan of slope, width and depth shall not be allowed as it directly impacts hydraulic capacity, storage capacity & velocity. Forms shall have a radius or square bottom as shown on plans and will allow for a monolithic concrete pour eliminating cold joints and water stop materials from being used in the trench invert. Forms and removal of forms shall not interfere or compromise the structural integrity of the load transfer assembly between the frame and encapsulation concrete. Forms, mounting brackets and liners shall be fully removed, without exception, to allow for 100% inspection of concrete consolidation. Inspection of consolidation below frames shall be 100%, partial inspection points will not be allowed. Formwork assembly must be prevented from floating during concrete placement without penetrating the sub grade. A means to assure constant frame spacing and grate seat dimension shall be provided.

756-2.1b Forms (18" Trench) – Removable trench forms to be pre-manufactured using non-CFC EPS foam, wood product, FRP and or plastics. Each former segment shall have an 18" wide I.D. with means of deforming and provide a minimum of a 22" grate seat width. Appropriate form release for smooth interior walls and easy form removal is to be used. Form segments are to provide trench dimensional accuracy of .0625". Trench slope and depths are to be as specified on the drawings. Deviations from plan of slope, width and depth shall not be allowed as it directly impacts hydraulic capacity, storage capacity & velocity. Forms shall have a radius or square bottom as shown on plans and will allow for a monolithic concrete pour eliminating cold joints and water stop materials from being used in the trench invert. Forms and removal of forms shall not interfere or compromise the structural integrity of the load transfer assembly between the frame and encapsulation concrete. Forms, mounting brackets and liners shall be fully removed, without exception, to allow for 100% inspection of concrete consolidation. Inspection of consolidation below frames shall be 100%, partial inspection points will not be allowed. Formwork assembly must be prevented from floating during concrete placement without penetrating the sub grade. A means to assure constant frame spacing and grate seat dimension shall be provided.

756-2.2 Frames (12' Trench) – Steel and or ductile iron components: Structural steel angle frames shall conform to ASTM A36/A36M-93a. Structural steel frame to be post fabrication hot dipped galvanized conforming to ASTM A123-89a. Ductile iron frames are to be uncoated and conform to ASTM A536-84. Either type of grate frame is to provide a minimum of 2.0 square inches concrete bearing area and a minimum of 4.5 square inches of concrete contact per inch of trench length on each side. Specialty frames are to be used as noted on plans to facilitate radii, intersections, grade changes and expansion, control & construction joints. There shall be a

minimum of four .5" diameter retainers per grate located at each corner of the grate. Grate retainers shall allow for non-rigid grate retention, rigid bolt-down assemblies will not be allowed. Frames shall have at minimum one anchor per side into the encapsulation concrete per 10" of trench. Headed concrete anchors shall have minimum dimensions of .5" diameter and 4" long. Anchored frames shall be made in USA and shall conform to the "Buy American Act" if Federal Aid finances apply.

756-2.2b Frames (18" Trench) - Steel and or ductile iron components: Structural steel angle frames shall conform to ASTM A36/A36M-93a. Structural steel frame to be post fabrication hot dipped galvanized conforming to ASTM A123-89a. Ductile iron frames are to be uncoated and conform to ASTM A536-84. Either type of grate frame is to provide a minimum of 2.25 square inches concrete bearing area and a minimum of 5.25 square inches of concrete contact per inch of trench length on each side. Specialty frames are to be used as noted on plans to facilitate radii, intersections, grade changes and expansion, control & construction joints. There shall be a minimum of four .5" diameter retainers per grate located at each corner of the grate. Grate retainers shall allow for non-rigid grate retention, rigid bolt-down assemblies will not be allowed. Frames shall have at minimum one anchor per side into the encapsulation concrete per 10" of trench. Headed concrete anchors shall have minimum dimensions of .5" diameter and 4" long.

756-2.3 Grating (12' Trench) - Grates shall have minimum dimension width of 11.38", ensuring a minimum edge distance of 1.69" each side of grate to the inner trench wall. Grates are to be uncoated ductile iron conforming to ASTM A536-84 with a minimum inlet area of 0.61ft²/Lft. Grates shall meet a minimum vertical proof load of 2496 psi (200,000 lbs) by utilizing a 9" x 9" centered contact area without failure. Grating shall be made in USA and shall conform to the "Buy American Act" if Federal Aid finances apply.

756-2.3b Grating (18" Trench) - Grates shall have a minimum dimension width of 21.8", ensuring a minimum edge distance of 1.9" each side of grate to the inner trench wall. Grates are to be uncoated ductile iron conforming to ASTM A536-84 with a minimum inlet area of 0.97ft²/Lft. Grates shall meet a minimum vertical proof load of 2496 psi (200,000 lbs) by utilizing a 9" x 9" centered contact area without failure.

PRE-CONSTRUCTION

756-3.1 Submittals - A submittal package consisting of a certificate of specification compliance, trench drain construction drawings, system details, specifications, warranty information, installation guide and independent laboratories grate load test data shall be submitted to the engineer of record for approval. In addition, the material submitted must include a reference list of no less than three projects with a minimum of five-year service in a similar application. A certificate of origin shall be provided for all steel and iron parts if the "Buy American Act" applies.

756-3.2 Training - A Pre-construction meeting with the manufacturer is mandatory for review of the installation process and installation materials. A manufacturer's representative shall be on site at job start and available for site visits during the construction phase to provide onsite assistance.

POST CONSTRUCTION

756-4.1 Inspection – Formwork, mounting brackets and liners are to be fully removed, without exception, to allow for 100% inspection by the OAR and if needed repair of voids and or concrete consolidation issues below the frame, trench walls and invert. Grate and grate retainer inspection shall be performed to ensure that all grates and retainers are installed and are properly seated in place.

METHOD OF MEASUREMENT

756-5.1 The length of trench drain shall be measured in linear feet of trench drain in place, completed, and approved. It shall be measured along the centerline of the drain from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections being measured.

BASIS OF PAYMENT

756-6.0 These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

756-6.1 Payment will be made at the contract unit price per linear foot for reinforced concrete pipe.

Payment will be made under:

Item 756-6.1	12" Trench drain per linear foot
Item 756-6.2	18" Trench drain per linear foot

END OF ITEM D-756

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TRENCH DRAIN AND FORMING SYSTEM
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Item F-162 Chain-Link Fence

DESCRIPTION

162-1.1 This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications, the details shown on the plans, and in conformity with the lines and grades shown on the plans or established by the ~~RPR~~ **OAR**.

MATERIALS

162-2.1 Fabric. The fabric shall be woven with a 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and shall meet the requirements of ASTM A392, Class 2. ***The fabric shall be black vinyl-coated when fence is to be constructed in water.***

162-2.2 Barbed wire. Barbed wire shall be 2-strand 12-1/2 gauge zinc-coated wire with 4-point barbs and shall conform to the requirements of ASTM A121, Class 3, Chain Link Fence Grade.

162-2.3 Posts, rails, and braces. Line posts, rails, and braces shall conform to the requirements of ASTM F1043 or ASTM F1083 as follows:

- Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.
- Roll Formed Steel Shapes (C-Sections) shall conform to the requirements of Group IIA, and be galvanized in accordance with the requirements of ASTM F1043, Type A.
- Hot-Rolled Shapes (H Beams) shall meet the requirements of Group III, and be galvanized in accordance with the requirements of ASTM F1043, Type A.
- Aluminum Pipe shall conform to the requirements of Group IB.
- Aluminum Shapes shall conform to the requirements of Group IIB.
- Vinyl or polyester coated steel shall conform to the requirements of ASTM F1043, Paragraph 7.3, Optional Supplemental Color Coating.
- Composite posts shall conform to the strength requirements of ASTM F1043 or ASTM F1083. The strength loss of composite posts shall not exceed 10% when subjected to 3,600 hours of exposure to light and water in accordance with ASTM G152, ASTM G153, ASTM G154, and ASTM G155.
- Posts, rails, and braces furnished for use in conjunction with aluminum alloy fabric shall be aluminum alloy or composite.

Posts, rails, and braces, with the exception of galvanized steel conforming to ASTM F1043 or ASTM F1083, Group 1A, Type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B117 as follows:

- External: 1,000 hours with a maximum of 5% red rust.
- Internal: 650 hours with a maximum of 5% red rust.

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Federal Specification RR-F-191/3.

162-2.4 Gates. Gate frames shall consist of galvanized steel pipe and shall conform to the specifications for the same material under paragraph 162-2.3. The fabric shall be of the same type material as used in the fence.

162-2.5 Wire ties and tension wires. Wire ties for use in conjunction with a given type of fabric shall be of the same material and coating weight identified with the fabric type. Tension wire shall be 7-gauge marcelled steel wire with the same coating as the fabric type and shall conform to ASTM A824. ***Bottom tension wire shall be attached to the mesh fabric with wire ties at a maximum of twenty-four (24) inch spacing.***

All material shall conform to Federal Specification RR-F-191/4.

162-2.6 Miscellaneous fittings and hardware. Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A153. Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

162-2.7 Concrete. Concrete shall have a minimum 28-day compressive strength of **3,500 psi**.

162-2.8 Marking. Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

162-2.9 Course Aggregate Bed. ***Coarse aggregate bed shall consist of a minimum four (4) inch thick layer of Number 57 Stone meeting the gradation requirements of Section 901 of the Florida Department of Transportation Specifications for Road and Bridge Construction, most current edition. Material shall be Natural Stones per Section 901-2, or Reclaimed Portland Cement Concrete per Section 901-5. Bedding shall be placed with an underlayment of Type D-1 or Type D-2 Woven Geotextile Fabric in accordance with the FDOT Standard Index Drawing 199, and FDOT Specification Section 985.***

CONSTRUCTION METHODS

162-3.1 General. The fence shall be constructed in accordance with the details on the plans and as specified here using new materials. All work shall be performed in a workmanlike manner satisfactory to the ~~RPR~~ **OAR**. The Contractor shall layout the fence line based on the plans. The Contractor shall span the opening below the fence with barbed wire at all locations where it is not practical to conform the fence to the general contour of the ground surface because of natural or manmade features such as drainage ditches. The new fence shall be permanently tied to the terminals of existing fences as shown on the plans. The Contractor shall stake down the woven wire fence at several points between posts as shown on the plans.

The Contractor shall arrange the work so that construction of the new fence will immediately follow the removal of existing fences. The length of unfenced section at any time shall not exceed 300 feet (90 m). The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence.

162-3.2 Clearing fence line. Clearing shall consist of the removal of all stumps, brush, rocks, trees, or other obstructions that will interfere with proper construction of the fence. Stumps within

the cleared area of the fence shall be grubbed or excavated. The bottom of the fence shall be placed a uniform distance above ground, as specified in the plans. When shown on the plans or as directed by the ~~RPR~~ **OAR**, the existing fences which interfere with the new fence location shall be removed by the Contractor as a part of the construction work unless such removal is listed as a separate item in the bid schedule. All holes remaining after post and stump removal shall be refilled with suitable soil, gravel, or other suitable material and compacted with tampers.

The cost of removing and disposing of the material shall not constitute a pay item and shall be considered incidental to fence construction.

162-3.3 Installing posts. All posts shall be set in concrete at the required dimension and depth and at the spacing shown on the plans.

The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within seven (7) days after the individual post footing is completed.

Should rock be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part Portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described above.

In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation shall be made for rock excavation.

162-3.4 Installing top rails. The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

162-3.5 Installing braces. Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

162-3.6 Installing fabric. The wire fabric shall be firmly attached to the posts and braced as shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the contour of the ground, with the bottom of the fence fabric no less than one inch (25 mm) or more than 4 inches (100 mm) from the ground surface. Grading shall be performed where necessary to provide a neat appearance.

At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used and multiple strands of barbed wire stretched to span the opening below the fence. The vertical clearance between strands of barbed wire shall be 6 inches (150 mm) or less.

162-3.7 Electrical grounds. Electrical grounds shall be constructed at 500 feet (150 m) intervals. The ground shall be accomplished with a copper clad rod 8 feet (2.4 m) long and a minimum of 5/8 inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. A No. 6 solid copper conductor shall be clamped **or welded** to the rod and to the fence in such a manner that each element of the fence is grounded **as indicated on the plans**. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction. The Contractor shall comply with FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities.

162-3.8 Cleaning up. The Contractor shall remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction. All disturbed areas shall be seeded per T-901.

METHOD OF MEASUREMENT

162-4.1 Chain-link fence will be not be measured for payment. Temporary fencing is addressed in Item C-106.

162-4.2 Gates will be not be measured. Temporary gates are addressed in Item C-106.

BASIS OF PAYMENT

162-5.1 Payment for temporary fencing and gates will be made under Item C-106.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A121	Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A392	Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A491	Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A824	Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM F668	Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and other Organic Polymer Coated Steel Chain-Link Fence Fabric
ASTM F1043	Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1083	Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F1183	Standard Specification for Aluminum Alloy Chain Link Fence Fabric
ASTM F1345	Standard Specification for Zinc 5% Aluminum-Mischmetal Alloy Coated Steel Chain-Link Fence Fabric
ASTM G152	Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

ASTM G154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp
Apparatus for Exposure of Nonmetallic Materials

ASTM G155 Standard Practice for Operating Xenon Arc Light Apparatus for
Exposure of Nonmetallic Materials

Federal Specifications (FED SPEC)

FED SPEC RR-F-191/3 Fencing, Wire and Post, Metal (Chain-Link Fence Posts,
Top Rails and Braces)

FED SPEC RR-F-191/4 Fencing, Wire and Post, Metal (Chain-Link Fence
Accessories)

FAA Standard

FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding and Shielding
Requirements for Facilities and Electronic Equipment

FAA Orders

5300.38 AIP Handbook

END OF ITEM F-162

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CHAIN-LINK FENCE
ITEM F-162

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Item P-100 Construction Survey

DESCRIPTION

100-1.1 GENERAL. Under this item, the Contractor shall perform all necessary surveying and project stakeout required to construct all elements of the Project as shown on the Contract Drawings and required by the Specifications. This shall include, but not be limited to; stakeout, layout and elevations for pavements, structures, forms and appurtenances as shown and required, consistent with the current practices and shall be performed by or under the direction of a State of Florida licensed professional land surveyor or OAR approved substitute. The stakeout survey shall proceed immediately following the Notice to Proceed or as soon as authorized by the OAR in accordance with the phasing of the construction and shall be expeditiously progressed to completion in a manner and at a rate satisfactory to the OAR. The Contractor shall keep the OAR fully informed as to the progress of the stakeout survey.

All survey work shall be provided under the direction of a State of Florida licensed professional land surveyor.

Construction survey shall be required for submittal to the OAR at several stages of the project for design verification. At a minimum, survey shall be completed by the Contractor to verify existing conditions, establish a post-grading survey, a post-paving and marking survey, and the required As-Built Survey as described below.

Contractor shall submit baseline survey to the OAR for approval five (5) days prior to any construction.

100-1.2 Contractor shall refer to The Orlando International Airport Geodetic Control Survey Horizontal and Vertical Control Network prepared by ZHA Incorporated and Regional Engineerings, Planners, and Surveyors, Inc. (November 1999, Updated December 2000 or latest version) for definition of horizontal and vertical control definition reference.

MATERIALS

100-2.1 All instruments, equipment, stakes, and any other material incidental and/or necessary to perform the work satisfactorily shall be provided by the Contractor.

All stakes, nails, discs, pins, or other markers/monumentation shall be of a type approved by the OAR. It shall be the Contractor's responsibility to maintain these artifacts in their proper position and location at all times. All costs associated with repair and/or replacement of artifacts will be the responsibility of the Contractor should damages be sustained.

CONSTRUCTION METHODS

100-3.1 The Contractor shall trim trees, brush and other interfering objects, not inconsistent with the Contract Drawings, from survey lines in advance of all survey work to permit accurate and unimpeded work by stakeout crews. Incidental clearing of any permitted wetland area shall be withheld pending issuance of the required permits unless otherwise approved in writing by the Owner.

The exact position of all work shall be established from control points, baseline transit points or other points of similar nature which are depicted on the Contract Drawings and/or modified by the

OAR. Prior to any layout of work to be constructed, the Contractor shall verify the location and accuracy of all survey points provided within the plans. Any error, apparent discrepancy or absence in or of data shown or required for accurately accomplishing the stakeout survey shall be referred to the OAR for interpretation or furnishing when such is observed or required.

The Contractor shall place two offset stakes or references at each centerline station and at such intermediate locations as the OAR may direct. From computations and measurements made by the Contractor, these stakes shall be clearly and legibly marked with the correct centerline station number, offset, and cut or fill as to permit the establishment of the exact centerline location and elevation during construction. If markings become faded or blurred for any reason, the markings shall be restored by the Contractor at the request of the OAR. Contractor shall locate and place all cut, fill, slope, finegrade, or other stakes and/or points, as the OAR may direct, for the proper progress of the work. All control points shall be properly guarded and flagged for easy identification.

Drainage structures shall be staked out by the Contractor at the locations and elevations shown on the Contract Drawings or as specified by the OAR.

Reference points, baselines, stakes, and benchmarks for stockpiles shall be established by the Contractor.

The Contractor shall be responsible for the accuracy of his work and shall maintain all reference points, stakes, etc., throughout the life of the Contract. Damage or destroyed points, benchmarks, stakes, monumentation, or any reference points made inaccessible by the progress of the construction, shall be replaced or transferred by the Contractor before they are damaged or destroyed. All control points shall be referenced by ties to acceptable objects and recorded. Any alterations or revisions in the ties shall be so noted and the information furnished to the OAR immediately. All stakeout survey work shall be referenced to the centerlines shown on the Contract Drawings. All computations necessary to establish the exact position of the work from control points shall be made and preserved by the Contractor. All computations, survey notes, and other records shall be made available to the OAR upon request and shall become property of the Owner and delivered to the OAR no later than the date of acceptance of the Contract.

The Contractor shall furnish, at his/her expense, all horizontal and vertical control, all staking and layout of construction work called for on the Contract Drawings. The OAR and Owner shall not be responsible for such work. However, the Owner and OAR reserve the right to check all said lines, grades, and measurements with their appointed surveyor. Should the Owner/OAR's surveyor detect errors and/or discrepancies in said lines, grades, and measurements, the Contractor shall pay for all said surveying costs and subsequent surveying costs performed to verify correction of errors found in said lines, grades, and measurements. Definition of an error shall be a discrepancy of 1/4-inch or more. In the case of a discrepancy between the technical specifications and this defined tolerance, the more severe tolerance shall govern.

During the progress of the construction work, the Contractor shall be required to furnish all of the surveying and stakeout incidental to the proper location by line and grade for all work. For paving and any other operation requiring defined accuracy with tolerances, the Contractor shall re-stake with pins or other acceptable hubs located directly adjacent to the work at a spacing acceptable to the OAR.

Any existing stakes, iron pins, survey monuments, or other artifact markers defining property lines which may be disturbed during construction shall be properly tied into fixed referenced points prior to being disturbed and accurately re-set in their proper position upon completion of the work.

Just prior to completion of the Contract, the Contractor shall re-establish, if necessary, and re-tie all control points as permanently as possible and to the satisfaction of the OAR.

100-3.2 AS-BUILT SURVEY. *The Contractor shall maintain a set of as-built contract documents (plans and specification) in their field office that are available for review by the OAR, Engineer and Owner at all times during the project. The as-built documents shall be continuously updated to reflect the built condition of the project and any changes made to the project.* Upon completion of the work, after Substantial Completion and before Final Acceptance, the Contractor shall supply to the OAR a complete as-built survey of the entire project site including, but not limited to: drainage structures, utilities (above ground and subsurface), and all contract improvements. All survey points, including horizontal and vertical control, property corners and references (hereinafter referred to as "survey point") shall be clearly marked and referenced prior to construction. These survey points must be sufficiently referenced so that they can be re-established after construction if they are disturbed. All survey data shall be in State Plane Coordinates, Florida North American Datum (NAD) 1983 US Foot.

This as-built survey will be a complete topographic and physical feature survey of the entire project site surrounded by the limits of construction plus an additional ten (10) feet beyond limits of construction in all directions. If any work is done outside the limits of construction for any reason, this limit of survey will be increased to include the additional area plus twenty-five (25) feet beyond in all directions.

This survey shall be certified by a State of Florida Licensed Professional Land Surveyor and meets the minimum requirements set forth by the Technical Standards for topographic surveys set forth in 5J-17.052 Standards of Practice: Specific Survey, Map, and Report Requirements., Florida Administrative Code (F.A.C.). This survey data must be supplied as a compilation of signed and sealed drawings (42" by 30" maximum size) at a minimum scale as the Contract Drawings and be submitted in electronic format as PDF and AutoCAD Civil 3D 2020 or later. AutoCAD Civil 3D file must contain all utilized survey point data and breakline information. Signed and sealed copies of all field notes, sketches, and calculations must be submitted concurrently with the as-built survey. Larger scale details shall be provided to clarify any complicated or complex areas. A separate point database file shall be electronically submitted in .TXT (text) or ASCII format, with each point on a single row with comma delimited columns with data orders as follows: *point number, northing, easting, elevation, and description*. Contractor shall provide any electronic surface TIN model data utilized in the development of the as-built.

The as-built survey is to be supplied to the OAR for review and approval not more than thirty (30) calendar days after substantial completion for the project has been issued. If the acceptable as-built survey is not supplied within the required time, the Owner/OAR reserves the right to perform the required survey at the expense of the Contractor.

METHOD OF MEASUREMENT

100-4.1 The work specified in this item consist of the requirements in the plans and remaining Contract Documents and Special Provisions for certified topographic land surveys before, during, and after construction, including by not limited to the staged mass earthwork grading surface surveys, base surveys, and final paving surveys.

BASIS OF PAYMENT

162-5.1 Payment for Construction Survey items shall be made at the lump sum price for all Construction Survey. The price shall be full compensation for furnishing all materials and for all layout, preparation, and installation of these materials and for all labor, equipment, tools, and incidentals necessary to complete the items per the Contract Documents.

Payment will be made under:

Item P-100-5.1 Construction Survey per Lump Sum (LS)

MATERIAL REQUIREMENTS

F.A.C. 5J-17.052 Standards of Practice: Specific Survey, Map, and Report Requirements

END OF ITEM P-100

SECTION P-101 - PREPARATION/REMOVAL OF EXISTING PAVEMENTS

PART 1 - DESCRIPTION

- 1.1 This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

PART 2 - EQUIPMENT AND MATERIALS

- 2.1 All equipment and materials shall be specified here and in the following paragraphs or approved by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)**. The equipment shall not cause damage to the pavement to remain in place.

PART 3 - CONSTRUCTION

3.1 REMOVAL OF EXISTING PAVEMENT

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

- A. Concrete pavement removal. Full depth saw cuts shall be made perpendicular to the slab surface. The Contractor shall saw through the full depth of the slab including any dowels at the joint, removing the pavement and installing new dowels as shown on the plans and per the specifications. Where the perimeter of the removal limits is not located on the joint and there are no dowels present, the perimeter shall be saw cut the full depth of the pavement. The pavement inside the saw cut shall be removed by methods which will not cause distress in the pavement which is to remain in place. If the material is to be wasted on the airport site, it shall be reduced to a maximum size of 3 inches. Concrete slabs that are damaged by under breaking shall be repaired or removed and replaced as directed by the ~~RPR~~ **OAR**.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Spall and underbreak repair shall be in accordance with the plans. Any underlying material that is to remain in place, shall be recompacted and/or replaced as shown on the plans. Adjacent areas damaged during repair shall be repaired or replaced at the Contractor's expense.

- B. Asphalt pavement removal. Asphalt pavement to be removed shall be cut to the full depth of the asphalt pavement around the perimeter of the area to be removed. If the material is to be wasted on the airport site, it shall be broken to a maximum size of 3 inches (mm).

- C. Repair or removal of Base, Subbase, and/or Subgrade. All failed material including surface, base course, subbase course, and subgrade shall be removed and repaired as shown on the plans or as directed by the **RPR OAR**. Materials and methods of construction shall comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process shall be repaired at the Contractor's expense.

3.2 PREPARATION OF JOINTS AND CRACKS PRIOR TO OVERLAY/SURFACE TREATMENT

Remove all vegetation and debris from cracks to a minimum depth of 1 inch (25 mm). If extensive vegetation exists, treat the specific area with a concentrated solution of a water-based herbicide approved by the **RPR OAR**. Fill all cracks greater than 1/4 inch (6 mm) wide) with a crack sealant per ASTM D6690. The crack sealant, preparation, and application shall be compatible with the surface treatment/overlay to be used. To minimize contamination of the asphalt with the crack sealant, underfill the crack sealant a minimum of 1/8 inch (3 mm), not to exceed 1/4 inch (6 mm). Any excess joint or crack sealer shall be removed from the pavement surface.

3.3 REMOVAL OF FOREIGN SUBSTANCES/CONTAMINATES PRIOR TO REMARKING

Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as directed by the **RPR OAR** in the field during construction.

High-pressure water, rotary grinding, or sandblasting may be used. If chemicals are used, they shall comply with the state's environmental protection regulations. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch (3 mm) deep. If it is deemed by the **RPR OAR** that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as directed by the **RPR OAR**.

Removal of foreign substances shall not proceed until approved by the **RPR OAR**. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans.

3.4 CONCRETE SPALL OR FAILED ASPHALTIC CONCRETE PAVEMENT REPAIR

- A. ~~Repair of concrete spalls in areas to be overlaid with asphalt. The Contractor shall repair all spalled concrete as shown on the plans or as directed by the RPR. The perimeter of the repair shall be saw cut a minimum of 2 inches (50 mm) outside the affected area~~

~~and 2 inches (50 mm) deep. The deteriorated material shall be removed to a depth where the existing material is firm or cannot be easily removed with a geologist pick. The removed area shall be filled with asphalt mixture with aggregate sized appropriately for the depth of the patch. The material shall be compacted with equipment approved by the RPR until the material is dense and no movement or marks are visible. The material shall not be placed in lifts over 4 inches (100 mm) in depth. This method of repair applies only to pavement to be overlaid.~~

- ~~B. Asphalt pavement repair. The Contractor shall repair all spalled concrete as shown on the plans or as directed by the RPR. The failed areas shall be removed as specified in paragraph 101-3.1b. All failed material including surface, base course, subbase course, and subgrade shall be removed. Materials and methods of construction shall comply with the applicable sections of these specifications.~~

3.5 COLD MILLING

Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The milling machine or grinder shall operate without tearing or gouging the underlying surface. The milling machine or grinder shall be equipped with grade and slope controls, and a positive means of dust control. All millings shall be removed and disposed off Airport property. If the Contractor mills or grinds deeper or wider than the plans specify, the Contractor shall replace the material removed with new material at the Contractor's Expense.

- A. Patching. The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of controlling the depth of cut. The ~~RPR~~ **OAR** shall layout the area to be milled with a straightedge in increments of 1-foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn't have the appropriate milling machine, or areas that are damaged because of his negligence, shall be repaired by the Contractor at the Contractor's Expense.
- B. Profiling, grade correction, or surface correction. The milling machine shall have a minimum width of 7 (2 m) and it shall be equipped with electronic grade control devices that will cut the surface to the grade specified. The tolerances shall be maintained within +0 inch and -1/4 inch (+0 mm and -6mm) of the specified grade. The machine must cut vertical edges and have a positive method of dust control. The machine must have the ability to remove the millings or cuttings from the pavement and load them into a truck. All millings shall be removed and disposed of off the airport.
- C. Clean-up. The Contractor shall sweep the milled surface daily and immediately after the milling until all residual materials are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove loose residual material. Waste materials shall be collected and removed from the pavement surface and adjacent areas by sweeping or vacuuming. Waste materials shall be removed and disposed off Airport property.

3.6. PREPARATION OF ASPHALT PAVEMENT SURFACES PRIOR TO SURFACE TREATMENT

Existing asphalt pavements to be treated with a surface treatment shall be prepared as follows:

- A. Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt pavement similar to that of the existing pavement in accordance with paragraph 101-3.4b.
- B. Repair joints and cracks in accordance with paragraph 101-3.2.
- C. Remove oil or grease that has not penetrated the asphalt pavement by scrubbing with a detergent and washing thoroughly with clean water. After cleaning, treat these areas with an oil spot primer.
- D. Clean pavement surface immediately prior to placing the surface treatment so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film.

3.7 MAINTENANCE

The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the ~~RPR~~ **OAR**. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor's expense.

3.8 PREPARATION OF JOINTS IN RIGID PAVEMENT PRIOR TO RESEALING

Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the ~~RPR~~ **OAR**, that the method used cleans the joint and does not damage the joint.

- 3.8.1 Removal of Existing Joint Sealant. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch (2 mm) from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry.
- 3.8.2 Cleaning prior to sealing. Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces will be surface-dry prior to installation of sealant.
- 3.8.3 Joint sealant. Joint material and installation will be in accordance with Item P-605 and Item P-604.

3.9 ~~PREPARATION OF CRACKS IN FLEXIBLE PAVEMENT PRIOR TO SEALING~~

~~Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the cracks and does not damage the pavement.~~

~~3.9.1 Preparation of Crack. Widen crack with [router] [random crack saw] by removing a minimum of 1/16 inch (2 mm) from each side of crack. Immediately before sealing, cracks will be blown out with a hot air lance combined with oil and water-free compressed air.~~

~~3.9.2 Removal of Existing Crack Sealant. Existing sealants will be removed by [routing] [random crack saw]. Following [routing] [sawing] any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.~~

~~3.9.3 Crack Sealant. Crack sealant material and installation will be in accordance with [Item P-605]~~

~~3.9.4 Removal of Pipe and other Buried Structures~~

~~A. Removal of Existing Pipe Material. Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off site in a timely manner following removal. Trenches shall be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 100% of ASTM D1557.~~

~~B. Removal of Inlets/Manholes. Where indicated on the plans or as directed by the RPR **OAR**, inlets and/or manholes shall be removed and legally disposed of off site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas must be compacted to 100% of ASTM D1557, when outside of paved areas must be compacted to 95% of ASTM D698.~~

PART 4 - METHOD OF MEASUREMENT

4.1 PAVEMENT REMOVAL

The unit of measurement for pavement removal shall be the number of square yards (square meters) removed by the Contractor. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to pavement removal. Dowel bar installation shall be incidental to pavement removal.

~~4.2 — REMOVAL OF PIPE AND OTHER BURIED STRUCTURES~~

~~The unit of measurement for removal of pipe and other buried structures will be made at the contract unit price for each completed and accepted item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.~~

PART 5 - BASIS OF PAYMENT

5.1 PAYMENT

Payment shall be made at contract unit price for the unit of measurement as specified above. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

Item P-101-5.1 Concrete Pavement Removal - per Square Yard (SY)

PART 6 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

END OF SECTION P-101

Item P-151 Clearing and Grubbing

DESCRIPTION

151-1.1 This item shall consist of clearing or clearing and grubbing, including the disposal of materials, for all areas within the limits designated on the plans or as required by the ~~Resident Project Representative (RPR)~~ **Owner Authorized Representative (OAR)**.

a. Clearing shall consist of the cutting and removal of all trees, stumps, brush, logs, hedges, the removal of fences and other loose or projecting material from the designated areas, **which in the opinion of the RPR OAR is unsuitable for the foundation of pavements, or other required structures,** ~~The grubbing of stumps and roots will not be required.~~

b. Clearing and grubbing shall consist of clearing the surface of the ground of the designated areas of all trees, stumps, down timber, logs, snags, brush, undergrowth, hedges, heavy growth of grass or weeds, fences, **rip rap, pavements**, structures, debris, **abandon utilities**, and rubbish of any nature, natural obstructions or such material which in the opinion of the ~~RPR~~ **OAR** is unsuitable for the foundation of strips, **rip rap**, pavements, or other required structures, including the grubbing of stumps, roots, matted roots, **abandoned utilities**, foundations, and the disposal from the project of all spoil materials resulting from clearing and grubbing.

~~**c. Tree Removal.** Tree Removal shall consist of the cutting and removal of isolated single trees or isolated groups of trees, and the grubbing of stumps and roots. The removal of all the trees of this classification shall be in accordance with the requirements for the particular area being cleared.~~

CONSTRUCTION METHODS

151-2.1 General. The areas denoted on the plans to be cleared or cleared and grubbed shall be staked on the ground by the Contractor as indicated on the plans **and approved by the OAR.**

The removal of existing structures and utilities required to permit orderly progress of work shall be accomplished by local agencies, unless otherwise shown on the plans. Whenever a telephone pole, pipeline, conduit, sewer, roadway, or other utility is encountered and must be removed or relocated, the Contractor shall advise the ~~RPR~~ **OAR** who will notify the proper local authority or owner to secure prompt action.

151-2.1.1 Disposal. All materials removed by clearing or by clearing and grubbing shall be disposed of in the designated waste disposal area, except when otherwise directed by the ~~RPR~~ **OAR**. ~~As far as practicable, waste concrete and masonry shall be placed on slopes of embankments or channels. When embankments are constructed of such material, this material shall be placed in accordance with requirements for formation of embankments.~~ **Waste concrete or asphalt shall not be used for construction of embankments and shall be disposed of by the Contractor off of Airport property at an approved County or State dump site.** Any broken concrete or masonry that cannot be used in construction and all other materials not considered suitable for use elsewhere, shall be disposed of by the Contractor. In no case, shall any discarded materials be left in windrows or piles adjacent to or within the airport limits. The manner and location of disposal of materials shall be subject to the approval of the ~~RPR~~ **OAR** and shall not create an unsightly or objectionable view. When the Contractor is required to locate a disposal area outside the airport property limits, the Contractor shall obtain and file with the ~~RPR~~ **OAR** permission in writing from the property owner for the use of private property for this purpose.

151-2.1.2 Blasting. Blasting shall not be allowed.

151-2.2 Clearing. The Contractor shall clear the staked or indicated area of all materials as indicated on the plans. Trees unavoidably falling outside the specified clearing limits must be cut up, removed, and disposed of in a satisfactory manner. To minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared. The Contractor shall preserve and protect from injury all trees not to be removed. The trees, stumps, and brush shall be cut flush with the original ground surface. The grubbing of stumps and roots will not be required.

Fences shall be removed and disposed of as directed by the ~~RPR~~ **OAR**. Fence wire shall be neatly rolled and the wire and posts stored on the airport if they are to be used again, or stored at a location designated by the ~~RPR~~ **OAR** if the fence is to remain the property of a local owner or authority.

151-2.3 Clearing and grubbing. In areas designated to be cleared and grubbed, all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials as indicated on the plans, shall be removed, except where embankments exceeding 3-1/2 feet (105 cm) in depth will be constructed outside of paved areas. For embankments constructed outside of paved areas, all unsatisfactory materials shall be removed, but sound trees, stumps, and brush can be cut off flush with the original ground and allowed to remain. Tap roots and other projections over 1-1/2 inches (38 mm) in diameter shall be grubbed out to a depth of at least 18 inches (0.5 m) below the finished subgrade or slope elevation.

Any buildings, **rip rap, pavements, abandoned utilities,** and miscellaneous structures **and other debris** that are ~~shown~~ **defined** on the plans **or directed by the OAR** to be removed shall be demolished or removed, and all materials shall be disposed of by removal from the site. The cost of removal is incidental to this item. ~~The remaining or existing foundations, wells, cesspools, and like structures shall be destroyed by breaking down the materials of which the foundations, wells, cesspools, etc., are built to a depth at least 2 feet (60 cm) below the existing surrounding ground.~~ Any broken concrete, blocks, or other objectionable material that cannot be used in backfill shall be removed and **properly** disposed of **off the site.** ~~at the Contractor's expense.~~ The holes or openings shall be backfilled with acceptable material and properly compacted **in accordance with the provision of Item P-152.**

All holes in embankment areas remaining after the grubbing operation shall have the sides of the holes flattened to facilitate filling with acceptable material and compacting as required in Item P-152. The same procedure shall be applied to all holes remaining after grubbing in areas where the depth of holes exceeds the depth of the proposed excavation.

METHOD OF MEASUREMENT

151-3.1 The quantities of clearing and grubbing as shown by the limits on the plans shall be the number of acres or fractions thereof, of land specifically cleared.

151-3.2 The quantities of BP-S196 Landside Civil Demolition as shown by the limits on the plans or directed by the OAR shall not be measured separately.

BASIS OF PAYMENT

151-4.1 Payment shall be made at the contract unit price per acre or fractions thereof for clearing. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

151-4.2 Payment shall be made at the lump sum (LS) price for BP-S196 Landside Civil Demolition. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-151-4.1	Clearing and grubbing - per lump sum (LS)
Item P-151-4.2	BP-S196 Landside Civil Demolition – per lump sum (LS)

END OF ITEM P-151

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

CLEARING AND GRUBBING
ITEM P-151

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Item P-152 Excavation, Subgrade, and Embankment

DESCRIPTION

152-1.1 This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

152-1.2 Classification. All material excavated shall be classified as defined below:

a. **Unclassified excavation.** Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature which is not otherwise classified and paid for under one of the following items.

b. **Muck excavation.** Muck excavation shall consist of the removal and disposal of deposits or mixtures of soils and organic matter not suitable for foundation material. ***Muck Excavation shall consist of the removal and disposal of deposits of soils with an organic content of 5 percent (by weight) or higher which is unsuitable as subgrade and embankment construction material.*** Muck shall include materials that will decay or produce subsidence in the embankment. It may consist of decaying stumps, roots, logs, humus, or other material not satisfactory for incorporation in the embankment.

c. **Drainage excavation.** Drainage excavation shall consist of all excavation made for the primary purpose of drainage and includes drainage ditches, such as intercepting, inlet or outlet ditches; temporary levee construction; or any other type as shown on the plans.

d. **Borrow excavation.** Borrow excavation shall consist of approved material required for the construction of embankments or for other portions of the work in excess of the quantity of usable material available from required excavations. Borrow material shall be obtained from areas designated ***approved*** by the ~~Resident Project Representative (RPR)~~ **Owner Authorized Representative (OAR)** within the limits of the airport property but outside the normal limits of necessary grading, or from areas outside the airport boundaries. ***No borrow areas have been identified on the airport for this project.***

152-1.3 Unsuitable excavation. Unsuitable material shall be disposed in designated waste areas as shown on the plans. Materials containing vegetable or organic matter ***in excess of 5 percent (by weight)***, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material suitable for topsoil may be used on the embankment slope ***as topsoil*** when approved by the ~~RPR~~ **OAR**.

CONSTRUCTION METHODS

152-2.1 General. ~~Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with Item P-151.~~ ***Before beginning excavation, grading, and embankment operations in existing pervious areas, the area shall have topsoil stripped to a minimum depth of 6 inches.***

The suitability of material to be placed in embankments shall be subject to approval by the ~~RPR~~ **OAR**. All unsuitable material shall be disposed ***of as directed by the OAR***. All waste areas shall

be graded to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas shall be specified on the plans or approved by the **RPR OAR**.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued and the **RPR OAR** notified per Section 70, paragraph 70-20. At the direction of the **RPR OAR**, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the **RPR OAR**, who shall arrange for their removal if necessary. The Contractor, at their own expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

a. Blasting. Blasting shall not be allowed.

152-2.2 Excavation. No excavation shall be started until the work has been staked out by the Contractor and the **RPR OAR** has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. The Contractor and **RPR OAR** shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

~~Digital terrain model (DTM) files of the existing surfaces, finished surfaces and other various surfaces were used to develop the design plans.~~

~~Volumetric quantities were calculated by comparing DTM files of the applicable design surfaces and generating Triangle Volume Reports. Electronic copies of DTM files and a paper copy of the original topographic map will be issued to the successful bidder.~~

~~Existing grades on the design cross sections or DTM's, where they do not match the locations of actual spot elevations shown on the topographic map, were developed by computer interpolation from those spot elevations. **The existing ground surface has been defined based on the best available information available at the time of the design. The project site and associated quantities may vary from the conditions defined in the plans.** Prior to disturbing original grade, Contractor shall **survey the existing site to establish the original ground surface to be used for calculation of earthwork quantities to be paid under this project. The Contractor's survey shall be reviewed and accepted by the OAR before it can be used as a basis for quantities determination.** verify the accuracy of the existing ground surface by verifying spot elevations at the same locations where original field survey data was obtained as indicated on the topographic map. Contractor shall recognize that, due to the interpolation process, the actual ground surface at any particular location may differ somewhat from the interpolated surface shown on the design cross sections or obtained from the DTM's. Contractor's verification of original ground surface, however, shall be limited to verification of spot elevations as indicated herein, and no adjustments will be made to the original ground surface unless the Contractor demonstrates that spot elevations shown are incorrect. For this purpose, spot elevations which are within 0.1 foot of the stated elevations for ground surfaces, or within 0.04~~

~~foot for hard surfaces (pavements, buildings, foundations, structures, etc.) shall be considered "no change". Only deviations in excess of these will be considered for adjustment of the original ground surface. If Contractor's verification identifies discrepancies in the topographic map, Contractor shall notify the RPR OAR in writing at least two weeks before disturbance of existing grade to allow sufficient time to verify the submitted information and make adjustments to the design cross sections or DTM's. Disturbance of existing grade in any area shall constitute acceptance by the Contractor of the accuracy of the original elevations shown on the topographic map for that area.~~

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the RPR OAR. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes **as** shown on the plans. All unsuitable material shall be disposed of as shown on the plans **or directed by the OAR.**

The grade shall be maintained so that the surface is well drained at all times. **Effective surface water control shall be required to prevent the disturbance to previously prepared or freshly exposed surfaces.**

When the volume of the excavation exceeds that required to construct the embankments to the grades as indicated on the plans, the excess shall be used to grade the areas of ultimate development or disposed as directed by the RPR OAR. **When the material can be utilized for another area within the project, the Contractor shall stockpile the material and shall provide erosion control measures completely around stockpiles.** When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from borrow areas **approved by the OAR.**

a. Selective grading. When selective grading is indicated on the plans, the more suitable material designated by the RPR OAR shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall **become property of the Owner and shall be properly placed in approved areas as directed by the OAR.** The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved.

b. Undercutting. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the RPR OAR. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport **or at the direction of the OAR.** The cost is incidental to this item. This excavated material shall be paid for at the contract unit price per cubic yard (per cubic meter) for ~~Unclassified~~ **Unsuitable** Excavation. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities **in accordance with the provisions of Item P-152.** The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans. Undercutting will be paid as ~~unclassified~~ **"Unsuitable Excavation"**.

c. Over-break. Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the RPR OAR. All over-break shall be graded or removed by the Contractor and disposed of as directed by the RPR OAR. The RPR OAR shall determine if the displacement of such material was unavoidable and their own

decision shall be final. Payment will not be made for the removal and disposal of over-break that the RPR OAR determines as avoidable. Unavoidable over-break will be classified as "Unclassified Unsuitable Excavation."

d. Removal of utilities. The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by the Contractor as indicated on the plans. All existing foundations shall be excavated at least 2 feet (60 cm) below the top of subgrade or as indicated on the plans, and the material disposed of as directed by the RPR OAR. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

152-2.3 Borrow excavation. ~~Borrow areas within the airport property are indicated on the plans. Borrow excavation shall be made only at these designated locations and within the horizontal and vertical limits as staked or as directed by the RPR.~~ **No borrow locations are identified on the Airport for this Project.** All unsuitable material shall be disposed of by the Contractor as shown on the plans **or directed by the OAR.** All borrow pits shall be opened to expose the various strata of acceptable material to allow obtaining a uniform product. Borrow areas shall be drained and left in a neat, presentable condition with all slopes dressed uniformly. Borrow areas shall not create a hazardous wildlife attractant.

There are no borrow sources within the boundaries of the airport property. **If borrow material is necessary to construct the project,** the Contractor shall locate and obtain borrow sources **and any environmental permits, hauling fees or other required incidental items to satisfy the requirements of the project,** subject to the approval of the RPR OAR. The Contractor shall notify the RPR OAR at least 15 days prior to beginning the excavation so necessary measurements and tests can be made by the RPR OAR. All borrow pits shall be opened to expose the various strata of acceptable material to allow obtaining a uniform product. Borrow areas shall be drained and left in a neat, presentable condition with all slopes dressed uniformly. Borrow areas shall not create a hazardous wildlife attractant.

All materials designated as borrow material shall meet the following criteria to be accepted:

Unified Soil Classification	SP, SP-SM Fine Sand, Fine Sand with Silt	SM Silty Fine Sand
% Passing No. 200 Sieve	Less than 12% by weight	Less than 18% by weight
Liquid Limit	Less than 20	Less than 20
Plasticity Index	Less than 4	Less than 4
Organic Content	Less than 3% by weight	Less than 3% by weight

All borrow material to be used for the project must have laboratory tests on file with OAR demonstrating aforementioned criteria prior to material being accepted onto airport property for incorporation as borrow material.

Any change in the sources or composition of borrow material will be discussed with OAR and laboratory test results must be approved prior to any change of material.

152-2.4 Drainage excavation. Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the **RPR OAR**. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted.

No direct payment shall be made for the work performed under this section.

152-2.5 Preparation of cut areas or areas where existing pavement has been removed. In those areas on which a subbase or base course is to be placed, the top 12 inches of subgrade shall be compacted to not less than 100 % of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

No direct payment shall be made for the work performed under this section. The work shall be incidental to P-101 Pavement Removal and P-152 Subgrade Preparation.

152-2.6 Preparation of embankment area. All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted per paragraph 152-2.10.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches (300 mm) and compacted as specified for the adjacent fill.

Where embankments are to be placed on natural slopes steeper than 1 vertical and 3 horizontal, horizontal benches shall be constructed.

No direct payment shall be made for the work performed under this section. The work shall be incidental to P-152 Subgrade Preparation.

152-2.7 Control Strip. The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the **RPR OAR**, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The **RPR OAR** must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the **RPR OAR**. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the **RPR OAR**.

152-2.8 Formation of embankments. The material shall be constructed in lifts as established in the control strip, but not less than 6 inches (150 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the ~~RPR~~ **OAR**. Materials such as **concrete and masonry debris, crushed concrete, pavement**, brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within $\pm 2\%$ of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The contractor will take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D1557. A new Proctor shall be developed for each soil type based on visual classification.

Density tests will be taken by the contractor for every 3,000 square yards of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies as determined by the ~~RPR~~ **OAR**.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than 100% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. Under all areas to be paved, the embankments shall be compacted to a depth of 12 inches and to a density of not less than 100 percent of the maximum density as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with ASTM D1556 or ASTM 6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The Contractor's laboratory shall perform all density tests in the ~~RPR's~~ **OAR's** presence and provide the test results upon completion to the ~~RPR~~ **OAR** for acceptance. If the specified density is not attained, the area represented by the test or as designated by the ~~RPR~~ **OAR** shall

be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4 inches (100 mm) in their greatest dimensions will not be allowed in the top 12 inches (300 mm) of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the ~~RPR~~ OAR and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, cement concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the ~~RPR~~ OAR.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in lifts of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in lifts not exceeding 2 feet (60 cm) in thickness. Each lift shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The lift shall not be constructed above an elevation 4 feet (1.2 m) below the finished subgrade.

Following placement of embankment the Contractor shall survey the site to establish the surface to be used for determination of the quantities of placed embankment. The survey will be reviewed by the OAR for approval prior to determination of the quantity of embankment to be paid.

All costs incidental to placing in lifts, compacting, discing, watering, mixing, sloping, and other operations necessary for construction of embankments will be included in the contract price for embankment.

152-2.9 Proof rolling. The purpose of proof rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. After compaction is completed, the subgrade area shall be proof rolled with a 20 ton (18.1 metric ton) Tandem axle Dual Wheel Dump Truck loaded to the legal limit with tires inflated to 80/100/150 psi (0.551 MPa/0.689 MPa/1.034 MPa) in the presence of the ~~RPR~~ OAR. Apply a minimum of 100% coverage, or as specified by the ~~RPR~~ OAR, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be removed and replaced with suitable material or reworked to conform to the moisture content and compaction requirements in accordance with these specifications. Removal and replacement of soft areas is incidental to this item.

152-2.10 Compaction requirements. The subgrade under areas to be paved shall be compacted to a depth of 12 inches and to a density of not less than 100percent of the maximum dry density as determined by ASTM D1557. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12 inches and to a density of not less than 95 percent of the maximum density as determined by ASTM D1557.

The material to be compacted shall be within $\pm 2\%$ of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the $\frac{3}{4}$ inch (19.0 mm) sieve, follow the methods in ASTM D1557 Tests for moisture content and compaction will be taken at a minimum of 1,000 S.Y. of subgrade. All quality assurance testing shall be done by the Contractor's laboratory in the presence of the ~~RPR~~ **OAR**, and density test results shall be furnished upon completion to the ~~RPR~~ **OAR** for acceptance determination.

Under all areas to be paved, the embankments shall be compacted to the depths and densities as specified below:

<i>Depth Below Finished Subgrade (in.)</i>	<i>Compaction for P-152 per ASTM D 1557</i>	<i>Required Soil Type</i>
<i>0 to 25 (fill and cut areas)</i>	<i>100%</i>	<i>SP and SP-SM only (<12% by weight)</i>
<i>25 to 44 (fill and cut areas)</i>	<i>95%</i>	<i>SP and SP-SM only (<12% by weight)</i>
<i>Below 44 (fill areas only)</i>	<i>95%</i>	<i>SP, SP-SM, and SM only (<18% by weight)</i>

Contractor shall provide (by digging) test pits on each 1,000 square yard area under proposed full strength pavement (or per each isolated area of construction) for OAR testing firm to perform density tests. Tests shall be taken at these locations at the various depths for density specified. All testing for excavation and backfilling of test pits shall be included as part of P-152-1.

The in-place field density shall be determined in accordance with ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

If the specified density is not attained, the entire lot shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the ~~RPR~~ **OAR** and the finished subgrade shall be maintained.

152-2.11 Finishing and protection of subgrade. Finishing and protection of the subgrade is incidental to this item. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly

compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been accepted by the ~~RPR~~ **OAR**.

152-2.12 Haul. All hauling, *both on and off Airport property*, will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be made for any work or materials associated with providing, maintaining and removing haul roads or routes.

152-2.13 Surface Tolerances. In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the ~~RPR~~ **OAR**. The Contractor shall perform all final smoothness and grade checks in the presence of the ~~RPR~~ **OAR**. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

- a. **Smoothness.** The finished surface shall not vary more than $\pm 1/2$ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.
- b. **Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within ± 0.05 feet (15 mm) of the specified grade.

On safety areas, turfed areas and other designated areas within the grading limits where no subbase or base is to be placed, grade shall not vary more than 0.10 feet (30 mm) from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.14 Topsoil. When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans and the approved CSPP, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the ~~RPR~~ **OAR**, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

METHOD OF MEASUREMENT

152-3.1 Measurement for payment for embankment, specified by the cubic yard (cubic meter) shall be computed *from the comparison of surveyed original and final surface approved by the OAR. The volume computed by a DTM model of the original and final surfaces established by the Contractor surveys and approved by the OAR shall be the basis of measurement.*

152-3.2 The quantity of unsuitable excavation to be paid for shall be the number of cubic yards measured in its original position as approved by the OAR. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

152-3.3 The quantity of subgrade preparation to be paid for shall be the number of square yards measure in its final place and accepted by the OAR. Measurement shall not include the quantity subgrade preparation perform outside the limits of work defined on the plans without authorization.

BASIS OF PAYMENT

152-4.1 Embankment payment shall be made at the contract unit price per cubic yard (cubic meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.1 Unsuitable excavation payment shall be made at the contract unit price per cubic yard (cubic meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.1 Subgrade preparation payment shall be made at the contract unit price per square yard (square meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-152-4.1	Embankment - per cubic yard
Item P-152-4.2	Unsuitable Excavation - per cubic yard
Item P-152-4.3	Subgrade Preparation - per square yard

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

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American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180 Standard Method of Test for Moisture-Density Relations of Soils
Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM International (ASTM)

ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics
of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))

ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place
by the Sand-Cone Method

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics
of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN-m/m³))

ASTM D6938 Standard Test Methods for In-Place Density and Water Content of
Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Advisory Circulars (AC)

AC 150/5370-2 Operational Safety on Airports During Construction Software

Software

FAARFIELD – FAA Rigid and Flexible Iterative Elastic Layered Design

U.S. Department of Transportation

FAA RD-76-66 Design and Construction of Airport Pavements on Expansive Soils

END OF ITEM P-152

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EXCAVATION, SUBGRADE, AND
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SECTION P-153 - CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

PART 1 - DESCRIPTION

- 1.1 This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)**.

PART 2 - MATERIALS

2.1 MATERIALS.

- A. Cement. Cement shall conform to the requirements of ASTM C150 Type I/II or ASTM C595 Type IL.
- B. Fly ash. Fly ash shall conform to ASTM C618, Class C or F.
- C. Fine aggregate (sand). Fine aggregate shall conform to the requirements of ASTM C33 except for aggregate gradation. Any aggregate gradation which produces the specified performance characteristics of the CLSM and meets the following requirements, will be accepted.
- | Sieve Size | Percent Passing by weight |
|----------------------|---------------------------|
| 3/4 inch (19.0 mm) | 100 |
| No. 200 (75 μ m) | 0 - 12 |
- D. Water. Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

PART 3 - MIX DESIGN

3.1 PROPORTIONS

The Contractor shall submit, to the ~~RPR~~ **OAR**, a mix design including the proportions and source of aggregate, fly ash, cement, water, and approved admixtures. No CLSM mixture shall be produced for payment until the ~~RPR~~ **OAR** has given written approval of the proportions. The proportions shall be prepared by a laboratory and shall remain in effect for the duration of the project. The proportions shall establish a single percentage or weight for aggregate, fly ash, cement, water, and any admixtures proposed. Laboratory costs are incidental to this item.

- A. Compressive strength. CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 1379 kPa) when tested in accordance with ASTM D4832, with no significant strength gain after 28 days.

- B. Consistency. Design CLSM to achieve a consistency that will produce an approximate 8-inch (200 mm) diameter circular-type spread without segregation. CLSM consistency shall be determined per ASTM D6103.

PART 4 - CONSTRUCTION METHODS

4.1 PLACEMENT

- A. Placement. CLSM may be placed by any reasonable means from the mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed so structures or pipes are not displaced from their final position and intrusion of CLSM into unwanted areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed by the ~~RPR~~ **OAR**. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one lift, the base lift shall be free of surface water and loose foreign material prior to placement of the next lift.
- B. Contractor Quality Control. The Contractor shall collect all batch tickets to verify the CLSM delivered to the project conforms to the mix design. The Contractor shall verify daily that the CLSM is consistent with 3.1a and 3.1b. Adjustments shall be made as necessary to the proportions and materials as needed. The Contractor shall provide all batch tickets to the ~~RPR~~ **OAR**.
- C. Limitations of placement. CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air or ground temperature is at least 35°F (2°C) and rising. Mixing and placement shall stop when the air temperature is 40°F (4°C) and falling or when the anticipated air or ground temperature will be 35°F (2°C) or less in the 24-hour period following proposed placement. At the time of placement, CLSM shall have a temperature of at least 40°F (4°C).

4.2 CURING AND PROTECTION

- A. Curing. The air in contact with the CLSM shall be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32°F (0°C), the material may be rejected by the ~~RPR~~ **OAR** if damage to the material is observed.
- B. Protection. The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the ~~RPR~~ **OAR** that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 3.1a.

4.3 QUALITY ASSURANCE (QA) ACCEPTANCE

CLSM QA acceptance shall be based upon batch tickets provided by the Contractor to the RPR **OAR** to confirm that the delivered material conforms to the mix design.

PART 5 - METHOD OF MEASUREMENT

5.1 MEASUREMENT

No separate measurement for payment shall be made for controlled low strength material (CLSM). CLSM shall be considered necessary and incidental to the work of this Contract.

PART 6 - BASIS OF PAYMENT

6.1 PAYMENT

No payment will be made separately or directly for controlled low strength material (CLSM). CLSM shall be considered necessary and incidental to the work of this Contract.

PART 7 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low-Strength Material (CLSM) Test Cylinders

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CONTROLLED LOW-STRENGTH
MATERIAL (CLSM)
SECTION P-153

ASTM D6103 Flow Consistency of Controlled Low Strength Material (CLSM)

END OF SECTION P-153

SECTION P-211 - LIME ROCK BASE COURSE

PART 1 - DESCRIPTION

- 1.1 This item shall consist of a base course composed of lime rock constructed on the prepared underlying course per these specifications and shall conform to the dimensions and typical cross-section shown on the plans.

PART 2 - MATERIALS

2.1 MATERIALS

The lime rock base course material shall consist of fossiliferous limestone of uniform quality. The material shall not contain hard or flinty pieces that will cause a rough surface containing pits and pockets. The rock shall show no tendency to “air slake” or undergo chemical change when exposed to the weather. The material when watered and rolled shall be capable of compacting to a dense and well-bonded base.

Lime Rock Base Course Material Properties²

	Oolitic	Non-Oolitic
Carbonates of calcium and magnesium ¹	70% minimum	75% minimum
Oxides of iron and aluminum ¹	Less than or equal to 2%	Less than or equal to 2%
Liquid limit	NA	Not greater than 35
Plasticity Index	NA	Not greater than 6
Organic or foreign matter	Not more than 0.5%	Not more than 0.5%
Lime Bearing Ratio (LBR) ³ at 0 to +1.5% optimum	125	125

¹ The combined amount of carbonates, oxides, and silica shall be at least 97%. The material shall be non-plastic.

² The chemical analysis of lime rock shall consist of determining the insoluble silica, iron oxide, and alumina by solution of the sample in hydrochloric (HCl) acid, evaporating, dehydrating, re-dissolving the residue, and neutralizing with ammonium hydroxide, filtering, washing, and igniting the residue lime rock. The difference between the percentage of insoluble matter and 100% is reported as carbonates of calcium and magnesium.

³ FM 5-515, Florida Method of Test for Lime Rock Bearing Ratio

Lime Rock Base Course Gradation

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
3-1/2 inch (87.5 mm)	100
3/4 inch (19.0 mm)	50-100

All fine material shall consist entirely of dust or fracture (fine portion passing the No. 10 (2.00 mm) sieve).

2.2 SAMPLING AND TESTING

- A. Aggregate base materials. The Contractor shall take samples of the aggregate base in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraph 2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements.
- B. Gradation requirements. The Contractor shall take at least two aggregate base samples per day in the presence of the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)** to check the final gradation. Sampling shall be per ASTM D75. Material shall meet the requirements in paragraph 209-2.1. The lot will be consistent with the lot size used for density. The samples shall be taken from the in-place, un-compacted material at sampling points and intervals designated by the ~~RPR~~ **OAR**.

2.3 SEPARATION GEOTEXTILE

Not used.

PART 3 - CONSTRUCTION METHODS

3.1 CONTROL STRIP

The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the ~~RPR~~ **OAR**, that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. Control strips that do not meet specification requirements shall be removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the ~~RPR~~ **OAR**. Upon acceptance of the control strip by the ~~RPR~~ **OAR**, the Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the ~~RPR~~ **OAR**.

3.2 PREPARING UNDERLYING COURSE

The ~~RPR~~ **OAR** shall check and accept the underlying course before placing and spreading operations are started. Any ruts or soft yielding places caused by improper drainage conditions, hauling, or any other cause shall be corrected at the Contractor's expense before the base course is placed. Material shall not be placed on frozen subgrade.

3.3 PLACEMENT

The material shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the ~~RPR~~ **OAR**, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

The material shall meet gradation and moisture requirements prior to compaction. The layer shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

3.4 COMPACTION

Immediately upon completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade. The field density of each compacted lift of material shall be at least 100% of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. The moisture content of the material during placing operations shall be within ± 2 percentage points of the optimum moisture content as determined by ASTM D1557. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

3.5 FINISHING

After the watering and rolling of the base course, the entire surface shall be scarified to a depth of at least 3 inches (75 mm) and shaped to the exact crown and cross-section with a blade grader. The scarified material shall be rewetted and thoroughly rolled. Rolling shall continue until the base is bonded and compacted to a dense, unyielding mass, true to grade and cross-section. Scarifying and rolling of the surface of the base shall follow the initial rolling of the lime rock by not more than four (4) days. When the lime rock base is constructed in two layers, the scarifying of the surface shall be to a depth of 2 inches (50 mm).

If cracks or checks appear in the base before the surface course is laid, the Contractor shall rescarifying, reshaping, watering, add lime rock where necessary, and recompact. If the underlying material becomes mixed with the base course material, the Contractor shall, without additional compensation, remove, reshape, and recompact the mixture.

3.6 WEATHER LIMITATIONS

Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on base course shall not be conducted when the subgrade or subbase is wet or frozen or the base material contains frozen material.

3.7 MAINTENANCE

The base course shall be maintained in a condition that will meet all specification requirements until the work is accepted by the ~~RPR~~ **OAR**. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at the Contractor's expense.

3.8 SURFACE TOLERANCE

After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompact to grade. until the required smoothness and accuracy are obtained and approved by the ~~RPR~~ **OAR**. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense. The smoothness and accuracy requirements specified here apply only to the top layer when base course is constructed in more than one layer.

- A. Smoothness. The finished surface shall not vary more than 3/8-inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.
- B. Grade. The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and -1/2 inch (12 mm) of the specified grade.

3.9 ACCEPTANCE SAMPLING AND TESTING

Lime rock base course shall be accepted for density on an area basis. Two tests shall be made for density and thickness for each 1200 square yds (1000 m²). Sampling locations will be determined on a random basis per ASTM D3665.

- A. Density. The Contractor's laboratory shall perform all density tests in the ~~RPR's~~ **OAR's** presence and provide the test results upon completion to the ~~RPR~~ **OAR** for acceptance.

Each area shall be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens compacted and tested per ASTM D1557. The in-place field density shall be determined per ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the entire area shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

- B. Thickness. Depth tests shall be made by test holes or cores at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the ~~RPR~~ **OAR** for each area. Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

Alternately the Contractor may request the OAR to permit the thickness determination by survey. Survey shall be required before and after placement of the base. The survey interval shall be no greater than a 50' X 50' grid across the project.

PART 4 - METHOD OF MEASUREMENT

- 4.1 The quantity of lime rock base course shall be the number of square yards (square meters) of base material placed, bonded, and accepted in the completed base course. The quantity of base course material shall be measured in final position based upon depth tests taken as directed by the ~~RPR~~ **OAR**. On individual depth measurements, thicknesses more than 1/2 inch (12 mm) in excess of that shown on the plans shall be considered as the specified thickness plus 1/2 inch (12 mm) in computing the yardage for payment.

PART 5 - BASIS OF PAYMENT

- 5.1 Payment shall be made at the contract unit price per square yards for lime rock base course. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

The cost of removing cracks and checks including the labor, and the additional lime rock necessary for crack elimination, will not be paid for separately but shall be included in the contract price per square yard for lime rock base course.

Payment will be made under:

Item P-211-5.1 6" Lime rock base course - per Square Yard (SY)

Item P-211-5.2	13" Lime rock base course	- per Square Yard (SY)
Item P-211-5.3	14" Lime rock base course	- per Square Yard (SY)
Item P-211-5.4	24" Lime rock base course	- per Square Yard (SY)

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2700 kN-m/m ³))
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile

American Association of State Highway and Transportation Officials (AASHTO)

M288	Standard Specification for Geosynthetic Specification for Highway Applications

END OF SECTION P-211

SECTION P-306 LEAN CONCRETE BASE COURSE

PART 1 - DESCRIPTION

- 1.1 This item shall consist of a lean concrete subbase material that is composed of aggregate and cement uniformly blended together and mixed with water. The mixture may also include approved cementitious additives, in the form of fly ash or slag, and chemical admixtures. The mixed material shall be spread, shaped, and consolidated using concrete paving equipment in accordance with these specifications and in conformity to the lines, grades, dimensions, and typical cross-sections shown on the plans.

PART 2 - MATERIALS

2.1 AGGREGATE

The coarse aggregate fraction shall be crushed stone, crushed or uncrushed gravel, crushed and adequately seasoned, air-cooled, iron blast furnace slag, crushed recycled concrete, or a combination thereof. The fine aggregate fraction may be part of the natural aggregate blend as obtained from the borrow source or it may be natural sand that is added at the time of mixing. The aggregate shall meet the gradation and material requirements in the tables below.

Aggregate Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate Portion (retained on the No. 4 (4.75 mm) sieve)		
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Flat Particles, Elongated Particles, or Flat and Elongated Particles ¹	10% maximum, by weight, for fraction retained on the ½ inch (12.5mm) sieve and 10% maximum, by weight, for the fraction passing the 1/2-inch (12.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate Portion (passing the No. 40 (425µm) sieve)		
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Soundness of Aggregates	Loss after 5 cycles: 10% maximum using Sodium sulfate - or -	ASTM C88

Material Test	Requirement	Standard
by Use of Sodium Sulfate or Magnesium Sulfate	15% maximum using magnesium sulfate	

¹ A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

Aggregate Gradation for Lean Concrete

Sieve Size (square openings)	Percentage by Weight Passing Sieves	
	Gradation A	Gradation B
1-1/2 inch (37.5 mm)	100	--
1 inch (25.0 mm)	70 - 95	100
3/4 inch (19.0 mm)	55 - 85	70 - 100
No. 4 (4.75 mm)	30 - 60	35 - 65
No. 40 (425 µm)	10 - 30	15 - 30
No. 200 (75 µm)	0 - 15	0 - 15

2.2 SAMPLING AND TESTING

A. Aggregate base materials

The Contractor shall take samples of the aggregate base stockpile in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraphs 2.1 and 2.2. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

2.3 CEMENT

Cement shall conform to the requirements of ASTM C150, Type I or II or ASTM C595, Type IL.

2.4 CEMENTITIOUS ADDITIVES

Pozzolanic and slag cement may be added to the lean concrete mix. If used, each material must meet the following requirements:

- A. Pozzolan. Pozzolan materials must meet the requirements of ASTM C618, Class F, or N with the exception of loss of ignition, where the maximum shall be less than 6%.
- B. Slag cement (ground granulated blast furnace (GGBF) slag). Slag shall conform to ASTM C989, Grade 100 or 120.

2.5 CHEMICAL ADMIXTURES

The Contractor shall submit certificates indicating that the material to be furnished meets all the requirements listed below. In addition, the ~~RPR~~ **Owner's Authorized Representative (OAR)** may require the Contractor to submit complete test data showing that the material to be furnished meets all the requirements of the cited specification.

- A. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260.
- B. Water-reducing admixtures. Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C494, Type A, D, E, F, or G. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions. The air entrainment agent and the water-reducing admixture shall be compatible.
- C. Retarding admixtures. Retarding admixtures shall meet the requirements of ASTM C494, Type B or D.
- D. Accelerating admixtures. Accelerating admixtures shall meet the requirements of ASTM C494, Type C.

2.6 WATER

Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

2.7 CURING MATERIALS

For curing lean concrete, use white-pigmented, liquid membrane-forming compound conforming to ASTM C309, Type 2, Class B, or clear or translucent Type 1-D, Class B with white fugitive dye.

2.8 BOND BREAKER

Choke stone shall be an ASTM C33 Number 89 stone.

PART 3 - COMPOSITION OF MIXTURE

3.1 MIX DESIGN

The lean concrete mix design shall be based on trial batch results conducted in the laboratory. The lean concrete shall be designed to meet the criteria in this section.

Compressive strength shall not be less than 500 pounds per square inch (3,445 kPa) nor greater than 800 pounds per square inch (5,516 kPa) at seven (7) days. Compressive strengths shall be taken as the average of two compressive strength test results. All compressive strength specimens shall be prepared and tested in accordance with ASTM C192 and ASTM C39, respectively.

The percentage of air entrainment shall be 6%, $\pm 1/2\%$. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

If there is a change in aggregate sources, type of cement used, or pozzolanic materials, a new mix design must be submitted

3.2 SUBMITTALS

At least 30 days prior to the placement of the lean concrete, the Contractor shall submit certified test reports to the ~~RPR~~ **OAR** for those materials proposed for use during construction, as well as the mix design information for the lean concrete material. The certification shall identify the specifications and test standard, the name of the testing laboratory, the date of the tests, and a statement that the materials comply with the applicable specifications. Tests older than six (6) months shall not be used. The submittal package shall include the following:

- A. Sources of materials, including aggregate, cement, admixtures, and curing and bond breaking materials.
- B. Physical properties of the aggregates, cement, admixtures, curing and bond breaking materials.
- C. Mix design:
 - Mix identification number
 - Weight of saturated surface-dry aggregates (fine and coarse)
 - Combined aggregate gradation
 - Cement factor
 - Water content
 - Water-cementitious material ratio (by weight)
 - Volume of admixtures and yield for one cubic yard (cubic meter) of lean concrete
 - Laboratory test results:
 - Slump
 - Unit weight
 - Air content
 - Compressive strength at 3, 7, and 28 days (average values)

Where applicable, the Contractor shall submit a jointing plan for transverse joints in the lean concrete layer for approval by the ~~RPR~~ **OAR**.

During production, the Contractor shall submit batch tickets for each delivered load.

PART 4 - EQUIPMENT

- 4.1 All equipment necessary to mix, transport, place, compact, and finish the lean concrete material shall be furnished by the Contractor and is subject to inspection and approval by the ~~RPR~~ **OAR**. The Contractor shall provide certification that all equipment conforms to the requirements of ASTM C94.

4.2 FORMS

Straight side forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall have a depth equal to the pavement thickness at the edge. Flexible or curved forms of proper radius shall be used for curves of 100 feet (30 m) radius or less. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the ~~RPR~~ **OAR**. The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when accepted by the ~~RPR~~ **OAR**.

4.3 CONCRETE PAVERS

A fixed form or slip-form concrete paver may be used to place lean concrete. The paver shall be fully energized, self-propelled and capable of spreading, consolidating, and finishing the lean concrete material, true to grade, tolerances, and cross-sections. The paver shall be of sufficient weight and power to construct the maximum specified concrete paving lane width, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. Slip-form pavers shall be equipped with electronic or hydraulic horizontal and vertical control devices. Bridge deck pavers are approved as paver-finishing machines for lean concrete, provided they are capable of handling the amount of lean concrete required for the full-lane width specified, and capable of spreading, consolidating, and finishing the lean concrete material, true to grade, tolerances, and cross-sections.

4.4 VIBRATORS

For fixed-form construction, vibrators may be either the surface pan type or internal type with either immersed tube or multiple spuds for the full width of the slab. They may be attached to the spreader, the finishing machine, or mounted on a separate carriage. They shall not come in contact with the subgrade or forms.

For slip-form construction, the paver shall be accomplished by internal vibrators for the full width and depth of the pavement being placed. The number, spacing, frequency, and eccentric weights of vibrators shall be provided to achieve acceptable consolidation without segregation and finishing quality. Internal vibrators may be supplemented by vibrating screeds operating on the surface of the lean concrete. Vibrators and screeds

shall automatically stop operation when forward motion ceases. An override switch shall be provided.

Hand held vibrators may be used in irregular areas.

4.5 JOINT SAWS

The Contractor shall provide a sufficient number of saws with adequate power to cut contraction or construction joints to the required dimensions as shown on the plans. The Contractor shall provide at least one standby saw in good working order.

PART 5 - CONSTRUCTION METHODS

5.1 CONTROL STRIP

The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the ~~RPR~~ **OAR**, that the materials, equipment, and construction processes meet the requirements of the specification. Control strips that do not meet specification requirements shall be removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the ~~RPR~~ **OAR**. Upon acceptance of the control strip by the ~~RPR~~ **OAR**, the Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the ~~RPR~~, **OAR**.

5.2 WEATHER LIMITATIONS

The Contractor shall follow the recommended practices in American Concrete Institute (ACI) 306R, Guide to Cold Weather Concreting. The temperature of the mixed lean concrete shall not be less than 50°F (10°C) at the time of placement. The lean concrete shall not be placed when the ambient temperature is below 40°F (4°C) or when conditions indicate that the temperature may fall below 35°F (2°C) within 24 hours. The lean concrete shall not be placed on frozen underlying courses.

The Contractor shall follow the recommended practices in ACI 305R, Guide to Hot Weather Concreting. The lean concrete temperature from initial mixing through final cure shall not exceed 90°F (32°C). When the maximum daily air temperature exceeds 85°F (30°C), the forms and/or the underlying material shall be sprinkled with water before placing the lean concrete.

The Contractor should stop operations prior to and during rain allowing time to cover and protect any plastic lean concrete. Areas damaged by rain shall be refinished or replaced at the Contractor's expense.

5.3 MAINTENANCE

The Contractor shall protect the lean concrete from environmental or mechanical damage. Traffic shall not be allowed on the pavement until test specimens made per ASTM C31 have attained a compressive strength of 500 psi (3445 kPa) when tested per ASTM C39. The Contractor shall maintain continuity of the applied curing method for the entire curing period.

5.4 FORM SETTING

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch (6 mm) at any joint. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). Forms shall be cleaned and oiled prior to the placing of lean concrete.

5.5 PREPARATION OF UNDERLYING COURSE

The underlying course shall be checked and accepted by the ~~RPR~~ **OAR** before placing operations begin. Prior to placing the material, the final grade should be firm, moist and free of frost. Use of chemicals to eliminate frost will not be permitted. The underlying course shall be wetted in advance of placing the lean concrete base course.

5.6 GRADE CONTROL

Grade control shall be as necessary to construct the layer to the profile and cross-sections as shown on the plans.

5.7 MIXING

The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials.

All lean concrete shall be mixed and delivered to the site per the requirements of ASTM C94. The mixing time should be adequate to produce lean concrete that is uniform in appearance, with all ingredients evenly distributed. Mixing time shall be measured from the time all materials are emptied into the drum (provided all the water is added before one-fourth the preset mixing time has elapsed) and continues until the time the discharge chute is opened to deliver the lean concrete.

If mixing in a batch plant, the mixing time shall not be less than 50 or greater than 90 seconds. If mixing in a truck mixer, the mixing time shall not be less than 70 or more than 125 truck-drum revolutions at a mixing speed of not less than six (6) or more than 18 truck-drum revolutions per minute.

The elapsed time from the addition of cementitious material to the mix until the lean concrete is deposited in place at the work site shall not exceed 45 minutes when the concrete is hauled in non-agitating trucks, or 90 minutes when it is hauled in truck mixers or truck agitators.

Re-tempering lean concrete will not be permitted, except when delivered in truck mixers. With truck mixers, additional water may be added to the batch materials if the addition of water is added within 45 minutes after the initial mixing operations and the water/cement ratio specified in the mix design is not exceeded.

5.8 PLACING

The lean concrete material shall be placed continuously at a uniform rate on the underlying course minimizing segregation and handling of the mix. Rakes shall not be allowed for spreading the lean concrete.

5.9 FINISHING

Shape the finished surface of the lean concrete base layer to the specified lines, grades, and cross-section. Hand finishing will not be permitted except in areas where the mechanical finisher cannot operate.

The surface of the lean concrete shall not be textured.

5.10 CONSTRUCTION LIMITATIONS

All placement and finishing operations shall be completed within two (2) hours from the start of mixing. Material not completed within the 2-hour time limit shall be removed and replaced at the Contractor's expense.

At the end of each day's construction and/or when operations are interrupted for more than 30 minutes, a straight transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true vertical face.

Completed portions may be opened to light traffic when it has achieved its 7-day strength and the curing is not damaged.

5.11 JOINTS

Locate all longitudinal and transverse construction joints as shown on the plans. Longitudinal joints shall be within 6 inches (150 mm) of planned joints in the overlaying concrete pavement and transverse joints shall be within 3 inches (75 mm) the planned joints of the overlying concrete surface. Joints shall be sawn as soon as the base can support the saws without damage to the lean concrete base. Joints shall be constructed by sawing the hardened lean concrete to a depth of at least one-third the thickness of the

lean concrete base, or 1/5th the depth of the lean concrete base when constructed using early entry saws.

5.12 CURING

Immediately after the finishing operations are complete and within two (2) hours of placement of the lean concrete, the entire surface and edges of the newly placed lean concrete shall be sprayed uniformly with [white pigmented, liquid membrane forming curing compound conforming to ASTM C309, Type 2, Class B or clear or translucent Type 1-D, Class B with white fugitive dye] in accordance with paragraph 2.7. The layer should be kept moist using a moisture-retaining cover or a light application of water until the curing material is applied. The curing compound shall not be applied during rainfall.

The curing material shall be applied at a maximum coverage of 200 square feet per gallon (5.0 m²/l) using pressurized mechanical sprayers. The spraying equipment shall be a fully atomizing type equipped with a tank agitator. At the time of use, the curing compound in the tank shall be thoroughly and uniformly mixed with the pigment. During application, the curing compound shall be continuously stirred by mechanical means. Edges of the lean concrete layer shall be sprayed with curing compound immediately following placement with slip-form pavers or when side-forms are removed. Hand spraying of odd widths or shapes and lean concrete surfaces exposed by the removal of forms is permitted.

The lean concrete temperature during curing shall be in accordance with paragraph 5.2.

If the curing material becomes damaged from any cause, including sawing operations, within the required 7-day curing period or until the overlying course is constructed, the Contractor shall immediately repair the damaged areas by application of additional curing compound or other means approved by the ~~RPR~~ **OAR**.

5.13 SURFACE TOLERANCE

The Contractor shall perform smoothness and grade checks daily. Any area not meeting smoothness and grade shall be corrected by the Contractor at the Contractor's expense. The Contractor shall provide smoothness and grade data to the ~~RPR~~ **OAR** on a daily basis.

- A. Smoothness. The finished surface shall not vary more than $\pm 3/8$ -inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline, and, moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid. The Contractor shall correct any high spots more than $3/8$ inch (9 mm) in 12-foot (3.7-m) with a grinding machine or remove and replace the material at the Contractor's expense. Any areas that have been ground shall have curing compound reapplied.
- B. Grade. The grade shall be measured on a 50-foot (15-m) grid and shall be within ± 0.05 feet (15 mm) of the specified grade. When the surface is more than $1/2$ inch (12 mm) above the grade shown in the plans, the surface shall be corrected at the Contractor's expense to an elevation that falls within a tolerance of $1/4$ inch (6 mm).

5.14 BOND-BREAKER

Choke stone per paragraph 2.8 shall be placed on the surface of the lean concrete to prevent bonding. The choke stone shall be placed in a layer approximately 1/4-inch (6 mm) thick. ***After application of the bond breaker, traffic will be limited to that required for placement of the PCC surface course.***

PART 6 - MATERIAL ACCEPTANCE

6.1 SAMPLING AND TESTING

Acceptance sampling and testing to determine conformance with the requirements specified in this section will be performed by the ~~RPR~~ **OAR** for each 1200 square yards (1000 square meters). Sampling locations will be determined by the ~~RPR~~ **OAR** on a random basis per ASTM D3665.

- A. Compressive Strength. One sample of freshly delivered lean concrete will be taken for compressive strength for each 1200 square yards (1000 square meters) in accordance with ASTM C172 and air content tests in accordance with ASTM C231. Two test cylinders will be made and cured from the sample per ASTM C31 and the 7-day compressive strength of each cylinder determined per ASTM C39. The compressive strength will be computed by averaging the two 7-day compressive strengths.

The Contractor shall provide for the initial curing of cylinders in accordance with ASTM C31 during the 24 hours after molding.

- B. Thickness. Cores shall be drilled by the Contractor at two different sampling locations for thickness determination for each 1200 square yards (1000 square meters). Thickness will be determined by measuring the depth of core holes and computed by averaging the thickness determination of the two locations.

Core holes shall be filled by the Contractor with lean concrete base or non-shrink grout.

Thickness will be determined by survey on a ~~25-foot by 25-foot grid~~ **50-foot by 50-foot grid.**

6.2 ACCEPTANCE

- A. Strength. If the lean concrete fails to meet the minimum compressive strength requirements, the Contractor shall remove and replaced the material at the Contractor's expense.
- B. Thickness. If the average thickness is not deficient by more than 1/2 inch (12 mm) from the plan thickness, full payment shall be made. When such measurement is deficient by more than 1/2 inch (12 mm) but less than one inch (25 mm) from the plan thickness, the area represented by the test shall be removed and replaced at the Contractor's expense

or shall be permitted to remain in-place at an adjusted payment of 75% of the contract unit price.

PART 7 - METHOD OF MEASUREMENT

- 7.1 The quantity of lean concrete base course will be determined by the number of square yard (~~m²~~) of lean concrete actually constructed and accepted by the ~~RPR~~, **OAR** as complying with the plans and specifications.

PART 8 - BASIS OF PAYMENT

- 8.1 The accepted quantities of lean concrete will be paid for at the contract unit price per square yard (~~m²~~) for lean concrete base. The price and payment shall be full compensation for furnishing and placing all materials, provided; however, for any pavement found deficient in thickness as specified in paragraph 6.2b, the reduced unit price shall be paid.

Item P-306-8.1 6" Lean Concrete Base Course - per Square Yard (SY)

PART 9 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Specification for Coal Fly Ash and Raw and Calcined Natural Pozzolans for Use in Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregates (Accelerated Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T136	Standard Method of Test for Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures
ASTM D3665	Standard Practice for Random Sampling of Construction Materials

American Concrete Institute (ACI)

ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting

END OF ITEM P-306

SECTION P-403 - ASPHALT MIX PAVEMENT SURFACE COURSE

PART 1 - DESCRIPTION

- 1.1 This item shall consist of pavement courses composed of mineral aggregate and asphalt binder mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

PART 2 - MATERIALS

2.1 AGGREGATE

Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The aggregates should have no known history of detrimental pavement staining due to ferrous sulfides, such as pyrite. Coarse aggregate is the material retained on the No. 4 (4.75 mm) sieve. Fine aggregate is the material passing the No. 4 (4.75 mm) sieve.

A. Coarse aggregate

Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Coarse aggregate material requirements are given in the table below.

Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum for surface, asphalt binder, and leveling course Loss: 50% maximum for base course	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Percentage of Fractured Particles	For pavements designed for aircraft gross weights of 60,000 pounds (27200 kg) or more:	ASTM D5821

Material Test	Requirement	Standard
	Minimum 75% by weight of particles with at least two fractured faces and 85% with at least one fractured face ¹	
	For pavements designed for aircraft gross weights less than 60,000 pounds (27200 kg): Minimum 50% by weight of particles with at least two fractured faces and 65% with at least one fractured face ¹	
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles with a value of 5:1 ²	ASTM D4791
Bulk density of slag ³	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29.

¹ The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

² A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

³ Only required if slag is specified.

B. Fine aggregate

Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel and shall be free from coatings of clay, silt, or other objectionable matter. Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. Fine aggregate material requirements are listed in the table below.

Fine Aggregate Material Requirements

Material Test	Requirement	Standard
Liquid limit	25 maximum	ASTM D4318
Plasticity Index	4 maximum	ASTM D4318
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Sand equivalent	45 minimum	ASTM D2419
Natural Sand	15% maximum by weight of total aggregate	ASTM D1073

C. Sampling

ASTM D75 shall be used in sampling coarse and fine aggregate, and ASTM C183 shall be used in sampling mineral filler.

2.2 MINERAL FILLER

Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler shall meet the requirements of ASTM D242.

Mineral Filler Requirements

Material Test	Requirement	Standard
Plasticity Index	4 maximum	ASTM D4318

2.3 ASPHALT BINDER

Asphalt binder shall conform to ASTM D6373 Performance Grade (PG) 76-22.

Asphalt Binder PG Plus Test Requirements

Material Test	Requirement	Standard
Elastic Recovery	75% minimum	ASTM D6084 ¹

¹Follow procedure B on RTFO aged binder.

2.4 ANTI-STRIPPING AGENT

Any anti-stripping agent or additive (anti-strip) shall be heat stable and shall not change the asphalt binder grade beyond specifications. Anti-strip shall be an approved material of the Department of Transportation of the State in which the project is located.

2.5 BOND BREAKER

Choke stone shall be an ASTM C33 Number 89 stone.

PART 3 - COMPOSITION

3.1 COMPOSITION OF MIXTURE

The asphalt plant mix shall be composed of a mixture of well-graded aggregate, filler and anti-strip agent if required, and asphalt binder. The several aggregate fractions shall be

sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

3.2 JOB MIX FORMULA (JMF) LABORATORY

The laboratory used to develop the JMF shall possess a current certificate of accreditation, listing D3666 from a national accrediting authority and all test methods required for developing the JMF, and listed on the accrediting authority's website. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the ~~RPR~~ **OAR** prior to start of construction.

3.3 JOB MIX FORMULA (JMF)

No asphalt mixture shall be placed until an acceptable mix design has been submitted to the ~~RPR~~ **OAR** for review and accepted in writing. The ~~RPR's~~ **OAR's** review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

When the project requires asphalt mixtures of differing aggregate gradations and/or binders, a separate JMF shall be submitted for each mix. Add anti-stripping agent to meet tensile strength requirements.

The JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 3.2. The asphalt mixture shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared and compacted using the gyratory compactor in accordance with ASTM D6925.

Should a change in sources of materials be made, a new JMF must be submitted to the ~~RPR~~ **OAR** for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the ~~RPR~~ **OAR** and a new or modified JMF is required for whatever reason, the subsequent cost of the new or modified JMF, including a new control strip when required by the ~~RPR~~ **OAR**, will be borne by the Contractor.

The ~~RPR~~ **OAR** may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates proposed for project use.

The submitted JMF shall be dated, and stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF in accordance with paragraph 2.3. Certificate of asphalt performance grade is with modifier already added, if used and must indicate compliance with ASTM D6373. For plant modified asphalt binder, certified test report indicating grade certification of modified asphalt binder.
- Manufacturer's Certificate of Analysis (COA) for the anti-stripping agent if used in the JMF in accordance with paragraph 2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 2.1 and 2.2.
- Percent passing each sieve size for individual gradation of each aggregate cold feed and/or hot bin; percent by weight of each cold feed and/or hot bin used; and the total combined gradation in the JMF.
- Specific Gravity and absorption of each course and fine aggregate.
- Percent natural sand.
- Percent fractured faces.
- Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).
- Percent of asphalt.
- Number of blows or gyrations.
- Laboratory mixing and compaction temperatures.
- Supplier recommended mixing and compaction temperatures.
- Plot of the combined gradation on the 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.
- Tensile Strength Ratio (TSR).
- Type and amount of Anti-strip agent when used.
- Asphalt Pavement Analyzer (APA) results.
- Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.

Table 1. Asphalt Design Criteria

Test Property	Value	Test Method
Number of blows/gyrations	75	
Air voids (%)	3.5	ASTM D3203
Percent voids in mineral aggregate (VMA), minimum	See Table 2	ASTM D6995
TSR ¹	not less than 80 at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA) ^{2,3}	Less than 10 mm @ 4000 passes	AASHTO T340 at 250 psi hose pressure at 64°C test temperature

¹ Test specimens for TSR shall be compacted at 7 ± 1.0 % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

² AASHTO T340 at 100 psi hose pressure at 64°C test temperature may be used in the interim. If this method is used, the required Value shall be less than 5 mm @ 8000 passes.

³ Where APA not available, use Hamburg wheel test (AASHTO T 324) 10 mm @ 20,000 passes at 50°C.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM C136 and ASTM C117.

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the sources of supply, be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

Table 2. Aggregate - Asphalt Pavements

Sieve Size	Percentage by Weight Passing Sieve
1 inch (25.0 mm)	--
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	90-100
3/8 inch (9.5 mm)	72-88
No. 4 (4.75 mm)	53-73
No. 8 (2.36 mm)	38-60
No. 16 (1.18 mm)	26-48
No. 30 (600 μ m)	18-38
No. 50 (300 μ m)	11-27

Sieve Size	Percentage by Weight Passing Sieve
No. 100 (150 µm)	6-18
No. 200 (75 µm)	3-6
Voids in Mineral Aggregate (VMA) ¹	15
Asphalt Percent:	
Stone or gravel	5.0-7.5
Slag	6.5-9.5
Recommended Minimum Construction Lift Thickness	2 inch

¹ To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition.

3.4 RECLAIMED ASPHALT PAVEMENT (RAP)

RAP shall not be used.

3.5 CONTROL STRIP

Full production shall not begin until an acceptable control strip has been constructed and accepted in writing by the ~~RPR~~ **OAR**. The Contractor shall prepare and place a quantity of asphalt according to the JMF. The underlying grade or pavement structure upon which the control strip is to be constructed shall be the same as the remainder of the course represented by the control strip.

The Contractor will not be allowed to place the control strip until the Contractor quality control program (CQCP), showing conformance with the requirements of paragraph 5.1, has been accepted, in writing, by the ~~RPR~~ **OAR**.

The control strip will consist of at least 250 tons (227 metric tons) or 1/2 subplot, whichever is greater. The control strip shall be placed in two lanes of the same width and depth to be used in production with a longitudinal cold joint. The cold joint must be cut back in accordance with paragraph 4.13 using the same procedure that will be used during production. The cold joint for the control strip will be an exposed construction joint at least four (4) hours old or when the mat has cooled to less than 160°F (71°C). The equipment used in construction of the control strip shall be the same type, configuration and weight to be used on the project.

The control strip shall be evaluated for acceptance as a single lot in accordance with the acceptance criteria in paragraph 6.1 and 6.2. The control strip shall be divided into equal sublots. As a minimum, the control strip shall consist of three (3) sublots.

The control strip will be considered acceptable by the ~~RPR~~ **OAR** if the gradation, asphalt content, and VMA are within the action limits specified in paragraph 5.5a; and Mat density, air voids, and joint density meet the requirements specified in paragraphs 6.2, and Mat density greater than or equal to 94%, air voids $3.5\% \pm 1\%$, and joint density greater than or equal to 92%.

If the control strip is unacceptable, necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made and another control strip shall be placed. Unacceptable control strips shall be removed at the Contractor's expense.

The control strip will be considered one lot for payment based upon the average of a minimum of 3 samples (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 8.1.

PART 4 - CONSTRUCTION METHODS

4.1 WEATHER LIMITATIONS

The asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the ~~RPR~~ **OAR**, if requested; however, all other requirements including compaction shall be met.

Table 4. Surface Temperature Limitations of Underlying Course

Mat Thickness	Base Temperature (Minimum)	
	Degrees F	Degrees C
3 inches (7.5 cm) or greater	40	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

4.2 ASPHALT PLANT

Plants used for the preparation of asphalt shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 including the following items:

A. Inspection of plant

The ~~RPR~~ **OAR**, or ~~RPR's~~ **OAR's** authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

B. Storage bins and surge bins

The asphalt mixture stored in storage and/or surge bins shall meet the same requirements as asphalt mixture loaded directly into trucks. Asphalt mixture shall not be stored in storage and/or surge bins for a period greater than twelve (12) hours. If the ~~RPR~~ **OAR** determines there is an excessive heat loss, segregation or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

4.3 AGGREGATE STOCKPILE MANAGEMENT

Aggregate stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

4.4 HAULING EQUIPMENT

Trucks used for hauling asphalt shall have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the ~~RPR~~ **OAR**. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

4.4.1 Material transfer vehicle (MTV)

Material transfer Vehicles shall be required due to the improvement in smoothness and decrease in both physical and thermal segregation. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

4.5 ASPHALT PAVERS

Asphalt pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The asphalt paver shall be equipped with a control system capable of automatically maintaining the specified screed grade and elevation.

If the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued.

The paver shall be capable of paving to a minimum width specified in paragraph 401-4.11.

4.6 ROLLERS

The number, type, and weight of rollers shall be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing of the aggregate, depressions or other damage to the pavement surface. Rollers shall be in good condition, capable of operating at slow speeds to avoid displacement of the asphalt. All rollers shall be specifically designed and suitable for compacting asphalt concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used.

4.6.1 Density device

The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall also supply a qualified technician during all paving operations to calibrate the density gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the ~~RPR~~ **OAR** upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

4.7 PREPARATION OF ASPHALT BINDER

The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of the unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

4.8 PREPARATION OF MINERAL AGGREGATE

The aggregate for the asphalt shall be heated and dried. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

4.9 PREPARATION OF ASPHALT MIXTURE

The aggregates and the asphalt binder shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all asphalt upon discharge shall not exceed 0.5%.

4.10 APPLICATION OF PRIME AND TACK COAT

Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A prime coat in accordance with Item P-602 shall be applied to aggregate base prior to placing the asphalt mixture.

A tack coat shall be applied in accordance with Item P-603 to all vertical and horizontal asphalt and concrete surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

4.11 LAYDOWN PLAN, TRANSPORTING, PLACING, AND FINISHING

Prior to the placement of the asphalt, the Contractor shall prepare a laydown plan with the sequence of paving lanes and width to minimize the number of cold joints; the location of any temporary ramps; laydown temperature; and estimated time of completion for each portion of the work (milling, paving, rolling, cooling, etc.). The laydown plan and any modifications shall be approved by the ~~RPR~~ **OAR**.

Deliveries shall be scheduled so that placing and compacting of asphalt is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to approximately ambient temperature. The Contractor, at their expense, shall be responsible for repair of any damage to the pavement caused by hauling operations.

Contractor shall survey each lift of asphalt surface course and certify to ~~RPR~~ **OAR** that every lot of each lift meets the grade tolerances of paragraph 401-6.2e before the next lift can be placed.

Edges of existing asphalt pavement abutting the new work shall be saw cut and the cut off material and laitance removed. Apply a tack coat in accordance with P-603 before new asphalt material is placed against it.

The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the asphalt mix shall begin along the centerline of a crowned section or on the high side of areas with a one way slope unless shown otherwise on the laydown plan as accepted by the ~~RPR~~ **OAR**. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 15 feet (m) except where edge lanes require less width to complete the area. Additional screed sections attached to widen the paver to meet the minimum lane width requirements must include additional auger sections to move the asphalt mixture uniformly along the screed extension.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m). On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the asphalt may be spread and luted by hand tools.

The ~~RPR~~ **OAR** may at any time, reject any batch of asphalt, on the truck or placed in the mat, which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or overheated asphalt mixture. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the ~~RPR~~ **OAR**, and if it can be demonstrated in the laboratory, in the presence of the ~~RPR~~ **OAR**, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

Areas of segregation in the surface course, as determined by the ~~RPR~~ **OAR**, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraph 401-3.3, Table 2 for the approved mix design. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

4.12 COMPACTION OF ASPHALT MIXTURE

After placing, the asphalt mixture shall be thoroughly and uniformly compacted by self-propelled rollers. The surface shall be compacted as soon as possible when the asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any surface defects and/or displacement occurring as a result of the roller, or from any other cause, shall be corrected at the Contractor's expense.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the asphalt to the roller, the wheels shall be equipped with a scraper and kept moistened with water as necessary.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power tampers.

Any asphalt that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

4.13 JOINTS

The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid asphalt except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh asphalt against the joint.

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. An asphalt tack coat or other product approved by the ~~RPR~~ **OAR** shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint. The cost of this work shall be considered incidental to the cost of the asphalt.

4.14 SAW-CUT GROOVING

Saw-cut grooving is not required.

4.15 DIAMOND GRINDING

Diamond grinding shall be completed prior to pavement grooving. Diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive.

Diamond grinding shall be performed with a machine designed specifically for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Equipment or grinding procedures that causes ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

4.16 NIGHTTIME PAVING REQUIREMENTS

The Contractor shall provide adequate lighting during any nighttime construction. A lighting plan shall be submitted by the Contractor and approved by the ~~RPR~~ **OAR** prior to the start of any nighttime work. All work shall be in accordance with the approved CSPP and lighting plan.

PART 5 - CONTRACTOR QUALITY CONTROL (CQC)

5.1 GENERAL

The Contractor shall develop a CQCP in accordance with Item C-100. No partial payment will be made for materials that are subject to specific QC requirements without an approved CQCP.

5.2 CONTRACTOR QUALITY CONTROL (QC) FACILITIES

The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The ~~RPR~~ **OAR** shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The ~~RPR~~ **OAR** will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely

affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

5.3 QUALITY CONTROL (QC) TESTING

The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved CQCP. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A QC Testing Plan shall be developed as part of the CQCP.

A. Asphalt content

A minimum of two tests shall be performed per day in accordance with ASTM D6307 or ASTM D2172 for determination of asphalt content. When using ASTM D6307, the correction factor shall be determined as part of the first test performed at the beginning of plant production; and as part of every tenth test performed thereafter. The asphalt content for the day will be determined by averaging the test results.

B. Gradation

Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of extracted aggregate in accordance with ASTM D5444 and ASTM C136, and ASTM C117.

C. Moisture content of aggregate

The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C566.

D. Moisture content of asphalt

The moisture content of the asphalt shall be determined once per lot in accordance with AASHTO T329 or ASTM D1461.

E. Temperatures

Temperatures shall be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the asphalt at the plant, and the asphalt at the job site.

F. In-place density monitoring

The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

G. Smoothness for Contractor Quality Control

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the ~~RPR~~ **OAR**. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using the FAA profile program, ProFAA, or FHWA ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

- (1) Transverse measurements. Transverse measurements shall be taken for each day's production placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the ~~RPR~~ **OAR**. The joint between lanes shall be tested separately to facilitate smoothness between lanes.
- (2) Longitudinal measurements. Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously placed material the first measurement shall start with one half the length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 4.15 or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 401-6.1d(3) Areas that have been ground shall be sealed with a surface treatment in accordance with Item P-608. To avoid the surface treatment creating any conflict with runway or taxiway markings, it may be necessary to seal a larger area.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

- H. Grade. Grade shall be evaluated daily to allow adjustments to paving operations when grade measurements do not meet specifications. As a minimum, grade shall be evaluated prior to the placement of the first lift and then prior to and after placement of the surface lift.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically and 0.1 feet (30 mm) laterally. The documentation will be provided by the Contractor to the ~~RPR~~ **OAR** within 24 hours.

Areas with humps or depressions that exceed grade or smoothness criteria and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 4.15.

The Contractor shall repair low areas or areas that cannot be corrected by grinding by removal of deficient areas to the depth of the final course plus 1/2 inch and replacing with new material. Skin patching is not allowed.

5.4 SAMPLING

When directed by the ~~RPR~~ **OAR**, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

5.5 CONTROL CHARTS

The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day shall be calculated and monitored by the QC laboratory.

Control charts shall be posted in a location satisfactory to the ~~RPR~~ **OAR** and kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the ~~RPR~~ **OAR** may suspend production or acceptance of the material.

A. Individual measurements

Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts shall use the JMF target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

Control Chart Limits for Individual Measurements

Sieve	Action Limit	Suspension Limit
3/4 inch (19.0 mm)	±6%	±9%
1/2 inch (12.5 mm)	±6%	±9%
3/8 inch (9.5 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (300 µm)	±3%	±4.5%
No. 200 (75 µm)	±2%	±3%
Asphalt Content	±0.45%	±0.70%
Minimum VMA	-0.5%	-1.0%

B. Range

Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of $n = 2$. Should the Contractor elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for $n = 3$ and by 1.27 for $n = 4$.

Control Chart Limits Based on Range
(n = 2)

Sieve	Suspension Limit
1/2 inch (12.5 mm)	11%
3/8 inch (9.5 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (300 µm)	6%
No. 200 (75 µm)	3.5%
Asphalt Content	0.8%

C. Corrective action

The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain sets of rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

- (1) One point falls outside the Suspension Limit line for individual measurements or range;
- or
- (2) Two points in a row fall outside the Action Limit line for individual measurements.

5.6 QUALITY CONTROL (QC) REPORTS.

The Contractor shall maintain records and shall submit reports of QC activities daily, in accordance with the CQCP described in Item C-100.

PART 6 - MATERIAL ACCEPTANCE

6.1 QUALITY ASSURANCE ACCEPTANCE SAMPLING AND TESTING

Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the ~~RPR~~ **OAR** at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

A. Quality Assurance (QA) testing laboratory

The QA testing laboratory performing these acceptance tests will be accredited in accordance with ASTM D3666. The QA laboratory accreditation will be current and listed

on the accrediting authority's website. All test methods required for acceptance sampling and testing will be listed on the lab accreditation.

B. Lot Size

A standard lot will be equal to one day's production divided into approximately equal sublots of between 400 to 600 tons. When only one or two sublots are produced in a day's production, the sublots will be combined with the production lot from the previous or next day.

Where more than one plant is simultaneously producing asphalt for the job, the lot sizes will apply separately for each plant.

C. Asphalt air voids

Plant-produced asphalt will be tested for air voids on a subplot basis.

(1) Sampling. Material from each subplot shall be sampled in accordance with ASTM D3665. Samples shall be taken from material deposited into trucks at the plant or at the job site in accordance with ASTM D979. The sample of asphalt may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to maintain the material at or above the compaction temperature as specified in the JMF.

(2) Testing. Air voids will be determined for each subplot in accordance with ASTM D3203 for a set of three compacted specimens prepared in accordance with ASTM D6925.

D. In-place asphalt mat and joint density

Each subplot will be tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

(1) Sampling. The Contractor will cut minimum 5 inches (125 mm) diameter samples in accordance with ASTM D5361. The Contractor shall furnish all tools, labor, and materials for cleaning, and filling the cored pavement. Laitance produced by the coring operation shall be removed immediately after coring, and core holes shall be filled within one day after sampling in a manner acceptable to the ~~RPR~~ **OAR**.

(2) Bond. Each lift of asphalt shall be bonded to the underlying layer. If cores reveal that the surface is not bonded, additional cores shall be taken as directed by the ~~RPR~~ **OAR** to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as directed by the ~~RPR~~ **OAR**.

(3) Thickness. Thickness of each lift of surface course will be evaluated by the ~~RPR~~ **OAR** for compliance to the requirements shown on the plans after any necessary corrections for grade. Measurements of thickness will be made using the cores extracted for each subplot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch (6 mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, will not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or subplot shall be corrected by the

Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the ~~RPR~~ **OAR** to circumscribe the deficient area.

- (4) Mat density. One core shall be taken from each subplot. Core locations will be determined by the ~~RPR~~ **OAR** in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each subplot sample by the TMD for that subplot.
- (5) Joint density. One core centered over the longitudinal joint shall be taken for each subplot which contains a longitudinal joint. Core locations will be determined by the ~~RPR~~ **OAR** in accordance with ASTM D3665. The bulk specific gravity of each core sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the lot. The TMD used to determine the joint density at joints formed between lots will be the lower of the average TMD values from the adjacent lots.

6.2 ACCEPTANCE CRITERIA

A. General

Acceptance will be based on the implementation of the Contractor Quality Control Program (CQCP) and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density and grade. ***Test results for air voids, mat density and joint density shall be documented and delivered to the OAR within 24 hours of each lot's placement.***

B. Air voids

Acceptance of each lot of plant produced material for air voids will be based upon the average air void from the sublots. If the average air voids of the lot are equal to or greater than 2% and equal to or less than 5%, then the lot will be acceptable. If the average is below 2% or greater than 5%, the lot shall be removed and replaced at the Contractor's expense.

C. Mat density

Acceptance of each lot of plant produced material for mat density will be based on the average of all of the densities taken from the sublots. If the average mat density of the lot so established equals or exceeds 94%, the lot will be acceptable. If the average mat density of the lot is below 94%, the lot shall be removed and replaced at the Contractor's expense.

D. Joint density

Acceptance of each lot of plant produced asphalt for joint density will be based on the average of all of the joint densities taken from the sublots. If the average joint density of the lot so established equals or exceeds 92%, the lot will be acceptable. If the average joint density of the lot is less than 92%, the Contractor shall stop production and evaluate the method of compacting joints. Production may resume once the reason for poor compaction has been determined and appropriate measures have been taken to ensure proper compaction.

E. Grade

The final finished surface of the pavement of the completed project shall be surveyed to verify that the grade elevations and cross-sections shown on the plans do not deviate more than 1/2 inch (12 mm) vertically or 0.1 feet (30 mm) laterally.

Cross-sections of the pavement shall be taken at a minimum 50-foot (15-m) longitudinal spacing and at all longitudinal grade breaks. Minimum cross-section grade points shall include grade at edge of taxiway pavement and edge of shoulder pavement.

The survey and documentation shall be stamped and signed by a licensed surveyor. Payment for sublots that do not meet grade for over 25% of the subplot shall not be more than 95%.

6.3 RESAMPLING PAVEMENT FOR MAT DENSITY

A. General

Resampling of a lot of pavement will only be allowed for mat density and then, only if the Contractor requests same in writing, within 48 hours after receiving the written test results from the ~~RPR~~ **OAR**. A retest will consist of all the sampling and testing procedures contained in paragraphs 6.1. Only one resampling per lot will be permitted.

(1) A redefined mat density will be calculated for the resampled lot. The number of tests used to calculate the redefined mat density will include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

B. Payment for resampled lots

The redefined mat density for a resampled lot will be used to evaluate the acceptance of that lot in accordance with paragraph 6.2.

C. Outliers

Check for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and density determined using the remaining test values.

PART 7 - METHOD OF MEASUREMENT

7.1 MEASUREMENT

Plant mix asphalt mix pavement shall be measured by the number of tons (kg) of asphalt pavement used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.

PART 8 - BASIS OF PAYMENT

8.1 PAYMENT

Payment for a lot of asphalt mixture meeting all acceptance criteria as specified in paragraph 6.2 shall be made at the contract unit price per ton (kg) for asphalt. The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-403-8.1	Asphalt Mixture Surface Course	- per Ton (TN)

PART 9 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C183	Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979	Standard Practice for Sampling Bituminous Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
ASTM D1074	Standard Test Method for Compressive Strength of Bituminous Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125	Standard Test Methods for Asphalt Content of Bituminous mixtures by the Nuclear Method
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5581	Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen)
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6307	Standard Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder
ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyratory Compactor
ASTM D6926	Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
ASTM D6927	Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures

ASTM D6995	Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (Gmm)
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO T329	Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
AASHTO T 340	Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA)

Asphalt Institute (AI)

MS-2	Mix Design Manual, 7th Edition
MS-26	Asphalt Binder Handbook AI State Binder Specification Database

FAA Orders

5300.1	Modifications to Agency Airport Design, Construction, and Equipment Standards

Federal Highway Administration (FHWA)

Long Term Pavement Performance Binder program

Software

FAARFIELD

END OF SECTION P-403

SECTION P-501- CEMENT CONCRETE PAVEMENT

PART 1 - DESCRIPTION

- 1.1 This work shall consist of pavement composed of cement concrete with and without reinforcement constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans. Additional work items included in this specification include reinforced sidewalk pavement, raising existing utility structures to grade, and hurricane tie-downs. The terms cement concrete, hydraulic cement concrete, and concrete are interchangeable in this specification.

PART 2 - MATERIALS

2.1 AGGREGATES

A. Reactivity

Fine and Coarse aggregates to be used in PCC on this project shall be tested and evaluated by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Tests must be representative of aggregate sources which will be providing material for production. ASTM C1260 and ASTM C1567 tests may be run concurrently.

1. Coarse aggregate and fine aggregate shall be tested separately in accordance with ASTM C1260, however, the length of test shall be extended to 28 days (30 days from casting). Tests must have been completed within 6 months of the date of the concrete mix submittal.
2. The combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.
3. If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662 in lieu of ASTM C1567. If lithium nitrate admixture is used, it shall be nominal 30% $\pm$ 0.5% weight lithium nitrate in water. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce

the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

B. Fine aggregate

Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and the parameters identified in the fine aggregate material requirements below. Fine aggregate material requirements and deleterious limits are shown in the table below.

Fine Aggregate Material Requirements		
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Sand Equivalent	45 minimum	ASTM D2419
Fineness Modulus (FM)	$2.50 \leq FM \leq 3.40$	ASTM C136
Limits for Deleterious Substances in Fine Aggregate for Concrete		
Clay lumps and friable particles	1.0% maximum	ASTM C142
Coal and lignite	0.5% using a medium with a density of Sp. Gr. of 2.0	ASTM C123
Total Deleterious Material	1.0% maximum	

C. Coarse aggregate

The maximum size coarse aggregate shall be 1.5-inch.

Aggregates delivered to the mixer shall be clean, hard, uncoated aggregates consisting of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates shall have no known history of detrimental pavement staining. Steel blast furnace slag shall not be permitted. Coarse aggregate material requirements and deleterious limits are shown in the table below; washing may be required to meet aggregate requirements.

Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates	Loss after 5 cycles: 12% maximum using Sodium sulfate - or -	ASTM C88

Material Test	Requirement	Standard
by Use of Sodium Sulfate or Magnesium Sulfate	18% maximum using magnesium sulfate	
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 for any size group coarser than 3/8 (9.5 mm) sieve ¹	ASTM D4791
Bulk density of slag ²	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29
D-cracking (Freeze-Thaw) ³	Durability factor ≥ 95	ASTM C666

¹ A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

² Only required if slag is specified.

³ Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

Limits for Deleterious Substances in Coarse Aggregate

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (75 μ m)	ASTM C117	1.0 ¹
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert ² (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	1.0 ³

¹ The limit for material finer than 75- μ m is allowed to be increased to 1.5% for crushed aggregates consisting of dust of fracture that is essentially free from clay or shale. Test results supporting acceptance of increasing limit to 1.5% with statement indicating material is dust of fracture must be submitted with Concrete mix. Acceptable techniques to characterizing these fines include methylene blue adsorption or X-ray diffraction analysis.

² Chert and aggregates with less than 2.4 specific gravity.

³ The limit for chert may be increased to 1.0 percent by mass in areas not subject to severe freeze and thaw.

D. Combined aggregate gradation

This specification is targeted for a combined aggregate gradation developed following the guidance presented in United States Air Force Engineering Technical Letter (ETL) 97-5: Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements. Base the aggregate grading upon a combination of all the aggregates (coarse and fine) to be used for the mixture proportioning. Three aggregate sizes may be required to achieve an optimized combined gradation that will produce a workable concrete mixture for its intended use. Use aggregate gradations that produce concrete mixtures with well-graded or optimized aggregate combinations. The Contractor shall submit complete mixture information necessary to calculate the volumetric components of the mixture. The combined aggregate grading shall meet the following requirements:

1. The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in paragraph 2.1d(4) below, the point thus determined shall fall within the parallelogram described therein.

2. The CF shall be determined from the following equation:

$$CF = (\text{cumulative percent retained on the } 3/8 \text{ in. (9.5 mm) sieve})(100) / (\text{cumulative percent retained on the No. 8 (2.36 mm) sieve})$$

3. The WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).
4. A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary. The point determined by the plotting of the CF and WF may be adjusted during production ± 3 WF and ± 5 CF. Adjustments to gradation may not take the point outside of the parallelogram.

- E. Contractors combined aggregate gradation. The Contractor shall submit their combined aggregate gradation using the following format:

Contractor's Combined Aggregate Gradation

Sieve Size	Contractor's Concrete mix Gradation (Percent passing by weight)
2 inch (50 mm)	*
1-1/2 inch (37.5 mm)	*
1 inch (25.0 mm)	*
3/4 inch (19.0 mm)	*
1/2 inch (12.5 mm)	*
3/8 inch (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 16 (1.18 mm)	*
No. 30 (600 µm)	*
No. 50 (300 µm)	*
No. 100 (150 µm)	*

2.2 CEMENT

Cement shall conform to the requirements of ASTM C150 Type I/II or ASTM C595 Type IL.

2.3 CEMENTITIOUS MATERIALS

A. Fly ash

Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total alkali content less than 3% per ASTM C311. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)**.

B. Slag cement (ground granulated blast furnace (GGBF))

Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

C. Raw or calcined natural pozzolan

Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

D. Ultrafine fly ash and ultrafine pozzolan

UltraFine Fly Ash (UFFA) and UltraFine Pozzolan (UFP) shall conform to ASTM C618, Class F or N, and the following additional requirements:

1. The strength activity index at 28 days of age shall be at least 95% of the control specimens.
2. The average particle size shall not exceed 6 microns.

2.4 JOINT SEAL

The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-604 or P-605 and shall be of the type specified in the plans.

2.5 ISOLATION JOINT FILLER

Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1751 or ASTM D1752 and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the ~~RPR~~ **OAR**. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the ~~RPR~~ **OAR**.

2.6 STEEL REINFORCEMENT

Reinforcing shall consist of #4 Bars conforming to the requirements of ASTM A615.

2.7 DOWEL AND TIE BARS

Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete.

A. Dowel Bars

Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078, Type 1, with a coating thickness after curing greater than 10 mils. Patched ends are not required for Type 1 coated dowels. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted.

Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

B. Tie Bars

Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

2.8 WATER

Water used in mixing or curing shall be potable. If water is taken from other sources considered non-potable, it shall meet the requirements of ASTM C1602.

2.9 MATERIAL FOR CURING CONCRETE

Curing materials shall conform to one of the following specifications:

- A. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class A, or Class B.
- B. White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.
- C. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.
- D. Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

2.10 ADMIXTURES

Admixtures shall conform to the following specifications:

- A. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entraining agent and any water reducer admixture shall be compatible.
- B. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D.
- C. Other admixtures. The use of set retarding and set-accelerating admixtures shall be approved by the ~~RPR~~ **OAR** prior to developing the concrete mix. Retarding admixtures shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating admixtures shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

- D. Lithium Nitrate. The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

Lithium Admixture

Constituent	Limit (Percent by Mass)
LiNO ₃ (Lithium Nitrate)	30 ±0.5
SO ₄ (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium nitrate admixture dispensing and mixing operations shall be verified and certified by the lithium manufacturer's representative.

2.11 EPOXY-RESIN

All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

- A. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.
- B. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.
- C. Material for use for injecting cracks shall be Type IV, Grade 1.
- D. Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

2.12 BOND BREAKER

Choke stone shall be an ASTM C33 Number 89 stone.

2.13 **RAISED SIDEWALK PAVEMENT**

- A. **All materials for 6" Raised Sidewalk Concrete Pavement shall meet the material requirements of Specification P-610.**

2.14 HURRICANE TIE-DOWNS

- A. Hurricane tie-downs shall consist of a mooring device cast into the pavement in accordance with the plans and details at locations selected by the OAR. The mooring device shall be Neenah Model No. R-3490-A or approved equal and consist of Ductile Cast Iron (ASTM A-536). Reinforcing shall consist of #4 Bars conforming to the requirements of ASTM A615. Concrete shall conform to the requirements of this specification.**

PART 3 - CONCRETE MIX

3.1. GENERAL

No concrete shall be placed until an acceptable concrete mix has been submitted to the **RPR OAR** for review and the **RPR OAR** has taken appropriate action. The **RPR's OAR's** review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

3.2 CONCRETE MIX LABORATORY

The laboratory used to develop the concrete mix shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix must be included in the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the **RPR OAR** prior to start of construction.

3.3 CONCRETE MIX PROPORTIONS

Develop the mix using the procedures contained in Portland Cement Association (PCA) publication, "Design and Control of Concrete Mixtures." Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 6.6 for a flexural strength of 620 psi per ASTM C78.

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be 470 pounds per cubic yard (280 kg per cubic meter). The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be between 0.38 – 0.45 by weight.

Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. At the start of the project, the Contractor shall determine an allowable slump as determined by ASTM C143 not to exceed 2 inches (50 mm) for slip-form placement. For fixed-form placement, the slump shall not exceed 3 inches (75 mm). For hand placement, the slump shall not exceed 4 inches (100 mm).

The results of the concrete mix shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

If a change in source(s) is made, or admixtures added or deleted from the mix, a new concrete mix must be submitted to the **RPR OAR** for approval.

The **RPR OAR** may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

3.4 CONCRETE MIX SUBMITTAL

The concrete mix shall be submitted to the **RPR OAR** at least 30 days prior to the start of operations. The submitted concrete mix shall not be more than 180 days old and must use the materials to be used for production for the project. Production shall not begin until the concrete mix is approved in writing by the **RPR OAR**.

Each of the submitted concrete mixes (i.e, slip form, side form machine finish and side form hand finish) shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items and quantities as a minimum:

- Certified material test reports for aggregate in accordance with paragraph 2.1. Certified reports must include all tests required; reporting each test, test method, test result, and requirement specified (criteria).
- Combined aggregate gradations and analysis; and including plots of the fine aggregate fineness modulus.
- Reactivity Test Results.
- Coarse aggregate quality test results, including deleterious materials.
- Fine aggregate quality test results, including deleterious materials.
- Mill certificates for cement and supplemental cementitious materials.
- Certified test results for all admixtures, including Lithium Nitrate if applicable.
- Specified flexural strength, slump, and air content.
- Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
- Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- Correlation ratios for acceptance testing and Contractor QC testing, when applicable.

- Historical record of test results documenting production standard deviation, when applicable.

3.5 CEMENTITIOUS MATERIALS

A. Fly ash

When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

B. Slag cement (ground granulated blast furnace (GGBF))

Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight.

C. Raw or calcined natural pozzolan

Natural pozzolan may be used in the concrete mix. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

D. Ultrafine fly ash (UFFA) and ultrafine pozzolan (UFP)

UFFA and UFP may be used in the concrete mix with the ~~PRR's~~ **OAR's** approval. When UFFA and UFP is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 7% and 16% by weight of the total cementitious material.

3.6 ADMIXTURES

A. Air-entraining admixtures

Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 3.5%. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

B. Water-reducing admixtures

Water-reducing admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements.

Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

C. Other admixtures

Set controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

D. Lithium nitrate

Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 2.10d.

3.7 RAISED SIDEWALK PAVEMENT

The concrete mix design for 6" Raised Sidewalk Concrete Pavement shall meet the requirements of this Specification or Specification P-610. The Contractor shall clearly indicate on the mix design submittal the Specification to which the mix is designed.

PART 4 - CONSTRUCTION METHODS

4.1 CONTROL STRIP

The control strip(s) shall be to the next planned joint after the initial 250 feet (75 m) of each type of pavement construction (slip-form pilot lane, slip-form fill-in lane, or fixed form). The Contractor shall demonstrate, in the presence of the **RPR OAR**, that the materials, concrete mix, equipment, construction processes, and quality control processes meet the requirements of the specifications. The concrete mixture shall be extruded from the paver meeting the edge slump tolerance and with little or no finishing. Pilot, fill-in, and fixed-form control strips will be accepted separately. Minor adjustments to the mix design may be required to place an acceptable control strip. Minor adjustments to the mix design may be required to place an acceptable control strip. The production mix will be the adjusted mix design used to place the acceptable control strip. Upon acceptance of the control strip by the **RPR OAR**, the Contractor must use the same equipment, materials, and construction methods for the remainder of concrete paving. Any adjustments to processes or materials must be approved in advance by the **RPR OAR**. Acceptable control strips will meet edge slump tolerance and surface acceptable with little or no finishing, air content within action limits, strength equal or greater than requirements of P3.3. The control strip will be considered one lot for payment (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 8.1 using a lot pay factor equal to 100.

4.2 EQUIPMENT

The Contractor is responsible for the proper operation and maintenance of all equipment necessary for handling materials and performing all parts of the work to meet this specification.

A. Plant and equipment

The plant and mixing equipment shall conform to the requirements of ASTM C94 and/or ASTM C685. Each truck mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades. The truck mixers shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

Equipment for transferring and spreading concrete from the transporting equipment to the paving lane in front of the finishing equipment shall be provided. The equipment shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

B. Finishing equipment

1. Slip-form. The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements.
2. Fixed-form. On projects requiring less than 10,000 cubic yards (7650 cubic meters) of concrete pavement or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with equipment specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the **RPR OAR**. Hand screeding and float finishing may only be used on small irregular areas as allowed by the **RPR OAR**.

C. Vibrators

Vibrator shall be the internal type. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation or voids. The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309R, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means

to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the **RPR OAR**.

Hand held vibrators may only be used in irregular areas and shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

D. Concrete saws

The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

E. Fixed forms

Straight side fixed forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the **RPR OAR**. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the **RPR OAR**. The forms shall extend the full depth of the pavement section.

4.3 FORM SETTING

Forms shall be set to line and grade as shown on the plans, sufficiently in advance of the concrete placement, to ensure continuous paving operation. Forms shall be set to withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the concrete placement.

4.4 BASE SURFACE PREPARATION PRIOR TO PLACEMENT

Any damage to the prepared base, subbase, and subgrade shall be corrected full depth by the Contractor prior to concrete placement. The underlying surface shall be entirely free of frost when concrete is placed. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. Bond breaker shall be applied in accordance with 2.12.

4.5 HANDLING, MEASURING, AND BATCHING MATERIAL

Aggregate stockpiles shall be constructed and managed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Store and maintain all aggregates at a uniform moisture content prior to use. A continuous supply of materials shall be provided to the work to ensure continuous placement.

4.6 MIXING CONCRETE

The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are placed into the drum until the drum is emptied into the truck. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94 or ASTM C685.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is discharged from the truck should not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. In no case shall the temperature of the concrete when placed exceed 90°F (32°C). Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified is not exceeded.

4.7 WEATHER LIMITATIONS ON MIXING AND PLACING

No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

A. Cold weather

Unless authorized in writing by the **RPR OAR**, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

Curing during cold weather shall be in accordance with paragraph 4.13d.

B. Hot weather

During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The concrete placement shall be protected from exceeding an evaporation rate of 0.2 psf (0.98 kg/m² per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. If the Contractor's measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

Curing during hot weather shall be in accordance with paragraph 4.13e.

C. Temperature management program. Prior to the start of paving operation for each day of paving, the Contractor shall provide the ~~RPR~~ **OAR** with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. (Federal Highway Administration HIPERPAV 3 is one example of a temperature management program.) As a minimum, the program shall address the following items:

1. Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.
2. Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 19-9, PCA, Design and Control of Concrete Mixtures.
3. Anticipated timing of initial sawing of joint.
4. Anticipated number and type of saws to be used.

D. Rain

The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate

movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

4.8 CONCRETE PLACEMENT

At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi (3.8 MPa), based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. The Contractor must determine that the above minimum strengths are adequate to protect the pavement from overloads due to the construction equipment proposed for the project.

The Contractor shall have available materials for the protection of the concrete during cold, hot and/or inclement weather in accordance with paragraph 4.7.

A. Slip-form construction

The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without, segregation, voids, or vibrator trails and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude should be adjusted proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

Not more than 15% of the total free edge of each 500-foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge.

When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump will be removed the full width of the slip form lane and replaced at the expense of the Contractor as directed by the **RPR OAR**.

B. Fixed-form construction

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars / dowel bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and coated with a release agent each time they are used and before concrete is placed against them.

Concrete shall be spread, screed, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery. The equipment must be specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the **RPR OAR**.

Concrete for the full paving width shall be effectively consolidated by internal vibrators. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation, voids, or leaving vibrator trails.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

C. Consolidation

Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 2 inches (50 mm). Vibrators shall not be used to transport or spread the concrete. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) or over-consolidation (vibrator trails, segregation, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the **RPR OAR**.

If a lack of consolidation of the hardened concrete is suspected by the **RPR OAR**, referee testing may be required. Referee testing of hardened concrete will be performed by the **RPR OAR** by cutting cores from the finished pavement after a minimum of 24 hours curing. The **RPR OAR** shall visually examine the cores for evidence of lack of consolidation. Density determinations will be made by the **RPR OAR** based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m²) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original concrete mix density, with no cores having a density of less than 96% of the original concrete mix density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

4.9 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT

Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screed. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

4.10 JOINTS

Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2-inch (12 mm) from their designated position and shall be true to line with not more than 1/4-inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12-foot (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

- A. Construction. Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

- B. Contraction

Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the

concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

C. Isolation (expansion)

Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint. The filler shall be fastened uniformly along the hardened joint face with no buckling or debris between the filler and the concrete interface, including a temporary filler for the sealant reservoir at the top of the slab. The edges of the joint shall be finished and tooled while the concrete is still plastic.

D. Dowels and Tie Bars for Joints

1. Tie bars

Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth and within the tolerances in paragraph 4.10(f.). When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.

2. Dowel bars

Dowel bars shall be placed across joints in the proper horizontal and vertical alignment as shown on the plans. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the **RPR OAR**. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

3. Placing dowels and tie bars

Horizontal spacing of dowels shall be within a tolerance of $\pm 3/4$ inch (19 mm). The vertical location on the face of the slab shall be within a tolerance of $\pm 1/2$ inch (12 mm). The method used to install dowels shall ensure that the horizontal and vertical alignment will not be greater than 1/4 inch per foot (6 mm per 0.3 m), except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

- (a) Contraction joints. Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

At the Contractor's option, dowels and tie bars in contraction joints may be installed by insertion into the plastic concrete using approved equipment and procedures per the paver manufacturer's design. Approval of installation methods will be based on the results of the control strip showing that the dowels and tie bars are installed within specified tolerances as verified by cores or non-destructive rebar location devices approved by the **RPR OAR**.

- (b) Construction joints. Install dowels and tie bars by the cast-in-place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms.
- (c) Joints in hardened concrete. Install dowels in hardened concrete by bonding the dowels into holes drilled into the concrete. The concrete shall have cured for seven (7) days or reached a minimum flexural strength of 450 psi (3.1 MPa) before drilling begins. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur. Spalling beyond the limits of the grout retention ring will require modification of the equipment and operation. Depth of dowel hole shall be within a tolerance of $\pm 1/2$ inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole by means of a suitable metal or plastic grout retention ring fitted around the dowel.

E. Sawing of joints

Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial saw-cut and maintained for the remaining cure period.

Joints shall be cut in locations as shown on the plans. The initial joint cut shall be a minimum 1/8 inch (3 mm) wide and to the depth shown on the plans. Prior to placement of joint sealant or seals, the top of the joint shall be widened by sawing as shown on the plans.

4.11 FINISHING

Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, edging of joints, and then texturing. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Equipment, mixture, and/or procedures which produce more than 1/4 inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way. Fog (mist) sprays or other surface applied finishing aids specified to prevent plastic shrinkage cracking, approved by the **RPR OAR**, may be used in accordance with the manufacturers requirements.

A. Machine finishing with slipform pavers

The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. Equipment, mixture, and/or procedures which produce more than 1/4 inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Remove excessive slurry from the surface with a cutting straightedge and wipe off the edge. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

B. Machine finishing with fixed forms

The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

C. Other types of finishing equipment

Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the ~~RPR's~~ **OAR's** approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

D. Hand finishing

Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical.

E. Straightedge testing and surface correction

After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a 12-foot (3.7-m) finishing straightedge swung from handles capable of spanning at least one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

4.12 SURFACE TEXTURE

The surface of the pavement shall be finished as designated below for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. The texture shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the ~~RPR~~ **OAR**.

A. Brush or broom finish

Shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface. ***All 6" raised sidewalk pavement sections shall receive a brush or broom finish.***

B. Burlap drag finish

Not used.

C. Artificial turf finish

Not used.

4.13 CURING

Immediately after finishing operations are completed and bleed water is gone from the surface, all exposed surfaces of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-saw-cut method is used to construct the contraction joint, the curing compound shall be applied to the saw-cut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

A. Impervious membrane method

Curing with liquid membrane compounds should not occur until bleed and surface moisture has evaporated. All exposed surfaces of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 square feet (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the ~~RPR~~ **OAR**, a double application rate shall be used to ensure coverage. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of

the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

B. White burlap-polyethylene sheets

The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

C. Water method

The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

D. Concrete protection for cold weather

Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the 7-day curing period. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

E. Concrete protection for hot weather

Concrete should be continuous moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the **RPR OAR**.

4.14 REMOVING FORMS

Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured in accordance with paragraph 4.13.

If honeycombed areas are evident when the forms are removed, materials, placement, and consolidation methods must be reviewed and appropriate adjustments made to assure adequate consolidation at the edges of future concrete placements. Honeycombed areas that extend into the slab less than approximately 1 inch (25 mm),

shall be repaired with an approved grout, as directed by the ~~RPR~~ **OAR**. Honeycombed areas that extend into the slab greater than a depth of 1 inch (25 mm) shall be considered as defective work and shall be removed and replaced in accordance with paragraph 4.19.

4.15 SAW-CUT GROOVING

~~If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.~~

4.16 SEALING JOINTS

The joints in the pavement shall be sealed in accordance with Items P-604 and P-605.

4.17 PROTECTION OF PAVEMENT

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until accepted by the ~~RPR~~ **OAR**. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the ~~RPR~~ **OAR**.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days, the joints are protected, the concrete has attained a minimum field cured flexural strength of 450 psi (3100 kPa), and the slab edge is protected.

All new and existing pavement carrying construction traffic or equipment shall be kept clean and spillage of concrete and other materials shall be cleaned up immediately.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

4.18 OPENING TO CONSTRUCTION TRAFFIC

The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of 450 pounds per square inch (3100 kPa) when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be

sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

4.19 REPAIR, REMOVAL, OR REPLACEMENT OF SLABS

New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable as defined by acceptance criteria in paragraph 6.6 shall be removed and replaced or repaired, as directed by the **RPR OAR**, at the Contractor's expense. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The **RPR OAR** will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall have a diameter of 2 inches (50 mm) to 4 inches (100 mm), shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with a bonding agent, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. Repair of cracks as described in this section shall not be allowed if in the opinion of the **RPR OAR** the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

A. Shrinkage cracks

Shrinkage cracks which do not exceed one-third of the pavement depth shall be cleaned and either high molecular weight methacrylate (HMWM) applied; or epoxy resin (Type IV, Grade 1) pressure injected using procedures recommended by the manufacturer and approved by the **RPR OAR**. Sandblasting of the surface may be required following the application of HMWM to restore skid resistance. Care shall be taken to ensure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the **RPR OAR**. Shrinkage cracks which exceed one-third the pavement depth shall be treated as full depth cracks in accordance with paragraphs 4.19b and 19c.

B. Slabs with cracks through interior areas

Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than one-third the pavement depth, that extend into the interior area.

C. Cracks close to and parallel to joints

All full-depth cracks within 6 inches (150 mm) either side of the joint and essentially parallel to the original joints, shall be treated as follows.

1. Full depth cracks and original joint not cracked. The full-depth crack shall be treated as the new joint and the original joint filled with an epoxy resin.

- i. Full-depth crack. The joint sealant reservoir for the crack shall be formed by sawing to a depth of 3/4 inches (19 mm), $\pm 1/16$ inch (2 mm), and to a width of 5/8 inch (16 mm), $\pm 1/8$ inch (3 mm). The crack shall be sawed with equipment specially designed to follow random cracks. Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent raveling or spalling. The joint shall be sealed with sealant in accordance with P-605 or as directed by the ~~RPR~~ **OAR**.
- ii. Original joint. If the original joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures.

Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

2. Full depth cracks and original joint cracked. If there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced.

D. Removal and replacement of full slabs

Make a full depth cut perpendicular to the slab surface along all edges of the slab with a concrete saw cutting any dowels or tie-bars. Remove damaged slab protecting adjacent pavement from damage. Damage to adjacent slabs may result in removal of additional slabs as directed by the ~~RPR~~ **OAR** at the Contractor's expense.

The underlying material shall be repaired, re-compacted and shaped to grade.

Dowels of the size and spacing specified for other joints in similar pavement on the project shall be installed along all four (4) edges of the new slab in accordance with paragraph 4.10d.

Placement of concrete shall be as specified for original construction. The joints around the new slab shall be prepared and sealed as specified for original construction.

E. Spalls along joints

1. Spalls less than one inch wide and less than the depth of the joint sealant reservoir, shall be filled with joint sealant material.
2. Spalls larger than one inch and/or deeper than the joint reservoir, but less than $\frac{1}{2}$ the slab depth, and less than 25% of the length of the adjacent joint shall be repaired as follows:

- (a) Make a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inches (50 mm). Saw cuts shall be straight lines forming rectangular areas surrounding the spalled area.
 - (b) Remove unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete between the saw cut and the joint or crack with a light chipping hammer.
 - (c) Clean cavity with high-pressure water jets supplemented with compressed air as needed to remove all loose material.
 - (d) Apply a prime coat of epoxy resin, Type III, Grade I, to the dry, cleaned surface of all sides and bottom of the cavity, except any joint face.
 - (e) Fill the cavity with low slump concrete or mortar or with epoxy resin concrete or mortar.
 - (f) An insert or other bond-breaking medium shall be used to prevent bond at all joint faces.
 - (g) A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints.
3. Spalls deeper than 1/2 of the slab depth or spalls longer than 25% of the adjacent joint require replacement of the entire slab.

F. Diamond grinding of Concrete surfaces

Diamond grinding shall be completed prior to pavement grooving. Diamond grinding of the hardened concrete should not be performed until the concrete is at least 14 days old and has achieved full minimum strength. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified.

Diamond grinding shall be performed with a machine specifically designed for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with sufficient number of flush cut blades that create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The Contractor shall determine the number and type of blades based on the hardness of the aggregate. Contractor shall demonstrate to the ~~RPR~~ **OAR** that the grinding equipment will produce satisfactory results prior to making corrections to surfaces.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. All grinding shall be at the expense of the Contractor.

4.20 RAISED SIDEWALK CONCRETE PAVEMENT

The Contractor shall adhere to all Construction Methods in this specification as is practicable. The OAR shall approve the use of methods included in Specification P-610 as applicable during construction.

4.21 HURRICANE TIE-DOWNS

Hurricane tie-downs shall be installed in accordance with the manufacturer's recommendations. Mooring devices shall be cast in place with the pavement in accordance with the plans and details. The Contractor shall take appropriate measures to protect the mooring device during construction.

PART 5 - CONTRACTOR QUALITY CONTROL (CQC)

5.1 QUALITY CONTROL PROGRAM

The Contractor shall develop a Quality Control Program in accordance with Item C-100. No partial payment will be made for materials that are subject to specific quality control requirements without an approved quality control program.

5.2 CONTRACTOR QUALITY CONTROL (CQC)

The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The ~~RPR~~ **OAR** shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The ~~RPR~~ **OAR** will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

5.3 CONTRACTOR QC TESTING

The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to this specification and as set forth in the CQCP. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content. A QC Testing Plan shall be developed and approved by the ~~RPR~~ **OAR** as part of the CQCP.

The ~~RPR~~ **OAR** may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the ~~RPR~~ **OAR**, and if it

can be demonstrated in the laboratory, in the presence of the ~~RPR~~ **OAR**, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

A. Fine aggregate

1. Gradation. A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.
2. Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.
3. Deleterious substances. Fine aggregate as delivered to the mixer shall be tested for deleterious substances in fine aggregate for concrete as specified in paragraph 2.1b, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

B. Coarse Aggregate

1. Gradation. A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.
2. Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.
3. Deleterious substances. Coarse aggregate as delivered to the mixer shall be tested for deleterious substances in coarse aggregate for concrete as specified in paragraph 2.1c, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

C. Slump

One test shall be made for each subplot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

D. Air content

One test shall be made for each subplot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

E. Unit weight and Yield

One test shall be made for each subplot. Unit weight and yield tests shall be in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

F. Temperatures

Temperatures shall be checked at least four times per lot at the job site in accordance with ASTM C1064.

G. Smoothness for Contractor Quality Control

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than $\frac{1}{4}$ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues.

The Contractor may use a 12-foot (3.7 m) straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the ~~RPR~~ **OAR**. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using the FAA profile program, ProFAA, or FHWA profile program ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

1. Transverse measurements. Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the ~~RPR~~ **OAR**. The joint between lanes shall be tested separately to facilitate smoothness between lanes.
2. Longitudinal measurements. Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously placed material the first measurement shall start with one half the length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 4.19f or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 6.6.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

H. Grade

Grade will be evaluated prior to and after placement of the concrete surface.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically and 0.1 feet (30 mm) laterally. The documentation will be provided by the Contractor to the ~~RPR~~ **OAR** within 48 hours.

Areas with humps or depression that exceed grade or smoothness and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. If these areas cannot be corrected with grinding then the slabs that are retaining water must be removed and replaced in accordance with paragraph 4.19d. Grinding shall be in accordance with paragraph 4.19f. All corrections will be at the Contractors expense.

5.4 CONTROL CHARTS

The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content. The Contractor shall also maintain a control chart plotting the coarseness factor/workability factor from the combined gradations in accordance with paragraph 2.1d.

Control charts shall be posted in a location satisfactory to the ~~RPR~~ **OAR** and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the ~~RPR~~ **OAR** may halt production or acceptance of the material.

A. Fine and coarse aggregate gradation

The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Superimposed on the control charts shall be the action and suspension limits. Gradation tests shall be performed by the Contractor per ASTM C136. The Contractor shall take at least two samples per lot to check the final gradation. Sampling shall be per ASTM D75 from the flowing aggregate stream or conveyor belt.

B. Slump and air content

The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

C. Combined gradation. The Contractor shall maintain a control chart plotting the coarseness factor and workability factor on a chart in accordance with paragraph 2.1d.

Control Chart Limits¹

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Gradation ²	*3	*3
Coarseness Factor (CF)	±3.5	±5
Workability Factor (WF)	±2	±3
Slump	+0.5 to -1 inch (+13 to -25 mm)	+1 to -1.5 inch (+25 to -38 mm)
Air Content	±1.5%	±2.0%

¹ Control charts shall developed and maintained for each control parameter indicated.

² Control charts shall be developed and maintained for each sieve size.

³ Action and suspension limits shall be determined by the Contractor.

5.5 CORRECTIVE ACTION AT SUSPENSION LIMIT

The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of control. The CQCP shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

A. Fine and coarse aggregate gradation. When two consecutive averages of five tests are outside of the suspension limits, immediate steps, including a halt to production, shall be taken to correct the grading.

- B. Coarseness and Workability factor. When the CF or WF reaches the applicable suspension limits, the Contractor, immediate steps, including a halt to production, shall be taken to correct the CF and WF.
- C. Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher shall be adjusted.
- D. Slump. The Contractor shall halt production and make appropriate adjustments whenever:
 - 1. one point falls outside the Suspension Limit line for individual measurements
 - OR
 - 2. two points in a row fall outside the Action Limit line for individual measurements.
- E. Air content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:
 - 1. one point falls outside the Suspension Limit line for individual measurements
 - OR
 - 2. two points in a row fall outside the Action Limit line for individual measurements.

PART 6 - MATERIAL ACCEPTANCE

6.1 QUALITY ASSURANCE (QA) ACCEPTANCE SAMPLING AND TESTING

All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the ~~RPR~~ **OAR**. The Contractor shall provide adequate facilities for the initial curing of beams. The Contractor shall bear the cost of providing initial curing facilities and coring and filling operations, per paragraph 6.5b(1).

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

6.2 QUALITY ASSURANCE (QA) TESTING LABORATORY

Quality assurance testing organizations performing these acceptance tests will be accredited in accordance with ASTM C1077. The quality assurance laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods will be submitted to the ~~RPR~~ **OAR** prior to start of construction.

6.3 LOT SIZE

Concrete will be accepted for strength and thickness on a lot basis. A lot will consist of a day's production not to exceed 2,000 cubic yards (1530 cubic meters). This is the equivalent of 4,000 square yards of 18-inch thick PCC or 6,000 SY of 12-inch thick PCC. Each lot will be divided into approximately equal sublots with individual sublots between 400 to 600 cubic yards. Where three sublots are produced, they will constitute a lot. Where one or two sublots are produced, they will be incorporated into the previous or next lot. Where more than one plant is simultaneously producing concrete for the job, the lot sizes will apply separately for each plant.

6.4 PARTIAL LOTS

When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot or for overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they will constitute a lot. Where one or two sublots have been produced, they will be incorporated into the next lot or the previous lot and the total number of sublots will be used in the acceptance criteria calculation, that is, $n=5$ or $n=6$.

6.5 ACCEPTANCE SAMPLING AND TESTING

A. Strength

1. Sampling. One sample will be taken for each subplot from the concrete delivered to the job site. Sampling locations will be determined by the ~~RPR~~ **OAR** in accordance with random sampling procedures contained in ASTM D3665. The concrete will be sampled in accordance with ASTM C172.
2. Test Specimens. The ~~RPR~~ **OAR** will be responsible for the casting, initial curing, transportation, and curing of specimens in accordance with ASTM C31. Two (2) specimens will be made from each sample and slump, air content, unit weight, and temperature tests will be conducted for each set of strength specimens. Within 24 to 48 hours, the samples will be transported from the field to the laboratory while in the molds. Samples will be cured in saturated lime water.

The strength of each specimen will be determined in accordance with ASTM C78. The strength for each subplot will be computed by averaging the results of the two test specimens representing that subplot.

3. Acceptance. Acceptance of pavement for strength will be determined by the ~~RPR~~ **OAR** in accordance with paragraph 6.6b(1). All individual strength tests within a lot will be checked for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and the remaining test values will be used to determine acceptance in accordance with paragraph 6.5b.

B. Pavement thickness

1. Sampling. One core will be taken by the Contractor for each subplot in the presence of the ~~RPR~~ **OAR**. Sampling locations will be determined by the ~~RPR~~ **OAR** in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, will be excluded from sample locations.

Cores shall be a minimum 4 inch (100 mm) in diameter neatly cut with a core drill. The Contractor will furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes will be filled by the Contractor with a non-shrink grout approved by the ~~RPR~~ **OAR** within one day after sampling.

2. Testing. The thickness of the cores will be determined by the ~~RPR~~ **OAR** by the average caliper measurement in accordance with ASTM C174. Each core shall be photographed and the photograph included with the test report.
3. Acceptance. Acceptance of pavement for thickness will be determined by the ~~RPR~~ **OAR** in accordance with paragraph 6.6.

6.6 ACCEPTANCE CRITERIA

A. General

Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 6.5b:

1. Strength
2. Thickness
3. Grade
4. ~~Profilograph smoothness~~
5. Adjustments for repairs

Acceptance for strength, thickness, and grade, will be based on the criteria contained in accordance with paragraph 6.6b(1), 6.6b(2), and 6.6b(3), respectively. Acceptance for profilograph smoothness will be based on the criteria contained in paragraph 6.6b(4).

Production quality must achieve 90 PWL or higher to receive full payment.

Strength and thickness will be evaluated for acceptance on a lot basis using the method of estimating PWL. Production quality must achieve 90 PWL or higher to receive full pavement. The PWL will be determined in accordance with procedures specified in Item C-110.

The lower specification tolerance limit (L) for strength and thickness will be:

Lower Specification Tolerance Limit (L)

Strength	$0.93 \times \text{strength specified in paragraph 3.3}$
Thickness	Lot Plan Thickness in inches, - 0.50 in

B. Acceptance criteria

1. Strength. If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 8.1.
2. Thickness. If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 8.1.
3. Grade. The final finished surface of the pavement of the completed project will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically [or 0.1 feet (30 mm) laterally]. The documentation, stamped and signed by a licensed surveyor shall be in accordance with paragraph 5.3h. Payment for sublots that do not meet grade for over 25% of the sublot shall reduced by 5% and not be more than 95%.
4. ~~Profilograph roughness for QA Acceptance. The final profilograph shall be the full length of the project to facilitate testing of roughness between lots. The Contractor, in the presence of the RPR shall perform a profilograph roughness test on the completed project with a profilograph meeting the requirements of ASTM E1274 or a Class I inertial profiler meeting ASTM E950. Data and results shall be provided within 48 hrs of profilograph roughness tests.~~

~~The pavement shall have an average profile index less than 15 inches per mile per 1/10 mile. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must grind" bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and~~

~~operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). Profilograph shall be performed one foot right and left of project centerline and 15 feet (4.5 m) right and left of project centerline. Any areas that indicate "must grind" shall be corrected with diamond grinding per paragraph 4.19f or by removing and replacing full depth of surface course, as directed by the RPR. Where corrections are necessary, a second profilograph run shall be performed to verify that the corrections produced an average profile index of 15 inches per mile per 1/10 mile or less.~~

5. Adjustments for repair. Sublots with spall repairs, crack repairs, or partial panel replacement, will be limited to no more than 95% payment.
6. Adjustment for grinding. For sublots with grinding over 25% of a subplot, payment will be reduced 5%.

6.7 **RAISED SIDEWALK CONCRETE PAVEMENT**

Concrete for each day's placement will be accepted on the basis of the compressive strength as specified in Specification P-610, Section 4.1. The OAR will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

PART 7 - METHOD OF MEASUREMENT

- 7.1 Concrete pavement shall be measured by the number of square yards (~~square meters~~) of plain or reinforced pavement as specified in-place, completed and accepted.
- 7.2 ***Raised sidewalk concrete pavement shall be measured by the number of square yards of plain reinforced pavement as specified in-place, completed and accepted.***
- 7.3 ***Hurricane tie-downs shall be measured by each number (EA) of mooring devices installed as specified, completed and accepted by the OAR.***

PART 8 - BASIS OF PAYMENT

8.1 PAYMENT

Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 6.6. Acceptance Criteria shall be based on results of strength, smoothness, and thickness tests. Payment for acceptable lots of concrete pavement shall be adjusted in accordance

with paragraph 8.1a for strength and thickness; 8.1b for repairs; 8.1c for grinding; and 8.1d for smoothness, subject to the limitation that:

The total project payment for concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of square yards (square meters) of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings.

A. Basis of adjusted payment

The pay factor for each individual lot shall be calculated in accordance with the Price Adjustment Schedule table below. A pay factor shall be calculated for both strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both strength and thickness are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both strength and thickness are less than 100%.

Price Adjustment Schedule¹

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject ²

¹ Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% shall be subject to the total project payment limitation specified in paragraph 8.1.

² The lot shall be removed and replaced unless, after receipt of FAA concurrence, the Owner and Contractor agree in writing that the lot will remain; the lot paid at 50% of the contract unit price; and the total project payment limitation reduced by the amount withheld for that lot.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 8.1. Payment in excess of 100% for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100%; except for rejected lots which remain in place and/or sublots with adjustments for repairs.

B. Adjusted payment for repairs

The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots which contain repairs in accordance with paragraph 4.19 on more than 20% of the slabs within the subplot. Payment factors greater than 100 percent for the strength and thickness cannot be used to offset adjustments for repairs.

C. Adjusted payment for grinding

The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots with grinding over 25% of a subplot.

~~D. Profilograph Roughness~~

~~The Contractor will receive full payment when the profilograph average profile index is in accordance with paragraph 6.6b(4). When the final average profile index for the entire length of pavement does not exceed 15 inches per mile per 1/10 mile, payment will be made at the contract unit price for the completed pavement.~~

E. ***Raised sidewalk concrete pavement***

No PWL lot pay factors shall be applied to concrete placed as raised sidewalk concrete pavement.

F. Payment

Payment shall be made under:

Item P-501-8.1	18" Aircraft Rated Concrete Pavement	- per Square Yard (SY)
Item P-501-8.2	12" Non-Aircraft Rated Concrete Pavement	- per Square Yard (SY)
Item P-501-8.3	6" Raised Sidewalk Concrete Pavement	- per Square Yard (SY)
Item P-501-8.4	Raise Existing Structures to Grade	- per Each (EA)
Item P-501-8.5	Hurricane Tie-Down	- per Each (EA)

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1035	Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM C29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete

ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064	Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface
American Concrete Institute (ACI)	
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
Advisory Circulars (AC)	
AC 150/5320-6	Airport Pavement Design and Evaluation
Federal Highway Administration (FHWA)	
HIPERPAV 3, version 3.2	
Portland Concrete Association (PCA)	
PCA	Design and Control of Concrete Mixtures, 16 th Edition

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

CEMENT CONCRETE PAVEMENT
SECTION P-501

U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD)

CRD C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

United States Air Force Engineering Technical Letter (ETL)

ETL 97-5	Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

END OF SECTION P-501

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ITEM P-602 - EMULSIFIED ASPHALT PRIME COAT

PART 1 - DESCRIPTION

- 1.1 This item shall consist of an application of emulsified asphalt material on the prepared base course in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

PART 2 - MATERIALS

2.1 EMULSIFIED ASPHALT MATERIAL

The emulsified asphalt material shall be as specified in ASTM D3628 for use as a prime coat appropriate to local conditions. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the emulsified asphalt material. The COA shall be provided to and approved by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)** before the emulsified asphalt material is applied. The furnishing of the COA for the emulsified asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

PART 3 - CONSTRUCTION METHODS

3.1 WEATHER LIMITATIONS

The emulsified asphalt prime coat shall be applied only when the existing surface is dry; the atmospheric temperature is 50°F (10°C) or above, and the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the ~~RPR~~ **OAR**.

3.2 EQUIPMENT

The equipment shall include a self-powered pressure asphalt material distributor and equipment for heating asphalt material.

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 65.0 psi (4.5 kg/sq cm) of tire width to prevent rutting, shoving or otherwise damaging the base, surface or other layers in the pavement structure. Design and equip the distributor to spray the asphalt material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 1.0 gallons per square yard (0.23 to 4.5 L/square meter), with a pressure range of 25 to 75 psi (172.4 to 517.1 kPa) and with an allowable variation from the specified rate of not more than ±5%, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer,

pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying asphalt material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the asphalt material during the heating process. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

A power broom and power blower suitable for cleaning the surfaces to which the asphalt coat is to be applied shall be provided.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the **RPR OAR**.

3.3 APPLICATION OF EMULSIFIED ASPHALT MATERIAL

Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material.

The asphalt emulsion material shall be uniformly applied with an asphalt distributor at the rate of 0.15 to 0.30 gallons per square yard (0.68 to 1.36 liters per square meter) depending on the base course surface texture. The type of asphalt material and application rate shall be approved by the **RPR OAR** prior to application.

Following application of the emulsified asphalt material and prior to application of the succeeding layer of pavement, allow the asphalt coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread sand to effectively blot up and cure excess asphalt material. The Contractor shall remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Owner. Keep traffic off surfaces freshly treated with asphalt material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

3.4 TRIAL APPLICATION RATES

The Contractor shall apply a minimum of three lengths of at least 100 feet (30 m) for the full width of the distributor bar to evaluate the amount of emulsified asphalt material that can be satisfactorily applied with the equipment. Apply three different application rates of emulsified asphalt materials within the application range specified in paragraph 3.3. Other trial applications can be made using various amounts of material as directed by the ~~RPR~~ **OAR**. The trial application is to demonstrate the equipment can uniformly apply the emulsified asphalt material within the rates specified and determine the application rate for the project.

3.5 FREIGHT AND WAYBILLS

The Contractor shall submit waybills and delivery tickets during the progress of the work. Before the final estimate is allowed, file with the ~~RPR~~ **OAR** certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

PART 4 - METHOD OF MEASUREMENT

- 4.1 The emulsified asphalt material for prime coat shall be measured by the gallon (liter). Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D4311. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

Application rates shall be determined using before and after readings of volume, in gallons, provided by the Contractor, for each work areas. The OAR shall determine the application rate by recording the volume provided over the area applied, in square yards. Application rates and an exhibit demonstrating the area of work shall be provided to the Engineer by the OAR at the end of the day's work.

PART 5 - BASIS OF PAYMENT

- 5.1 Payment shall be made at the contract unit price per gallon (liter) for emulsified asphalt prime coat. This price shall be full compensation for furnishing all materials and for all preparation, delivering, and applying the materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

EMULSIFIED ASPHALT PRIME COAT
ITEM P-602

Item P-602-5.1	Emulsified Asphalt Prime Coat	- per Gallon (GAL)

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

June 26, 2022

ITEM P-603 - EMULSIFIED ASPHALT TACK COAT

PART 1 - DESCRIPTION

- 1.1 This item shall consist of preparing and treating an asphalt or concrete surface with asphalt material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

PART 2 - MATERIALS

2.1 ASPHALT MATERIALS

The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)** before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

PART 3 - CONSTRUCTION METHODS

3.1 WEATHER LIMITATIONS

The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the ~~RPR~~ **OAR**.

3.2 EQUIPMENT

The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of

triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the ~~RPR~~ **OAR**.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

3.3 APPLICATION OF EMULSIFIED ASPHALT MATERIAL

The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the ~~RPR~~ **OAR** prior to application.

Emulsified Asphalt

Surface Type	Residual Rate, gal/SY (L/square meter)	Emulsion Application Bar Rate, gal/SY (L/square meter)
New asphalt	0.02-0.05 (0.09-0.23)	0.03-0.07 (0.13-0.32)
Existing asphalt	0.04-0.07 (0.18-0.32)	0.06-0.11 (0.27-0.50)
Milled Surface	0.04-0.08 (0.18-0.36)	.006-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the ~~RPR~~ **OAR**. The Contractor shall protect the tack

coat and maintain the surface until the next course has been placed. When the tack coat has been disturbed by the Contractor, tack coat shall be reapplied at the Contractor's expense.

3.4 FREIGHT AND WAYBILLS

The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the ~~RPR~~ **OAR** certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

PART 4 - METHOD OF MEASUREMENT

- 4.1 The emulsified asphalt material for tack coat shall be measured by the gallon (liter). Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

Application rates shall be determined using before and after readings of volume, in gallons, provided by the Contractor, for each work area. The OAR shall determine the application rate by recording the volume provided over the area applied, in square yards. Application rates and an exhibit demonstrating the area of work shall be provided to the Engineer by the OAR at the end of the day's work.

PART 5 - BASIS OF PAYMENT

- 5-1 Payment shall be made at the contract unit price per gallon (liter) of emulsified asphalt material. This price shall be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-603-5.1 Emulsified Asphalt Tack Coat - per Gallon (GAL)

PART 6 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

END OF ITEM P-603

ITEM P-604 - COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS

PART 1 - DESCRIPTION

- 1.1 This item shall consist of preformed polychloroprene compression seals used for sealing joints of rigid pavements.

PART 2 - MATERIALS

2.1 COMPRESSION SEALS

Compression joint seal materials shall be a vulcanized elastomeric compound using polychloroprene as the only base polymer. The material and the manufactured seal shall conform to ASTM D2628.

The joint seal shall be a labyrinth type seal. The uncompressed depth of the face of the compression seal (that is to be bonded to the joint wall) shall be greater than the uncompressed width of the seal, except that for seals one inch (25 mm) or greater in width, the depth need be only one inch (25 mm) or greater. The actual width of the uncompressed seal shall be as recommended by the joint seal manufacturer for the type and width of joints as shown on the plans. The tolerance on the seal shall be +1/8 inch or -1/16 inch (+3 mm or -2 mm), below the top of the pavement surface or bottom of groove for grooved pavement.

The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the joint seal material delivered to the project. The COA shall be provided to and approved by the ~~RPR~~ OAR before the material is installed. The furnishing of the vendor's certified test report shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided at the job site to protect materials from weather and maintain materials at temperatures recommended by the manufacturer.

Representative sample of joint seal material will be sampled and retained by the ~~RPR~~ OAR for possible testing.

2.2 LUBRICANT/ADHESIVE

Lubricant/adhesive used for the compression elastomeric joint seal shall be a one-component compound conforming to ASTM D2835.

PART 3 - CONSTRUCTION METHODS

3.1 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved by the ~~RPR~~ OAR before the work starts and shall be maintained by the Contractor in satisfactory condition at all times.

A. Joint cleaning equipment

1. Concrete saw. A self-propelled power saw with water-cooled diamond saw blades shall be provided for cutting joints to the depths and widths specified and for removing filler, existing old joint seal or other material embedded in the joints or adhered to the joint faces.
2. Waterblasting equipment. Waterblasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, a wand with safety release cutoff controls, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary water resupply equipment shall be of sufficient capacity to permit continuous operations. The pumps, hoses, wand, and nozzle shall be of sufficient capacity to permit the cleaning of both walls of the joint and the pavement surface for a width of at least 1/2 inch (12 mm) on either side of the joint. The pump shall be capable of supplying a pressure of at least 3,000 psi (20.7 MPa). A pressure gauge mounted at the pump shall show at all times the pressure in pounds per square inch (psi) (kPa) at which the equipment is operating.
3. Sandblasting equipment. Sandblasting equipment shall include an air compressor, hose, and a long-wearing venturi-type nozzle of proper size, shape, and opening. The maximum nozzle opening should not exceed 1/4 inch (6 mm). The air compressor shall be portable and shall be capable of furnishing not less than 150 cubic feet (4200 liters) per minute and maintaining a line pressure of not less than 90 psi (620 kPa) at the nozzle while in use. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint about one inch (25 mm) above the pavement surface and will direct the blast to clean the joint walls. The height, angle of inclination, and the size of the nozzle shall be adjusted as necessary to ensure satisfactory results.

- B. Sealing equipment. Equipment used to install the compression seal shall place the compression seal to the prescribed depths within the specified tolerances without cutting, nicking, twisting, or otherwise damaging the seal. The equipment shall not stretch or compress the seal more than 2.0% longitudinally during installation. The machine shall be an automatic self-propelled joint seal application equipment and shall be engine powered. The machine shall include a reservoir for the lubricant/adhesive, a device for conveying the lubricant/adhesive in the proper quantities to the sides the preformed seal or the sidewalls of the joint, a reel capable of holding one full spool of compression seal, and a power-driven apparatus for feeding the joint seal through a compression device and inserting the seal into the joint. The equipment shall also include a guide to maintain the

proper course along the joint being sealed. The machine shall at all times be operated by an experienced operator.

Hand operated joint seal application equipment may be used for localized areas and for projects less than 500 square yards (450 square meters). The equipment shall be a two-axle, four-wheel machine that includes means for compressing and inserting the compression seal into the joint and a reel capable of holding one full spool of compression seal material.

PART 4 - CONSTRUCTION METHODS

4.1 ENVIRONMENTAL CONDITIONS

The ambient temperature and the pavement temperature within the joint wall shall be at least 35°F (2°C) and rising at the time of installation of the materials. Sealant application will not be permitted if moisture or any foreign material is observed in the joint.

4.2 TRIAL JOINT SEAL AND LUBRICANT/ADHESIVE INSTALLATION

Prior to the cleaning and sealing of the joints for the entire project, a control strip at least 200 feet (69 meters) long shall be prepared at a location designated by the ~~RPR~~ OAR using the specified materials and the approved equipment, to demonstrate the materials and construction processes for joint preparation and sealing of all types of joints included in the project. No other joints shall be sealed until the test installation has been approved by the ~~RPR~~ OAR.

If materials or installation do not meet requirements, the materials shall be removed, and the joints shall be cleaned and a new trial joint seal installation shall be performed at the Contractor's expense. The ~~RPR~~ OAR approved trial section will be incorporated into the permanent work.

4.3 PREPARATION OF JOINTS

Immediately before installation of the compression joint seal, the joints shall be thoroughly cleaned to remove all laitance, filler, existing sealer, foreign material and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Cleaning shall extend along pavement surfaces at least 1/2 inch (12 mm) on either side of the joint. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left free of debris and water. Any irregularity in the joint face that would prevent uniform contact between the joint seal and the joint face shall be corrected prior to the installation of the joint seal.

- A. Sawing. Joints shall be sawed to clean and to open them to the full specified width and depth. Immediately following the sawing operation, the joint faces and opening shall be thoroughly cleaned using a water jet to remove all saw cuttings or debris remaining on the faces or in the joint opening. Compression seal shall be installed within three (3) calendar

days of the time the joint cavity is sawed. Depth of the joint cavity shall be in accordance with manufacturer's instructions. Submit printed copies of manufacturers' instructions 60 days prior to use on the project. The saw cut for the joint seal cavity shall at all locations be centered over the joint line. The nominal width of the sawed joint seal cavity shall be as follows; the actual width shall be within a tolerance of $\pm 1/16$ inch (2 mm):

1. If a nominal $13/16$ inch (21 mm) wide compression seal is furnished, the nominal width of the saw cut shall be $1/2$ inches (12.5 mm) when the pavement temperature at the time of sawing is between 30 and 110°F (-1 and 43°C). If the pavement temperature at the time of sawing is above this range, the nominal width of the saw cut shall be decreased $1/16$ inch (2 mm). If the pavement temperature at the time of sawing is below this range, the nominal width of the saw cut shall be increased $1/16$ inch (2 mm).
 2. If a nominal one inch (25 mm) wide compression seal is furnished, the nominal width of the saw cut shall be $9/16$ inches (14 mm) when the pavement temperature at the time of sawing is between 30 and 170°F (-1 and 77°C). If the pavement temperature at the time of sawing is above this range, the nominal width of the saw cut shall be decreased $1/16$ inch (2 mm). If the pavement temperature at the time of sawing is below this range, the nominal width of the saw cut shall be increased $1/16$ inch (2 mm).
 3. The pavement temperature shall be measured and recorded in the presence of the RPR OAR. Measurement shall be made each day before commencing sawing and at any other time during the day when the temperature appears to be moving out of the allowable sawing range.
- B. Waterblast cleaning. The concrete joint faces and pavement surfaces extending at least $1/2$ inch (12 mm) from the joint edges shall be waterblasted clean. A multiple pass technique shall be used until the surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water.
- C. Sandblast cleaning. The concrete joint faces and pavement surfaces extending at least $1/2$ inch (12 mm) from the joint edges shall be sandblasted clean. A multiple pass technique shall be used until the surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water.
- D. Rate of progress. Cleaning of the joint faces shall be limited to the linear footage of joint that can be sealed during the same workday.

4.4 INSTALLATION OF THE COMPRESSION SEAL

- A. Time of installation. Joints shall be sealed within 3 calendar days of sawing the joint seal cavity and the final cleaning of the joint walls, or a temporary seal shall be installed to prevent infiltration of foreign material. If rain interrupts the sealing operations, the joints shall be washed, cleaned with air and be dry before proceeding with installing of the lubricant/adhesive and compression seal.
- B. Installation Sequence. Longitudinal joints shall be sealed first, then seal the transverse joints. Transverse joint seals will be continuous from edge to edge of the pavement. Intersections shall be made monolithic by use of joint seal adhesive and care in fitting the intersection parts together. Seals which do not reach an intersection shall be removed and replaced with new seal as directed by the ~~RPR~~ OAR at the Contractor's Expense. Seal extender pieces shall not be used at intersections.
- C. Sealing joints. The sides of the joint seal or the sides of the joint shall be covered with a coating of lubricant/adhesive and the seal installed as specified. Butt joints and seal intersections shall be coated with liberal applications of lubricant/adhesive. Lubricant/adhesive spilled on the pavement shall be removed immediately to prevent setting on the pavement.

The joint seal shall be placed at a uniform depth within the tolerances specified. The compression joint seal shall be placed to a depth of 3/16 inch (5 mm), $\pm 1/8$ inch (3 mm), below the pavement surface or below the depth of the groove unless otherwise directed by the ~~RPR~~ OAR.

The seal shall be installed in the longest practicable lengths in longitudinal joints and shall be cut at the joint intersections to provide continuous installation of the seal in the transverse joints. The joint seal shall be installed in an upright position, free from twisting, distortion, and cuts. If stretch of installed joint seal exceeds 1%, adjustments shall be made to the installation equipment and procedure. Stretch of installed joint seals exceeding 2% stretch shall be removed and replaced.

After installation of the longitudinal joint seals, it shall set for a minimum of one (1) hour prior to cutting the seal at the joint intersections. For all transverse joints, the minimum length of the preformed joint seal shall be the pavement width from edge to edge.

4.5 CLEAN-UP

Upon completion of the project, all unused materials shall be removed from the site, all lubricant/adhesive on the pavement surface shall be removed, and the pavement shall be left in clean condition.

4.6 QUALITY CONTROL AND QUALITY ASSURANCE

- A. Quality Control. The application equipment shall be inspected to assure uniform application of lubricant/adhesive to the sides of the compression joint seal or the walls of the joint. Equipment causing cutting, twisting, nicking, excessive stretching or

compressing of the compression seal, or improper application of the lubricant/adhesive, shall not be used until causes of the deficiencies are determined and corrected by the Contractor.

The seal shall be inspected by the Contractor a minimum of once per 400 feet (120 m) of seal for compliance to the shrinkage or compression requirements. Measurements shall be made at the same interval to determine conformance with depth and width installation requirements.

- B. Quality Assurance. Cleaned joints shall be approved by the ~~RPR~~ OAR prior to installation of the lubricant/adhesive and compression joint seal.

Conformance to stretching and compression limitations shall be determined by the ~~RPR~~ OAR using the following procedures:

1. Mark the top surface of the compression seal at one foot (30 cm) intervals in a manner clear and durable to enable length determinations of the seal.
2. After installation, the distance between the marks on the seal shall be measured by the Contractor.
3. If the stretching or compression exceeds the specified limit, the seal shall be removed and replaced with new joint seal at the Contractor's Expense. The seal shall be removed up to the last correct measurement.

4.7 ACCEPTANCE

The joint sealing system (compression seal and lubricant/adhesive) shall be inspected by the ~~RPR~~ OAR for proper rate of cure and bonding to the concrete, cuts, twists, nicks, and other deficiencies. Seals exhibiting any defects prior to final acceptance of the project, shall be removed from the joint, wasted, and replaced with new material in a satisfactory manner, at the Contractor's expense, as determined by the ~~RPR~~ OAR.

PART 5 - METHOD OF MEASUREMENT

5.1 MEASUREMENT

Compression joint seals shall be considered incidental and no separate measurement shall be made.

PART 6 - BASIS OF PAYMENT

6.1 PAYMENT

Compression joint seals shall be considered incidental and no separate payment shall be made.

PART 7 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D2628	Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

ASTM D2835	Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements

Corps of Engineers

CRD C548	Standard Specification for Jet-Fuel and Heat Resistant Preformed Polychloroprene Elastomeric Joint Seals for Rigid Pavements

Unified Facilities Criteria (UFC)

UFC 3-250-08FA	Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements

END OF ITEM P-604

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

COMPRESSION JOINT SEALS FOR
CONCRETE PAVEMENTS
ITEM P-604

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ITEM P-605 JOINT SEALANTS FOR PAVEMENTS

PART 1 - DESCRIPTION

- 1.1 This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints in pavement; joints between different types of pavements; and cracks in existing pavement.

PART 2 - MATERIALS

2.1 JOINT SEALANTS

Joint sealant materials shall meet the requirements of D6690.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

2.2 BACKER ROD

The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant in accordance with ASTM D5249. The backer-rod material shall be $25\% \pm 5\%$ larger in diameter than the nominal width of the joint.

2.3 BOND BREAKING TAPES

Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material shall have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

PART 3 - CONSTRUCTION METHODS

3.1 TIME OF APPLICATION

Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be 50°F (10°C) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

3.2 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 30 days prior to use on the project.

- A. Tractor-mounted routing tool. Provide a routing tool, used for removing old sealant from the joints, of such shape and dimensions and so mounted on the tractor that it will not damage the sides of the joints. The tool shall be designed so that it can be adjusted to remove the old material to varying depths as required. The use of V-shaped tools or rotary impact routing devices will not be permitted. Hand-operated spindle routing devices may be used to clean and enlarge random cracks.
- B. Concrete saw. Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified.
- C. Sandblasting equipment. The Contractor must demonstrate sandblasting equipment including the air compressor, hose, guide and nozzle size, under job conditions, before approval in accordance with paragraph 3.3. The Contractor shall demonstrate, in the presence of the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)**, that the method cleans the joint and does not damage the joint.
- D. Waterblasting equipment. The Contractor must demonstrate waterblasting equipment including the pumps, hose, guide and nozzle size, under job conditions, before approval in accordance with paragraph 3.3. The Contractor shall demonstrate, in the presence of the ~~RPR~~ **OAR**, that the method cleans the joint and does not damage the joint.
- E. Hand tools. Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.
- F. Hot-poured sealing equipment. The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

3.3 PREPARATION OF JOINTS

Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. The Contractor shall demonstrate, in the presence of the ~~RPR~~ **OAR**, that the method cleans the joint and does not damage the joint.

- A. Sawing. All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.
- B. Sealing. Immediately before sealing, the joints shall be thoroughly cleaned of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant and other foreign material from the sides and upper edges of the joint space to be sealed. Cleaning shall be accomplished by sandblasting, tractor-mounted routing equipment, concrete saw or waterblaster as specified in paragraph 3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm) from it. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.
- C. Backer Rod. When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a backer rod in accordance with paragraph 2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.
- D. Bond-breaking tape. Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-separating tape breaker in accordance with paragraph 2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

3.4 INSTALLATION OF SEALANTS

Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the ~~RPR~~ **OAR** before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch (6 mm) $\pm$ 1/16 inch (2 mm) below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the ~~RPR~~ **OAR**. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

3.5 INSPECTION.

The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

3.6 CLEAN-UP.

Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

PART 4 - METHOD OF MEASUREMENT

4.1 Joint sealing shall be considered incidental and no separate measurement shall be made.

PART 5 - BASIS OF PAYMENT

5.1 Joint sealing shall be considered incidental and no separate payment shall be made.

PART 6 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D789	Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)
ASTM D5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt]

Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids

END OF ITEM P-605

ITEM P-606 ADHESIVE COMPOUNDS, TWO-COMPONENT FOR SEALING WIRE AND
LIGHTS IN PAVEMENT

PART 1 - DESCRIPTION

- 1.1 This specification covers two types of material; a liquid suitable for sealing electrical wire in saw cuts in pavement and for sealing light fixtures or bases in pavement, and a paste suitable for embedding light fixtures in the pavement. Both types of material are two-component filled formulas with the characteristics specified in paragraph 2.4. Materials supplied for use with asphalt and/or concrete pavements must be formulated so they are compatible with the asphalt and/or concrete.

PART 2 - MATERIALS

2.1 CURING

When pre-warmed to 77°F (25°C), mixed, and placed in accordance with manufacturer's directions, the materials shall cure at temperatures of 45°F (7°C) or above without the application of external heat.

2.2 STORAGE

The adhesive components shall not be stored at temperatures over 86°F (30°C), unless otherwise specified by the manufacturer.

2.3 CAUTION

Installation and use shall be in accordance with the manufacturer's recommended procedures. Avoid prolonged or repeated contact with skin. In case of contact, wash with soap and flush with water. If taken internally, call doctor. Keep away from heat or flame. Avoid vapor. Use in well-ventilated areas. Keep in cool place. Keep away from children.

2.4 CHARACTERISTICS

When mixed and cured in accordance with the manufacturer's directions, the materials shall have the following properties shown in Table 1.

Table 1. Property Requirements

Physical or Electrical Property	Minimum	Maximum	ASTM Method
Tensile			
Portland cement concrete	1,000 psi (70 kg/sq cm)		D 638
Asphalt concrete	500 psi (35 kg/sq cm)		
Elongation			
Portland cement concrete		See note ¹	D 638
Asphalt concrete	50%		D 638
Coef. of cub. exp. cu. cm/cu. cm/°C	0.00090	0.00120	D 1168
Coef. of lin. exp. cm/cm/°C	0.000030	0.000040	D 1168
Dielectric strength, short time test	350 volts/mil.		D 149
Arc resistance	125 sec		
Pull-off			
Adhesion to steel	1,000 psi (70 kg/sq cm)		
Adhesion to Portland cement concrete	200 psi (14 kg/sq cm)		
Adhesion to asphalt concrete	No test available.		
Adhesion to aluminum	250 psi		

¹ 20% or more (without filler) for formulations to be supplied for areas subject to freezing.

PART 3 - SAMPLING, INSPECTION, AND TEST PROCEDURES

3.1 TENSILE PROPERTIES

Tests for tensile strength and elongation shall be conducted in accordance with ASTM D638.

3.2 EXPANSION

Tests for coefficients of linear and cubical expansion shall be conducted in accordance with, Method B, except that mercury shall be used instead of glycerine. The test specimen shall be mixed in the proportions specified by the manufacturer, and cured in a glass tub approximately 2 inch (50 mm) long by 3/8 inch (9 mm) in diameter. The interior of the tube shall be precoated with a silicone mold release agent. The hardened sample shall be

removed from the tube and aged at room temperature for one (1) week before conducting the test. The test temperature range shall be from 35°F (2°C) to 140°F (60°C).

3.3 TEST FOR DIELECTRIC STRENGTH

Test for dielectric strength shall be conducted in accordance with ASTM D149 for sealing compounds to be furnished for sealing electrical wires in pavement.

3.4 TEST FOR ARC RESISTANCE

Test for arc resistance shall be conducted for sealing compounds to be furnished for sealing electrical wires in pavement.

3.5 TEST FOR ADHESION TO STEEL

The ends of two smooth, clean, steel specimens of convenient size (1 inch by 1 inch by 6 inch) (25 mm by 25 mm by 150 mm) would be satisfactory when bonded together with adhesive mixture and allowed to cure at room temperature for a period of time to meet formulation requirements and then tested to failure on a Riehle (or similar) tensile tester. The thickness of adhesive to be tested shall be 1/4 inch (6 mm).

3.6 ADHESION TO PORTLAND CEMENT CONCRETE

A. Concrete test block preparation. The aggregate grading shall be as shown in Table 2.

The coarse aggregate shall consist of crushed rock having a minimum of 75% of the particles with at least one fractured face and having a water absorption of not more than 1.5%. The fine aggregate shall consist of crushed sand manufactured from the same parent rock as the coarse aggregate. The concrete shall have a water-cement ratio of 5.5 gallons (21 liters) of water per bag of cement, a cement factor of 6, ± 0.5 , bags of cement per cubic yard (0.76 cubic meter) of concrete, and a slump of 2-1/2 inch (60 mm), $\pm 1/2$ inch (60 mm ± 12 mm). The ratio of fine aggregate to total aggregate shall be approximately 40% by solid volume. The air content shall be 5.0%, $\pm 0.5\%$, and it shall be obtained by the addition to the batch of an air-entraining admixture such as Vinsol® resin. The mold shall be of metal and shall be provided with a metal base plate.

Means shall be provided for securing the base plate to the mold. The assembled mold and base plate shall be watertight and shall be oiled with mineral oil before use. The inside measurement of the mold shall be such that several one inch (25 mm) by 2-inch (75 mm) by 3-inch (25 mm by 50 mm by 75 mm) test blocks can be cut from the specimen with a concrete saw having a diamond blade. The concrete shall be prepared and cured in accordance with ASTM C192.

Table 2. Aggregate for Bond Test Blocks

Type	Sieve Size	Percent Passing
Coarse Aggregate	3/4 inch (19.0 mm)	97 to 100
	1/2 inch (12.5 mm)	63 to 69
	3/8 inch (9.5 mm)	30 to 36
	No. 4 (4.75 mm)	0 to 3
Fine Aggregate	No. 4 (4.75 mm)	100
	No. 8 (2.36 mm)	82 to 88
	No. 16 (1.18 mm)	60 to 70
	No. 30 (600 µm)	40 to 50
	No. 50 (300 µm)	16 to 26
	No. 100 (150 µm)	5 to 9

- B. Bond test. Prior to use, oven-dry the test blocks to constant weight at a temperature of 220°F to 230°F (104°C to 110°C), cool to room temperature, 73.4°F ±3°F (23°C ±1.6°C), in a desiccator, and clean the surface of the blocks of film or powder by vigorous brushing with a stiff-bristled fiber brush. Two test blocks shall be bonded together on the one inch by 3 inch (25 mm by 75 mm) sawed face with the adhesive mixture and allowed to cure at room temperature for a period of time to meet formulation requirements and then tested to failure in a Riehle (or similar) tensile tester. The thickness of the adhesive to be tested shall be 1/4 inch (6 mm).

3.7 COMPATIBILITY WITH ASPHALT MIX

Test for compatibility with asphalt in accordance with ASTM D5329.

3.8 ADHESIVE COMPOUNDS - CONTRACTOR'S RESPONSIBILITY

The Contractor shall furnish the vendor's certified test reports for each batch of material delivered to the project. The report shall certify that the material meets specification requirements and is suitable for use with concrete and asphalt concrete pavements. The report shall be provided to and accepted by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)** before use of the material. In addition, the Contractor shall obtain a statement from the supplier or manufacturer that guarantees the material for one year. The supplier or manufacturer shall furnish evidence that the material has performed satisfactorily on other projects.

3.9 APPLICATION

Adhesive shall be applied on a dry, clean surface, free of grease, dust, and other loose particles. The method of mixing and application shall be in strict accordance with the manufacturer's recommendations. When used with Item P-605, such as light can installation, Item P-605 shall not be applied until the Item P-606 has fully cured.

PART 4 - METHOD OF MEASUREMENT

- 4.1 ~~The adhesive compound shall be measured by the gallon (l) of adhesive as specified, in place, complete and accepted.~~ When required in the installation of an in-runway in-pavement lighting system or portion thereof, no measurement will be made for direct payment of adhesive, as the cost of furnishing and installing shall be considered as a subsidiary obligation in the completion of the installation.

PART 5 - BASIS OF PAYMENT

- 5.1 No payment shall be made for the adhesive. This item shall be considered as a subsidiary obligation in the completion of the installation of the in-pavement lighting system. This includes furnishing all materials, and all preparation, delivering, and application of these materials, and all labor, equipment, tools, and incidentals necessary to complete the item.

PART 6 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D5329	Standard Test Methods for Sealants and Fillers, Hot-applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements

END OF ITEM P-606

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

ADHESIVE COMPOUNDS,
TWO-COMPONENT FOR SEALING
WIRE AND LIGHTS IN PAVEMENT
ITEM P-606

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ITEM P-608 EMULSIFIED ASPHALT SEAL COAT

PART 1 - DESCRIPTION

- 1.1 This item shall consist of the application of a emulsified asphalt surface treatment composed of an emulsion of natural and refined asphalt materials, water and a polymer additive, for taxiways and runways with the application of a suitable aggregate to maintain adequate surface friction; and airfield secondary and tertiary pavements including low-speed taxiways, shoulders, overruns, roads, parking areas, and other general applications with or without aggregate applied as designated on the plans. The terms seal coat, asphalt sealer, and asphalt material are interchangeable throughout this specification. The term emulsified asphalt means an emulsion of natural and refined asphalt materials.

PART 2 - MATERIALS

2.1 AGGREGATE

The aggregate material shall be a dry, clean, dust and dirt free, sound, durable, angular shaped manufactured specialty sand, such as that used as an abrasive, with a Mohs hardness of 6 to 8. The Contractor shall submit the specialty sand manufacturer's technical data and a manufacturer's Certificate of Analysis (COA) indicating that the specialty sand meets the requirements of the specification to the ~~RPR~~ **Owner's Authorized Representative (OAR)** prior to start of construction. The sand must be approved for use by the ~~RPR~~ **OAR** and shall meet the following gradation limits when tested in accordance with ASTM C136 and ASTM C117:

Aggregate Material Gradation Requirements¹

Sieve Designation (square openings)	Individual Percentage Retained by Weight
No. 10 (2.00 mm)	0
No. 14 (1.41 mm)	0-4
No. 16 (1.18 mm)	0-8
No. 20 (850 µm)	0-35
No. 30 (600 µm)	20-50
No. 40 (425 µm)	10-45
No. 50 (300 µm)	0-20
No. 70 (212 µm)	0-5
No. 100 (150 µm)	0-2
No. 200 (75 µm)	0-2

¹ Locally available sand or abrasive material that is slightly outside of the gradation requirements may be approved by the RPR with concurrence by the seal coat manufacturer for the use of locally available sand or abrasive material. The ~~RPR~~ **OAR**

and manufacturer's field representative should verify acceptance during application of Control strips indicated under paragraph 3.2.

The Contractor shall provide a certification showing particle size analysis and properties of the material delivered for use on the project. The Contractor's certification may be subject to verification by testing the material delivered for use on the project.

2.2 ASPHALT EMULSION

The asphalt emulsion shall meet the properties in the following table:

Concentrated Asphalt Emulsion Properties

Properties	Specification	Limits
Viscosity, Saybolt Furol at 77°F (25°C)	ASTM D7496	20 – 100 seconds
Residue by Distillation or Evaporation	ASTM D6997 or ASTM D6934	57% minimum
Sieve Test	ASTM D6933	0.1% maximum
24-hour Stability	ASTM D6930	1% maximum
5-day Settlement Test	ASTM D6930	5.0% maximum
Particle Charge ¹	ASTM D7402	Positive 6.5 maximum pH

¹ pH may be used in lieu of the particle charge test which is sometimes inconclusive in slow setting, asphalt emulsions.

The asphalt material base residue shall contain not less than 20% gilsonite, or uitaite and shall not contain any tall oil pitch or coal tar material and shall contain no less than one percent (1%) polymer.

Tests on Residue from Distillation or Evaporation

Properties	Specification	Limits
Viscosity at 275°F (135°C)	ASTM D4402	1750 cts maximum
Solubility in 1, 1, 1 trichloroethylene	ASTM D2042	97.5% minimum
Penetration	ASTM D5	50 dmm maximum
Asphaltenes	ASTM D2007	15% minimum
Saturates	ASTM D2007	15% maximum
Polar Compounds	ASTM D2007	25% minimum
Aromatics	ASTM D2007	15% minimum

The asphalt emulsion, when diluted in the volumetric proportion of two parts concentrated asphalt material to one part hot water shall have the following properties:

One-to-One Dilution Emulsion Properties

Properties	Specification	Limits
In Ready-to-Applied Form, one part concentrate to one part water, by volume		
Viscosity, Saybolt Furol at 77°F (25°C)	ASTM D7496	5 – 50 seconds
Residue by Distillation or Evaporation	ASTM D6997 or ASTM D6934	28.5% minimum
Pumping Stability ¹		Pass

¹ Pumping stability is tested by pumping one pint (475 ml) of seal coat diluted one (1) part concentrate to one (1) part water, at 77°F (25°C), through a 1/4-inch (6 mm) gear pump operating 1750 rpm for 10 minutes with no significant separation or coagulation.

Two-to-One Dilution Emulsion Properties

Properties	Specification	Limits
In Ready-to-Applied Form, two parts concentrate to one part water, by volume		
Viscosity, Saybolt Furol at 77°F (25°C)	ASTM D7496	5 – 50 seconds
Residue by Distillation or Evaporation	ASTM D6997 or ASTM D6934	38% minimum
Pumping Stability ¹		Pass

¹ Pumping stability is tested by pumping one pint (475 ml) of seal coat diluted one (1) part concentrate to one (1) part water, at 77°F (25°C), through a 1/4-inch (6 mm) gear pump operating 1750 rpm for 10 minutes with no significant separation or coagulation.

The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the emulsified asphalt delivered to the project. If the asphalt emulsion is diluted at other than the manufacturer's facility, the Contractor shall provide a supplemental COA from an independent laboratory verifying the asphalt emulsion properties.

The COA shall be provided to and approved by the ~~RPR~~ **OAR** before the emulsified asphalt is applied. The furnishing of the vendor's certified test report for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

The asphalt material storage and handling temperature shall be between 50°F - 160°F (10°C - 70°C) and the material shall be protected from freezing, or whenever outside temperature drops below 40°F (4°C) for prolonged time periods.

Contractor shall provide a list of airport pavement projects, exposed to similar climate conditions, where this product has been successfully applied within at least 5 years of the project.

2.3 WATER

Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use. Water used in making and diluting the emulsion shall be potable, with a maximum hardness of 90ppm calcium and 15ppm magnesium; deleterious iron, sulfates, and phosphates maximum 7ppm, and less than 1ppm of organic byproducts. Water shall be a minimum of 140°F (60°C) prior to adding to emulsion.

2.4 POLYMER

The polymer shall meet the properties in the following table:

Polymer Properties

Properties	Limits
Solids Content	47% to 65%, Percent by Weight
Weight	8.0 to 9.0 pounds/gallon (1.07 to 1.17 kg/L)
pH	3.0 to 8.0
Particle Charge	Nonionic/Cationic
Mechanical Stability	Excellent
Film Forming Temperature, °C	+5°C, minimum
Tg, °C	22°C, maximum

The manufacturer shall provide a copy of the Certificate of Analysis (COA) for the polymer used in the seal coat; and the Contractor shall include the COA with the emulsified asphalt COA when submitting to the RPR **OAR**.

2.5 SEAL COAT WITH AGGREGATE

The Contractor shall submit friction test data from no less than one of the airport projects identified under 2.2. The test data must be from the same project and include technical details on application rates, aggregate rates, and point of contact at the airport to confirm use and success of sealer with aggregate.

Friction test data in accordance with AC 150/5320-12, at 40 or 60 mph (65 or 95 km/h) wet, must include as a minimum; the friction value prior to sealant application; two values, between 24 and 96 hours after application, with a minimum of 24 hours between tests; and one value between 180 days and 360 days after the application. The results of the tests between 24 and 96 hours shall indicate friction is increasing at a rate to obtain similar friction value of the pavement surface prior to application, and the long-term test shall indicate no apparent adverse effect with time relative to friction values and existing pavement surface.

Seal coat material submittal without required friction performance will not be approved. Friction tests performed on this project cannot be used as a substitute of this requirement.

PART 3 - COMPOSITION AND APPLICATION RATE

3.1 APPLICATION RATE

The approximate amounts of materials per square yard (square meter) for the asphalt surface treatment shall be as provided in the table for the treatment area(s) at the specified dilution rate(s) as noted on the plans. The actual application rates will vary within the range specified to suit field conditions and will be recommended by the manufacturer's representative and approved by the ~~RPR~~ **OAR** from the test area/sections evaluation.

Application Rate

Dilution Rate	Quantity of Emulsion gal/yd ² (l/m ²)	Quantity of Aggregate lb/yd ² (kg/m ²)
4:1	~~0.10-0.17~~ (~~0.45-0.77~~)	~~0.20-0.50~~ (~~0.11-0.27~~)
2:1	0.08-0.17 (0.36-0.77)	0.20-0.50 (0.11-0.27)

3.2 CONTROL AREAS AND CONTROL STRIPS

Prior to full application, the control strip must be accepted by the ~~RPR~~ **OAR**. The surface preparation, personnel, equipment, and method of operation used on the test area(s) and control strip(s) shall be the same as used on the remainder of the work.

A qualified manufacturer's representative shall be present in the field to assist the Contractor in applying control areas and/or control strips to determine the appropriate application rate of both emulsion and aggregate to be approved by the RPR.

A test area(s) and control strip(s) shall be applied for each differing asphalt pavement surface identified in the project. The test area(s) and control strip(s) shall be used to determine the material application rate(s) of both emulsion and sand prior to full production.

- A. For taxiway, taxilane and apron surfaces. Prior to full application, the Contractor shall place test areas at varying application rates as recommended by the Contractor's manufacturer's representative to determine appropriate application rate(s). The test areas will be located on representative section(s) of the pavement to receive the asphalt surface treatment designated by the ~~RPR~~ **OAR**.

~~B. For runway and high speed exit taxiway surfaces. Prior to full application, the Contractor shall place a series of control strips a minimum of 300 feet (90 m) long by 12 feet (3.6 m) wide, or width of anticipated application, whichever is greater, at varying application rates as recommended by the manufacturer's representative and acceptable to the RPR **OAR** to determine appropriate application rate(s). The control strips should be separated by a minimum of 200 feet between control strips. The area to be tested will be located on a representative section of the pavement to receive the asphalt surface treatment designated by the RPR **OAR**. The control strips should be placed under similar field conditions as anticipated for the actual application. The skid resistance of the existing pavement shall be determined for each control strip with a continuous friction measuring equipment (CFME). The skid resistance of existing pavement can be immediately adjacent to the control strip or at the same location as the control strip if testing prior to application. The Contractor may begin testing the skid resistance of runway and high-speed exit taxiway control strips after application of the asphalt surface treatment has fully cured, generally 8 to 36 hours after application of the control strips depending on site and environmental conditions. Aircraft shall not be permitted on the runway or high speed exit taxiway control strips until such time as the Contractor validates that its surface friction meets the maintenance planning friction levels in AC 150/5320-12, Table 3-2 when tested at speeds of 40 and 60 mph (65 and 95 km/h) wet with approved CFME.~~

If the control strip should prove to be unsatisfactory, necessary adjustments to the application rate, placement operations, and equipment shall be made. Additional control strips shall be placed and additional skid resistance tests performed and evaluated. Full production shall not begin without the RPR's approval of an appropriate application rate(s). Acceptable control strips shall be paid for in accordance with paragraph 8.1.

PART 4 - CONSTRUCTION METHODS

4.1 WORKER SAFETY

The Contractor shall obtain a Safety Data Sheet (SDS) for both the asphalt emulsion product and sand and require workmen to follow the manufacturer's recommended safety precautions.

4.2 WEATHER LIMITATIONS

The asphalt emulsion shall be applied only when the existing pavement surface is dry and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application of the material. No material shall be applied in strong winds that interfere with the uniform application of the material(s), or when dust or sand is blowing or when rain is anticipated within eight (8) hours of application completion. The atmospheric temperature and the pavement surface temperature shall both be at, or above 60°F (16°C) and rising. Seal coat shall not be applied when pavement temperatures are expected to exceed 130°F within the subsequent 72 hours if traffic will be opened on pavement within those 72 hours. During application, account for wind drift. Cover existing buildings, structures, runway edge lights, taxiway edge lights, informational signs, retro-reflective marking and in-pavement duct markers as necessary to protect against overspray before applying the emulsion. Should emulsion get on any light or marker fixture, promptly clean the fixture.

If cleaning is not satisfactory to the ~~RPR~~ **OAR**, the Contractor shall replace any light, sign or marker with equivalent equipment at no cost to the Owner.

4.3 EQUIPMENT AND TOOLS

The Contractor shall furnish all equipment, tools, and machinery necessary for the performance of the work.

- A. Pressure distributor. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven hundred (700) feet per minute (213 m per minute). The equipment will be tested under pressure for leaks and to ensure proper set-up before use. The Contractor will provide verification of truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application per nozzle manufacturer, spray-bar height and pressure and pump speed appropriate for the viscosity and temperature of sealer material, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a 12-foot (3.7-m), minimum, spray bar with individual nozzle control. The distributor truck shall be capable of specific application rates in the range of 0.05 to 0.25 gallons per square yard (0.15 to 0.80 liters per square meter). These rates shall be computer-controlled rather than mechanical. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy.

The distributor truck shall effectively heat and mix the material to the required temperature prior to application in accordance with the manufacturer's recommendations.

The distributor shall be equipped with a hand sprayer to spray the emulsion in areas not accessible to the distributor truck.

- B. Aggregate spreader. The asphalt distributor truck will be equipped with an aggregate spreader mounted to the distributor truck that can apply sand to the emulsion in a single pass operation without driving through wet emulsion. The aggregate spreader shall be equipped with a variable control system capable of uniformly distributing the sand at the specified rate at varying application widths and speeds. The aggregate spreader must be adjusted to produce an even and accurate application of specified aggregate. Prior to any seal coat application, the aggregate spreader will be calibrated onsite to ensure acceptable uniformity of spread. The ~~RPR~~ **OAR** will observe the calibration and verify the results. The aggregate spreader will be re-calibrated each time the aggregate rate is changed either during the application of test strips or production. The Contractor may consult the seal coat manufacturer representative for procedure and guidance. The sander shall have a minimum hopper capacity of 3,000 pounds (1361 kg) of sand. Push-

type hand sanders will be allowed for use around lights, signs and other obstructions, if necessary.

- C. Power broom/blower. A power broom and/or blower shall be provided for removing loose material from the surface to be treated.
- D. Equipment calibration. Asphalt distributors must be calibrated within the same construction season in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the ~~RPR~~ **OAR**.

4.4 PREPARATION OF ASPHALT PAVEMENT SURFACES

Clean pavement surface immediately prior to placing the seal coat so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film. Remove oil or grease from the asphalt pavement by scrubbing with a detergent, washing thoroughly with clean water, and then treat these areas with a spot primer. Any additional surface preparation, such as crack repair, shall be in accordance with Item P-101, paragraph 101-3.6.

- A. New asphalt pavement surfaces. Allow new asphalt pavement surfaces to cure so that there is no concentration of oils on the surface.

Perform a water-break-free test to confirm that the surface oils have degraded and dissipated. (Cast approximately one gallon (4 liters) of clean water out over the surface. The water should sheet out and wet the surface uniformly without crawling or showing oil rings.) If signs of crawling or oil rings are apparent on the pavement surface, additional time must be allowed for additional curing and retesting of the pavement surface prior to treatment.

4.5 EMULSION MIXING

The application emulsion shall be obtained by blending asphalt material concentrate, water and polymer, if specified. Always add heated water to the asphalt material concentrate, never add asphalt material concentrate to heated water. Mix one part heated water to two parts asphalt material concentrate, by volume.

Add 1% polymer, by volume, to the emulsion mix. If the polymer is added to the emulsion mix at the plant, submit weight scale tickets to the RPR. As an option, the polymer may be added to the emulsion mix at the job site provided the polymer is added slowly while the asphalt distributor truck circulating pump is running. The mix must be agitated for a minimum of 15 minutes or until the polymer is mixed to the satisfaction of the ~~RPR~~ **OAR**.

4.6 APPLICATION OF ASPHALT EMULSION

The asphalt emulsion shall be applied using a pressure distributor upon the properly prepared, clean and dry surface at the application rate recommended by the manufacturer's representative and approved by the ~~RPR~~ **OAR** from the test area/sections evaluation for each designated treatment area. The asphalt emulsion should be applied

at a temperature between 130°F (54°C) and 160°F (70°C) or in accordance with the manufacturer's recommendation.

If low spots and depressions greater than 1/2 inch (12 mm) in depth in the pavement surface cause ponding or puddling of the applied materials, the pavement surface shall be lightly broomed with a broom or brush type squeegee until the pavement surface is free of any pools of excess material.

During all applications, the surfaces of adjacent structures shall be protected to prevent their being spattered or marred.

4.7 APPLICATION OF AGGREGATE MATERIAL

Immediately following the application of the asphalt emulsion, friction sand at the rate recommended by the manufacturer's representative and approved by the ~~RPR~~ **OAR** from the test area/sections evaluation for each designated application area, shall be spread uniformly over the asphalt emulsion in a single-pass operation simultaneous with the sealer application. The aggregate shall be spread to the same width of application as the asphalt material and shall not be applied in such thickness as to cause blanketing.

Sprinkling of additional aggregate material, and spraying additional asphalt material over areas that show up having insufficient cover or bitumen, shall be done by hand whenever necessary. In areas where hand work is necessitated, the sand shall be applied before the sealant begins to break.

Minimize aggregate from being broadcast and accumulating on the untreated pavement adjacent to an application pass. Prior to the next application pass, the Contractor shall clean areas of excess or loose aggregate and remove from project site.

PART 5 - QUALITY CONTROL (QC)

5.1 MANUFACTURER'S REPRESENTATION

The manufacturer's representative knowledgeable of the material, procedures, and equipment described in the specification is responsible to assist the Contractor and ~~RPR~~ **OAR** in determining the appropriate application rates of the emulsion and aggregate, as well as recommendations for proper preparation and start-up of seal coat application. Documentation of the manufacturer representative's experience and knowledge for applying the seal coat product shall be furnished to the ~~RPR~~ **OAR** a minimum of 10 work days prior to placement of the control strips. The cost of the manufacturer's representative shall be included in the Contractor's bid price.

5.2 CONTRACTOR QUALIFICATIONS

The Contractor shall provide documentation to the ~~RPR~~ **OAR** that the seal coat Contractor is qualified to apply the seal coat, including personnel, and equipment, and has made at least three (3) applications similar to this project in the past two (2) years.

PART 6 - MATERIAL ACCEPTANCE

6.1 APPLICATION RATE

The rate of application of the asphalt emulsion shall be verified at least twice per day.

6.2 FRICTION TESTS

Friction tests in accordance with AC 150/5320-12, Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces, shall be performed on all runway and high-speed taxiways that received a seal coat. Each test includes performing friction tests at 40 mph and 60 mph (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of runway centerline with approved continuous friction measuring equipment (CFME). The Contractor shall coordinate testing with the **RPR OAR** and provide the **RPR OAR** a written report of friction test results. The **RPR OAR** shall be present for testing.

PART 7 - METHOD OF MEASUREMENT

7.1 ASPHALT SURFACE TREATMENT

The quantity of asphalt surface treatment shall not be measured for individual payment.

~~The Contractor must furnish the **RPR OAR** with the certified weigh bills when materials are received for the asphalt material used under this contract. The Contractor must not remove material from the tank car or storage tank until initial amounts and temperature measurements have been verified.~~

PART 8 - BASIS OF PAYMENT

- 8.1 No separate payment shall be made for asphalt surface treatment. All costs associated with surface preparation, furnishing all materials, delivery and application of these materials, for all labor, equipment, tools, and incidentals necessary to complete the item, including the friction testing and all work required to meet AC 150/5320-12, and any costs associated with furnishing a qualified manufacturer's representative to assist with control strips shall be considered incidental.

PART 9 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C117	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D5	Standard Test Method for Penetration of Asphalt Materials
ASTM D244	Standard Test Methods and Practices for Emulsified Asphalts
ASTM D2007	Standard Test Method for Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum-Derived Oils by the Clay-Gel Absorption Chromatographic Method
ASTM D2042	Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene
ASTM D2995	Standard Practice for Estimating Application Rate of Bituminous Distributors
ASTM D4402	Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D5340	Standard Test Method for Airport Pavement Condition Index Surveys

Advisory Circulars (AC)

AC 150/5320-12	Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces
AC 150/5320-17	Airfield Pavement Surface Evaluation and Rating (PASER) Manuals
AC 150/5380-6	Guidelines and Procedures for Maintenance of Airport Pavements

END OF ITEM P-608

ORLANDO INTERNATIONAL AIRPORT
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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

EMULSIFIED ASPHALT SEAL COAT
ITEM P-608

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ITEM P-610 - CONCRETE FOR MISCELLANEOUS STRUCTURES

PART 1 - DESCRIPTION

- 1.1 This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

PART 2 - MATERIALS

2.1 GENERAL

Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)** before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

- A. Reactivity. Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the ~~RPR~~ **OAR**. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20% the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation; or aggregates that meet P-501 reactivity test requirements may be utilized.

2.2 COARSE AGGREGATE

The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1 1/2 inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
3/4 inch (19 mm)	67
1/2 inch (12.5 mm)	7

2.2.1 Coarse Aggregate susceptibility to durability (D) cracking. Not used.

2.3 FINE AGGREGATE

The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

2.4 CEMENT

Cement shall conform to the requirements of ASTM C150 Type I/II or ASTM C595 Type IL.

2.5 CEMENTITIOUS MATERIALS

- A. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the ~~RPR~~ **OAR**.
- B. Slag cement (ground granulated blast furnace (GGBF)). Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

2.6 WATER

Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

2.7 ADMIXTURES

The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the ~~RPR~~ **OAR** may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the ~~RPR~~ **OAR** from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

- A. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.
- B. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.
- C. Other chemical admixtures. The use of set retarding, and set-accelerating admixtures shall be approved by the ~~RPR~~ **OAR**. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

2.8 PREMOLDED JOINT MATERIAL

Premolded joint material for expansion joints shall meet the requirements of ASTM 1751.

2.9 JOINT FILLER

The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

2.10 STEEL REINFORCEMENT

Reinforcing shall consist of reinforcing steel conforming to the requirements of ASTM A615 or welded steel wire fabric conforming to ASTM A1064.

2.11 MATERIALS FOR CURING CONCRETE

Curing materials shall conform to ASTM C309 White-pigmented Liquid Membrane-Forming Compound, Type 2, Class B.

PART 3 - CONSTRUCTION METHODS

3.1 GENERAL

The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the ~~RPR~~ **OAR**.

3.2 CONCRETE MIXTURE

The concrete shall develop a compressive strength of 4000 psi (28 MPa) in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 470 pounds of cementitious material per cubic yard (280 kg per cubic meter). The water cementitious ratio shall not exceed 0.45 by weight. The air content of the concrete shall be 5% +/- 1.2% as determined by ASTM C231 and shall have a slump of not more than 4 inches (100 mm) as determined by ASTM C143.

3.3 MIXING

Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the ~~RPRs~~ **OAR's** approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

3.4 FORMS

Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the ~~RPR~~ **OAR**. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be

smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

3.5 PLACING REINFORCEMENT

All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

3.6 EMBEDDED ITEMS

Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

3.7 CONCRETE CONSISTENCY

The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

3.8 PLACING CONCRETE

All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the ~~RPR~~ **OAR**. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

3.9 VIBRATION

Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

3.10 JOINTS

Joints shall be constructed as indicated on the plans.

3.11 FINISHING

All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

3.12 CURING AND PROTECTION

All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

3.13 COLD WEATHER PLACING

When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

3.14 HOT WEATHER PLACING

When concrete is placed in hot weather greater than 85°F (30 °C), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

PART 4 - QUALITY ASSURANCE (QA)

4.1 QUALITY ASSURANCE SAMPLING AND TESTING

Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 3.2. The ~~RPR~~ **OAR** will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

4.2 DEFECTIVE WORK

Any defective work that cannot be satisfactorily repaired as determined by the ~~RPR~~ **OAR**, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

PART 5 - METHOD OF MEASUREMENT

5.1 Concrete shall be considered incidental and no separate measurement shall be made.

PART 6 - BASIS OF PAYMENT

6.1 Concrete shall be considered incidental and no separate payment shall be made.

PART 7 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars

ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

American Concrete Institute (ACI)

ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to External Curing of Concrete
ACI 309R	Guide for Consolidation of Concrete

END OF ITEM P-610

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

CONCRETE FOR MISCELLANEOUS
STRUCTURES
ITEM P-610

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ITEM P-620 - RUNWAY AND TAXIWAY MARKING

PART 1 - DESCRIPTION

- 1.1 This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)**. The terms "paint" and "marking material" as well as "painting" and "application of markings" are interchangeable throughout this specification.

PART 2 - MATERIALS

2.1 MATERIALS ACCEPTANCE

The Contractor shall furnish manufacturer's certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer's surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the ~~Resident Project Representative (RPR)~~ **Owner's Authorized Representative (OAR)** prior to the initial application of markings. The reports can be used for material acceptance or the ~~RPR~~ **OAR** may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the ~~RPR~~ **OAR** upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the ~~RPR~~ **OAR**.

2.2 MARKING MATERIALS

Table 1. Marking Materials

Paint ¹				Glass Beads ²	
Type	Color	Fed Std. 595 Number	Application Rate Maximum	Type	Application Rate Minimum
Waterborne Type III	White	37925	90 ft ² /gal	Type III	10 lb/gal
Waterborne Type III	Yellow	33538	90 ft ² /gal	Type III	10 lb/gal
Waterborne Type III	Red	31136	90 ft ² /gal	Type I	8 lb/gal
Waterborne Type III	Black	37038	90 ft ² /gal	n/a	n/a

¹ See paragraph 2.2a

² See paragraph 2.2b

- A. Paint. Paint shall be waterborne in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595.

Waterborne. Paint shall meet the requirements of Federal Specification TT-P-1952F, Type III. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis. ***Paint shall be furnished with a biocide compatible with manufacturer when tested in accordance with ASTM D 711 (not required for black paint).***

- B. Reflective media. Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type III.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A.

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

PART 3 - CONSTRUCTION METHODS

3.1 WEATHER LIMITATIONS

Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time. ***The weather shall not be excessively gusty, dusty, or foggy and the suitability of the weather will be determined by the OAR.***

3.2 EQUIPMENT

Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

The Contractor shall provide vacuum type equipment capable of removing excess or loose beads from the pavement surface.

3.3 PREPARATION OF SURFACES

Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminants that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the ~~RPR~~ **OAR**. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

- A. Preparation of new pavement surfaces. The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the ~~RPR~~ **OAR** to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.
- B. Preparation of pavement to remove existing markings. Existing pavement markings shall be removed by rotary grinding, water blasting, or by other methods approved by the ~~RPR~~ **OAR** minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.
- C. Preparation of pavement markings prior to remarking. Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the ~~RPR~~ **OAR**. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the ~~RPR~~ **OAR** prior to the initial application of markings.

3.4 LAYOUT OF MARKINGS

The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

3.5 APPLICATION

A period of 28 days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the ~~RPR~~ **OAR**.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

3.6 APPLICATION--PREFORMED THERMOPLASTIC AIRPORT PAVEMENT MARKINGS

Preformed thermoplastic pavement markings not used.

3.7 CONTROL STRIP

Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the ~~RPR~~ **OAR**. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

3.8 RETRO-REFLECTANCE

Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings

taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m ² /lux		
	White	Yellow	Red
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than ¹	100	75	10

¹ Prior to remarking, determine if removal of contaminants on markings will restore retro-reflectance

3.9 PROTECTION AND CLEANUP

After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the ~~RPR~~ **OAR**. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

PART 4 - METHOD OF MEASUREMENT

- 4.1A The quantity of surface preparation shall not be measured directly for payment.
- 4.1B The quantity of markings shall be paid for shall be measured by the number of square feet of painting.
- 4.1C The quantity of reflective media shall not be measured directly for payment.
- 4.1D Temporary markings not required.

PART 5 - BASIS OF PAYMENT

5.1 This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the ~~RPR~~ **OAR** in accordance with these specifications.

~~5.1A Payment for surface preparation shall be made at the contract price for.~~

5.2B Payment for markings shall be made at the contract price for the number of square feet of painting.

~~5.3C Payment for reflective media shall be made at the contract unit price for [the number of pounds (lb) of reflective media] [lump sum].~~

5.4D Temporary markings are not required.

Item P-620-5.1	Markings - Yellow	- per Square Foot (SF)
Item P-620-5.2	Markings – White	- per Square Foot (SF)
Item P-620-5.3	Markings - Red	- per Square Foot (SF)
Item P-620-5.4	Markings - Black	- per Square Foot (SF)

PART 6 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1652	Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D7585	Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments

ASTM E303	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2302	Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

Code of Federal Regulations (CFR)

40	CFR	Part 60, Appendix A-7, Method 24
		Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings
29 CFR Part 1910.1200		Hazard Communication

Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D	Beads (Glass Spheres) Retro-Reflective
FED SPEC TT-P-1952F	Paint, Traffic and Airfield Marking, Waterborne
FED STD 595	Colors used in Government Procurement

Commercial Item Description

A-A-2886B	Paint, Traffic, Solvent Based

Advisory Circulars (AC)

AC 150/5340-1	Standards for Airport Markings
AC 150/5320-12	Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

END OF ITEM P-620

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SECTION SP-100 - GENERAL PROVISIONS AND REQUIREMENTS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SPECIAL REQUIREMENTS FOR ELECTRICAL WORK

- A. This item shall apply to all electrical work contained within the Contract Documents. Where the contract general conditions, special provisions or other parts of the Contract Documents also apply, the stricter of the documents shall govern.

1.2 AUXILIARIES AND ACCESSORIES

- A. Include all auxiliaries and accessories for a complete, fully functional and properly operating system in accordance with the Contract Documents.
- B. Provide and install all electrical systems and any necessary appurtenances as per Federal Aviation Administration (FAA) Advisory Circulars and FAA Orders, NFPA 70 - National Electrical Code (NEC), federal, state and local codes whether specified or shown in the Contract Documents or not. The content of the Contract Documents in general only refers to work required above and beyond the requirements of the FAA, NEC and applicable federal, state and local codes.

1.3 PROJECT PAY ITEMS

- A. The project pay items are provided to be inclusive of all work to be performed as shown in the Contract Documents. All work not identified with a specific pay item shall be considered required work to complete the project and shall be considered subsidiary to the cost of the project pay items provided.

1.4 CONTRACTOR EXPERIENCE

- A. All Contractors used to perform work of this contract shall be licensed to perform electrical work in the state in which the project is located at the time bids are submitted. At least one member (qualifier) of the electrical contracting firm shall hold a state certified (unlimited, unrestricted) electrical contractor's license.

1.5 EXPERIENCE AND SUPERVISION OF CONTRACTOR PERSONNEL

- A. Provide a resident on-site electrical supervisor to manage work at the job site whenever electrical work is being performed or affected. Electrical work is defined as any work described, included, depicted or contained within the Construction Specifications Institute (CSI) Division 16, 26, 27, 28, 33 or 34 specifications, L-XXX specification series, SP-XXX specification series, E- series drawings, ED-series drawings, and all other work within the Contract Documents dealing with the distribution of electrical power/light, electrical/electronic/light monitoring, communication and control.

- B. When work is being performed within the Aircraft Operations Area, the on-site supervisor shall also be within the Aircraft Operations Area, except for incidental absences. Incidental absences shall not exceed 45 minutes in length. The Contractor is encouraged to keep the same on-site supervisor(s) from commencement to completion of work.
- C. Each on-site supervisor shall have a minimum of 5 years (2,000 hours per year) of successful supervisory experience either constructing or maintaining airfield lighting systems. At least 3 of these years of experience shall have occurred in the last 5 years on projects of comparable size and complexity. On-site supervisor shall be certified as a "Qualified Person". The definition of a Qualified Person is defined in OSHA 1910.399 and NFPA 70E (Article 100 & 110.2(1)). The certification shall be signed by the Contractor's Electrical License qualifier. Equivalent experience and training may be considered by the Engineer. On-Site supervisor may substitute one year of education in qualified electrical curriculum for one-half year electrical experience for a maximum of 2,000 hours of the required 10,000 hours of experience. Records of on-site supervisor's experience demonstrating compliance with these requirements shall be submitted to the Engineer for verification and review prior to starting work. Experience records shall include contact information for references (name, title and phone number) from airports where the proposed on-site supervisor has completed the required electrical experience. Only on-site supervisors whose experience records have been confirmed by the Engineer shall supervise work. Work shall not start prior to approval of the on-site supervisor, unless under the direct supervision of the Contractor's Electrical License qualifier. Multiple certified on-site supervisors may be required to support multiple shifts or around the clock activities.
- D. If at any time the Owner Authorized Representative (OAR) believes that work is being performed without the presence of an on-site supervisor, the OAR will request that the workman in question demonstrate that the on-site supervisor is present. If the on-site supervisor's presence cannot be verified within 45 minutes the OAR may direct the Contractor to suspend work until proper supervision is made available. The Contractor shall not be remunerated for costs associated with suspension of work under these conditions.
- E. It is agreed and understood that, if requested in writing by the OAR, the Contractor shall replace any on-site supervisor with another meeting the required qualifications within seven (7) days of receipt of request.
- F. Electricians are tasked with installing raceways and fittings; electrical distribution and supply equipment, pulling, splicing and terminating wire/cable; grounding, lightning protection, installing light bases, light fixtures; connecting signs; performing electrical testing or other work contained in the Contract Documents or as described in 1.5(A) above. Electricians performing work shall have a minimum of 4 years (2,000 hours per year) of successful experience either constructing or maintaining airfield lighting systems and shall be certified a "Qualified Person". A copy of each Electrician's experience shall be submitted to the OAR. Each electrician's experience submittal shall comply with the above requirements. An apprentice/helper/laborer may assist the electrician with the above tasks as directed by the on-site supervisor. An electrician may supervise a maximum of four apprentices/helpers/laborers.

- G. Electrical apprentices, helpers, laborers, shall be qualified persons for the work they are performing and shall be under the supervision of the on-site supervisor or electrician.
- H. Other helpers, laborers, equipment operators, concrete workers and other crafts persons (skilled or unskilled) shall be qualified persons for the work they are performing and shall be under the supervision of the on-site supervisor and are not subject to the four person limitation in 1.5.f.
- I. Any person who does not have the required experience or who demonstrates a lack of knowledge appropriate for the task they are performing shall be dismissed from the project for remainder of the contract.

PART 2 - SUMMARY OF WORK

2.1 GENERAL

- A. In support of this project this contract includes installation of airfield lighting, counterpoise, signage, power distribution, standby generator, lightning protection and other electrical work as shown in the Contract Documents. The above is not intended to be all inclusive but is provided as an aid to the Contractor. It is the intent of the Contract Documents that the Contractor is to furnish and install all materials and provide the necessary supervision, transportation, preparation, assembly, survey and installation of these materials, and for all labor, equipment, tools, incidentals, and appurtenances necessary to provide a fully functional and operational system as described by these Contract Documents. All items are new and unused unless specifically noted otherwise.

2.2 RECORD DOCUMENTS

- A. The Contractor shall maintain the Contract Documents, Shop Drawings and samples at the site, in good order and annotated daily to show all changes made during the construction process per Item SP-106. These shall be available to the OAR for examination.

2.3 ENGINEERING OBSERVATIONS

- A. Items noted by Engineer during construction and before final acceptance, which does not comply with the Contract, will be listed in accordance with the general conditions. These items will be sent to the Contractor for action. The Contractor shall have these items corrected.
- B. The Contractor shall check items noted after acceptance during the warranty/guarantee period in the same manner as above.

2.4 EXISTING CONDITIONS

- A. Investigate site thoroughly and reroute all conduit/duct and wiring in area of new construction in order to maintain continuity of existing circuitry. Existing conduit/duct shown in the Contract Documents show approximate locations only. Contractor must verify and coordinate existing site conduit/ducts, wiring and piping. The bids shall include hand digging and all required rerouting in areas of existing conduit/ducts and/or pipes.
- B. Check site and existing conditions thoroughly before bidding. Advise Engineer of discrepancies or questions noted. If any difference is discovered between the existing conditions and the Contract Documents, the Engineer shall be notified in writing immediately.
- C. The Electrical Contractor shall investigate all existing systems within the construction limits and complete the performance verification prior to the beginning of any work, which could affect these existing systems.
- D. Advise Engineer in writing of all deficiencies in existing system(s) prior to work. All systems will be assumed to be fully operational if written notification is not received by Engineer prior to work on system.
- E. The work involved is in connection with existing systems/facilities, which must remain in operation while work is being performed. Work must be done in accordance with the schedule specified in the Contract Documents. Schedule all work to minimize the period when systems are inoperable. Request written permission and receive written approval from Engineer a minimum of 2 weeks in advance of any shutdown of existing systems. (FAA requires 45 days minimum notice.) Perform work required at other than standard working hours where outages cannot be accepted during regular working hours. Protect existing buildings and equipment during construction as required.
- F. There may be piping, fixtures or other items, which must be removed or relocated in order to perform the alteration work. All conduit/duct, wiring, boxes, etc. that do not comply with the Contract Documents shall be removed or corrected to comply with the Contract Documents. All unused conduit/duct not removed shall be identified and a pull line shall be installed. Bid shall include all removal and relocation required for completion of the alterations and the new construction.
- G. Special attention is directed to relocation of the existing power conduits and duct bank and communication systems. Cable counts, location, and function must be field verified before starting work.
- H. The Contractor shall verify the areas, conditions, and features necessary to tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities. This requirement assumes that existing items comply with current codes and standards.

2.5 SYSTEMS WARRANTY

- A. The work required under this division shall include a one (1) year warranty from the date of final acceptance unless required otherwise by the Contract Documents. This warranty shall be by the Contractor/Manufacturer to the Owner for any defective workmanship or material, which has been furnished under this contract. The Contractor/Manufacturer at no cost to the Owner shall perform replacement of defective workmanship or material for a period of one (1) year (or greater if noted in the Contract Documents) from the date of final acceptance of the system. This warranty shall not include light bulbs in service after one (1) month from date of substantial completion of the system. Explain the provisions of the warranty to the Owner during project close out.
- B. In accordance with EB-67D, Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures; all LED light fixtures with the exception of obstruction lighting (AC 150/5345-43) shall be warranted by the manufacturer for a minimum of four (4) years after date of installation inclusive of all electronics. This warranty shall be by the Contractor/Manufacturer to the Owner for any defective workmanship or material, which has been furnished under this contract. The Contractor/Manufacturer at no cost to the Owner shall perform replacement of defective LED fixture workmanship or material for a period of four (4) years after date of installation.

2.6 SUBSTANTIAL COMPLETION

- A. All specified work shall be complete prior to final observation of work, and all forms and other information requested, including Operation and Maintenance Manuals, shall be submitted to the Engineer for approval one (1) week before the request for substantial completion of the work.

2.7 CONTRACTORS RESPONSIBILITIES

- A. Provide necessary layout, labor, material, equipment, tools, transportation, full time supervision and services required for the satisfactory and timely completion of the work in accordance with the Contract Documents.
- B. Unload, store, protect and re-handle the materials required for this Contract until such time that material is in place. Provide protection of materials required of this contract after installation.
- C. Provide all required transportation, erection, maintenance, dismantling and removal of temporary facilities and equipment required by this contract.
- D. Provide all transportation, unloading, distribution, hoisting, rigging, material handling and scaffolding required installing the work of this contract.
- E. Provide all engineering and layout required to perform the work from established base lines and benchmarks.
- F. The Electrical Contractor shall coordinate the work of all the Electrical Contractors vendors and subcontractors to provide a fully functional and operating system.

- G. Provide temporary electrical power and temporary water and sanitary sewer for this Contractor's field office, if required. Pay all utility company charges. Provide temporary power required for this Contractor's work.
- H. Prior to start of work this Contractor is to inspect work performed by others on which this work is to be placed on or adjacent to, and report in writing to the Engineer, any condition found to be unacceptable. Failure to make said report shall constitute acceptance of the conditions found and any claims made thereafter due the unacceptable conditions will not be considered by the Engineer.
- I. Provide all required coordination and supervision where work connects to or is affected by work of others and comply with all requirements affecting this work. Work required under other items of the Contract Documents to be performed by this Contractor shall be coordinated with the respective Contractor, and such work performed at no additional cost to the Owner including but not limited to electrical work in support of other trades as shown in the Contract Documents.
- J. It is the responsibility of the Contractor to coordinate the exact required location of any electrical or electronic equipment, system, or cabinets to be installed or relocated. No existing equipment may be relocated without prior coordination and with approval of the Engineer.
- K. Provide and pay for all permits, licenses, fees and inspections required for the performance of the work. The Contractor shall pay all sales, consumer, use and other taxes required in accordance with the law of the place of the project.
- L. Provide all tests as required, per the Contract Documents and submit all test reports to the Engineer.
- M. Provide all excavation, backfill, compaction, shoring and dewatering required for performance of the work.
- N. Provide sleeves for all conduit/duct required as specified.
- O. Protect all work of this Contract from damage and intrusion of dirt and foreign objects. Close off open ends of conduit/duct and sleeves on work, which is to be completed at a later date. Remove closure material prior to continuance of work.
- P. Prior to Final Inspection, submit to the Engineer, all Record Drawings and Operation and Maintenance Manuals as specified. Instruct Owner's maintenance personnel in the operation and maintenance of the systems as required by the Contract Documents.
- Q. The above is not all inclusive of the work described by the Contract Documents, which form the basis for this Contract, but is presented for the Contractor's convenience.

2.8 EXISTING UTILITIES

- A. The Contractor is solely responsible for the location of all existing utilities within the project limits. Please refer to SP-104 for additional requirements.
- B. The Contractor is solely responsible for the protection of all existing utilities within the project limits. All manholes, hand holes, light bases, conduits and ducts shall be kept tightly closed and sealed during all phases of construction. The items may be opened in support of the work but shall be resealed or closed or covered immediately upon completion of the specific task that required them to be opened.

PART 3 - BASIC MATERIAL & METHODS

3.1 REQUIREMENTS OF BASIC MATERIALS AND METHODS

- A. The work shall include the furnishing of the systems, equipment and material specified in this Division and as called for in the Contract Documents, to include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation. Provide the necessary inter-trade/Contractor coordination for the installation to be in a neat and work person like manner.
- B. Drawings for the work are diagrammatic, intended to convey the Scope of the Work and to indicate the general arrangement and locations of the work. The drawings shall not be scaled for exact sizes or locations. Because of the scale of the drawings, certain basic items such as: conduit/duct fittings, access panels, sleeves, pull and junction boxes may not be shown. Where such items are required by Code or by other items or where they are required for proper installation of the work, such items shall be included. Coordinate final equipment locations with governing architectural, civil and structural drawings as applicable. Layout equipment before installation so that all trades may install equipment in the space available.
- C. Equipment Specifications may not deal with minute items such as components, parts, controls and devices, which may be required to produce the equipment performance specified, or as required to meet the equipment warranties. Where such items are required, the Contractor/Supplier of the equipment shall include them, whether specifically called for or not.
- D. Conduit/duct routed through the building/structure that interferes with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit/duct, and fixtures shall fit into available spaces in the building/structure; do not introduce these into the building/structure at such times or in such manner as to cause damage to the structure. Equipment that requires servicing shall be readily accessible.
- E. Locate all openings required for work performed under this item. Provide sleeves, guards or other acceptable methods to allow passage of items installed under this item.
- F. Keep cutting and patching to a minimum. Insofar as possible, determine in advance the proper chase size and openings necessary for the work.

- G. Where cutting and patching are required due to an error of the Contractor, or where the Contractor has not given enough advance notice of the need for holes, recesses, and chases, patching shall be performed by those trades skilled in the use of the materials involved and shall be done at the Contractor's expense.
- H. Any cutting of work in place shall be patched and decorated by such mechanics and in such a manner that the quality of workmanship and finish shall be compatible with that of adjacent construction.
- I. The location of electrical work is indicated on the drawings. The Engineer may adjust exact locations of new work as work progresses. Before any item is installed, the indicated location may be changed by twenty-five (25) feet in any direction without additional cost.
- J. All penetrations through roof, wall or floor shall maintain structure fire rating and environmental barriers. Any roof penetrations shall be made by a state licensed roofing Contractor and shall maintain any in place roofing warranty.
- K. Surface mounted fixtures, outlets, cabinets, conduit/duct, panels, etc., shall have finish or shall be painted as directed by Engineer. Paint shall be in accordance with other applicable items of the Contract Documents.
- L. All materials utilized shall be suitable for the environment encountered. No combination of materials shall be used that forms an electrolytic coupling of such nature that in the presence of moisture corrosion is accelerated.
- M. In general, all relays, contactors, panelboards, dry type transformers, disconnect switches, and circuit breakers are to be supplied and manufactured by the same manufacturer and shall be submitted and accepted equivalent to that specified.
- N. Where the requirements of another division, item, or part of these Contract Documents exceed the requirements of this division, those requirements shall govern.
- O. Make electrical connections to regulators, transformers, instruments, mechanical equipment, controls and at other locations as required with approximately 3 feet (12" minimum) of liquid tight flexible metal conduit. Grounding type liquid tight flexible metallic conduit connectors shall be used. Determine the requirements from the Contract Documents and the accepted manufacturer drawings.
- P. Provide inserts, hangers, supports, braces, and anchor bolts as necessary for all work called for under the Contract Documents.
- Q. Provide equipment grounding conductor in all conduit/ducts, for all circuits, except series airfield lighting.
- R. All galvanized materials shall be hot-dip galvanized after fabrication, conforming to ASTM A-386 and/or A-153, unless noted otherwise (UNO).
- S. Unless noted otherwise, all panelboards, junction boxes, wire ways, etc., shall be spaced off the concrete structure by using a Unistrut P-1060 series square washer or accepted equivalent between the mounting surface and the equipment at each mounting point. Equipment as listed above, mounted on Unistrut or accepted equivalent shall have

Unistrut P-1060 series square washer, Unistrut P-28XX flat plate fitting or accepted equivalent installed between the Unistrut channel or accepted equivalent and the equipment at each mounting point.

- T. All bolted connections and equipment mountings shall utilize two flat washers, lock washer and hex head bolting hardware, unless noted otherwise.
- U. Unless noted otherwise, all wire sizes are based on a 90 Deg. C., THWN-2, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.
- V. Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductor pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.
- W. All equipment enclosures, junction boxes, wire ways, pull boxes, etc. utilized in damp, wet or exterior locations shall be NEMA 4X stainless steel. All mounting channel, hardware, nuts, bolts, lock washers, etc. utilized in damp, wet or exterior locations shall be stainless steel.
- X. All electrical conductors, windings, bus bars, etc. shall be high conductivity (98% conductivity) copper.
- Y. This Contractor shall furnish and install all required overcurrent protection required by the NEC and the Contract Documents. The overcurrent protection shall be sized according to the equipment nameplate data.
- Z. Powder-actuated fasteners will not be allowed without express written approval of the Engineer. No fasteners shall pierce the structure until accepted by the Engineer.
- AA. Use Ideal NOALOX antioxidant compound or accepted equivalent on all aluminum to aluminum mechanical or electrical connections. Use Thomas and Betts KOPR-SHIELD or accepted equivalent on all rigid galvanized steel conduit connections and all copper grounding connections using mechanical lugs. Use an approved anti-seize compound on all bolted connections.

3.2 ELECTRICAL REFERENCE SYMBOLS

- A. Symbols used in the Contract Documents are defined in the Electrical Legend. Not necessarily will all symbols defined be applicable to the project.

3.3 ACTIVE SERVICES

- A. Existing active services, water, gas, sewer, electric, communication, jet fuel, etc. when encountered, shall be protected against damage. Do not prevent or disturb operation of active services, which are to remain. If active services are encountered which require relocation, make request to Authorities Having Jurisdiction (AHJ) for determination of procedures. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the AHJ, Utility or Municipality having jurisdiction.

3.4 CODES AND STANDARDS

- A. Install in accordance with latest edition of the National Electrical Code and the regulations of governing Federal, State, County, local and other applicable codes, including the Utility Companies. Where a conflict in code requirements occurs the most stringent requirement shall govern. The Contractor shall be responsible to obtain and pay for all required licenses, fees and inspections including meter installation fee. The cost for such shall be included in the bid price.
- B. The work shall meet the requirements and recommendations of applicable portions of the latest editions of these laws, codes and standards:
 - 1. OSHA 1910 & 1926
 - 2. NFPA 70, National Electrical Code
 - 3. NFPA 70E, Standard for Electrical Safety in the Workplace
 - 4. NFPA 101, Life Safety Code
 - 5. NFPA 409, Standard on Aircraft Hangars
 - 6. NFPA 780, Standard for the Installation of Lightning Protection Systems (UL 96, UL 96A)
 - 7. FAA Advisory Circulars, Engineering Briefs and Orders
 - 8. Applicable local building code
 - 9. Florida Building Code Project State Specific
 - 10. ANSI C2, National Electrical Safety Code
 - 11. NEMA Standards (NEMA)
 - 12. Underwriter's Laboratories (UL)
 - 13. Institute of Electrical and Electronics Engineers (IEEE)
 - 14. FDOT - Standard Specifications for Road and Bridge Construction Project State Specific

- 15. FDOT – Design Standards Index Project State Specific
- 16. AWS D1.1, Structural Welding Code – Steel
- 17. Merriam-Webster Dictionary

The above is not all inclusive of applicable codes and standards but is presented for the Contractors convenience.

The advisory circulars are available online at:

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.list?display=current&q=

3.5 LISTED AND LABELED

- A. All materials shall be new and free of defects and shall be U.L. listed, bear the U.L. label or be labeled or listed with an accepted, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards. All U.L. listed material shall be used only for the intended purpose.

3.6 UTILITY COMPANY FEES, CHARGES, AND COSTS

- A. It is the Contractor's responsibility to contact the applicable Utility Company(s) to determine if any fees, charges or costs will be due the Utility Company(s) as required by the Utility Company(s) for temporary power, installations, hook-ups, etc. This fee, charge or cost shall be included in this Contractor's price.

3.7 TESTING – QUALITY CONTROL

- A. Systems shall be tested by the Contractor, in the presence of the OAR, and placed in proper working order prior to demonstrating systems to the Owner. Refer to the requirements in each item for other applicable standards.
- B. Provide all tests as required, per the Contract Documents and submit all test reports to the OAR. Costs of all testing shall be borne by the Contractor and shall be considered incidental to the respective pay item of the tested item. The Contractor shall perform all Quality Control in accordance with the Contract Documents and the Contractor's Quality Control Plan General Conditions. The Owner will perform Quality Assurance/Acceptance.
- C. After work is completed a load balance test shall be made to demonstrate that with full lighting and mechanical load the balance between phases is within 5%. Unbalance beyond this limit shall be corrected.
- D. Perform such tests as required by AHJ over the site.

- E. Testing methods shall be acceptable to the Engineer and shall be submitted to the OAR for review, a minimum of thirty (30) days prior to the scheduled test.

3.8 LAMINATED PHENOLIC PLASTIC NAMEPLATES

- A. Contractor shall provide nameplates for wiring systems and equipment as called for herein. All nameplates shall have beveled edges and one-half inch (1/2") lettering. If equipment is smaller than ten inches by six inches (10"x 6"), one-quarter inch (1/4") lettering may be used. Smaller lettering may be used with permission of the OAR.
- B. Nameplates shall be laminated phenolic plastic, black front and back with white core, with lettering etched through the outer covering. White engraved letters on black background. Emergency systems shall use red front and back with white core for nameplates. Attach nameplates with stainless steel pop rivets, sealed with clear silicon caulk. Adhesive may be used only on panelboard interiors. Where conditions do not warrant piercing the enclosure "LOCTITE" brand adhesive or accepted equivalent may be used with permission of the OAR.
- C. Coordinate nameplates with Contract Documents and submit 1 to 1 scale detail of all nameplates to OAR for review.
- D. All electrical equipment, enclosures, pull boxes and all similar items in the sole opinion of the OAR shall be equipped with nameplates. Examples are all constant current regulators, motors, pushbutton stations, hand holes, pull boxes, junction boxes, manholes, control panels, system cabinets, terminal cabinets, time switches, disconnect switches, panelboards, circuit breakers, contactors, relays, high voltage boxes and cabinets. Special electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- E. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed in the Contract Documents, inscription and size of letters shall be as shown. Nameplates for panelboards and switchboards shall include the panel designation, panel name, source(s) of power and voltage and phase of the supply. For example, "Equip YY, Panel A, fed from Panel XYZ, 480/277V, 3-phase, 4-wire." The unique name of a particular piece of equipment shall be used consistently on all nameplates referencing that particular piece of equipment. Equipment name/numbers utilized shall be consistent throughout the entire system. When equipment has multiple sources of power, all sources of power shall appear on the nameplate. Power source descriptions shall contain as a minimum the information listed above. Nameplates shall include as a minimum the following.
 - 1. Equipment Number
 - 2. Equipment Name
 - 3. Power Source(s)
 - 4. Voltage Level and number of phases (for each power source)

- F. Panelboard and distribution panels shall have each breaker position identified with phenolic labels.
- G. All major pull and junction boxes in service areas, tunnels, above accessible ceilings and in accessible chases shall have nameplates identifying the feeder or system. This shall include the access cover on lighting pole bases.
- H. Systems with conductors exceeding 100 volts to ground shall have voltage identification nameplates with one-half inch (1/2") high letters on all panels, switches, pull boxes and junction boxes.

3.9 CONCRETE WORK

- A. Concrete bases and pads for all equipment furnished by Contractor shall be the responsibility of Contractor unless noted otherwise.
- B. Furnish and install reinforced concrete pads for transformers, switchgear, and motor control centers, etc. of size as shown in the Contract Documents. Chamfer the top edges 1". Trowel all surfaces smooth, provide broom finish where noted. Reinforce the pads as shown in the Contract Documents.
- C. Concrete equipment pads shall be installed by tradespersons skilled in concrete work. Equipment pads shall be level within one-eighth inch (1/8") in 10 feet (10'). Equipment pads not meeting the previous requirements shall be removed and replaced at the Contractor's expense.
- D. The Contractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

3.10 EXCAVATING, TRENCHING AND BACKFILLING

- A. This Contractor shall do excavating necessary for light bases, underground wiring, conduit, duct banks and other underground work and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a footing, pad or other structural item. Where a line must pass under a footing, pad or other structural item the crossing shall be made by the smallest possible trench to accommodate the conduit/duct. Excavations shall be kept free from water. No greater length of trench shall be left open in advance of conduit/duct installation than that, which is authorized or directed by the OAR.
- B. Roots shall be removed to a level of eighteen (18") below finished grades and deeper as required for conduit/duct runs, manholes and light pole bases. No roots shall be allowed to remain under the work.
- C. Backfill about the work shall be placed, where practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of conduit/duct lines shall progress as rapidly as the testing and acceptance of the finished items of the work will permit and shall be carried to a crown approximately six

inches (6") above the existing grades. In backfilling around conduit/duct lines, selected material shall be compacted firmly around the conduit/duct. Fill and backfill shall be clean and free from vegetable matter and refuse.

- D. All loose materials shall be removed from all excavations for electrical items. The bottom of the excavation shall be compacted to the following criteria:

SOIL TYPE	DESIGN AIRCRAFT GROSS WEIGHT	TEST STANDARD	UNDER PAVEMENT	IN TURF
<30% RETAINED ON ¾" SIEVE	>60,000 LBS	ASTM D1557	100%	95%
<30% RETAINED ON ¾" SIEVE	≤60,000 LBS	ASTM D698	100%	98%
>30% RETAINED ON ¾" SIEVE	>60,000 LBS	AASHTO T-180	100%	95%
>30% RETAINED ON ¾" SIEVE	≤60,000 LBS	AASHTO T-99	100%	95%

Backfill shall comply with the same compaction requirements.

- E. All trenches and other excavation left open by necessity shall be barricaded and guarded as required by OSHA or applicable codes and regulations.

3.12 WELDING

- A. All welding and weld procedures shall be in accordance with AWS D1.1, Latest Edition. Qualifications of welders and welding operators shall be in accordance with AWS D1.1, Latest Edition. The welder qualification test shall be performed on a 1" A-36 Test Coupon in the 3G and 4G positions. The welder qualification shall be current within 12 months of the work being performed. Weld inspections shall be per the criteria set forth in AWS D1.1 for visual weld inspection.

3.13 ELECTRONIC DRAWING FILES

- A. Electronic versions of the Contract Documents may be available for the Contractors use. Please be advised that Engineer cannot be held responsible for third party use of this information, and furthermore, that this information is supplied as a professional courtesy. This applies to all electronic data files transmitted on behalf of Engineer to third parties.
- B. The files are without warranty as to performance, accuracy, or freedom from error, or as to any results generated through their use at any time. Written dimensions in file, details, specifications take precedence.
- C. The files being transmitted are the intellectual property of Engineer and as such are protected by the copyright laws of the United States. The files are being transmitted for the single use on this project only.

- D. The electronic files provided are non-sealed and unofficial versions of the Contract Documents that have been created by the Engineer. The electronic files are provided only for the convenience of explicitly authorized users.
- E. The hard copy Conformed Documents that have been provided are the only official documents that may be relied upon for accurate presentation. The electronic files provided will be at the authorized user's risk and does not pose any risk or liability to the Owner or Engineer.
- F. Engineer does not guarantee or warrant the authenticity of electronic files. The authorized users agree and recognize that the electronic files may unintentionally become corrupted or modified without the authorization of the Engineer.
- G. Written dimensions will govern over scaled values.
- H. AutoCAD files were developed using base files provided by others.
- I. Variations in printer drivers may cause the electronic file presentation to vary considerably.

PART 4 - DESIGNATION OF MATERIALS

4.1 DESIGNATION OF MATERIALS

- A. Where equipment or materials are specified using the name and catalog number of one manufacturer, that equipment or material specified shall set the quality and functionality of the item. Equivalents accepted by the Engineer will be acceptable.
- B. Where equipment or materials are specified using the name and catalog number of more than one manufacturer, that equipment or material shall be one of those specified. No alternative will be acceptable.
- C. Where no brand name is specified, the source and quality shall be subject to the Engineer's review and acceptance.
- D. When a product is specified to be in accordance with a trade association or government standard, at the request of Engineer, Contractor shall furnish a certificate that the product complies with the referenced standard. Upon request of the Engineer, the Contractor shall submit supporting test data to substantiate compliance.
- E. The Engineer shall be the sole judge of whether the proposed "equivalent" is suitable for use in the work.
- F. The Engineer reserves the right to reject any and all equipment, materials or procedures, which, in the Engineer's opinion, does not meet the system design and the standards and codes, shown in the Contract Documents.
- G. Each Bidder represents their bid is based upon the materials and equipment described in the Contract Documents.

PART 5 - PROTECTION OF MATERIALS, EQUIPMENT AND WORK

5.1 PROTECTION OF MATERIALS, EQUIPMENT AND WORK

- A. Materials shall be stored to assure the preservation of their quality and fitness for the work. Stored materials, even though accepted before storage, shall be subject to reinspection prior to their use in the work. The Contractor shall coordinate the storage of all materials with the OAR.
- B. The Contractor shall protect electrical raceway, cable, lighting fixtures, associated support systems, and all other electrical items against damage from movement of equipment and material, welding, flame cutting, and other construction damage. Raceways and supporting structures for raceway and lighting fixtures shall not be used as access scaffolding at any time. Whenever welding or flame cutting operations occur above or near raceways, cables lighting fixtures, etc not shielded from such operations by concrete floor or other protective covers, the Contractor shall protect the items from damage by means of fireproof boards or blankets. Damaged materials shall be repaired or replaced, by and at the Contractor's expense, subject to the OAR's direction and acceptance.
- C. Surfaces of most equipment, such as panels, switchgear, transformers, constant current regulators (CCR) and circuit breakers, are finished at the factory. Great care shall be exercised to prevent damage to this original finish during installation of the equipment and during construction work.
- D. If the factory finish is damaged during construction, the entire surface of the damaged component shall be refinished by and at the expense of the Contractor.
- E. The refinished surface shall be equivalent in every respect to the original surface, including color, texture and smoothness. Refinishing paint, if furnished with the equipment, may be used; otherwise, the paint shall be obtained from the equipment manufacturer.
- F. All cut edges of galvanized materials and marred or scratched galvanized surfaces shall be repaired using LPS-1G cold galvanizing compound or accepted equivalent.

PART 6 - GENERAL CONSTRUCTION REQUIREMENTS

6.1 GENERAL CONSTRUCTION REQUIREMENTS

- A. Provide the bracing, shoring, rails, guards, and covers necessary to prevent damage or injury. Do not leave energized electrical items exposed or unprotected. Protect personnel from exposure to contact with electricity. Deliver equipment and materials to the job site in their original, unopened, labeled containers. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring.
- B. Maintain separation between stainless steel items and carbon steel items to prevent contamination of stainless-steel item and subsequent rust stains on stainless steel item.

- C. All sheeting, shoring, dewatering and cleaning necessary to keep trenches and their grades in proper condition for the work to be continued, including the removal of water by mechanical means, shall be the Contractor's responsibility.

PART 7 - METHOD OF MEASUREMENT

7.1 METHOD OF MEASUREMENT

- A. The items described in Item SP-100 are incidental to other pay items and shall not be measured for payment.

PART 8 - BASIS OF PAYMENT

8.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Item SP-100. The work described in Item SP-100 is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

END OF ITEM SP-100

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SECTION SP-104 - GENERAL ELECTRICAL SAFETY REQUIREMENTS AND TEMPORARY
AIRFIELD LIGHTING

PART 1 - DESCRIPTION

1.1 PURPOSE

- A. The purpose of this item is to assist in establishing the proper safety guidelines necessary to protect aircraft, passengers, crews, the general public, Owner, Engineer, all workers and vehicles involved in their daily tasks.
- B. The Contractor is solely responsible for all issues related to the safety program and guidelines and implementation of such programs and guidelines necessary to protect aircraft, passengers, crews, the general public, Owner, Engineer, all workers and vehicles involved in their daily tasks.
- C. The Contractor shall comply with FAA Advisory Circulars, FAA Engineering Bulletins, specific airport requirements, OSHA 29CFR1910, OSHA 29CFR1926 and NFPA 70E as minimum requirements.

1.2 REFERENCED STANDARDS AND CODES

- A. All applicable requirements of the below listed advisory circulars, codes, standards and related reading, as a minimum, shall be compiled with:
 - 1. AC 150/5200-18, Airport Safety Self-Inspection
 - 2. AC 150/5210-5, Painting, Marking and Lighting of Vehicles
 - 3. AC 150/5340-1, Standards for Airport Markings
 - 4. AC 150/5340-18, Standards for Airport Sign Systems
 - 5. AC 150/5340-26, Maintenance of Airport Visual Aid Facilities
 - 6. AC 150/5340-30, Design and Installation Details for Airport Visual Aids
 - 7. AC 150/5370-2, Operational Safety On Airports During Construction
 - 8. 29 CFR Part 1926/1910, Occupational Safety and Health Standards
 - 9. NFPA 70, National Electrical Code
 - 10. NFPA 70E, Standard for Electrical Safety in the Workplace
 - 11. ANSI C2, National Electrical Safety Code

The Contractor is responsible for obtaining and using the latest edition of the referenced documents. This list is not all inclusive but is offered as a convenience to the Contractor. The advisory circulars are available online at:

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.list?display=current&q=

1.3 GENERAL SAFETY PROVISIONS

- A. Contractor shall take safety and health measures in performing work under this contract. Contractor shall meet with the Engineer and Owner to develop a mutual understanding relative to administration of the safety plan. The Contractor is subject to and shall comply with all applicable federal, state and local laws, regulations, ordinances, codes and orders relating to safety and health in effect on the date of this contract. Where the contract general conditions, special provisions or other parts of the Contract Documents also apply, the stricter of the documents shall govern.
- B. As a minimum workplace safety shall comply with NFPA 70E, Standard for Electrical Safety in the Workplace, OSHA, federal, state and local requirements. Where a conflict in requirements occurs the most stringent requirement shall govern.
- C. During the performance of work under this contract, the Contractor shall comply with procedures prescribed for control and safety of persons visiting the project site.
- D. Contractor is responsible for the Contractor's personnel and for familiarizing each of the Subcontractors with safety requirements.
- E. Contractor shall advise the Engineer of any special safety restrictions established so that Owner and Engineer personnel can be notified of these restrictions.
- F. The Contractor shall be solely and completely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work. The Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
 - 1. All employees on the work and all other persons (including but not limited to the general public) who may be affected thereby,
 - 2. All the work and all materials or equipment to be incorporated therein, whether in storage on or off the site,
 - 3. Other property at the site, adjacent thereto, or utilized by the Contractor including but not limited to trees, shrubs, lawns, walks, pavements, structures, underground facilities, and other utilities not designated for removal, relocation or replacement in the course of construction regardless of whether or not such other property is indicated in the Contract Documents.

- G. The installation and/or removal of lighting equipment may be critical to airport operations; therefore, the Contractor shall follow work schedules established in the Contract Documents or as directed by the OAR. The system shall be installed in accordance with the Contract Documents, FAA criteria, the National Electrical Code and/or federal, state, or local code requirements.
- H. The Contractor shall generate and submit for approval A Maintenance of Power Plan for all electrical services impacted by this project. The Contractor shall always maintain power (permanent or temporary) to all FAA and airport owned facilities during this project. Power outages may be scheduled at the FAA and Owners convenience. Scheduling and duration of any power outage is at the sole discretion of the power system owner. Cost of maintenance of power and all necessary materials, labor transportation, supervision, coordination and all appurtenances shall be considered incidental to the SP-1 or SP-2 pay items.
- I. The Contractor shall provide temporary wiring as required to reconnect existing circuits to provide guidance for aircraft to pass through the construction areas on those taxiways/runways, which must remain open. The Contractor, in conjunction with the Owner's Maintenance Department, shall perform a visual lighting check of all lighting circuits within the Contractor's area of responsibility before dark each day (or at additional times as designated by the OAR) to assure that they are fully functional. In the event of failure, the Contractor shall immediately take steps to restore operation.

1.4 FIRE PREVENTION AND PROTECTION

- A. All tools producing sparks or heat, open-flame heating devices, operations utilizing such devices, etc. shall be in accordance with the airport fire department and airport "Burn Permit Procedures". Work shall not start until all requirements of the burn permit procedures are met
- B. Open fires, salamanders and open-flame heating devices will not be permitted except by special approval in writing. Such permission will not be granted unless the Contractor has taken reasonable precautions to make such devices safe. Burning trash, brush or wood on the project site will not be permitted. Approval for open fires and open-flame heating devices will in no way relieve the Contractor from the responsibility for any damage incurred because of fires.
- C. Flammable liquids shall be stored and handled in accordance with NFPA and OSHA requirements.
- D. Smoking shall not be permitted within the AOA or in areas such as paint storage, fuel storage, and posted no smoking areas.
- E. Welding, flame cutting, melting and other such operations in all operating areas, shall not be permitted until approved at the beginning of each workday by the OAR. The OAR may approve longer periods of time for welding and burning in some operating areas if the detailed safety procedures are established beforehand. Operating open flame devices shall not be left unattended in any area.

- F. Contractor shall provide the necessary firefighting equipment, fire prevention methods and fire watch.
- G. A Contractor's employee shall be assigned as fire watch for every welding and burning operation. The fire watch shall be properly trained in firefighting techniques and the operation of the fire extinguishers. The fire watch shall be equipped with two full 15-pound Class A, B & C fire extinguishers and shall check all areas around and below the welding or burning operation for fires. The fire watch shall continue this check for at least 60 minutes after the completion of the welding or burning operation.
- H. Contractor shall discontinue all burning, welding, or cutting operations, one hour prior to the end of the normal workday. Contractor shall provide a fire watch to remain at the site for one hour after discontinuing these operations. This fire watch shall make a thorough inspection of the area for possible sources of latent combustion. Any unsafe conditions shall be corrected.
- I. During operations involving possible fire hazard, the Contractor shall notify the OAR and not proceed until clearance is obtained in writing. The OAR may request a standby from the Fire Station. However, this does not relieve the Contractor of responsibility for welding and cutting safety.
- J. Clean up of scrap materials and waste of this Contractor shall be completed as a minimum daily or more often as required to maintain airport operations.

1.5 TEMPORARY EXITS AND ENTRANCES

- A. Such passageways shall provide adequate fire protection and safety of Owner personnel and representatives.

1.6 SWITCHING

- A. Electrical switching required for clearance to work on equipment operating from electrical circuits will be performed only by Owner personnel authorized as safety operators for the specific equipment or as specifically authorized by the Owner.

1.7 REMOVAL OF EQUIPMENT

- A. When permanently removing equipment, the electrical wiring, conduit/duct and control boxes shall be removed to the source of feed, unless otherwise specified or indicated.
- B. After equipment has been removed, the electrical wiring diagrams, schematics, etc., shall be marked to show the change.
- C. Conduit/duct not removed shall have a pull string installed.

1.8 OTHER SAFETY REQUIREMENTS

- A. Temporary wiring shall comply with NEC. Indiscriminate use of extension cords, portable cable or junction boxes creating tripping hazards as well as overloaded circuits will not be permitted.
- B. Unplug or disconnect energy source of power tools when not in use.
- C. Before maintaining or repairing any electrical equipment, it shall be disconnected from the power source.
- D. Do not use any equipment that has frayed cords or three-wire plugs that have had the grounding prongs removed. Faulty equipment and tools shall be repaired by a qualified person.
- E. Do not use metal ladders when working on electrical equipment.

1.9 EXISTING UTILITIES

- A. The Contractor is solely responsible for the location of all existing utilities within the project limits. Prior to initiation of any construction in the field, the Contractor shall provide a written notice (return receipt requested) to each of the utility companies, along with the various airport departments and Florida Sunshine One Call as prescribed by state law. The Contractor shall provide the Owner and Engineer with a copy of the receipt of said written notification to each of the utility companies or airport departments. This requirement is in addition to any other state laws regarding public notification prior to excavation.

PART 2 - EXCAVATION

2.1 EXCAVATION OPERATIONS

- A. Prior to any excavation or demolition, the Contractor shall obtain an "Airport Dig Permit".
- B. Methods of excavation, means of earth support, and manner of backfill shall be conducted with consideration for the safety of persons and work, and prevention of damage to adjacent pavement, utilities, structures and other facilities, due to settlement, lateral movement, undermining and washout. Minimum requirements for trench shoring and bracing shall be in accordance with OSHA, State and local requirements. Excavation shall be performed in a manner to prevent surface water and subsurface or groundwater from flowing into excavations, and to prevent water from flooding conduit/duct trench and adjacent or surrounding area.

PART 3 - PROTECTION OF WORK

3.1 PROTECTION OF WORK

- A. Provide adequate stand-by mechanical equipment for emergency use.
- B. Excavations shall have substantial barricades and be posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.
- C. Barricades shall be erected immediately around manhole openings when covers are opened/removed.
- D. Prior to performing any excavation work or any surface penetrations 6 inches or deeper (such as driving stakes more than 6 inches in the ground) on any ground surface, for personnel safety and to prevent possible interruption of major utility services encountered during excavation, the following procedures shall be followed:
 - 1. Refer to 1.9.
 - 2. The Contractor shall obtain from the OAR, local utilities, etc., the current up-to-date subsurface utility drawing of the particular area to be worked on.
 - 3. All agencies/utilities, etc. that may be affected by the excavating shall be contacted by the Contractor so that all lines, pipes, etc. can be marked/staked. The Contractor shall be responsible to maintain the utility locate markings.
 - 4. The Contractor shall stake out subsurface high voltage cables, communication cables, pipelines, all subsurface utilities, etc., indicated within the scope of the work contemplated. All subsurface utilities shall be located by hand digging; hand digging shall extend for 5 feet on both sides of the subsurface utility. Hand digging and protection of existing systems shall not be paid for separately but shall be considered incidental to the item being installed.
 - 5. After hand exposure of cable or pipelines, the Contractor shall obtain agreement from the OAR, AHJ, Agency/Utility on how much closer to cable or pipe the excavations can be permitted.
 - 6. Detectable printed mylar foil warning tape, color coded, printed with the words "CAUTION ELECTRIC LINE BELOW," red, "CAUTION COMMUNICATION LINE BELOW," orange, "CAUTION WATER LINE BELOW," blue, "CAUTION FUEL LINE BELOW," yellow, etc., shall be installed over the buried utilities. Material and installation of detectable tape shall be in accordance with L-110.
 - 7. Contractor shall notify the OAR, 72 hours prior to the start of excavation work or surface penetration, to enable the OAR to review measures being taken to prevent hazard to employees and to prevent possible damage to subsurface utilities. Where emergency conditions preclude the 72 hours advance notification, Contractor shall nevertheless inform the OAR of the Contractor's intention to initiate work prior to actual start of activity.

8. After all underground utilities have been located and staked, the Contractor shall proceed with excavating work, or other surface penetration work. The Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 5 feet of the staked-out cable or pipeline, until Contractor has hand excavated down to expose the underground utility to exactly fix its location.
9. No digging, dirt moving, or other heavy equipment shall physically enter any construction area before all FAA utilities, airport utilities and all other underground utilities have been located and properly staked out. It is the Contractor's responsibility to locate all utilities before digging, sawing, coring, boring, etc. Any damage caused by digging, sawing, boring coring, etc., is the Contractor's responsibility for repair. Any damage must be reported immediately to the OAR. No repair shall be attempted without approval.
10. All electrical cables shall be disconnected before excavation is attempted.
11. Provide minimum of 48" undisturbed earth cover or 1" thick steel plate over electrical conduit/duct, cables or other utilities when heavy equipment is being used in the area to protect underground systems/utilities. In addition, protect utilities in accordance with AHJ requirements.
12. The requirements listed above shall be considered incidental to the item for which the excavation is required.
13. A written description of the utility protection measures shall be submitted to the OAR for review by the Owner, FAA and AHJ.

PART 4 - SAFETY TAGGING AND LOCKOUT

4.1 SAFETY WITH ELECTRICAL CIRCUITS AND EQUIPMENT:

- A. No one may work on an energized circuit without written permission from the Contractor's On-Site Supervisor. The Contractor's On-Site Supervisor shall review the circumstances and the necessary safety precautions with the OAR, prior to giving permission for the energized work. The Contractor assumes all liability in connection with any work on energized circuits.
- B. No one may disconnect or cause to be disconnected any electrical circuit before permission is requested from and granted by the Owner or authorized representative through the OAR.
- C. Identification markings on light and power circuits shall not be relied on for establishing electrically safe work conditions. Always verify the proper safe "deenergized" conditions with properly operating test equipment.
- D. Before any circuit supplying radar, ILS, weather, VORTAC, airport beacon, runway/taxiway lighting equipment or any other equipment is disconnected, permission

must first be granted by the systems Owner or authorized representative, and, if applicable, FAA Sector Field Office and the Airport's Air Traffic Control Tower. After permission is granted, the following requirements must be compiled with. THE FAA REQUIRES 45 DAY NOTICE PRIOR TO WORKING ON OR DISTURBING FAA CABLES OR EQUIPMENT.

- E. As a minimum the LOCK OUT/TAG OUT (LOTO) procedure shall comply with the Owner's requirements, OSHA1910.147, OSHA1910.147 Appendix A and NFPA 70E. If conflicts between standards arise the stricter requirement shall apply.
- F. Comply with OSHA 1910.333, Selection and Use of Work Practices.
- G. A qualified person shall perform a hazard risk assessment, job safety plan, and job briefing in accordance with NFPA 70E.
- H. A qualified person shall create an Electrically Safe Work Condition in accordance with NFPA 70E.
- I. Restoration shall be accomplished in a safe manner and locks/tags removed only by the Electrical Contractor's qualified person who placed the locks and tags in the presence of the Owner or authorized representative. Should the qualified person who placed the lock/tag not be available, see OSHA 1910.333(b)(2)(v)(C).
- J. The Owner or authorized representative shall record time, date and operational status of circuit after restoration.
- K. Electrical circuits and apparatus shall be operated at these facilities only by qualified persons and authorized personnel.
- L. The OAR shall be provided contact names and phone numbers for two qualified persons (one as primary, one as backup) to provide for removal or addition of any Contractor LOTO work during off hours. The qualified person(s) shall respond onsite within one hour of initial contact.

4.2 TEMPORARY AIRFIELD LIGHTING AND SIGNAGE

- A. Temporary airfield electrical fixtures and conductors are allowable when necessary, but shall be installed as follows:
 - 1. Temporary lights shall be bolted to the pavement in a manner rendering the light stationery and allowing space for conductors to enter or exit and to be spliced.
 - 2. When the above is not practical, lights shall be fastened to a weighted object adaptable for the purpose and of sufficient weight to inhibit movement by jet engine blast.
 - 3. Temporary conductors supplying temporary lights shall be installed in a rigid galvanized steel conduit system and secured every five feet to prevent movement by jet engine blast. See temporary airfield lighting details.

4. All joints or splices in temporary conductors shall have heat shrink tubing with integral sealant or tape applied to secure mechanical and electrical connection and prevent water entry.
 5. All temporary plug-in connections shall comply with the permanent wiring detailed in L-108 and the wiring details.
 6. Temporary lights and signage shall conform as closely as possible to permanent locations normally on the taxiway or runway but shall guide aircraft in a safe path. Please refer to the temporary airfield lighting details provided in the Contract Documents for additional requirements.
- B. Closed taxiways and runways shall be blacked out in a manner acceptable to FAA, OAR and Airport Operations and said black/out/markings/lighting shall be kept in acceptable condition.
1. The required method of temporarily bypassing a fixture is to unplug and bypass the primary side of the L-830 isolation transformer.
 2. Alternately, pipe sleeves may be used to obscure the elevated edge lights. Pipe sleeve length shall be of sufficient length to block all light output and to prevent any light leakage.
 3. In extreme circumstances and with written permission of the Engineer, no more than 5% of the fixtures in each airfield lighting circuit may be unplugged from the L-830 isolation transformer secondary or have the lamp removed. If at any time a larger number of fixtures are required to be bypassed (or have the lamp removed); the L-830 isolation transformer secondary shall have a shorting device installed.
 4. During runway closures the respective runway's mandatory signs shall remain operational.
 5. During runway closures the respective runway's approach lighting systems (PAPI, REIL, MALSR, ALSF, etc.) shall be turned off.
 6. Airfield signs providing directions to closed areas shall be covered (black out). No stray light may be emitted from the covered portions of the sign. The signs shall be covered with 3/8" thick exterior plywood panels. The plywood panels shall be painted black and shall be banded to the sign. Please refer to the temporary airfield lighting details provided in the Contract Documents for additional requirements.
 7. Areas closed to aircraft shall not be lighted (black out). The Contractor shall ensure that lighting in the closed areas cannot be inadvertently energized.
 8. Adequate lighting in the opinion of the Engineer or Airport Operations shall be provided to delineate the active and closed areas of the AOA.
- C. **CAUTION:** The series lighting circuit must always be complete before a regulator is energized. Normal circuit voltage is less than 5,000 volts; open circuit voltage can approach 10,000 volts. All personnel shall be instructed to protect the integrity of the

lighting circuit. Turn off and lock out/tag out the regulator at the vault before opening the circuit. Continuity of the circuit shall be checked before the regulator is reconnected and reenergized.

- D. The installation and/or removal of lighting equipment is critical to airport operations; therefore, the Contractor shall follow work schedules established in the Contract Documents or as directed by the OAR. The Contractor shall attend weekly coordination meetings with Airport Operations for the duration of the contract. The system shall be installed in accordance with applicable FAA Advisory Circulars, the National Electrical Code and/or other federal, state or local requirements.
- E. The Contractor shall provide temporary wiring as required to reconnect existing circuits to provide guidance for aircraft to pass through the construction areas on those taxiways/runways, which must remain open. The Contractor shall bypass or otherwise render inoperative those portions of the runway/taxiway lighting circuits in closed areas of the airfield.
- F. All runways/taxiways not closed for construction shall have fully operable airfield lighting systems using the airport airfield lighting control system. The Contractor shall coordinate the temporary airfield lighting requirements for each phase with the OAR. The Contractor shall submit a temporary airfield lighting plan to the OAR two weeks prior to the need for the temporary airfield lighting. The OAR will coordinate the plan with the airport and FAA. The Contractor shall make revisions/corrections to the temporary airfield lighting plan as required by the OAR.
- G. Existing conditions may vary from the existing information shown in the Contract Documents. The Contractor's means and methods and sequence of construction within a specific phase is determined by the Contractor. Therefore, the temporary airfield lighting plan in 4.2.f above is the Contractor's responsibility. The Owner and Engineer will provide reasonable assistance to the Contractor.
- H. It shall be the Contractor's responsibility to determine that all airfield lighting circuits, except those that are serving closed taxiways or runways, are fully functional, using tower controls, at the end of each work shift and shall so certify to the OAR at the end of each shift. The Contractor shall not leave the work area until the OAR has confirmed circuit operation. The certification shall be provided to the OAR at 4:00 PM and one hour before sunset. Second shift report shall report one hour before sunset. Any other shift shall report one hour prior to the need for airfield lighting or as determined by the OAR. Should bad weather cause poor visibility the OAR may require additional status reports of system operability and may call for the operation of the airfield lighting system at any time. In the event of airfield lighting system failure, the Contractor shall immediately take the necessary steps to restore proper operation of the airfield lighting system.
- I. During runway closures the respective runway's mandatory signs shall remain operational.

- J. It shall be the Contractor's responsibility to determine that all airfield lighting and signage circuits serving closed taxiways or runways (except runway mandatory signs) are turned off, bypassed as previously described or completely obscured at the end of each work shift and shall so certify to the OAR at the end of each shift. The Contractor shall not leave the work area until the OAR has confirmed the closed area is properly blacked out.
- K. The Contractor shall check the status of the temporary airfield lighting/signage and black out equipment on a daily basis. The Contractor shall provide temporary airfield lighting/signage and black out maintenance and support on a 24 hour a day, seven days a week basis for the duration of the project. The OAR shall be provided contact names and phone numbers for two persons (one as primary, one as backup) to provide maintenance or to meet temporary airfield lighting/signage and black out needs during off hours. The designated person shall respond onsite within one hour of initial contact.
- L. Whenever the scope of work requires connection to an existing circuit, or should the scope of work involve working adjacent to or near an existing circuit, and the work could have any impact on the existing circuit, the circuit's insulation resistance shall be tested, in the presence of the OAR. The test shall be performed in accordance with Item SP-111 and prior to any activity affecting or impacting the respective circuit. The Contractor shall record the results on forms included in SP-111. When the work affecting the circuit is complete (or at end of shift prior to energization), the circuit's insulation resistance shall be checked again, in the presence of the OAR. The Contractor shall record the results on forms included in SP-111. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. The Contractor shall measure and record the insulation resistance of ALL airfield lighting circuits prior to starting any work. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.
- M. Should the Contractor fail to perform the tests prior to starting work, the Contractor shall be responsible to bring the impacted circuits to a minimum 50 megohm insulation resistance value or higher value in conformance with any previous airport test records.
- N. Provide temporary wiring to permit operation of lighting circuits associated with each phase of construction. Temporary cable connections shall be made in airfield lighting circuits when permanent wiring cannot be completed during daylight hours.
- O. The Contractor shall furnish, install and maintain hazard marking and lighting to identify closure areas, open manholes, small areas under repair, stockpiles, and other construction related areas hazardous to aircraft or personnel.
- P. The Contractor is responsible for operating all temporary circuits within their rated capacity.
- Q. The cost of temporary and reconnected airfield lighting/power shall be considered incidental to the pay items provided within the Contract Documents.

4.3 TEMPORARY ELECTRICAL AND LIGHTING INSTALLATION

- A. Temporary electrical and/or lighting fixtures shall be provided in operational areas of buildings where required to maintain public safety and continued airport operations.
- B. Provide temporary roadway lighting on airport roads and detours during construction. Design installation and removal of temporary systems shall be the responsibility of the Contractor. Light levels shall be 1.0 maintained foot-candles on the traveled part of the roadway. Lighting under the bridges during construction shall have a metal halide or other white light source, providing a maintained light level of 2.0 foot-candles. Maximum to minimum uniformity ratios shall be 10:1.
- C. Temporary lighting must be installed to ANSI/OSHA standards for impacted area. Light levels shall also meet the requirements of the Illuminating Engineering Society for the type of task being performed.
- D. Temporary installations shall comply with the NEC and shall be acceptable to the Owner, OAR or authorized representative.
- E. The cost of temporary and reconnected area/building lighting/power shall be considered incidental to the pay items provided within the Contract Documents.

4.4 MISCELLANEOUS REGULATIONS

- A. Electrical main distribution panels, branch circuits panels, control panels, etc., may have their front covers removed for access to live parts. Access to live parts shall be guarded/barricaded in accordance with NFPA 70E.
- B. Draw-out type breakers, regardless of operating voltage must be drawn completely out to open position and tagged and locked out per 4.1.
- C. In hazardous locations, regardless of class, all electrical tools and extension cords shall be of a type accepted for use in such areas.
- D. No counterpoise/grounding conductors may be joined, connected, or affixed to any terminal, grounding electrode, or other point of attachment by any method except exothermic welding, or accepted equivalent. See Item L-108.
- E. All counterpoise or grounding systems, when damaged, shall be immediately reported to the OAR. Once the repair/replace procedure has been accepted by the OAR the Contractor shall immediately repair/replace the counterpoise or grounding components.
- F. No high voltage switch shall be engaged or disengaged under load.
- G. All backhoes, cranes, etc., shall be enclosed by safety pylon or other markers and rope festooned by accepted safety tapes.
- H. All security gates in use by Contractors are the responsibility of the Contractor and must be used in a fully secure manner. Any damage to a security gate shall be reported immediately to the OAR.

4.5 TEMPORARY COMMUNICATIONS/CONTROL

- A. Temporary communication and control systems shall be provided in operational areas of buildings where required to maintain public safety and continued airport operations. Temporary communication and control systems shall be as described in the Contract Documents.
- B. The cost of temporary and reconnected communication and control shall be considered incidental to the pay items provided within the Contract Documents.

PART 5 - METHOD OF MEASUREMENT

5.1 METHOD OF MEASUREMENT

- A. Except for the pay item described below all other items shall be considered incidental to other items and shall be included with its applicable system.
- B. Temporary Power & Temporary Airfield Lighting/Signage/Navigational Facilities shall be measured as a lump sum item.

PART 6 - BASIS OF PAYMENT

6.1 BASIS OF PAYMENT

- A. Except for the pay item, as described below, no direct payment shall be made for the work described in this section. The work described in this section is incidental to other items and shall be paid for the respective bid item of which it is a component part.
- B. Temporary Power & Temporary Airfield Lighting/Signage/Navigational Facilities payment shall be made at the contract lump sum price for the required work. This item shall include all testing, troubleshooting, maintenance and other consequential work required to maintain the temporary power, and temporary airfield lighting, signage, and Navigational Facilities as impacted by this Contract. This price shall be full compensation for all planning, supervision, furnishing all material, labor, transportation, services, equipment, utility company fees and for all preparation, removal of the temporary materials and equipment and for all labor, equipment, tools and all incidentals required to furnish and install Temporary Power and Temporary Airfield Lighting, Signage, and Navigational Facilities in accordance with the Contract Documents. This item includes all excavation, backfill, cable, conduit and other materials and appurtenances necessary to complete these items.

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

GENERAL ELECTRICAL SAFETY
REQUIREMENTS AND TEMPORARY
AIRFIELD LIGHTING
SECTION SP-104

Payment will be made under:

Item SP-104-6.1	Temporary Power & Temporary Airfield Lighting/Signage/Navigational Facilities	-- Lump Sum (LS)

END OF SECTION SP-104

ITEM SP-105 - ALTERATIONS, REMOVAL AND DEMOLITION

PART 1 - GENERAL

1.1 GENERAL

- A. This item shall apply to all electrical work contained within the Contract Documents. Where the contract general conditions, special provisions or other parts of the Contract Documents also apply, the stricter of the documents shall govern.
- B. Alterations shall mean any change or rearrangement in the component parts, including structural, mechanical, and electrical systems, or internal or external arrangements of an existing item, component, system or structure.
- C. Removal shall mean the dismantling and disposal of existing materials, components, equipment, and utilities. Removed items shall be handled, prepared for storage, transported to storage areas, or disposed of as specified.
- D. Demolition shall mean abandonment, removal and disposal, or salvage and delivery to the Owner as required by the Contract Documents.
- E. The installation and/or removal of lighting equipment may be critical to airport operations; therefore, the Contractor shall follow work schedule established in the Contract Documents or as directed by the Engineer.
- F. Temporary power and lighting shall be accomplished in accordance with the Contract Documents.

1.2 CONDITION OF EXISTING FACILITIES

- A. The Contractor shall verify the areas, conditions, and features necessary to tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.
- B. The Contractor shall protect all existing utilities from damage resulting from alteration, removal and demolition activities.
- C. Any hazardous waste issue shall be immediately reported to the Engineer.
- D. Whenever the scope of work requires, connection to an existing circuit, or should the scope of work involve working adjacent or near to an existing circuit and the work could have an adverse impact on the existing circuit, the circuit's insulation resistance shall be tested, in the presence of the Engineer. The test shall be performed in accordance with Item SP-111 and prior to any activity affecting or impacting the respective circuit. The Contractor shall record the results on forms included in Item SP-111. When the work affecting the circuit is complete (or at end of shift prior to energization), the circuit's insulation resistance shall be checked again, in the presence of the Engineer. The

Contractor shall record the results on forms included in Item SP-111. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. The Contractor shall measure and record the insulation resistance of ALL airfield lighting circuits prior to starting any work. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

- E. Should the Contractor fail to perform the insulation resistance tests prior to starting work, the Contractor shall be responsible to bring the impacted circuits to a minimum 50 megohm earth resistance value or higher value in conformance with any previous airport test records.

1.3 OCCUPANCY AND USE OF EXISTING FACILITIES

- A. The Owner will occupy and use the facilities within the areas of work during the entire construction period. The Contractor shall be required to plan and coordinate the Contractor's activities in order to provide all necessary controls for the abatement of dust, noise, and inconvenience to Owner personnel during all phases of the work.

1.4 VACATING OCCUPIED AREAS

- A. The Owner will remove all portable items of furniture, equipment, and fixtures prior to the start of work.

1.5 SAFETY REQUIREMENTS

- A. The Contractor shall conduct all operations in a manner that will ensure the safety of persons and property in accordance with the OSHA requirements of CFR 29 Part 1926/1910.
- B. The Contractor shall comply with the Airport Maintenance Department's LOCK OUT/TAG OUT (LOTO) procedure and NFPA 70E.

1.6 CLASSIFICATION OF REMOVED ITEMS

- A. Existing materials and equipment indicated to be removed will be classified as "salvageable" and shall remain the property of the Owner or will be classified as "demolition or debris" and shall be legally disposed.
- B. Salvageable Items:
 - 1. Salvaged materials and equipment shall be reused in the work only in construction of temporary electrical facilities, unless noted otherwise.

2. Properly box, protect and ready for transport salvageable items. Retained salvaged items shall be stored on Owner property.
3. Salvaged materials and equipment to be retained by the Owner but not reused in the work shall be turned over to the Owner at a site at the facility to be determined by the Owner.
4. Airfield lighting fixtures, signs and isolation transformers designated to be removed and reinstalled by the Contractor shall be stored indoors in a conditioned space. The indoor conditioned space shall be provided by the Contractor and considered incidental to the pay items provided. As each item designated for removal and reinstallation is removed the Contractor and Engineer shall immediately inspect the item for appropriateness for reinstallation. Any damage not reported in writing to the Engineer within two hours of removal shall become the Contractor's responsibility for replacement/repair of the material as directed by the Engineer. The Contractor is asked to pay special attention to the protection of the semiflush fixture leads. The semiflush fixture lead insulation is easily damaged which results in water infiltration into the fixture.

C. Demolition or Debris

1. Items classified as demolition or debris shall be legally disposed of off the Owner's property. The cost of such disposal shall be included in the bid price.

1.7 TEMPORARY PROTECTION

- A. Contractor shall protect persons and property throughout the progress of the work in accordance with the Contract Documents.

1.8 DEMOLITION TASK PLAN AND SCHEDULE

- A. The Contractor shall submit to the Engineer a Demolition Task Plan and Schedule for all existing utility relocation(s) and demolition work. The task plan shall be submitted within 30 days of notice to proceed but no later than 30 days prior to the start of the relocation/demolition work.
- B. The task plan and schedule shall detail the phasing of the utility relocation(s) and demolition activities with the balance of the project phasing plan. The task plan and schedule shall detail the Contractor's plan for protection of the existing utilities.
- C. The task plan and schedule shall demonstrate preliminary coordination has taken place with the FAA, Airport, communications and power utilities and also demonstrates compliance with the Contract Documents.
- D. No work shall be initiated until the task plan and schedule has been submitted to the Engineer and accepted by the utilities. No demolition, alteration or relocation work shall be started until the permanent work replacing the demolition, alteration or relocation is

complete, in place, accepted and ready for operation; or until other temporary means have been approved and accepted by the Engineer.

PART 2 - EXECUTION

2.1 DISCONNECTING UTILITIES

- A. Prior to the start of work, the Contractor shall coordinate with the Owner and effected utility companies to have each utility placed in a safe work condition.
- B. Each utility effected shall be locked out and tagged by the Contractor. Proper safety grounds or equivalent shall be placed for personnel protection.

2.2 TEMPORARY UTILITY SERVICES

- A. Contractor shall install temporary utility services in satisfactory operating condition before disconnecting existing utilities. Such temporary services shall be maintained during the period of construction and removed only after new permanent services have been tested and are in operation. Please refer to Item SP-104.

2.3 REMOVAL WORK

- A. The Contractor shall not disturb the existing construction beyond that indicated or necessary for installation of new work. Temporary shoring and bracing for support of building components to prevent settlement or other movement shall be as required to protect the work and existing facilities.
- B. The Contractor shall provide protective measures to control accumulation and migration of dust and dirt in all areas of work, particularly those adjacent to occupied areas. The Contractor shall remove dust, dirt, and debris from the areas of work daily.

2.4 SALVAGEABLE MATERIALS AND EQUIPMENT

- A. The Contractor shall remove all salvageable materials and equipment in a manner that will cause the least possible damage thereto. Salvageable items, which are to be retained by the Owner, shall be carefully handled, stored, and protected.
- B. The Contractor shall provide identification tags on all salvageable items boxed or placed in containers, indicating the type, size, and quantity of materials.
- C. The Contractor shall exercise extreme care when removing airfield lighting bolting hardware. The existing bolting hardware may have been installed in excess of twenty-five years. The Contractor shall be responsible for the proper removal/repair/replacement of all stripped/broken/damaged fixture bolts or light base bolts or tapped holes in light bases and/or appurtenances encountered during

construction. Contractor shall use drilling/tapping/inserts fixture/jigs/tooling and methods approved by the light base manufacturer or an accepted equivalent. Payment for this work shall be considered incidental to the respective fixture and light base pay items provided in the Contract Documents.

2.5 ELECTRICAL EQUIPMENT AND FIXTURES

- A. Wiring systems and components shall be salvaged. Loose items shall be boxed and tagged for identification.
- B. Primary, secondary, control, communication, and signal circuits shall be disconnected at the point of attachment to their distribution system.
- C. The Contractor shall remove and salvage electrical fixtures. Incandescent lamps, mercury-vapor lamps, and fluorescent lamps shall be salvaged, boxed and tagged for identification, and protected from breakage. The fixtures shall be turned over to the Owners Maintenance Department. This Contractor shall legally dispose of concrete bases, etc. off the Airport property.
- D. The Contractor shall remove and salvage switches, receptacles, fixtures, transformers, regulators, meters, instruments, cover plates, circuit breakers, panelboards, outlet boxes, and similar items; these items shall be boxed, and tagged for identification according to type and size.
- E. The Contractor shall remove and salvage cable tray, wiring ducts and troughs.
- F. The Contractor shall remove and dispose of conductors, including insulated wire, nonmetallic sheathed and flexible armored cable.
- G. All removed or demolished items not identified for reuse in the work or to be turned over to the Owner, unless noted otherwise, shall be properly and legally disposed of off the airport site.

2.6 DEMOLITION OPERATIONS

- A. Demolition operations shall be conducted to ensure the safe passage of persons to and from facilities occupied and used by the Owner.
- B. The sequence of operations shall be such that maximum protection from inclement weather will be provided for materials and equipment in partially dismantled state.

2.7 MAINTAINING TRAFFIC

- A. Demolition operations and removal of debris to disposal areas shall be conducted to ensure minimum interference with roads, streets, walks, and other facilities occupied and used by the Owner.

- B. Streets, walks, runways, taxiways and other facilities occupied and used by the Owner shall not be closed or obstructed without written permission.

2.8 UTILITY ADJUSTMENTS

- A. The Contractor shall adjust utility elevations and or locations as described in the Contract Documents.

PART 3 - DISPOSAL OF REMOVED/DEMOLISHED MATERIALS

3.1 GENERAL

- A. The Contractor shall dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from demolition/removal operations. Removed/demolished materials shall not be stored or disposed of on the project site.
- B. Removed/demolished materials shall be properly and legally disposed of off airport property.
- C. Removed/demolished debris shall be transported from Owner property and legally disposed at no additional cost to the Owner. The Contractor shall pay permits and fees for disposal.

3.2 RACEWAY DEMOLITION

- A. Pull wire out of existing raceways. Underground conduit/duct may be abandoned in place when not in an area of excavation. When abandoned in place install waterproof caps/plugs and concrete end of duct markers.
- B. Raceways that interfere with new work shall be completely removed.
- C. Install 200 pound test pull rope in all conduits/ducts to remain in place. Conduit/duct banks may be abandoned in place if they are not within 24" of any new subgrade material.
- D. Dispose of raceway as debris.

3.3 AIRFIELD LIGHTING AND SIGNS

- A. Carefully remove existing airfield lighting, signs, etc. as noted in the Contract Documents. Properly store all signs, fixtures, base plates and spacer rings for reinstallation or turn over to Owner as noted in the Contract Documents.

- B. There may be concrete foundations (anchors) around light bases that extend into the existing asphalt surface as well as concrete backfilled trenches, conduits and duct banks within the asphalt paved areas that may be encountered during the required milling process. To the extent known, these duct banks and conduits are shown on the Contract Documents under/within the paved areas. The milling of any such concrete around the light bases, or over trenches, ducts and conduits shall be considered incidental to the milling pay item.
- C. Existing concrete sign pads, light bases, and raceways shall be demolished, transported from Owner property and legally disposed.
- D. If required by the Contract Documents reinstall signs and fixtures.
- E. Turn over to the Owner all signs, fixtures, base plates and spacer rings not reinstalled as a part of this contract.
- F. Remove existing light bases, L-824 cable, L-830 isolation transformers and associated foundations and legally dispose.

3.4 MANHOLE/HAND HOLE DEMOLITION

- A. Manholes, hand holes, pull boxes, etc. shall be removed and disposed of as demolition debris.
- B. Demolished manholes, hand holes, pull boxes, etc. below the new full strength pavement shall be completely removed.
- C. Demolished manholes, hand holes, pull boxes, etc. below shoulder pavement or in turfed areas shall be cut down to a depth of 48" min. below finished grade, filled and compacted in accordance with the Contract Documents.

3.5 GENERAL – CUTTING AND PATCHING

- A. Cutting, patching, repairing, and other alteration work shall be done by mechanics skilled in the particular trade or work required.
- B. Salvaged items for reuse shall be as accepted by the Engineer.
- C. Where required to patch or extend existing construction, or both, such alteration work shall match existing exposed surface materials in finish, color, texture, and pattern.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. All Electrical Demolition covered by this item will be paid for at the contract lump sum price, as set forth below, for demolition, alteration and removal complete and in accordance with the Contract Documents.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. Payment will be made at the contract lump sum price for the required demolition, alteration and removal. This price shall be full compensation for furnishing all material, equipment and for all preparation, removal of the demolished materials and equipment and for all materials, labor, equipment, tools, services and incidentals necessary or required for the electrical demolition as shown in the Contract Documents. It is the intent of the demolition pay item that all equipment, devices, raceway, pull boxes, manholes, fixtures, wiring, materials, systems, appurtenances, etc., which are no longer required as a result of the project be removed. All waste materials shall be removed from the airport property and legally disposed of by the Contractor. This item includes all backfill, P-610, sod and other materials and appurtenances not specifically identified, but necessary to complete these items in accordance with the Contract Documents. This price shall include the required demolition and removal of VRC A1 Type manholes.

Payment will be made under:

Item SP-105-5.1	Electrical Demolition	-- Lump Sum (LS)

END OF ITEM SP-105

SECTION SP-106 - SUBMITTALS, RECORD DOCUMENTS AND MAINTENANCE MANUALS

PART 1 - DESCRIPTION

1.1 GENERAL

- A. The items described in this item are applicable to all electrical work. Electrical work is defined as any work described, included, depicted or contained within the L-XXX specification series, SP-XXX, L- series drawings, E- series drawings, ED- series drawings and all other work within the Contract Documents dealing with the distribution of electrical power/light, electrical/electronic/light monitoring, communication and control.
- B. Only Third Party Certified manufacturers, listed in AC 150/5345-53, Appendix 3 Addendum (as required) and meeting the BUY AMERICAN preference requirements can provide equipment and materials specified in the Contract Documents. Documentation certifying compliance with the BUY AMERICAN preference rules for AIP (in accordance with Title 49, United State Code [USC], 1990; later designated as 49 USC §50101) shall be included with each equipment and material submittal.
- C. The requirements for submittals, record drawings and Operation and Maintenance (O&M) Manuals supplement the requirements and are in addition to the requirements of the general conditions, special provisions or other parts of the Contract Documents. Where the contract general conditions, special provisions or other parts of the Contract Documents also apply, the stricter of the documents shall govern.

1.2 SCOPE

- A. This item includes the requirements for submittals, record documents and operation and maintenance (O&M) manuals. All submittals and O & M Manuals shall be submitted in book form as described by this item.

PART 2 - REQUIREMENTS FOR SUBMITTALS

2.1 DATA, SHOP DRAWINGS AND SAMPLES

- A. Shop drawings are drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor or any subcontractor, manufacturer, supplier or distributor, and which illustrate some portion of the work.
- B. Submittal data for electrical materials and equipment shall consist of shop drawings and/or catalog cuts showing technical data as necessary to evaluate the material or equipment, to include dimensions, wiring diagrams, performance curves, ratings, control sequence and other descriptive data necessary to describe fully the item proposed and its operating characteristics.

- C. Prior to the installation of any material or equipment and within 30 days of notice to proceed, the Contractor shall provide to the Engineer all submittals as required by the Contract Documents. The submittals shall be complete and made in ONE submission in the format required by this item. Partial submission will only be considered under special circumstances.
- D. The Contractor shall perform no portion of the work, nor purchase any materials, requiring submission until the Engineer has accepted the relevant submittal/shop drawing/sample. Should the Contractor commence any work or install any materials prior to the receipt of an accepted submittal/shop drawing/sample the Contractor is deemed to be proceeding at the Contractor's own risk.
- E. Samples are physical examples furnished by the Contractor to illustrate materials, equipment or workmanship, and to establish standards by which the work will be judged. Each sample shall be accompanied by the manufacturer's instructions regarding installation, operation and maintenance and shall be identified by item number, and specification.
- F. By approving and submitting Shop Drawings and Samples, the Contractor thereby represents that the Contractor has determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data and that the Contractor, has checked and coordinated each Shop Drawing and Sample with the requirements of the work of the Contract Documents.
- G. Unless otherwise stated in the Contract Documents the Engineer will review Data, Shop Drawings and Samples within thirty (30) days after receipt, but only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Engineer's review of a separate item shall not indicate approval of an assembly in which the item functions.
- H. The Engineer reserves the right to reject any and all equipment, materials and procedures, which, in the Engineer's opinion, does not comply with the system design and the standards and codes specified herein.
- I. The Engineer shall be the sole judge of whether the proposed "acceptable equivalent" is suitable for use in the work.
- J. The Contractor shall make any corrections required by the Engineer and shall resubmit the required number of corrected shop drawings or new samples until accepted. The Contractor shall direct specific attention in writing on resubmitted shop drawings to revisions other than the corrections requested by the Engineer on previous submissions.
- K. If the Contractor desires to substitute materials or deviate from the requirements of the Contract Documents, the Contractor shall separately submit all substitute materials and deviations to the Contract Documents. Such submittals shall be clearly and boldly marked "SUBSTITUTION" or "DEVIATION TO CONTRACT DOCUMENTS". If the substitution or deviation is accepted, the Contractor will not be excused from producing work in conformity with the Contract Documents. If a trial use establishes the work does not comply with the Contract Documents, the Contractor shall take such action as the Engineer determines necessary.

- L. The Engineer's approval of shop drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents unless the Contractor has informed the Engineer in writing of such deviation at the time of submission and the Engineer has provided written acceptance to the specific deviation. The Engineer's approval shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings or samples.
- M. The submittals will be checked only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action noted by the Engineer on the submittal is subject to the requirements of the Contract Documents.
- N. The Contractor is responsible for dimensions, quantities, fabrication processes and methods of construction, coordination of the Contractors work with that of all trades. The Contractor shall be responsible for satisfactory performance of the Contractor's work and supplying a complete and fully functional system. The Contractor shall confirm and correlate dimensions at the jobsite.
- O. Samples shall be submitted upon request or as required by the Contract Documents.
- P. The Contractor shall maintain an accurate updated "SUBMITTAL REGISTER" containing the status of all submittals. The log shall be updated on a weekly basis. The Contractor shall bring the submittal register to each progress meeting. The submittal register shall contain the following information:
 - 1. Submittal description and number assigned.
 - 2. Contract Document required submittal date.
 - 3. Submittal electrical system type; airfield lighting or airfield lighting control or airfield lighting vault power system.
 - 4. Reference Item # (L-108, 26 05 33.13, etc).
 - 5. Date sent to Engineer.
 - 6. Date returned to Contractor from Engineer.
 - 7. Submittal status.
 - 8. Date of resubmittal and return – as applicable.
 - 9. Date material released for fabrication.
 - 10. Projected date of fabrication.
 - 11. Projected date of delivery to site.

2.2 ELECTRONIC SUBMITTAL

- A. Electronic submittal shall consist of a single PDF document separated and book marked per each electrical system, per specification section as described in section 2.2.d. containing all materials for each item to be installed in the project.
- B. Electronic submittals larger than 10 megabyte shall be separated into smaller PDF files for transmission to make up a single PDF document. Each separate PDF shall be book marked per specification section containing all materials for each item to be installed in the project.
- C. Each PDF for electronic transmission shall be clearly labeled as transmittal X of Y per submittal section.
- D. Provide separate submittal PDF's for each of the following electrical system types:
 - 1. One PDF submittal set for the Airfield Lighting System. All components to be included in the contract for lighting, conduit, grounding and miscellaneous systems shall be included.
 - 2. One PDF submittal set for the Airfield Lighting Control System.
 - 3. One PDF submittal set for the Airfield Lighting Vault Modifications,

2.3 SUBMITTAL CONTENTS

- A. First sheet(s) in shall be a cover sheet containing the project information and location. See appendix A at the end of SP-106 specification.
- B. The second sheet shall be a table of contents identifying the specification section(s) being submitted.
- C. Third sheet shall be prepared and filled out by Contractor and shall list project address of airport, Engineer, Contractor & subcontractor(s).
- D. Fourth sheet shall also be filled out by Contractor and list project schedule information.
- E. Submittals consisting of marked catalog sheets or shop drawings shall be inserted in the PDF in specification number/section order. Submittal data shall be presented in a clear and thorough manner. Original PDF catalog sheets are preferred. Scans of catalog sheets are acceptable provided they are equivalent in quality to the original document.
- F. Clearly and boldly mark each page to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Markings shall be boldly and clearly made with arrows or circles (highlighting is not acceptable).
- G. All sheets within the submittal shall be oriented in a portrait setting. Mixing of portrait and landscape oriented standard 8.5 X 11 sheets shall not be permitted.

- H. All sheets contained within the PDF shall be straight. Sheets scanned on a drastic angle making the submittal page difficult to read shall not be permitted and shall result in the submittal being rejected.
- I. Some catalog sheets have colored backgrounds or colored text. When scanned these items appear black and obscure the printed text and markings by the contractor. For this reason, all scans of sheets with colored backgrounds or text shall be made in color. Sheets that are not readable due to obscured information shall be rejected.
- J. Submittals for components of electrical equipment and systems shall identify the equipment for which they are a component part on each submittal sheet.
- K. Shop Drawings: Drawings to include identification of project and names of Engineer(s), General Contractor, subcontractor and supplier, data, number sequentially and indicate the following:
 - 1. Fabrication and erection dimensions.
 - 2. Arrangements and sectional views.
 - 3. Necessary details, including complete information for making connections with other work.
 - 4. Kinds of materials and finishes.
 - 5. Descriptive names of equipment.
 - 6. Modifications and options to standard equipment required by the work.
 - 7. Leave blank area, size approximately 5 x 5 inches, near title block for the Engineer's stamp imprint.
 - 8. Point-to-point wiring diagrams.
 - 9. Conduit/duct/raceway rough-in drawings.
 - 10. See specific items of the Contract Documents for further requirements.
- L. Submittal Product Data - Technical data is required for all items as called for in the Contract Documents, regardless, if item furnished is as specified.
 - 1. Submit technical data verifying that the item submitted complies with the requirements of the Contract Documents. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate all optional equipment and changes from the standard item as called for in the Contract Documents. Furnish drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.

2. In order to facilitate review of product data, insofar as practicable, they shall be noted, indicating by cross reference the Contract Documents, note, drawing number and/or specification number and item paragraph numbers where item(s) occur in the Contract Documents.
3. See specific items in Contract Documents for further requirements.

2.4 PROCESSING SUBMITTALS

- A. Submit the PDF submittal and shop drawings per Specification section
- B. The Contractor shall review, stamp with the Contractor's approval and submit to the Engineer, eight (8) prints of shop drawings, eight (8) copies of submittal books and three (3) sets of samples where required, as described in this item,
- C. The General Contractor shall review the submittal books before submitting to the Engineer. No request for payment will be considered until the submittal book has been reviewed and submitted for review by the Engineer.
- D. Product Data: For standard manufactured materials, products and items, submit one (1) copy or sets of data (per book).
- E. Shop Drawings for custom fabricated items and systems:
 1. Initially submit a transparency (suitable for reproduction) together with four (4) prints made the transparency.
 2. When submittal is acceptable, furnish one (1) print per book made from the accepted transparency.
- F. Acceptance: When returned to Contractor, the front of each submittal will be marked with the Engineer's stamp. If box marked "Submit Specified Item", or "Rejected" or "Revise and Resubmit" is checked, submittal is not accepted and Contractor is to correct and resubmit as noted. If submittal is marked "Make Correction Noted" Contractor may begin construction utilizing the submitted item with corrections made. However, the corrected submittal must be resubmitted for record keeping purposes. Contractor is to comply with notation making necessary corrections on submittal and resubmit for final record.
- G. If the submittal is marked "No Exception Taken" the Engineer took no exceptions to the submitted items.
- H. Corrections or comments made on the shop drawings during this review do not relieve Contractor from compliance with requirements of the Contract Documents. This check is only for review of the general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for; confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating the

Contractor's work with that of all other trades and performing all work in a safe and satisfactory manner.

- I. Note that the acceptance of shop drawings or other information submitted in accordance with the requirements contained in this item, does not assure that the Engineer or any other Owner's Representative attests:
 - 1. To the dimensional accuracy or dimensional suitability of the material or equipment involved.
 - 2. The ability of the material or equipment involved to perform as designed.
 - 3. The mechanical or electrical performance of equipment.
- J. Approval of shop drawings does not invalidate the Contract Documents if in conflict; unless a letter requesting such a change is submitted and accepted on the Engineer's letterhead.

2.5 DELAYS

- A. Contractor is responsible for delays in job progress accruing directly or indirectly from late submissions or resubmissions of shop drawings, or product data.

2.6 RE-SUBMITTALS

- A. The Engineer shall be reimbursed for engineering costs to review resubmittals subsequent to the second submittal.

PART 3 – RECORD DOCUMENTS

3.1 PROGRESS AND RECORD DRAWINGS

- A. Keep two sets of blue line prints on the job and neatly mark up design drawings each day as components are installed. Red pencil shall be used for additions and green pencil for deletions. Use of "white out" or similar products is not permitted.
- B. All items on record drawings shall be shown in actual location installed. Drawings shall be inspected weekly, by the Engineer, for compliance and accuracy. Project payments shall be withheld if the marked-up drawings are not current.
- C. Change the equipment schedules to agree with items actually furnished.
- D. All hand holes, pull boxes, junction can plazas, manholes, underground ducts, conduits, force mains, drains, ground grids, etc. (all underground utilities) installed by this Contractor or located by this Contractor during the construction of this project shall be surveyed and recorded on the record documents. Record utility locations in state plane grid coordinates. Provide north-south, east-west coordinate and elevation.

- E. At the end of the project, all changes shall be reviewed by the Electrical Contractor. The drawings shall be marked "As Built" and dated and signed by the Electrical Contractor's Superintendent.
- F. Prior to request for final payment, furnish a set of "As Built" prints to the Engineer for review. The final prints shall be professionally drafted to indicate "As Built" conditions to the Engineer. The prints shall be stamped "As Built" signed and dated by the Contractor. The Contractor's signature shall certify to the Engineer that the "As Built" drawings are accurate and complete.
- G. The Contractor's failure to produce representative "As Built" drawings in accordance with requirements of this item, shall be cause for the Engineer to produce such "As-built" drawings and the Contractor shall reimburse Engineer for all costs to produce a representative set of "As Built" drawings.

PART 4 - PERATION AND MAINTENANCE MANUALS

4.1 REQUIREMENTS FOR OPERATION AND MAINTENANCE MANUALS:

- A. Two (2) CD's shall be provided with all O & M Manual information included in PDF format. The Operation and Maintenance Manual shall be submitted as a PDF document. As a minimum, the Operation and Maintenance Manual shall contain the following:
 - 1. Safety precautions used while maintaining the equipment.
 - 2. Theory of circuit and system operation.
 - 3. Complete schematic and interconnecting wiring diagrams.
 - 4. Complete parts list with each circuit component keyed to designations assigned on schematics and wiring diagrams. Complete information shall be given for each part to permit ordering for replacement purposes. This information shall include the components rating, name of manufacturer and the manufacturer's part number.
 - 5. Recommended preventative maintenance, including care, cleaning lubrication, service intervals, etc.
 - 6. Troubleshooting procedures.
 - 7. Physical characteristics (weight, size, mounting dimensions, etc.).
 - 8. Installation instructions.
 - 9. Operating instruction.
 - 10. Recommended spare parts and usage for a one (1) year period.

11. Submit for checking purposes a specific set of written operating instructions on each item, which requires instructions to operate. After acceptance, provide one copy for insertion in each Operation and Maintenance Manual.
12. Submit for acceptance maintenance information consisting of manufacturer's printed instructions and parts list for each major item of equipment. After acceptance, insert information in each Operations and Maintenance Manual. Detailed schematic diagrams shall be furnished for all electrical/electronic equipment.
13. Bill of materials.
14. Physical layout plans.
15. Equipment supplier list.
16. Panel schedules shall be submitted with the respective panel data.
17. Special instructions
18. Service maintenance contracts including the name, address and 24 hour phone number and contact of manufacturer's authorized Repair Company.

There shall be no "Black Boxes" for which there are no schematic/wiring diagrams.

4.2 OPERATION AND MAINTENANCE MANUALS

- A. O & M Manuals shall consist of a PDF document. The manual shall be bookmarked into sections by Table of Contents, Project Contacts, and each technical specification section. Shop drawings, product data and/or catalog sheets shall be inserted into the O & M PDF by technical specification.
- B. Provide correct designation of project on first page of each technical specification submittal section. Description sheet shall be white with black letters, minimum of 11" high and full width of page. Description shall describe project and match project Contract Document description. Description to include submittal type.
- C. All documents inserted into the O & M Manual PDF, including but not limited to catalog cut sheets, theory of operation, and all other related product data, shall be the original documentation from the manufacturer.
- D. Any scanned documentation shall be legible, and have the correct orientation in the pdf so the document can be read horizontally, from left to right, in line with all other pages in the O & M Manual. Failure to meet these requirements will result in the O & M Manual's rejection. Upon rejection any errata shall be fixed and resubmitted to the engineer for approval.
- E. Provide one O & M Manual for the electrical system required by the contract documents.

4.3 OPERATION AND MAINTENANCE MANUAL CONTENTS

A. Operation & Maintenance Manuals shall include:

1. First sheet in PDF shall be the cover sheet.
2. The second sheet shall be a table of contents.
3. The third sheet shall be filled out by Contractor and shall list project address of airport, Engineer, Contractor & subcontractor(s).
4. The fourth sheet shall also be filled out by Contractor and list project schedule information showing project "as completed".
5. Shop Drawings: Shop drawings shall be a copy of the final and accepted shop drawings submitted. These shall be inserted into the PDF in specification number/section order. Each catalog sheet shall clearly identify where the product is used and the Contract Document identification for equipment.
6. Product data and/or catalog sheets shall be a copy of the final and accepted submittal. These shall be inserted into the PDF in specification number/section order. Each catalog sheet shall clearly identify where the product is used and the Contract Document identification for equipment.
7. Warranty/Guarantee: Provide copy of warranty/guarantee and letters of certification, in respective location in O & M Manual PDF. Original warranty/guarantee shall be incorporated into separate project warranty PDF with warranty/guarantees provided for other items and submitted for Engineer review.

4.4 PROCESSING OPERATION AND MAINTENANCE MANUALS

- A. The General Contractor shall review the manuals before submitting to the Engineer. Submit one CD containing the PDF set of O& M Manuals to the owner and one CD containing the PDF set to the Engineer.

4.5 DELAYS

- A. Contractor is responsible for delays in job progress accruing directly or indirectly from late submissions or resubmissions of the Operation and Maintenance Manuals.

4.6 RE-SUBMITTALS

- A. The Engineer shall be reimbursed the cost to review Operation and Maintenance Manual re-submittals subsequent to the second submittal.

PART 5 - METHOD OF MEASUREMENT

5.1 METHOD OF MEASUREMENT

- A. The items described in Item SP-106 are incidental to other pay items and shall not be measured for payment.

PART 6 - BASIS OF PAYMENT

6.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Item SP-106. The work described in Item SP-106 is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

PART 7 - SUBMITTAL LIST

7.1 SUBMITTAL LIST

- A. The following is a list of materials expected by the Engineer to be incorporated within the project. This list is not all inclusive as the Contractor's chosen means and methods will have a direct impact on the materials used.
- B. It is the intent of this item that all materials used or incorporated into this project is submitted to the Engineer for review.
- C. The Contractor shall maintain a submittal register in accordance with Part 2 of this item. The Submittal register shall include all items used or incorporated into the project.

LIST TO FOLLOW:

Spec. Section Number	Spec Paragraph Number	Submittal Description
SP-100	1.4-A	CERTIFICATION OF ELECTRICAL CONTRACTOR'S EXPERIENCE
SP-100	1.4-A	COPY OF ELECTRICAL CONTRACTOR'S STATE ELECTRICAL LICENSE
SP-100	1.5-C	CERTIFICATION OF ELECTRICAL SUPERINTENDENT'S EXPERIENCE
SP-100	1.5-C	ELECTRICAL SUPERINTENDENT'S RESUME' AND COPY OF JOURNEYMAN ELECTRICIAN LICENSE

SP-100	1.5-C	ELECTRICAL SUPERINTENDENT'S REFERENCES, AIRPORT NAME, CONTACT AND PHONE NUMBER
SP-100	1.5-F	COPY OF EACH JOURNEYMAN ELECTRICIAN'S LICENSE
SP-100	2.4-B	EXISTING FACILITIES INVESTIGATION MEMO
SP-100	2.4-E	SCHEDULED SHUTDOWNS
SP-100	2.5-A	WARRANTIES
SP-100	2.6-A	O&M MANUALS
SP-100	2.7-O	RECORD DOCUMENTS
SP-100	3.1-A	GENERAL LIGHTING PROVISIONS SUPERVISION & ATTENDANCE (SD-08)
SP-100	3.1-K	COLOR CODE PAINT
SP-100	3.7-D	LOAD BALANCE TEST
SP-100	3.8-C	PHENOLIC NAMEPLATES 1 TO 1 SCALE DETAIL OF EACH NAMEPLATE
SP-100	3.9	ADHESIVE BACKED CLOTH MARKERS
SP-100	3.12-A	WELDER QUALIFICATIONS
SP-100	3.12-A	WELDING PROCEDURES
SP-100	3.12-A	WELDER QUALIFICATION TEST
SP-100	GENERIC REQUIREMENT	PERMANENT BLACK MARKER
SP-100	GENERIC REQUIREMENT	SELF-ADHESIVE CLEAR PRINTED LABELS W/ BLACK TYPED LETTERS
SP-104	1.3-A	SAFETY PLAN (SD-01)
SP-104	1.9-A	WRITTEN VERIFICATION PROVIDING PROOF OF CORRESPONDENCE WITH REPRESENTATIVES OF ALL UTILITIES/AGENCIES TO LOCATE ALL EXISTING UTILITIES/SYSTEMS WITHIN THE PROJECT LIMITS
SP-104	4.1-A	TAGGING AND LOCKOUT PROCEDURE
SP-104	4.1-D	FAA 45 DAY WRITTEN NOTICE OF WORK
SP-104	4.2-F	TEMPORARY AIRFIELD LIGHTING/POWER PLAN
SP-104	4.2-J	INSULATION RESISTANCE TESTS ON EXISTING CIRCUITS TO BE MODIFIED BY CONTRACTOR
SP-105	1.2-A	VERIFICATION OF EXISTING CONDITIONS (SD-21)
SP-105	1.2-D	INSULATION RESISTANCE TESTS ON EXISTING CIRCUITS TO BE MODIFIED BY CONTRACTOR
SP-105	1.8-A	DEMOLITION TASK PLAN

SP-105	1.8-B	EXISTING CABLE PROTECTION PLAN
L-108	2.1 - D	ALL MATERIALS AND EQUIPMENT USED TO CONSTRUCT THIS ITEM SHALL BE SUBMITTED TO THE ENGINEER
L-108	2.1 - F	WARRANTY
L-108	2.1 - G	CREW MIX
L-108	2.2 - A	#8 AWG, 5KV L-824 AIRFIELD LIGHTING CABLE (6.6A)
L-108	2.2 - A	L-824 SECONDARY CONDUCTORS, EXTENSION CORDS, ETC.
L-108	2.2 - B	CERTIFIED COPY OF FACTORY TEST REPORTS FOR ALL CABLE PROVIDED
L-108	2.2 - F	THWN-2 WIRE FOR CIRCUITS UP TO 600V
L-108	2.2 - F	COPPER BUS BAR BY SIZE, TYPE AND USE
L-108	2.2 - G	CONTROL CABLE
L-108	2.2 - H	FIBER OPTIC CABLE
L-108	2.2 - I	ALCS CONTROL CABLE
L-108	2.3 - A	#2 AWG SOLID COPPER COUNTERPOISE
L-108	2.3 - B	4/0 AWG GROUND GRID WIRE
L-108	2.3 - C	#6 AWG, GREEN THWN-2 INSULATED BONDING JUMPER
L-108	2.3 - D	#2 AWG, GREEN THWN-2 INSULATED BONDING JUMPER
L-108	2.3 - F	3/4" DIAMETER BY 10' LONG COPPER CLAD STEEL SECTIONAL GROUND ROD
L-108	2.3 - F	GROUND ROD COUPLINGS
L-108	2.3 - F	GROUND ROD DRIVING STUDS
L-108	2.3 - I	GROUNDING CONDUCTORS FOR VOLTAGE CIRCUITS
L-108	2.4 - B	CAST SPLICE INCLUDING BLOCKING COMPOUND, CONNECTORS, SPLICE AND CRIMPING TOOL
L-108	2.4 - C	FIELD-ATTACHED PLUG-IN SPLICE
L-108	2.4 - E	TAPED OR HEAT-SHRIINKED SPLICE METHODS
L-108	2.4 - F	LIST OF APPROVED CRIMP CONNECTORS AND CRIMPING TOOLS
L-108	2.4 - F	COMPRESSION BUTT SPLICES INCLUDING MANUFACTURER'S INSTRUCTIONS
L-108	2.4 - F	COMPRESSION LUGS INCLUDING MANUFACTURER'S INSTRUCTIONS

L-108	2.4 - F	C-TAPS INCLUDING MANUFACTURER'S INSTRUCTIONS
L-108	2.4 - F	COMPRESSION TOOLING, CALIBRATION CERTIFICATE, PROCEDURES AND MANUFACTURER'S RECOMMENDED PRACTICES
L-108	2.4 - G	EXOTHERMIC CONNECTIONS INCLUDING ALL MOLDS, SHOTS AND MANUFACTURER'S INSTRUCTIONS
L-108	2.4 - G	BASE CAN GROUND CLAMPS
L-108	2.5 - A	AIRFIELD LIGHTING CABLE SPLICER QUALIFICATIONS
L-108	2.5 - B	AIRFIELD LIGHTING CABLE SPLICING DEMONSTRATIONS
L-108	2.5 - B	LIST OF APPROVED AIRFIELD LIGHTING CABLE SPLICERS AND ASSIGNED SPLICER IDENTIFICATION NUMBER.
L-108	2.5 - C	EXOTHERMIC WELDER QUALIFICATIONS
L-108	2.5 - C	SAMPLE EXOTHERMIC WELD DEMONSTRATIONS
L-108	2.5 - C	LIST OF APPROVED EXOTHERMIC WELDERS.
L-108	2.5 - D	ALL GROUNDING AND BONDING TOOLS AND EQUIPMENT
L-108	2.5 - D	GROUNDING AND BONDING QUALIFICATIONS
L-108	2.5 - D	SAMPLE CONNECTOR/LUG DEMONSTRATIONS
L-108	2.5 - D	LIST OF APPROVED GROUNDING AND BONDING PERSONNEL
L-108	2.8 - A	CABLE IDENTIFICATION TAGS AND TYRAP
L-108	2.8 - A	CABLE ID TAG STAMPED SAMPLES
L-108	2.9 - A	ALL ELECTRICAL TAPES
L-108	2.9 - A	HEAT SHRINK TUBING
L-108	2.10	ELECTRICAL COATING
L-108	2.11	INSULATION RESISTANCE TESTS OF EXISTING CIRCUITS
L-108	2.12	FIELD LIGHTING ARRESTOR ASSEMBLY CONNECTIONS
L-108	2.13	DETECTABLE WARNING TAPE
L-108	3.1 - G	L-823 CONNECTORS INCLUDING MANUFACTURER'S INSTRUCTIONS
L-108	3.1 - K	ADDITIONAL L-823 CONNECTORS TURNED OVER TO OWNER

L-108	3.2 - C	PULL ROPE
L-108	3.2 - D	MOISTURE-SEAL TAPE
L-108	3.2 - D	CABLE PULLING LUBRICANT
L-108	3.2 - E	CABLE PULLING TENSION VALUES
L-108	3.4 - A	WIRE/CABLE MARKERS
L-108	3.5 - F	CABLE STRIPPING AND PENCILING TOOLS
L-108	3.7 - H	EXOTHERMIC WELD PHOTOGRAPHIC LOG AND CD
L-108	3.7 - I	EXOTHERMIC WELD MANUFACTURER'S INSPECTION / ACCEPTANCE CRITERIA
L-108	3.8-D	LIGHTING AND POWER CIRCUIT CONTINUOUS OPERATION TEST
L-108	3.8-D	COUNTERPOISE CONTINUITY TEST
L-108	4.3	GROUND ROD INSPECTION PITS
L-108	GENERIC REQUIREMENT	MECHANICAL LUGS AND TORQUING REQUIREMENTS
L-108	GENERIC REQUIREMENT	TORQUE WRENCH, CALIBRATION CERTIFICATE AND MANUFACTURER'S RECOMMENDED PRACTICES
L-108	GENERIC REQUIREMENT	WIRE NUTS
L-108	GENERIC REQUIREMENT	TERMINAL BLOCKS
L-108	GENERIC REQUIREMENT	SS WIRE MESH STRAIN RELIEF BASKETS FOR 5 KV CABLES
L-108	GENERIC REQUIREMENT	ELECTRICAL JOINT COMPOUND
L-110	2.1	UNDERGROUND DUCT (SD-01, -09)
L-110	2.2	RIGID GALVANIZED STEEL (RGS) CONDUIT
L-110	2.3-B	SCHEDULE 40 PVC CONDUIT (2",3",4")
L-110	2.3-B	SCHEDULE 40 PVC END BELLS, FITTINGS, TERMINATIONS, CLEANER AND SOLVENT CEMENT (2",3",4")
L-110	2.4	SPLIT CONDUIT (4")
L-110	2.5	CONDUIT SPACERS AND DUCT PLUGS
L-110	2.6	CONCRETE
L-110	2.7	FLOWABLE BACKFILL
L-110	2.8	DETECTABLE MARKER TAPE

L-110	2.9	LONG RADIUS RGS BENDS
L-110	2.10	DIRECTIONAL BORE DUCT
L-110	2.10	DIRECTIONAL BORE WORK PLAN, SCHEDULE, PROCEDURE, METHODS AND EQUIPMENT
L-110	2.10	DIRECTIONAL BORE DRILLING FLUID MIXING AND DELIVERY SYSTEM
L-110	2.10	DIRECTIONAL BORE GUIDANCE SYSTEM
L-110	2.12	PAVEMENT REINFORCEMENT MESH
L-110	3.9	CONDUIT PITTING LUBRICANT
L-110	3.10	RACEWAY DRAIN
L-110	GENERIC REQUIREMENT	WEATHER PROOF CONDUIT HUBS
L-110	GENERIC REQUIREMENT	LOCKNUTS
L-110	GENERIC REQUIREMENT	GROUNDING BUSHINGS W/ INSULATED THROAT
L-110	GENERIC REQUIREMENT	BUSHINGS W/ INSULATED THROAT
L-110	GENERIC REQUIREMENT	CONDULETS, COVERS AND GASKETS
L-110	GENERIC REQUIREMENT	EXPANSION FITTINGS
L-110	GENERIC REQUIREMENT	CABLE RACKS, SUPPORTS, TIES AND STRAPS
L-110	GENERIC REQUIREMENT	CONDUIT THREAD COMPOUND
L-110	GENERIC REQUIREMENT	COLD GALVANIZING COMPOUND
L-110	GENERIC REQUIREMENT	ASPHALTUM PAINT
L-110	GENERIC REQUIREMENT	EXPANSION FITTINGS
SP-111	2.1-A	SUBMIT ALL MATERIALS, TEST EQUIPMENT, WRITTEN PROCEDURES, EQUIPMENT CALIBRATION CERTIFICATES FOR PERFORMING THE FOLLOWING TESTS:
SP-111	2.1-C, 2.3	QUALIFICATION OF FIRM PERFORMING HI-POT TESTING
SP-111	2.1-D	FIELD TEST PLAN

SP-111	2.3-A	QUALIFICATIONS OF TESTING PERSONNEL
SP-111	2.3-E	QUALIFICATIONS OF CALIBRATION LAB
SP-111	2.3-G	QUALIFICATION OF FIRM PERFORMING AIRFIELD LIGHTING PHOTOMETRIC TESTING
SP-111	3.1	COUNTERPOISE TESTING
SP-111	3.1	EXOTHERMIC WELD TESTS
SP-111	3.2	GROUND ROD TESTING
SP-111	3.3	FIELD LIGHTNING ARRESTOR ASSEMBLY TESTING
SP-111	3.4	EXISTING AIRFIELD LIGHTING CIRCUIT INSULATION RESISTANCE TESTING
SP-111	3.5	NEW AIRFIELD LIGHTING CIRCUIT CONTINUITY TESTING
SP-111	3.6	NEW AIRFIELD LIGHTING CIRCUIT INSULATION RESISTANCE TESTING
SP-111	3.7	NEW AIRFIELD LIGHTING CIRCUIT HIGH POTENTIAL TESTING
SP-111	3.8	CONCLUDING AIRFIELD LIGHTING CIRCUIT TESTS
SP-111	3.9	CONSTANT CURRENT REGULATOR CALIBRATION AND PERFORMANCE TEST PROCEDURE AND TEST EQUIPMENT
SP-111	3.10	CONTROL SYSTEM TESTS
SP-111	3.11	FIXTURE WIRING SEQUENCE TESTING
SP-111	3.12	AIRFIELD LIGHTING PHOTOMETRIC TESTING PROCEDURE AND EQUIPMENT
SP-111	3.13	AIRFIELD SIGN PHOTOMETRIC TESTING
SP-111	3.14	SHIRT CIRCUIT/COORDINATION/DEVICE EVALUATION/ARC FLASH ANALYSIS
SP-111	GENERIC REQUIREMENTS	TESTING REQUIRED BY EQUIPMENT MANUF.
SP-111	GENERIC REQUIREMENTS	TORQUING OF ELECTRICAL TERMINATIONS
SP-111	GENERIC REQUIREMENTS	TORQUING OF ANCHOR BOLTS
L-115	2.1-C,2.2	ELECTRICAL MANHOLES AND JUNCTION STRUCTURES
L-115	2.1-C, 2.2	STRUCTURAL SLAB
L-115	2.6, 2.18	FRAMES AND COVERS
L-115	2.16	MOWING APRONS

L-115	2.17	TRANSITIONAL APRONS
L-125	1.1	INSTALLATION OF AIRPORT LIGHTING SYSTEMS (SD-01, -09, -20)
L-125	1.2-A	SHOP DRAWINGS OF EACH AIRFIELD LIGHTING COMPONENT, INDICATING FAA APPROVAL, SHALL BE SUBMITTED TO THE OAR FOR REVIEW AND APPROVAL AND BE APPROVED PRIOR TO ORDERING ANY MATERIALS FOR THIS ITEM. THIS SUBMITTAL SHALL INCLUDE THE PROPOSED METHOD OF INSTALLATION FOR ALL AIRFIELD LIGHTING COMPONENTS. THE SUBMITTAL SHALL INCLUDE DATA ON ALL COMPONENT PARTS OF THE ITEM OR SYSTEM, AND SHALL INCLUDE THE MANUFACTURERS LIST OR RECOMMENDED SPARE PARTS FOR ONE YEARS USE.
L-125	1.2-B	THE MANUFACTURER OF THE LIGHTING FIXTURES AND SIGNS PROPOSED SHALL PROVIDE DATA, CERTIFICATION, AND FIVE (5) AIRPORT REFERENCES THAT EACH TYPE OF PROPOSED FIXTURE, AS CURRENTLY DESIGNED UNLESS A NEW DESIGN THAT HAS NOT BEEN REQUIRED IN THE UNITED STATES HERETOFORE, HAS BEEN IN OPERATION UNDER NORMAL AIRFIELD CONDITIONS FOR A MINIMUM OF 3 YEARS WITH A CERTIFIED REPAIR REQUIREMENT RATE OF NO MORE THAN THREE (3) PERCENT.
L-125	1.2-B	AIRFIELD LIGHTING FIXTURE MANUFACTURER QUALIFICATIONS
L-125	1.3-A	SPARE PARTS GUARANTEE
L-125	1.4-A(6)	SURVEY OF EXISTING FIXTURES, BASE CANS, ETC
L-125	2.2	GUARANTEE
L-125	2.7	L-852C(L) BI-DIRECTIONAL GREEN LED TAXIWAY CENTERLINE LIGHT - INCLUDING AS APPLICABLE: LIGHT BASES (BASE CANS), EXTENSIONS AND TOP SECTIONS, COVERS, GASKETS, GROUND LUGS, LOAD RINGS, ANTI-ROTATIONAL FINS, SPACER RINGS, CONCRETE RINGS, ADAPTER RINGS, SS BOLTING HARDWARE, L-830 ISOLATION TRANSFORMERS, FRANGIBLE COUPLINGS, LAMPS, INSTALLATION DETAIL, ALL COMPONENTS , ACCESSORIES AND INCIDENTALS.

L-125	2.7	L-852D(L) BI-DIRECTIONAL GREEN LED TAXIWAY CENTERLINE LIGHT - INCLUDING AS APPLICABLE: LIGHT BASES (BASE CANS), EXTENSIONS AND TOP SECTIONS, COVERS, GASKETS, GROUND LUGS, LOAD RINGS, ANTI-ROTATIONAL FINS, SPACER RINGS, CONCRETE RINGS, ADAPTER RINGS, SS BOLTING HARDWARE, L-830 ISOLATION TRANSFORMERS, FRANGIBLE COUPLINGS, LAMPS, INSTALLATION DETAIL, ALL COMPONENTS , ACCESSORIES AND INCIDENTALS.
L-125	2.7	L-852T(L), OMNIDIRECTIONAL, RED, LED, STYLE 3, T/W EDGE LIGHT, MOUNTED ON AN L-868B, 2 PIECE, DEEP LIGHT BASE WITH A PROPERLY SIZED SPACER RING (W/CONCRETE RING) AND PROPERLY SIZED L-830 TRANSFORMER, L-823 CONNECTORS, AND ALL INCIDENTALS. ALIGN AND LEVEL AS REQUIRED.
L-125	2.7	L-861T(L) OMNI-DIRECTIONAL BLUE LED TAXIWAY EDGE LIGHT - INCLUDING AS APPLICABLE: LIGHT BASES (BASE CANS), EXTENSIONS AND TOP SECTIONS, COVERS, GASKETS, GROUND LUGS, LOAD RINGS, ANTI-ROTATIONAL FINS, SPACER RINGS, CONCRETE RINGS, ADAPTER RINGS, SS BOLTING HARDWARE, L-830 ISOLATION TRANSFORMERS, FRANGIBLE COUPLINGS, LAMPS, INSTALLATION DETAIL, ALL COMPONENTS , ACCESSORIES AND INCIDENTALS.
L-125	2.8	L-858(L) Y, R, L SIGN 2 MODULE SIGN - INCLUDING AS APPLICABLE: LIGHT BASES (BASE CANS), EXTENSIONS AND TOP SECTIONS, COVERS, GASKETS, GROUND LUGS, LOAD RINGS, ANTI-ROTATIONAL FINS, SPACER RINGS, CONCRETE RINGS, SIGN TETHERS, SS ANCHOR BOLTS, SS BOLTING HARDWARE, L-830 ISOLATION TRANSFORMERS, FRANGIBLE COUPLINGS, LAMPS, INSTALLATION DETAIL, ALL COMPONENTS , ACCESSORIES AND INCIDENTALS.
L-125	2.8	L-858(L) Y, R, L SIGN 3 MODULE SIGN - INCLUDING AS APPLICABLE: LIGHT BASES (BASE CANS), EXTENSIONS AND TOP SECTIONS, COVERS, GASKETS, GROUND LUGS, LOAD RINGS, ANTI-ROTATIONAL FINS, SPACER RINGS, CONCRETE RINGS, SIGN TETHERS, SS ANCHOR BOLTS, SS BOLTING HARDWARE, L-830 ISOLATION TRANSFORMERS, FRANGIBLE COUPLINGS, LAMPS, INSTALLATION DETAIL, ALL COMPONENTS , ACCESSORIES AND INCIDENTALS.

L-125	2.8	L-858(L) Y, R, L SIGN 4 MODULE SIGN - INCLUDING AS APPLICABLE: LIGHT BASES (BASE CANS), EXTENSIONS AND TOP SECTIONS, COVERS, GASKETS, GROUND LUGS, LOAD RINGS, ANTI-ROTATIONAL FINS, SPACER RINGS, CONCRETE RINGS, SIGN TETHERS, SS ANCHOR BOLTS, SS BOLTING HARDWARE, L-830 ISOLATION TRANSFORMERS, FRANGIBLE COUPLINGS, LAMPS, INSTALLATION DETAIL, ALL COMPONENTS , ACCESSORIES AND INCIDENTALS.
L-125	PLAN DETAILS	MISC SIGN ITEMS
L-125	PLAN DETAILS	L-858 SIGN MESSAGE SCHEDULE
L-125	PLAN DETAILS	SIGN LOAD CALCULATION OR TEST RESULTS SUPPORTING 200MPH REQUIREMENT PER AC 150/5345-44F
L-125	PLAN DETAILS	VINYL DIE CUT LABELS AND SAMPLE
L-125	PLAN DETAILS	CONCRETE SIGN PAD - 1 TO 4 MODULE
L-125	PLAN DETAILS	SIGN STYLE CONVERSIONS
L-125	PLAN DETAILS	REINFORCING STEEL
L-125	2.12	L-867/L-868 BASE CANS AND ACCESSORIES
L-125	2.16	JUNCTION CAN PLAZA - (XX CAN), INCLUDING ALL INCIDENTALS
L-125	5.1	¾" GALVANIZED STEEL BLANK COVER – INCLUDING ALL INCIDENTALS AND SECURED WITH STAINLESS STEEL BOLTS.
L-125	2.13	L-830 ISOLATION TRANSFORMERS
L-125	PLAN DETAILS	FRANGIBLE CONNECTIONS
L-125	PLAN DETAILS	FIXTURE AND BASE CAN BOLTING HARDWARE
L-125	PLAN DETAILS	ANTI-SEIZE COMPOUND
L-125	PLAN DETAILS	IDENTIFICATION/NUMBER MARKERS
L-125	PLAN DETAILS	24 EACH SAMPLES OF ID MARKERS L-125.32
L-125	5.1	FIELD LIGHTNING ARRESTOR ASSEMBLY – INCLUDING ALL COMPENENTS, ACCESSORIES, AND INCIDENTALS.
L-125	PLAN DETAILS	FIXTURE AND SIGN BONDING JUMPER AND LUG
L-125	PLAN DETAILS	SPARE PARTS
L-125	5.1	EACH COMPONENT SHALL BE IDENTIFIED WITH THE SPECIFIC PAY ITEM OF WHICH IT IS A COMPONENT PART. COMPLETE ASSEMBLIES SHALL BE SUBMITTED FOR EACH PAY ITEM.

APPENDIX 1

“EXAMPLE OF COVER SHEET”

AIRPORT NAME

AIRPORT OWNER

PROJECT NAME

AIRPORT PROJECT NUMBER

AIP#

DOT#

AIRFIELD LIGHTING SYSTEM
OPERATION AND MAINTENANCE MANUAL

OWNER MANUAL #1

Note:

Submittal books and spline information similar.

END OF SECTION SP-106

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SECTION L-108 - UNDERGROUND POWER CABLE FOR AIRPORTS

PART 1 - DESCRIPTION

- 1.1 This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the **OAR RPR**. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

PART 2 - EQUIPMENT AND MATERIALS

2.1 GENERAL

- A. Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.
- B. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the **OAR RPR**.
- C. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the **OAR RPR**) 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 **OAR RPR** for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

- E. The data submitted shall be sufficient, in the opinion of the **OAR RPR**, to determine compliance with the plans and specifications. The Contractor's submittals shall be neatly electronically submitted in pdf format. The **OAR RPR** reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.
- F. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of 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. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 3.10e with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested in accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

2.2 CABLE

Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge (AWG), L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type THWN-2, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors,

pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

2.3 BARE COPPER WIRE (COUNTERPOISE, BARE COPPER WIRE GROUND AND GROUND RODS).

Wire for counterpoise or ground installations for airfield lighting systems shall be No. 2 AWG bare solid copper wire for counterpoise and/or No. 2 AWG insulated stranded for grounding bond wire per ASTM B3 and ASTM B8 and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper-clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 10 feet (2.54 m) long and 3/4 inch (19 mm) in diameter.

2.4 CABLE CONNECTIONS

In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

- A. The cast splice. A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, "Scotchcast" Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.
- B. The field-attached plug-in splice. Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall be in accordance with the manufacturer's requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.
- C. The factory-molded plug-in splice. Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.
- D. The taped or heat-shrink splice. Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for

multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer's recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

2.5 SPLICER QUALIFICATIONS

Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the ~~OAR RPR~~ proof of the qualifications of each proposed cable splicer for the airport 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/splicing medium voltage cable.

2.6 CONCRETE

Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

2.7 FLOWABLE BACKFILL

Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

2.8 CABLE IDENTIFICATION TAGS

Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

2.9 TAPE

Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as

manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

2.10 ELECTRICAL COATING

Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

2.11 EXISTING CIRCUITS

Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the **OAR RPR**. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the **OAR RPR**. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the **OAR RPR**. The Contractor shall record the results on forms acceptable to the **OAR RPR**. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

2.12 DETECTABLE WARNING TAPE

Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

PART 3 - CONSTRUCTION METHODS

3.1 GENERAL

The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Cable shall be run without splices, from fixture to fixture.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous

lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the **OAR RPR** or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the **OAR RPR**.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

3.2 INSTALLATION IN DUCT BANKS OR CONDUITS

This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, 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 re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the **OAR RPR** of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the **OAR RPR** prior to any cable installation. If required by the **OAR RPR**, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the **OAR RPR**. Cable pull tensions shall be recorded by the Contractor and reviewed by the **OAR RPR**. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the **OAR RPR**, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

3.3 INSTALLATION OF DIRECT-BURIED CABLE IN TRENCHES. Not used.

3.4 CABLE MARKERS FOR DIRECT-BURIED CABLE. Not used.

3.5 SPLICING

Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

- A. Cast splices. These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer's instructions and to the satisfaction of the **OAR RPR**.
- B. Field-attached plug-in splices. These shall be assembled per the manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.
- C. Factory-molded plug-in splices. These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.
- D. Taped or heat-shrink splices. A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable

surfaces within the limits of the heat-shrink application shall be clean and free of contaminants prior to application.

- E. Assembly. Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

3.6 BARE COUNTERPOISE WIRE INSTALLATION FOR LIGHTNING PROTECTION AND GROUNDING

If shown on the plans or included in the job specifications, bare solid #2 AWG copper counterpoise wire shall be installed for lightning protection of the underground cables. The **OAR RPR** shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

- A. Equipotential. The counterpoise size is as shown on the plans. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc. – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches (200 mm) minimum or 12 inches (300 mm) maximum above the raceway or cable to be protected, except as permitted below:

- (1) The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.
- (2) The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

- B. Isolation. Not used.
- C. Common Installation requirements. Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

- D. Parallel Voltage Systems. Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

3.7 COUNTERPOISE INSTALLATION ABOVE MULTIPLE CONDUITS AND DUCT BANKS

Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

3.8 COUNTERPOISE INSTALLATION AT EXISTING DUCT BANKS

When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

3.9 EXOTHERMIC BONDING

Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the **OAR RPR**. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the **OAR RPR**, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

- A. All slag shall be removed from welds.
- B. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See AC 150/5340-30 for galvanized light base exception.
- C. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

3.10 TESTING

The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the **OAR RPR**. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the **OAR RPR**. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

- A. Earth resistance testing methods shall be submitted to the **OAR RPR** for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the **OAR RPR**. All such testing shall be at the sole expense of the Contractor.
- B. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The **OAR RPR** shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the **OAR RPR** the following:

- C. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.
- D. That all affected circuits (existing and new) are free from unspecified grounds.
- E. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than 500 megohms. Verify continuity of all series airfield lighting circuits prior to energization.
- F. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.
- G. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.
- H. That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

That the impedance to ground of each ground rod does not exceed 10 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the **OAR RPR** prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the **OAR RPR**. Where connecting new cable to existing cable, insulation resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved "repair" procedures for items that have failed testing other than complete replacement.

PART 4 - METHOD OF MEASUREMENT

- 4.1 The cost of all excavation, backfill, dewatering and restoration regardless of the type of material encountered shall be included in the unit price bid for the work.
- 4.2 Counterpoise wire installed in above conduit or duct bank, and cable installed in duct bank or conduit shall be measured by the number of linear feet (meters) installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Separate measurement shall be made for each counterpoise wire installed above conduit or duct bank, and cable installed in duct bank or conduit. The measurement for this item shall include additional quantities required for slack.
- 4.3 Ground rods shall be measured by each 10-foot section installed complete, ***including the earth resistance readings of each completed installation being tested and recorded for the engineer per 3.10. See specification SP-111 "AIRFIELD ELECTRICAL INSTALLATION TESTING" for ground rod testing method and "EARTH RESISTANCE TEST"***

PART 5 - BASIS OF PAYMENT

- 5.1 Payment will be made at the contract unit price for bare counterpoise wire installed above duct bank or conduit, or cable and equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the **OAR RPR**. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals, including ground rods and ground connectors and trench marking tape, necessary to complete this item.

Payment will be made under:

Item L-108-5.1	1/C L-824-Type C Unshielded #8 AWG 5 KV Stranded Copper Cable, Installed in Duct or Conduit	-- per Linear Foot (LF)
Item L-108-5.2	1/C #2 AWG Solid Copper Counterpoise Cable, Installed over Duct or Conduit	-- per Linear Foot (LF)
Item L-108-5.3	3/4" Diameter by 10.00' Long Copper Clad Steel Sectional Ground Rod	-- per Each (EA)

PART 6 - REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description

A-A-59544A	Cable and Wire, Electrical (Power, Fixed Installation)
A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

Mil Spec

MIL-PRF-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems

American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

UNDERGROUND POWER CABLE
FOR AIRPORTS
SECTION L-108

Federal Aviation Administration Standard

FAA STD-019E Lightning and Surge Protection, Grounding Bonding and Shielding
Requirements for Facilities and Electronic Equipment

END OF SECTION L-108

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SECTION L-110 - AIRPORT UNDERGROUND ELECTRICAL DUCT BANKS AND CONDUITS

PART 1 - DESCRIPTION

- 1.1 This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

PART 2 - EQUIPMENT AND MATERIALS

2.1 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 requested by the **OAR RPR**.
- B. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the **OAR RPR**. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the **OAR RPR** and replaced with materials, that comply with these specifications, at the Contractor's cost.
- C. All materials and equipment used to construct this item shall be submitted to the **OAR RPR** 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.
- D. The data submitted shall be sufficient, in the opinion of the **OAR RPR**, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The **OAR RPR**

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

- 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.

2.2 STEEL CONDUIT

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 mils 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. In lieu of PVC coated RGS, corrosion wrap tape shall be permitted to be used where RGS is in contact with direct earth."

2.3 PLASTIC CONDUIT

Plastic conduit and fittings shall conform to the following requirements:

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

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:

- A. Type I—Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.
- B. Type II—Schedule 40 PVC suitable for either above ground or underground use.
- C. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.

- D. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

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

2.4 SPLIT CONDUIT

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

2.5 CONDUIT SPACERS

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.

2.6 CONCRETE

Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

2.7 PRECAST CONCRETE STRUCTURES

Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another **OAR RPR** approved third party certification program. Precast concrete structures shall conform to ASTM C478.

2.8 FLOWABLE BACKFILL

Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

2.9 DETECTABLE WARNING TAPE

Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), orange (telephone/fiber optic cabling) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

PART 3 - CONSTRUCTION METHODS

3.1 GENERAL

The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The ~~OAR RPR~~ 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. Under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade; in other locations, the top of the duct bank or underground conduit shall be not less than 18 inches (0.5 m) below finished grade.

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.

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 ~~OAR RPR~~ of any blockage in the existing ducts.

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.

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).

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.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

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

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.

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 (6.3 mm) sieve. Flowable backfill may alternatively be used

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 **OAR RPR**. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

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).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

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 **OAR RPR**, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Additional duct bank supports shall be installed, as approved by the **OAR RPR**.

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion per federal, state, and local requirements is incidental to Item L-110.

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

Any excess excavation shall be filled with suitable material approved by the **OAR RPR** and compacted per Item P-152.

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:

- A. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred
- B. Trenching, etc., in cable areas shall then proceed with approval of the **OAR RPR**, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

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

3.2 DUCT BANKS

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.

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, 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. The Contractor shall space the conduits not less than 3 inches (75 mm) 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. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

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 **OAR RPR** for review prior to use.

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.

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.

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.

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 **OAR RPR** 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 **OAR RPR**.

3.3 CONDUITS WITHOUT CONCRETE ENCASEMENT. Not used.

3.4 MARKERS

The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word "DUCT" or "CONDUIT" on each marker slab. Impression of letters shall be done in a manner, approved by the **OAR RPR**, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the **OAR RPR**. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as

determined by the **OAR RPR**. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

3.5 BACKFILLING FOR CONDUITS

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 except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

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

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.

Any excess excavated material shall be removed and disposed of per instructions issued by the **OAR RPR**.

3.6 BACKFILLING FOR DUCT BANKS

After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 "Excavation and Embankment" 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 P-152, 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.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

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.

Any excess excavated material shall be removed and disposed of per instructions issued by the **OAR RPR**.

3.7 RESTORATION

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 sodding **per the Contract Documents 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 L-110 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.

3.8 OWNERSHIP OF REMOVED CABLE. Not used.

PART 4 - METHOD OF MEASUREMENT

- 4.1 Underground conduits and duct banks shall be measured by the linear feet (meter) of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated material, and restoration, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

PART 5 - BASIS OF PAYMENT

- 5.1 Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material, and, for drain lines, the termination at the drainage structure. This price shall be full compensation for removal and disposal of existing duct banks and conduits as shown on the plans, furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

Payment will be made under:

Item L-110-5.1	1 Way 2" Schedule 40 PVC Concrete Encased Duct	- per Linear Foot (LF)
Item L-110-5.2	8 Way 2" Schedule 40 PVC Concrete Encased Duct	- per Linear Foot (LF)
Item L-110-5.3	2 Way 4" Schedule 40 PVC Concrete Encased Duct	- per Linear Foot (LF)

Item L-110-5.4	4 Way 4" Schedule 40 PVC Concrete Encased Duct	- per Linear Foot (LF)
Item L-110-5.5	1 Way 4" Split Duct	- per Linear Foot (LF)

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circular (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)

Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit - Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 1242	Electrical Intermediate Metal Conduit Steel
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

END OF SECTION L-110

ITEM SP-110S-02310 INSTALLATION OF UNDERGROUND ELECTRICAL DIRECTIONAL
BORE DUCT

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. The work specified in this section consists of furnishing and installing underground utilities using the method of installation commonly referred to as directional boring. This work shall include all supervision, services, equipment, materials, labor, area restoration, environmental protection and incidentals for the complete and functional installation of the directional bore duct as shown in the Contract Documents. A copper counterpoise conductor, in accordance with the details, shall be installed with and external to the directional bore duct. Quantity of counterpoise shall be per the details. 2 AWG solid copper counterpoise shall be paid for by the linear foot in accordance with Item L-108. 4/0 AWG OUC bare stranded copper counterpoise shall be considered incidental to the OUC duct pay item.

1.2 RELATED DOCUMENTS AND SECTIONS

- A. Item L-110; Airport Underground Electrical Duct Banks and Conduits.
- B. Section 555; Directional Bore - FDOT *Specifications for Road and Bridge Construction*, latest edition.

1.3 SUBMITTALS

- A. Work Plan: Prior to beginning work, the Contractor shall submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the work task. Plan shall document the thoughtful planning required to successfully complete the work.
- B. Demonstration of compliance with Item L-110 and State DOT requirements.
- C. Equipment: Contractor shall submit specifications on directional drilling equipment to be used in the work to ensure that the equipment will be adequate to complete the project.
- D. Material: Specifications on material to be used shall be submitted to Engineer. Material shall include the pipe, conduit, fittings, splicing/coupling method, means of transition from HDPE to PVC and any other item, which is to be an installed component of the project.

1.4 WARRANTY

- A. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of 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 – EQUIPMENT REQUIREMENTS

2.1 GENERAL

- 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.

2.2 GUIDANCE SYSTEM

- A. 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.
- B. The locating and tracking system must provide information on:
 - 1. Clock and pitch information.
 - 2. Depth.
 - 3. Transmitter temperature.
 - 4. Battery status.
 - 5. Position (X,Y).
 - 6. Azimuth, where direct overhead readings (walkover) are not possible (i.e. subaqueous or limited access transportation facility).
 - 7. Ensure proper calibration of all equipment before commencing directional drilling operation.
- C. Take and record alignment readings or plot points such that elevations on top of and offset dimensions from the center of the product to a permanent fixed feature are provided. Such permanent fixed feature must have prior approval of the Engineer. Provide elevations and dimensions at all bore alignment corrections (vertical and horizontal) with a maximum distance of 5 feet between points. Provide additional points when requested by the Engineer. Provide a sufficient number of elevations and offset distances to accurately plot the vertical and horizontal alignment of the installed product.

2.3 CONDUIT/DUCT

- A. The directional bore conduit/duct shall be UL Listed Schedule 80 HDPE electrical conduit as described in NFPA 70, Article 353 suitable for placement with directional boring systems or accepted equivalent. HDPE conduit shall comply with UL Category EAZX and ANSI/UL 651A.
- B. Orlando Utilities Commission requires the use of restrained joint schedule 40 PVC conduit system. The restrained joint schedule 40 PVC conduit directional bore duct for Orlando Utility Commission (OUC) use shall be Carlon Bore-Gard (Prime Conduit) or Certainteed; Certa-Com, no equivalents accepted. See Specification 26 05 12, *OUC Underground Electric*.
- C. Conduit to meet all applicable ASTM testing and be UL listed. Conduit to be chamfered on inside diameter male ends to minimize cable damage. The bending radius for 4" PVC pipe should be no less than 100' as recommended by the PVC Pipe Industry. Installation bend radius should be kept at a minimum to reduce the tensile pull forces displaced onto the pipe. Pipe installation and joint assembly shall be per manufacturer recommendations.

2.4 CONCRETE

- A. Concrete shall conform to item P-610, Structural Portland Cement Concrete or FDOT *Standard Specification for Road and Bridge Construction* specification Section 346, latest edition, concrete mix with Type I/II cement using 1-inch maximum size coarse aggregate (#57 stone) with a minimum 28 day compressive strength of 4,000 psi. Where reinforced duct banks are specified, reinforcing steel shall conform to ASTM A 615 grade 60. Concrete and reinforcing steel are incidental to the respective pay item of which they are a component part.
- B. High early strength P-610 concrete will be required for use with ducts, conduits, base cans and other work as directed by the Engineer, in existing operational areas and within the safety areas of operational pavement to comply with the project phasing and scheduling requirements and where the pavement is required to open to aircraft at the end of the designated work period. The extra cost for the high early strength P-610 concrete shall be considered incidental to the respective pay item of which it is a component part.

2.5 COPPER COUNTERPOISE WIRE

- A. The copper counterpoise wire shall comply with Item L-108 and/or Specification 26 05 12 as applicable. The copper counterpoise wire shall be installed with and externally to the directionally bored duct.

PART 3 – EXECUTION

3.1 GENERAL

- A. The Engineer shall be notified 48 hours in advance of starting work. The Directional Bore shall not begin until the Engineer is present at the job site and agrees that proper preparations for the operation have been made. The Engineer's approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract.

3.2 BORING PATH REPORT

- A. Furnish a bore path report to the Engineer within seven days of the completion of each bore path. Include the following in the report:
 - 1. Location of project and financial project number including the permit number when assigned.
 - 2. Name of person collecting data, including title, position and company name.
 - 3. Investigation site location (Contract plans station number or reference to a permanent structure within the project right-of-way).
 - 4. Identification of the detection method used.
 - 5. Elevations and offset dimensions as required in 2.2.
- B. Provide the Engineer a complete set of as-built plans showing all bores (successful and failed) within 30 calendar days of completing the work. As-built plans shall be PDF files or AutoCAD files, in the same scale as the Contract Plans, and formatted on 22 inch by 34 inch sheets. Ensure that the plans are dimensionally correct copies of the Contract Plans and include pavement/area plan and profile, cross-section, boring location and subsurface conditions as directed by the Engineer. The plans must show elevations referenced to a permanent feature (edge of pavement, manhole, mast arm foundation, manhole inlet cover, head wall, etc). Specific plans content requirements include but may not be limited to the following:
 - 1. Provide a horizontal plan and a profile plan for each bore path at 5 foot intervals, to an accuracy of 1 inch. Horizontal and vertical plan dimensions shall be referenced to fixed permanent monuments/references at the bore location.
 - 2. In addition to the directional bore duct information, show the ground or pavement surface and crown elevation of each position along the bore path to an accuracy of 1 inch and at the ends and other exposed locations. Profile plans for bore paths crossing the runway, taxiway or roadway shall denote stationing of the crossing on the Contract Plans.

3. If, during boring, an obstruction is encountered which prevents completion of the installation in accordance with the design location and specification, and the product is left in place and taken out of service, show the failed bore path along with the final bore path on the plans. Note the failed bore path as "Failed Bore Path - Taken Out of Service". Also show the name of the utility owner, location and length of the drill head and any drill stems not removed from the bore path.
4. Show the top elevation, diameter and material type of all utilities encountered and physically observed during the work. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top and lowest elevation observed, and note if the obstruction continues below the lowest point observed.
5. Include bore notes on each plan stating the final bore path diameter, product diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the product, or facility placed out of service. Note if the product is a casing as well as the size and type of carrier pipes placed within the casing as part of the Contract work.

3.3 SPLICING, COUPLING AND TERMINATION

- A. The HDPE duct shall "relax" for 48 hours after installation prior to splicing, coupling or termination.
- B. Only Engineer accepted methods shall be used to splice, couple or terminate the HDPE duct.
 1. Dura-line Shur-Lok II Couplings,
 2. Carlon HDPE to PVC Couplings
 3. 8 inch minimum length Morris Compression Couplings
 4. Fusion couplings
 5. OUC use: Carlon or Certainteed Restrained Joint.
- C. All splicing, coupling and termination of HDPE or PVC ducts shall be performed and completed in strict accordance with the manufacturer's instructions and recommendations.
- D. Splices and couplings shall be permitted only where connection to conventionally installed ducts or manholes are required. Fusion coupling is the only method of splicing ducts subject to installation pull tensions.
- E. The duct shall be properly reamed in accordance with the applicable specification or details. prior to assembly.
- F. All HDPE and PVC duct/conduit splicing, coupling and termination fittings and materials shall be listed or approved.

3.4 GROUND MOVEMENT

- A. Before excavation, establish control points for measuring vertical movement of the runway, taxiway, roadway bore path under obstruction at 10 feet intervals along the centerline and 10 feet each side of the pipeline. A land surveyor licensed in the state in which the project is located shall monitor these points daily until construction is complete.
- B. Cease trenchless operations when measured movement exceeds 0.02 feet. Determine cause of settlement and repair as necessary. Modify trenchless methods as needed.

3.5 BORE DEPTH MINIMUM COVER

- A.

Bore Diameter	Minimum Cover
>2 inches to 6 inches	6 feet
>6 inches up to 14 inches	12 feet
>14 inches up to 24 inches	15 feet
>24 inches up to 48 inches	25 feet
- B. Contractor shall survey to verify bottom elevation of ditches, swales, ponds, rivers etc. to determine bottom of obstruction. Bottom is considered natural earth less any settlement or sludge.
- C. Contractor shall maintain 25-foot minimum cover between the bottom (not including sediments) of the pond, river or other body of water.
- D. Proposed bore alignment shall maintain a minimum clearance of 10 foot horizontal and 5 foot vertical between bore and any obstruction.
- E. Blow-out of any drill mud shall be immediately corrected and cleaned up by the Contractor at no additional expense to the Owner.

PART 4 – METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in this item are incidental to other items and shall not be measured for payment.

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

INSTALLATION OF UNDERGROUND
ELECTRICAL DIRECTIONAL BORE DUCT
ITEM SP-110S-02310

PART 5 – BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in this item. All directional bore costs shall be considered incidental to the respective L-108, L-110 or 26 05 12 pay items.

END OF ITEM SP-110S-02310

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SECTION SP-111 - AIRFIELD ELECTRICAL INSTALLATION TESTING

PART 1 - DESCRIPTION

1.1 GENERAL

- A. This item shall consist of performing all tasks necessary to prove proper performance of electrical and airfield lighting systems. Airfield lighting systems include airfield signage systems, approach lighting systems and other associated NAVAIDS.
- B. Drawings, general provisions and special provisions of the Contract Documents, including Contractual Conditions and Division 1 Specification sections apply to this Item.
- C. This section describes the electrical quality control testing furnished by the Contractor. The Contractor shall provide all testing as required by this item, including retesting of failed items. All items furnished and/or installed by the Contractor shall be tested in accordance with this item.
- D. The Contractor shall provide for all electrical testing to confirm that the installations associated with this project comply with the Contract Documents. Contractor shall engage an independent organization to perform the Hi-Pot Testing and to perform specified Photometric Testing with the Contractor providing all testing assistance.
- E. The Contractor shall furnish all equipment, labor, supervision, transportation, materials and appliances necessary or required for testing the airport lighting systems before and after installation. The Contractor shall perform all tests in the presence of the Engineer. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the Engineer. All costs for testing are incidental to the pay item for the respective item being tested.
- F. Any system installation errors or discrepancies of installation not in conformance with the Contract Documents shall be corrected at no additional cost to the Owner. Equipment, cables and other components which do not satisfy the test requirements of this Item shall be removed and replaced with new equipment, cables and other components which do satisfy the requirements of this item with no additional cost to the Owner. Any necessary retesting shall be performed at no additional cost to the Owner.
- G. There are no approved "repair" procedures for items that have failed testing other than complete replacement. The Contractor shall replace all items that may be damaged during testing at no additional cost to the Owner.
- H. Weather information necessary to complete the testing forms may be obtained from the listed website http://www.faa.gov/air_traffic/weather/asos/ by double clicking on the respective state and airport ID.

PART 2 - EQUIPMENT AND MATERIALS

2.1 SUBMITTALS

- A. Materials and equipment covered by this item shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer. All equipment, materials, methods and record keeping procedures shall be submitted to the Engineer for review.
- B. The submittal shall include a list of the proposed test and measurement equipment to be used, the test and measurement equipment serial number, the current calibration certificate for each piece of equipment and a written description of the proposed test. A copy of the test and measurement equipment manufacturer's recommended test procedure is acceptable as a written description of the proposed test.
- C. The Contractor shall submit the qualifications of the organization performing the Hi-Pot and Photometric testing. The submittal shall include:
 - 1. The organizations name and address.
 - 2. References for the organization from five previous air carrier airports with similar jobs to include names and phone numbers.
 - 3. A complete list of all test, measurement equipment and all accessories proposed for use including the serial numbers of the equipment and a copy of the respective calibration certificates.
 - 4. Test procedures and safety precautions required during testing.
 - 5. Qualifications and experience of persons performing the testing.
 - 6. References for the person designated to perform the testing from five previous similar jobs to include names and phone numbers.
- D. Submit a proposed field test plan, 60 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits. The Contractor shall submit a complete list of required tests and a proposed schedule and duration of the tests. The schedule shall be integrated with the overall project schedule. The Contractor shall update the testing schedule on a monthly basis for the duration of the project.
- E. All test results shall be submitted in the Operation and Maintenance (O&M) Manual. See Item SP-106 for submittal requirements.
- F. The Engineer reserves the right to reject any and all equipment, materials or procedures, which, in the Engineer's opinion, does not meet the system design and the standards and codes, specified herein.

2.2 SAFETY

- A. Dangerous voltages are present during the system testing. The Contractor is solely responsible for the safety of all personnel involved in the testing activities and shall ensure that all testing areas are secured to prevent the entry of unqualified personnel.
- B. Observe all safety instructions or precautions recommended by testing equipment manufacturer.
- C. The Contractor shall perform a "Hazard/Risk Evaluation" of each test site and procedure. The Contractor shall provide a job briefing and install the necessary barriers and barricades at the respective approach boundaries prior to starting the testing.
- D. The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any device or equipment which is damaged due to improper test procedures or handling.
- E. In addition to compliance with the Contractors safety program, the Contractor shall comply with the following documents/programs:
 - 1. OSHA, 29CFR1910 Occupational Safety and Health Standards
 - 2. OSHA 29CFR1926 Safety and Health regulations for Construction
 - 3. NFPA 70B Recommended Practice for Electrical Equipment Maintenance
 - 4. NFPA 70E Standard for Electrical Safety in the Workplace
 - 5. AC 150/5340-26 Maintenance of Airport Visual Aid Facilities
 - 6. Owner's safety program.

2.3 QUALIFICATIONS

- A. Each person performing testing shall have a minimum of 5 years (2,000 hours per year) of successful testing experience either constructing or maintaining airfield lighting systems. At least 3 of these years of experience shall have occurred in the last 5 years on projects of comparable size and complexity. Person performing testing shall be certified as a "Qualified Person". The definition of a Qualified Person is defined in OSHA 1910.399 and NFPA 70E (Article 100 & 110.2(1)). The certification shall be signed by the Contractor's Electrical License qualifier. Equivalent experience and training may be considered by the Engineer. Person performing testing may substitute one year of education in qualified electrical curriculum for one-half year electrical experience for a maximum of 2,000 hours of the required 10,000 hours of experience. Records of person performing testing experience demonstrating compliance with these requirements shall be submitted to the Engineer for verification and review prior to starting work. Experience records shall include contact information for references (name, title and phone number) from airports where the proposed person performing testing has completed the required electrical experience. Work shall not

start prior to approval of the person performing testing, unless under the direct supervision of the Contractor's Electrical License qualifier.

- B. The person performing the tests shall be a "qualified person" as defined in NFPA 70E and OSHA 29 CFR 1926.32(l).
- C. The person performing the tests shall be thoroughly familiar with the test equipment used in the test performed and shall be sufficiently experienced to detect equipment abnormalities or questionable data obtained during the test procedure.
- D. Each piece of test and measurement equipment utilized to demonstrate compliance with the Contract Documents shall be calibrated. The level of calibration shall be "*NIST traceable, Z540 Calibration with Data*". The test and measurement equipment calibration shall be valid for one year. At any time, the Engineer may require the Contractor to have a piece of test and measurement equipment recalibrated. Should the Engineer have any reason to doubt the accuracy of a piece of test and measurement equipment, even within current calibration, the test and measurement equipment shall be removed from the project. The Engineer shall determine which tests shall be redone due to the malfunctioning equipment.
- E. The test and measurement equipment calibration lab as a minimum shall meet the requirements of ANSI/NCCL Z-540 and shall be A2LA accredited.
- F. The High Potential (Hi-Pot) tests shall be performed by an independent agency certified by the National Electrical Testing Association (NETA) with certified technicians using properly calibrated equipment and standard procedures.
- G. Electrical and photometric testing of airfield lighting systems shall be performed by a firm with demonstrated capability for field measurement of electrical characteristics of airfield lighting circuits and regulators and of the photometric performance of airfield lighting fixtures and signs. Because of the correlation between the electrical performance of airfield lighting circuits and the photometric performance of the airfield lighting fixtures, all work shall be done by a single firm. The firm shall have experience in evaluating the test results against FAA standards and manufacturers' performance criteria. See below for listed firms or approved equivalent.
- H. Two possible electrical and photometric testing firms are listed below:

Lean Photometrics, LLC
113 S. 25th Street
Phoenix, Arizona 85034
Contact: Doron Lean
(602) 244-1076
dlean@leanphotometrics.com

MALMS Navaid
481 Pleasant Hill Road
Rutherfordton, NC 28139
Contact: Bryan Fountain
(855) 440-0541
bfountain@malms.aero

2.4 TESTING COORDINATION

- A. After installation of all required components and before final acceptance, in accordance with project phasing and schedule make required tests to determine proper function of all circuits.
- B. Ten days prior to any testing the Contractor shall notify the Engineer of the need to perform testing. A mutually agreed upon time and date for each test will be set. All requirements under this item shall be coordinated with the Engineer.
- C. The Contractor shall perform the necessary inspection and tests for some items concurrently with the installation because of subsequent inaccessibility of some components.
- D. Photometric testing of a runway lighting system shall occur prior to opening the runway. Photometric testing of a taxiway lighting system may occur after all fixtures have been installed, provided the lighting system passes a visual inspection prior to opening to air traffic.
- E. The Contractor shall ensure that all test and measurement equipment, accessories and qualified personnel are available prior to scheduling tests.
- F. Forty-eight (48) hours prior to each test the Contractor shall send the Engineer a written confirmation that the scheduled test will occur at the proposed date and time. Any rescheduling of the test shall be coordinated with the Engineer.
- G. The Engineer shall be provided reasonable opportunity to observe all tests. Testing shall not proceed until the Engineer or designated representative is present to observe the testing, or until the Engineer has provided written instruction to proceed with the testing in the Engineer's absence.
- H. All test results shall be recorded by the Contractor and witnessed by the Engineer. Test results shall be submitted in the O&M Manuals in accordance with Item SP-106.
- I. The Contractor is reminded that due to phasing constraints the HI-POT testing organization, photometric testing organization or any other testing organization/groups may have multiple mobilizations required to test airfield lighting systems as each area is complete. For projects completed in phases, the respective required testing must be completed by phase.

2.5 TEST AND MEASUREMENT EQUIPMENT

- A. Electrical test and measurement equipment shall be an off the shelf item, not a one of a kind prototype. The test and measurement equipment shall be manufactured by a firm regularly engaged in the manufacture of precision electrical test and measurement equipment for the industrial, commercial and utility marketplace. Typical accuracy for test equipment shall be $\pm 2\%$ of instrument reading and shall be TRUE RMS.

- B. The Engineer shall confirm that the test and measurement equipment proposed for use by the Contractor is suitable for the intended use. The Engineer shall have sole discretion to determine if the test and measurement equipment is suitable for the intended use.
- C. The airfield lighting photometric test and measurement equipment is utilized in a specific airfield lighting application and is not required to meet Item A. above.
- D. The ground point for the cable test equipment shall be the vault ground bus. The vault ground bus, vault ground system, airport ground grid and counterpoise system shall be complete prior to cable testing.

PART 3 - CONSTRUCTION METHODS

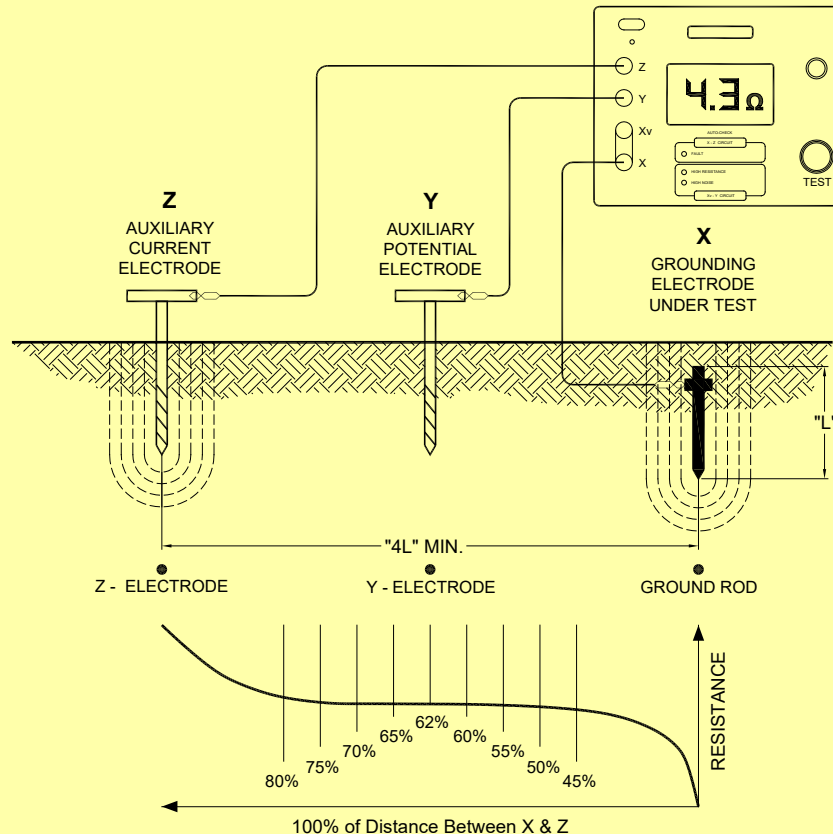
3.1 COUNTERPOISE TESTING

- A. Continuity of counterpoise system shall be checked by visual inspection as construction progresses, prior to work being covered up.
- B. Verification of counterpoise system continuity shall be checked by visual inspection at accessible locations during normal inspections.
- C. Verification of counterpoise system continuity to the vault grounding system shall be tested with a micro-ohmmeter. Micro-Ohmmeter shall be Megger Ductor DLRO-10 or accepted equivalent. Resistance readings shall be corrected to standard temperature.
- D. Should the counterpoise or ground grid conductors be damaged or are suspected to be damaged by construction activities (in the opinion of the Engineer) the Contractor shall test the conductors for continuity with a micro-ohmmeter. The conductors shall be isolated such that there is no parallel path. Alternatively, the Contractor may conduct tests and through mathematical computations prove the continuity of the conductors.
- E. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- F. Record test results on the record drawing set indicating point to point readings.

3.2 GROUND ROD TESTING

- A. Contractor shall provide equipment and personnel to measure the resistance to earth of each ground rod installed. Earth resistance measurement tests shall adhere to recommendations of IEEE Standard 142, latest edition.
- B. Earth resistance measurements shall be made in normally dry conditions not less than 48 hours after the last rainfall.

- C. Initially the Contractor shall test each ground rod in accordance with the following instructions. The horizontal distance between the Ground Electrode Under Test (Electrode X) and the Auxiliary Current Electrode (Electrode Z) shall be 4 times the depth (length) of the ground electrode under test.



- D. The three electrodes shall be installed in a straight line in a direction away from other underground metallic items. The test leads shall be separated.
- E. The first test shall be conducted with the Auxiliary Potential Electrode (Electrode Y) at 45% of the distance between the X and Z electrodes. The earth resistance shall be measured and recorded at the 45% position. The Y electrode will then be moved 5% closer to the Z electrode to the 50% position and the earth resistance shall be measured and recorded. The previous steps will be repeated at 5% distance intervals through the 80% position. Graph the resultant points on the form provided at the end of this item.
- F. The above test method shall be utilized at each new ground rod installation until otherwise determined by the Engineer. The Engineer will use the acquired data to establish a revised distance ratio between the X and Z electrode.
- G. Once the new electrode distance ratio is set by the Engineer, the Contractor may perform the tests with a single test position for electrode Y.

- H. Earth resistance tests shall be performed as each ground rod is installed. Earth resistance tests shall be conducted prior to the connection of any grounded, grounding or counterpoise conductors. Ground rods not in compliance with the not to exceed maximum earth resistance shall have an additional 10' section(s) added until the required earth resistance is achieved.
- I. Should the Contractor install 100 feet of sectional ground rod (ten rods) at a single location and not achieve the required earth resistance, the Contractor shall stop installing rods at this specific location and contact the Engineer for resolution.

3.3 FIELD LIGHTNING ARRESTOR ASSEMBLY TESTING

- A. Each field lightning arrestor assembly (FLA) shall receive an inspection upon receipt by the Contractor.
- B. The Contractor shall group the FLAs by circuit. Mark each FLA with circuit designation and unique number.
- C. Each FLA shall be tested for continuity between the airfield lighting series circuit L-823 connectors. A reading of 200 milliohms or less is acceptable.
- D. Each FLA shall have its internal resistance tested between the airfield lighting series circuit L-823 connector and the grounding screw. A reading of less than 10 gigohms is cause for rejection. Any FLA testing less than 10 gigohms shall be rejected.
- E. The FLA internal resistance test shall be performed with a megohmmeter providing a test voltage of 1,000 volts DC. The output of the megohmmeter shall be direct reading in megohms and shall have an upper range limit in excess of 10 gigohms.
- F. The Contractor shall then interconnect each FLA within that circuit to the other. The Contractor shall interconnect the ground screws on each unit with a #12AWG bare copper conductor. The Contractor shall then megger test the FLA circuit assembly and record the reading.
- G. The Contractor shall repackage the FLA units, maintaining the circuit designations. The FLA shall be stored in a clean dry location until installation in the base cans.
- H. Record data on insulation resistance test form provided at the end of this item.

3.4 EXISTING AIRFIELD LIGHTING CIRCUIT INSULATION RESISTANCE TESTING

- A. Whenever the scope of work requires connection to an existing circuit, or should the scope of work involve working adjacent to or near an existing circuit, and the work could have any impact on the existing circuit, the existing circuit's insulation resistance shall be tested. The test shall be performed prior to any activity which could possibly affect or impact the respective circuit. The Contractor shall record the results on forms included at the end of this item.

- B. The existing airfield lighting circuit insulation resistance test shall be performed with a megohmmeter providing a test voltage of 1,000 volts DC. The output of the megohmmeter shall be direct reading in megohms and shall have an upper range limit in excess of 10 gigohms.
- C. Observe required safety precautions.
- D. Connect the test instrument in accordance with the manufacturer's recommendations. The insulation resistance test shall be conducted for two (2) minutes). Record data at 30 second intervals on the form provided at the end of this Item. The insulation resistance measurement results shall be corrected to 20⁰ Centigrade (68⁰ Fahrenheit).
- E. When the work effecting the circuit is complete (or at end of shift prior to energization), the circuit's insulation resistance shall be checked again, in the presence of the Engineer. The Contractor shall record the results on forms included at the end of this item. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading.
- F. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor.
- G. Should the Contractor fail to perform the tests prior to starting work, the Contractor shall be responsible to bring the impacted circuits to a minimum 50 megohm insulation resistance value or higher value in conformance with any previous airport test records.

3.5 NEW AIRFIELD LIGHTING CIRCUIT CONTINUITY TESTING

- A. After new cable installation and before the operating test or connection to an existing system, the airfield lighting series circuit cable system shall be given a circuit internal resistance (continuity) test.
- B. This test shall be conducted at the proposed point of connection to the Constant Current Regulator and shall be used to prove continuity of the entire circuit. The Contract Documents shall be reviewed to confirm proper circuit routing, connection and installation of necessary components prior to testing.
- C. No Field Lighting Arrestor Assemblies shall be installed in the circuit during the internal resistance (continuity) test. No airfield lighting fixtures or signs shall be connected to the secondary of the L-830 isolation transformers internal resistance (continuity) test.
- D. The L-824C series circuit cable, complete with all L-823 connectors and L-830 isolation transformers installed, shall be tested for continuity. The cable, connectors and transformers shall be in their final configuration, ready for connection to the constant current regulator (CCR).
- E. Observe required safety precautions.

- F. The circuit's internal resistance (continuity) test shall be performed using an ohmmeter with sufficient output to measure the circuit's internal resistance. The expected internal circuit resistance should be between 20 ohms and 70 ohms.
- G. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- H. Upon successful completion of circuit's internal resistance (continuity) test, record the measured circuits internal resistance on the cable test form included at the end of this item.

3.6 NEW AIRFIELD LIGHTING CIRCUIT INSULATION RESISTANCE TESTING

- A. Upon successful completion of the airfield lighting circuit's internal resistance (continuity) test perform an airfield lighting circuit insulation resistance test.
- B. In addition to successfully completing the airfield lighting circuit internal resistance (continuity) test, all prerequisite conditions required prior to performing the airfield lighting circuit internal resistance (continuity) test shall be performed prior to starting the airfield lighting circuit insulation resistance test.
- C. Airfield lighting circuit insulation resistance tests shall be made in normally dry conditions not less than 48 hours after the last rainfall.
- D. The airfield lighting circuit insulation resistance test shall be performed with a megohmmeter providing a test voltage of 1,000 volts DC. The output of the megohmmeter shall be direct reading in megohms and shall have an upper range limit in excess of 10 gigohms.
- E. Observe required safety precautions.
- F. Ground all other conductors within the conduits or ducts containing the conductor under test.
- G. Connect the test instrument in accordance with the manufacturer's recommendations. The insulation resistance test shall be conducted for ten (10) minutes). Record data at the required intervals on the form provided at the end of this Item. The insulation resistance measurement results shall be corrected to 20⁰ Centigrade (68⁰ Fahrenheit).
- H. The expected insulation resistance for the completed circuit should be in excess of 500 megohms.
- I. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- J. Upon successful completion of circuit's insulation resistance test, record the measured circuits internal resistance on the cable test form included at the end of this item.

3.7 NEW AIRFIELD LIGHTING CIRCUIT HIGH POTENTIAL TESTING

- A. Upon successful completion of the airfield lighting circuit's insulation resistance test perform an airfield lighting circuit High Potential (Hi-Pot) test.
- B. In addition to successfully completing the airfield lighting circuit insulation resistance test, all prerequisite conditions required prior to performing the airfield lighting circuit insulation resistance test shall be performed prior to starting the airfield lighting circuit Hi-Pot testing.
- C. Airfield lighting circuit Hi-Pot tests shall be made in normally dry conditions not less than 48 hours after the last rainfall.
- D. The airfield lighting circuit Hi-Pot test shall be performed with a suitable high voltage test set which has steady, filtered direct current output voltage. The high voltage test set shall include an accurate voltmeter and microammeter for reading the voltage applied to the circuit and resultant insulation leakage current.
- E. Observe required safety precautions.
- F. Ground all other conductors within the conduits or ducts containing the conductor under test.
- G. Connect the Hi-Pot test instrument in accordance with the manufacturer's recommendations. Clean and dry the cable for a distance of 1 foot from the ends. Connect both ends of the circuit together and to the high voltage test set.
- H. The Hi-Pot test shall be conducted for fifteen (15) minutes). Step the voltage up, hold and down in accordance with the test form included at the end of this item. Record data at the required intervals on the form provided at the end of this Item. The insulation resistance measurement results shall be corrected to 20⁰ Centigrade (68⁰ Fahrenheit).
- I. Insulation leakage current shall be measured and recorded for each circuit after a 1 minute application of the test voltage. If leakage current exceeds values specified below, the circuit shall be sectionalized and retested and the defective parts shall be repaired or replaced. Leakage current limits include allowances for the normal number of connectors and splices for each circuit as follows:
 - 1. Three microamperes for each (300m) 1000 feet of cable.
 - 2. Two microamperes for each 200 watt and each 500 watt 5,000-volt series transformer.
 - 3. Two microamperes for each 30/45-Watt 5,000 volt series transformer.
- J. If the measured value of insulation leakage current exceeds calculated value, the circuit shall be sectionalized and tested as specified for each section. Defective components shall be corrected or replaced until repeated tests indicate an acceptable value of leakage current for the entire circuit. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.

3.8 CONCLUDING AIRFIELD LIGHTING CIRCUIT TESTS

- A. Upon successful completion of the airfield lighting circuit and High Potential (Hi-Pot) test install and connect all airfield lighting fixtures, signs and perform an airfield lighting circuit insulation resistance test. Conduct test similar to test performed above (3.6).
- B. Airfield lighting circuit insulation resistance tests shall be made in normally dry conditions not less than 48 hours after the last rainfall.
- C. The airfield lighting circuit insulation resistance test shall be performed with a megohmmeter providing a test voltage of 1,000 volts DC. The output of the megohmmeter shall be direct reading in megohms and shall have an upper range limit in excess of 10 gigohms.
- D. Observe required safety precautions.
- E. Ground all other conductors within the conduits or ducts containing the conductor under test.
- F. Connect the test instrument in accordance with the manufacturer's recommendations. The insulation resistance test shall be conducted for ten (10) minutes). Record data at the required intervals on the form provided at the end of this Item. The insulation resistance measurement results shall be corrected to 20⁰ Centigrade (68⁰ Fahrenheit).
- G. The expected insulation resistance for the completed circuit should be in excess of 500 megohms.
- H. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- I. Upon successful completion of circuit's insulation resistance test, record the measured circuits internal resistance on the cable test form included at the end of this item.
- J. Install respective circuit designated FLA assemblies. Use the sum of reciprocals rule to calculate the final circuit insulation resistance. Perform insulation resistance test on completed circuit in accordance with above criteria. Record final circuit insulation resistance value on form provided at the end of this Item.

3.9 CONSTANT CURRENT REGULATOR (CCR) TESTS

- A. Each constant current regulator shall be examined to ensure that porcelain bushings are not cracked, no shipping damage has occurred, internal and external connections are correct, switches and relays operate freely and are not tied or blocked, fuses, if required, are correct, and liquid level of liquid-filled regulators is correct. Relay panel covers shall be removed only for this examination; it is not necessary to open the main tank of liquid-filled regulators. The Contractor shall comply with the manufacturer's startup and operational instructions. Covers shall be replaced tightly after completing examinations and tests.

- B. Verify the supply voltage and nameplate input voltage are the same. Verify CCR is properly grounded. With the loads disconnected, regulator shall be energized and the open circuit protector observed to ensure that it de-energizes the regulator within 2 seconds.
- C. Comply with the manufacturer's recommendation for calibration and set up of each new CCR and each existing CCR connected to a new or modified airfield lighting circuit. The regulator output current and voltage shall be calibrated using a true RMS meter. The CCR calibration shall be complete prior to making any other CCR measurements.
- D. Verify all airfield lighting fixtures and loads are operational.
- E. Complete an Airfield Lighting Circuit Data Sheet for each new CCR and each existing CCR connected to a new or modified airfield lighting circuit.
- F. A sample Airfield Lighting Circuit Data Sheet is included at the end of this Item.
- G. Record notable current, voltage or power wave forms of the circuits tested to demonstrate and identify normal operation and any unusual circuit characteristics.
- H. Comply with the manufacturer's recommendation for calibration and set up of each new CCR and each existing CCR connected to a new or modified airfield lighting circuit. The regulator output current and voltage shall be calibrated using a true RMS meter. The CCR calibration shall be complete prior to opening the lighted pavement to aircraft and prior to performing photometric testing.
- I. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- J. Perform required testing to complete information requested on the Airfield Lighting Circuit Data Sheet.

3.10 CONTROL SYSTEM TESTS

- A. The equipment shall be demonstrated to operate in accordance with the requirements of the Contract Documents. Each applicable control device in the air traffic control tower (ATCT) airfield lighting control panel and other control locations shall be operated so that each control device position is engaged at least ten times. During this process, all lights and associated equipment shall be observed to determine that each control device/switch/indicator properly operates the corresponding component. Radio communication between the operator and the observers shall be provided by the Contractor.
- B. The above tests shall be repeated for each individual circuit from the local control switches on the regulators. Each installed or revised lighting circuit shall be tested by operating the lamps throughout the range of applicable steps and shall be operated separately at step 3 or step 5 as appropriate for full intensity for not less than 4 hours. Visual examination shall be made at the beginning and at the end of this test to determine that the installed airfield light fixtures are illuminating at full intensity.

- C. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- D. Systems tests shall confirm by demonstration that all airfield lighting circuits are in required operating condition in accordance with the Contract Documents.

3.11 FIXTURE WIRING SEQUENCE TEST

- A. The fixture wiring sequence testing shall be performed at night with minimum interference to airport operations.
- B. The Contract Documents require all centerline lighting fixtures be wired in numerical order. Touch down zone and edge lights shall be wired in numerical sequence without zig-zagging back and forth across the runway or taxiway.
- C. The 5 kV L-824 airfield lighting series circuit cables shall be supplied with factory imprinted numbers.

1. Odd numbered circuits shall utilize:

- Wire #1 Routed from the constant current regulator (CCR) output terminal S1 to the lowest numbered fixture in the circuit.
- Wire #3 Routed from the lowest numbered fixture to the highest numbered fixture in the circuit. The fixtures shall be connected in numerical sequence. When the series circuit loops back in the same raceway, all fixtures shall be connected into the same leg of the circuit conductor. The return portion of the loop shall not have any fixtures installed into that portion of the conductor.
- Wire #5 Routed from the highest numbered fixture in the circuit to the CCR output terminal S2.

2. Even numbered circuits shall use numbers 2, 4 and 6.

- D. To verify proper wiring sequence from fixture to fixture temporary intentional grounds shall be inserted into the 5 kV airfield lighting series circuits. The temporary intentional grounds shall be inserted in sequence, one location at a time, at each PC, PT or PI where the cable returns (loops in the same conduit) with the fixture conductor. The Engineer shall designate each point as circuiting is completed.
- E. The Contractor is solely responsible for the safety of all personnel, materials and equipment within the construction area. In addition to the Contractor's requirements each temporary intentional ground location shall be barricaded. The barricade shall extend a minimum of twenty-five (25) feet in all directions around the temporary intentional ground. No one shall be allowed within the barricaded area during the test.

- F. All wiring for the 5 kV airfield lighting series circuits shall be complete prior to the sequence testing. The test circuit shall consist of the #1 conductor connected between the constant current regulator (CCR) output terminal S1 and the lowest numbered airfield lighting fixture. The #3 conductor connected from fixture to fixture to the first test point noted in the Contract Documents. A temporary intentional ground shall be inserted at this point. The constant current regulator (CCR) output terminal S2 shall be connected to a temporary intentional ground. Each temporary intentional ground shall be barricaded. All personnel shall be outside the barricade. The CCR shall be energized remotely. A visual inspection of the airfield lighting fixtures shall be made to determine proper wiring sequence.
- G. The temporary intentional ground shall be moved to the next test point and this procedure shall be repeated for each temporary intentional ground.
- H. The final temporary intentional ground for each circuit shall test proper routing of the #1 wire from the CCR output terminal S1 to the lowest numbered fixture. The temporary intentional grounds shall be placed at the output terminal S1 of the CCR and on the #1 wire side of the lowest numbered fixture. Each temporary intentional ground shall be barricaded. All personnel shall be outside the barricade. The CCR shall be energized remotely. A visual inspection of the airfield lighting fixtures shall be made to determine proper wiring sequence.
- I. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents and retest.
- J. Once proper wiring sequence has been verified remove all intentional temporary grounds and place 5 kV airfield lighting series circuits in proper working order.
- K. Systems tests shall confirm by demonstration that all airfield lighting circuits are in required operating condition in accordance with the Contract Documents.

3.12 AIRFIELD LIGHTING FIXTURE PHOTOMETRIC TESTING

- A. Photometric testing shall be performed at night with minimum interference to airport operations. Not more than 24 hours prior to starting the test, the Contractor shall clean all the light fixture lens to assure that the system is ready for the photometric testing.
- B. The photometric report shall include test results, general quality of installation in terms of photometric performance, identification of deficient lights, analysis to identify the cause of any deficient lights (e.g., fixture alignment, light fixture or specific primary circuit segment), and recommendation for correcting any deficiencies found. The test data shall be presented in the form of a log book with the first readings entered in the log book, and with provisions for entering future readings for each light.
- C. The photometric test and measurement equipment shall have an array of sensors capable of taking simultaneous readings along the horizontal axis of the light output. (Reference FAA Advisory Circular (AC) 150/5345-46, Latest Edition). Photometric testing shall include the measurement at each light fixture of the light distribution along the horizontal axis. The measurements shall be compared with FAA standards presented in the AC for each type of light fixture.

- D. The highest sensor reading, together with the two adjacent readings, will be averaged, and the calculated average shall be at least 20% greater than the minimum average intensity specified in the AC or in the project specifications, whichever is greater, in order for that fixture to be considered acceptable.
- E. In addition, all other readings within the specified ellipse shall be at least 50 percent of the specified minimum average intensity in order for the fixture to be considered acceptable. Results shall also be compared with the requirements set forth in FAA AC 150/5345-46.
- F. The photometric equipment system software shall be capable of recording the data and analyzing that data to calculate:
 - 1. The average photometric output of the main beam of the fixture,
 - 2. The location of the maximum reading,
 - 3. The location of the minimum reading,
 - 4. The ratio of the maximum reading to the average output,
 - 5. The ratio of the minimum reading to the average output, and
 - 6. Comparisons of these values with FAA specified values.
- G. In every group of fixtures, that is, touchdown zone, centerline, or other such group, ten percent (10%) of the fixtures shall be evaluated at three (3) different vertical angles, on the centerline of the light beam, and at two (2) degrees above and below the centerline of the beam.
- H. All sensor readings for the light fixture being evaluated shall be displayed simultaneously for operator and Engineer review and evaluation. All sensor readings shall be recorded automatically through the computer and shall be printed out via a computer controlled printer. Hand written data will not be accepted.
- I. For minimum impact on airport operations, the taking of photometric data at any one fixture shall be completed within thirty seconds.
- J. Interim reports will be submitted periodically during the progress of the work so that corrective measures may be taken as required by test results.
- K. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.
- L. Retesting shall be performed by the testing agency to verify that the deficient condition has been corrected.
- M. The documented test results of each fixture's photometric condition shall be graded as:

1. Passes/Meets FAA Requirements - This classification includes those new light fixtures which exceed the FAA requirement, or, in the case of existing lighting systems, those fixtures which exceed 70 percent of FAA requirements. (FAA specifies that airfield lights must be replaced when the outputs are less than 70 percent of the required output.) In such cases, no further action is necessary other than periodic monitoring by the Owner. When nothing is indicated in the "Remarks" column of the photometric data, the light fixture is satisfactory.
2. Fail/Investigate - These light fixtures have not met the FAA required photometric output for their particular type of light fixture. These fixtures shall be investigated by the Contractor to determine the cause of unacceptable performance. Appropriate corrective measures shall be taken to bring the performance of the fixtures to FAA standards, and the fixtures shall then be retested to assure that the repairs/replacements are satisfactory.

N. Photometric test data shall be tabulated with the following minimum information:

Fixture Number	From the Identification sheets of the Contract Documents
Light Direction	Direction of light beam
Max CD	Maximum candela output in a point along the main beam
Avg CD	Average candela output of the main beam
Min Level (70%)	70 Percent of FAA specified output for type of fixture
Lens Color	Color of lens on fixture being tested
Con for 70%	Condition compared with 70 percent of FAA standard (blank if fixture is acceptable).
Remarks	Notes pertaining to the fixture being tested.
Corrective Action	Notes action taken to correct deficiency.

3.13 AIRFIELD SIGN PHOTOMETRIC TESTING

- A. All signs shall be tested in accordance with specification 150/5345-44. The photometric testing of the signs shall evaluate the performance of signs with respect to the following FAA criteria:
 1. Luminance: The background of Type L-858Y signs and the legends of Type L-858R and L-858L signs shall have an average luminance of 10 to 30 ft lamberts.
 2. Uniformity: Photometric measurements shall be made on a 3 inch (76 mm) grid over the entire face of the sign, with no measurement being closer than 3 inches (76 mm) to the sign frame. Adjacent measurements shall not exceed a 1.5:1 ratio.

3. The sign shall be discernable from eight hundred (800') away.
- B. All new airfield guidance panels or signs installed on this project shall be tested at night. Style 2 and Style 3 signs shall be tested at each input current throughout the range on which the sign is to operate. Style 5 signs shall be tested at the highest rated input current (5.5 amperes). The photometric performance of the signs shall be evaluated using digital color images. These images shall be converted to gray-scale images that can be analyzed directly for photometric output. To provide calibration and control for the evaluation of the gray-scale image, direct photometric readings of the light output in foot-lamberts (FL) shall be taken at several locations on the face of the sign using a calibrated photometer. Light emitted only from the sign shall be permitted to reach the photometer.
- C. To document compliance with FAA requirements, the final report shall present the following information and data for each color for each sign tested:
 1. Sign Designation & Date Sign was tested.
 2. Digital & Gray-Scale Image of Sign.
 3. Step - The step intensity of the regulator controlling the sign.
 4. Arithmetic average of illumination levels (FL).
 5. Maximum illumination level on sign face and/or message (FL).
 6. Minimum illumination level sign face and/or message (FL).
 7. Ratio of Maximum illumination to Minimum illumination.
 8. Uniformity. The maximum ratio of the average illumination levels of adjacent 3-inch areas over the face of the sign.
 9. Visual Discernability of the Sign including comments.
 10. Statements whether or not sign meets FAA criteria.
- D. Photometric measurements shall also be taken of the red background on mandatory signs (white message on red background) to evaluate the signs red to white contrast. (FAA does not have criteria for contrast).
- E. Interim reports will be submitted periodically during the progress of the work so that corrective measures may be taken as required by test results.
- F. The documented test results of each signs photometric condition shall be graded as Passes/Meets FAA Requirements or Fail/Investigate.
- G. Investigate unsatisfactory results and make necessary corrections or replacements as required by the Contract Documents.

- H. Retesting shall be performed by the testing agency to verify that the deficient condition has been corrected.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in this section are incidental to other items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in this item.

END OF SECTION SP-111

AIRFIELD LIGHTING CIRCUIT DATA SHEET

Circuit Designation: _____ Date: _____

Circuit Description: _____ Ph. Wire Size/Type: _____

Source Panel/Ckt _____ GND. Wire Size/Type: _____

Panel Ø; CB Size: _____ Conduit Size/Type: _____

CCR Size: _____ CCR Output Amps: _____

CCR Manufacturer: _____ Yr. Manufactured: _____

CCR Type No.: _____ Part No.: _____

Output Amp Steps: / / / /

Input Volts: Ph.: Hz.: Input Amps: _____

Control Voltage: _____ Serial Number: _____

Oil Capacity: **Gal.** Oil Test Date: _____ Weight: **lbs.**

CCR Insp./Calib.: Date: _____ Circuit Age: **Years**

Insul. Resist. at 1 min.: **Ω @ 1000 V** Weather: _____

Lamps in Ckt.: Lamp Watts: Lamps Out: _____

Manufacturer's Set up and Calibration Completed by: _____

	Calibration	LOAD TEST							
Step	Output Amps	Output Amps	Output Voltage	Output KVA	Output PF	Input Amps	Input Volts	Input KVA	Input PF
B1/B10									
B2/B30									
B3/B100									
B4									
B5									

Comments:

Earth Resistance Test

Instrument Mfg. _____

Test Date _____

Model _____

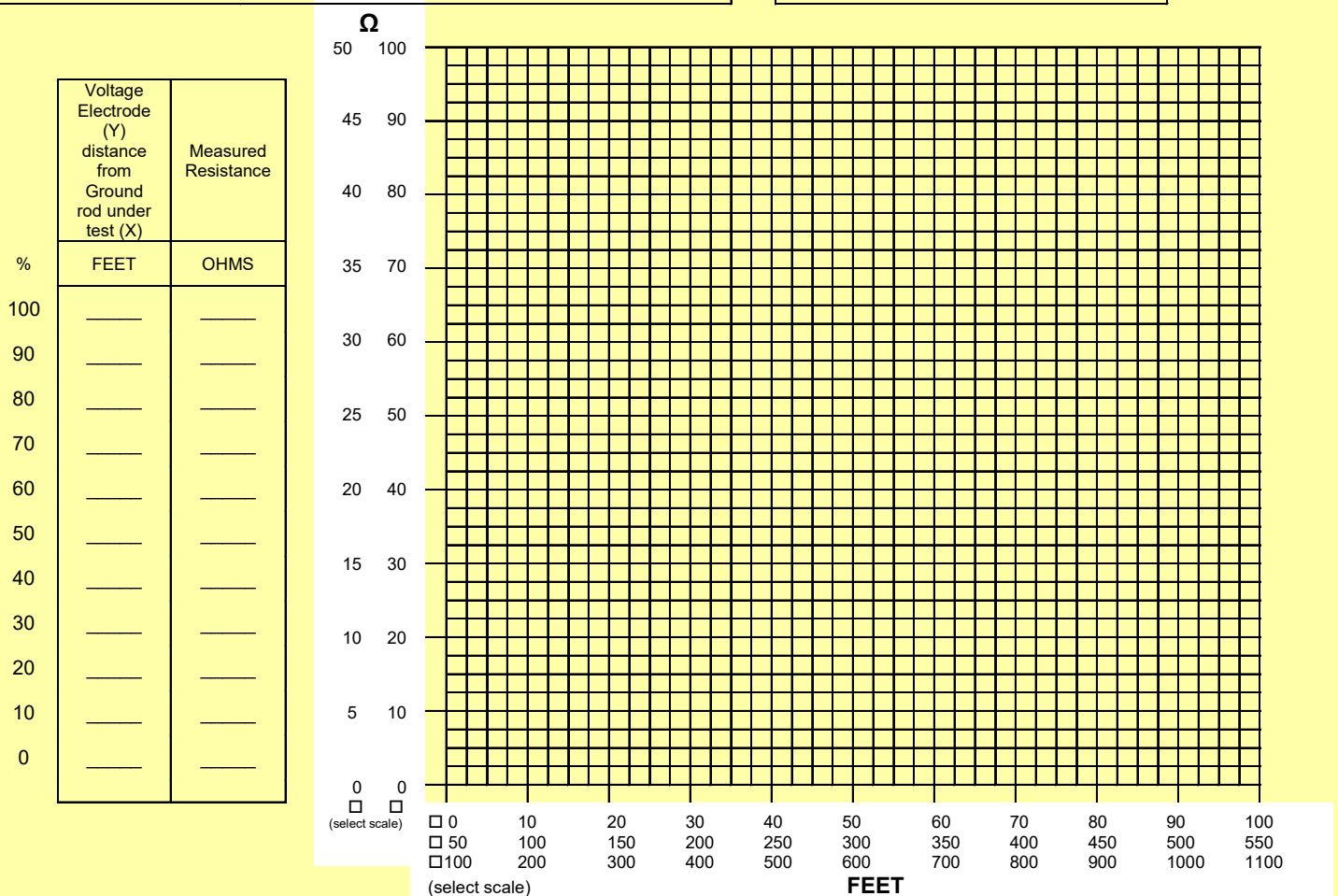
Operator Name _____

Serial Number _____

Test Location _____

Test Conditions			
Soil Condition:	☐ Moist	☐ Dry	Temperature _____ °F °C
Soil Type:	☐ Clay	☐ Limestone	☐ Sand & Gravel
(choose one)	☐ Granite	☐ Shale	☐ Sandstone
	☐ Loam	☐ Slate	☐ Other

Weather Conditions
Relative Humidity: _____
Precipitation Accumulation: _____
Sky Conditions: _____
Grounding System
☐ Single Rod
Rod Depth _____ ft



Comments: _____

HIGH POTENTIAL TEST REPORT

Date: _____

Start Time: _____ / Stop Time _____

Circuit Designation: _____		Circuit Description _____		Circuit Length _____	
Circuit Operating Voltage _____		Circuit Isolation Transformers Qty/Size: _____			
Hazard Risk Evaluation Performed? Yes No		Ambient Temperature: _____ Relative Humidity: _____ Sky Conditions.: _____ Rain last 48hrs: _____			
Test Equipment:	Manufacturer _____	Model # _____	Serial# _____	Upper Range Limit: _____	
Associated Equipment included in test: _____ _____					
Circuit Continuity: _____		Test Voltage: _____		Cable Manufacturer: _____	
VISUAL/MECHANICAL INSPECTION					
CHECK POINT	*COND	NOTES	CHECK POINT	*COND	NOTES
GROUPS PROPERLY TERMINATED			ACCEPTABLE BENDING RADIUS		
PHYSICAL DAMAGE			TIGHTNESS CABLE CONNECTION		
ELECTRICAL TESTS					
MEGGER @ 2500 VDC (1 MINUTE) = >50 KΩ					
TEST VOLTAGE (KV)	LEAKAGE CURRENT (MICRO-AMPS)	TIME HELD AT TEST VOLTAGE (MINUTES)			
3		1			
6		1			
9		1			
12		1			
15		1			
15		15 sec			
15		30 sec			
15		45 sec			
15		60 sec			
15		15 sec			
15		30 sec			
15		45 sec			
15		60 sec			
15		3 min			
15		4 min			
15		5 min			
15		6 min			
15		7 min			
15		8 min			
15		9 min			
15		10 min			
DECAYING VOLTAGE =		@ 30 SECONDS =		KV @1 MINUTE = KV	
NOTES:					
*CONDITION: A=ACCEPTBLE R=NEEDS REPAIR , REPLACEMENT OR ADJUSTMENT C=CORRECTED NA-NOT APPLICABLE					

Engineer: _____

Witness: _____

Tested by: _____ SP-111 - 22

Airfield Lighting Circuit Continuity and Insulation Resistance Testing

Date: _____

Start Time: _____ / Stop Time _____

Circuit Designation: _____		Circuit Description _____		Circuit Length _____	
Circuit Operating Voltage _____		Circuit Isolation Transformers Qty/Size: _____		_____	
Hazard Risk Evaluation Performed?		Ambient Temperature: _____		Relative Humidity: _____	
Yes No		Sky Conditions.: _____		Rain last 48hrs: _____	
Test Equipment: _____	Manufacturer _____	Model # _____	Serial# _____	Upper Range Limit: _____	
Associated Equipment included in test: _____					
Circuit Continuity: _____		Test Voltage: _____		Cable Manufacturer: _____	
Tested by: _____			Witness: _____		

Minutes	0.25	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Reading												
Correction												
Megohms	Infinity											
	10,000											
	5,000											
	3,000											
	2,000											
	1,000											
	800											
	600											
	400											
	300											
	200											
	150											
	100											
	80											
	60											
	40											
	30											
	20											
	15											
	10											
	6											
	4											
	2											
	1											
	0.6											
	0.2											
	0.1											
	0.06											
	0.02											
	Zero											

Comments: _____

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SECTION L-115 - ELECTRICAL MANHOLES AND JUNCTION STRUCTURES

PART 1 - DESCRIPTION

- 1.1 This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the **OAR RPR**. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the **OAR RPR**.

PART 2 - EQUIPMENT AND MATERIALS

2.1 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 **OAR RPR**.
- B. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the **OAR RPR**) and replaced with materials that comply with these specifications at the Contractor's cost.
- C. All materials and equipment used to construct this item shall be submitted to the **OAR RPR** for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.
- D. d. The data submitted shall be sufficient, in the opinion of the **OAR RPR**, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The **OAR RPR** reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.
- 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 the date of 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.

2.2 CONCRETE STRUCTURES

Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures shall be as shown on the plans.

2.3 PRECAST CONCRETE STRUCTURES

Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand 100,000 lb aircraft loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the **OAR RPR** shall be submitted by the Contractor to allow for a full evaluation by the **OAR RPR**. The **OAR RPR** shall review per the process defined in the General Provisions.

2.4 JUNCTION BOXES

Junction boxes shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a L-894 blank cover, gasket, and stainless steel hardware. All bolts, studs, nuts, lock washers, and other similar fasteners used for the light fixture assemblies must be fabricated from 316L (equivalent to EN 1.4404), 18-8, 410, or 416 stainless steel. If 18-8, 410, or 416 stainless steel is utilized it shall be passivated and be free from any discoloration. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868. All junction boxes shall be provided with both internal and external ground lugs.

2.5 MORTAR

The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The

hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

2.6 CONCRETE

Concrete shall be proportioned, placed and cured per Item P-610, Concrete for Miscellaneous Structures.

2.7 FRAMES AND COVERS

The frames shall conform to one of the following requirements:

A.	ASTM A48	Gray iron castings
B.	ASTM A47	Malleable iron castings
C.	ASTM A27	Steel castings
D.	ASTM A283, Grade D	Structural steel for grates and frames
E.	ASTM A536	Ductile iron castings
F.	ASTM A897	Austempered ductile iron castings

All castings specified shall withstand a maximum tire pressure of 250 psi and maximum load of 100,000 lbs.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word "ELECTRIC" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a "DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

2.8 LADDERS Not used.

2.9 REINFORCING STEEL

All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

2.10 BEDDING/SPECIAL BACKFILL

Bedding or special backfill shall be as shown on the plans.

2.11 FLOWABLE BACKFILL

Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

2.12 CABLE TRAYS Not used.

2.13 PLASTIC CONDUIT

Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

2.14 CONDUIT TERMINATORS

Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

2.15 PULLING-IN IRONS

Pulling-in irons shall be manufactured with 7/8-inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

2.16 GROUND RODS

Ground rods shall be one piece copper clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 10 feet long nor less than 3/4 inch in diameter.

PART 3 - CONSTRUCTION METHODS

3.1 UNCLASSIFIED EXCAVATION

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the **OAR RPR** without additional expense to the Owner.

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the **OAR RPR**. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the **OAR RPR**. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the **OAR RPR**. Structures shall be placed after the **OAR RPR** has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the **OAR RPR** as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

3.2 CONCRETE STRUCTURES

Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the **OAR RPR** before the concrete is placed.

3.3 PRECAST UNIT INSTALLATIONS

Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

3.4 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES AND FITTINGS

All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the **OAR RPR** and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the **OAR RPR** and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor's expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

3.5 INSTALLATION OF LADDERS

Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

3.6 REMOVAL OF SHEETING AND BRACING

In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The **OAR RPR** may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

3.7 BACKFILLING

After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the **OAR RPR**.

Backfill shall not be placed against any structure until approval is given by the **OAR RPR**. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the **OAR RPR** establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the **OAR RPR** may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

3.8 CONNECTION OF DUCT BANKS

To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

3.9 GROUNDING

A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm) diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtailed shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

3.10 CLEANUP AND REPAIR

After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer's recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

3.11 RESTORATION

After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

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.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

3.12 INSPECTION

Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 10 ~~25~~ ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

3.13 MANHOLE ELEVATION ADJUSTMENTS Not used.

3.14 DUCT EXTENSION TO EXISTING DUCTS

Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

PART 4 - METHOD OF MEASUREMENT

- 4.1 Electrical junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering; sheeting and bracing; all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections; and ground rod testing

PART 5 - BASIS OF PAYMENT

- 5.1 The accepted quantity of junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item L-115-5.1 Junction Can Plaza – Eight L-867D Cans -- per Each (EA)

This item includes all materials, labor, transportation, supervision, services and all incidentals required to provide and install a junction can plaza with L-867D, 24" deep light bases. Conduit, ground rods and counterpoise wire are paid under their respective pay items. This item includes all concrete, rebar, excavation, forming, backfill, sod, light bases, cover plates, hardware, identification tags, etc., and all appurtenances to construct a junction can plaza with eight light bases in accordance with the Contract Documents and to the satisfaction of the Engineer.

Item L-115-5.2 Aircraft Rated Electrical Manhole Type A-1 -- per Each (EA)

Item L-115-5.3 Aircraft Rated Electrical Manhole Type A-2 -- per Each (EA)

Item L-115-5.4 Existing Aircraft Rated Electrical
Manhole/Handhole/Junction Structure Elevation -- per Each (EA)
Adjustment up to and Including 5'x5' Inside Dimension

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/IEEE STD 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance,
and Earth Surface Potentials of a Ground System

Advisory Circular (AC)

AC 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport
Lighting Circuits

AC 150/5345-26 Specification for L-823 Plug and Receptacle, Cable Connectors

AC 150/5345-42 Specification for Airport Light Bases, Transformer Housings,
Junction Boxes, and Accessories

AC 150/5340-30 Design and Installation Details for Airport Visual Aids

AC 150/5345-53 Airport Lighting Equipment Certification Program

Commercial Item Description (CID)

A-A 59544 Cable and Wire, Electrical (Power, Fixed Installation)

ASTM International (ASTM)

ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application

ASTM A47 Standard Specification for Ferritic Malleable Iron Castings

ASTM A48 Standard Specification for Gray Iron Castings

ASTM A123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products

ASTM A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A536 Standard Specification for Ductile Iron Castings

ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A897 Standard Specification for Austempered Ductile Iron Castings

ASTM C144 Standard Specification for Aggregate for Masonry Mortar

ASTM C150 Standard Specification for Portland Cement

ASTM C206 Standard Specification for Finishing Hydrated Lime

FAA Engineering Brief (EB)

EB #83 In Pavement Light Fixture Bolts

Mil Spec

MIL-P-21035 Paint High Zinc Dust Content, Galvanizing Repair

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

END OF SECTION L-115

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SECTION L-125 - INSTALLATION OF AIRPORT LIGHTING SYSTEMS

PART 1 - DESCRIPTION

- 1.1 This item shall consist of airport lighting systems furnished and installed in accordance with this specification, the referenced specifications, and the applicable advisory circulars (ACs). The systems shall be installed at the locations and in accordance with the dimensions, design, and details shown in the plans. This item shall include the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the **OAR RPR**.

PART 2 - EQUIPMENT AND MATERIALS

2.1 GENERAL

- A. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified under the Airport Lighting Equipment Certification Program in accordance with AC 150/5345-53, current version. FAA certified airfield lighting shall be compatible with each other to perform in compliance with FAA criteria and the intended operation. If the Contractor provides equipment that does not perform as intended because of incompatibility with the system, the Contractor assumes all costs to correct the system for to operate properly.
- B. Manufacturer's certifications shall not relieve the Contractor of their responsibility to provide materials in accordance with these specifications and acceptable to the **OAR RPR**. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the **OAR RPR** and replaced with materials, which do comply with these specifications, at the sole cost of the Contractor.
- C. All materials and equipment used shall be submitted to the **OAR RPR** for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Clearly mark each copy to identify pertinent 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 clearly made with arrows or circles (highlighting is not acceptable). The Contractor shall be responsible for delays in the project accruing directly or indirectly from late submissions or resubmissions of submittals.
- D. The data submitted shall be sufficient, in the opinion of the **OAR RPR**, to determine compliance with the plans and specifications. The Contractor's submittals shall be submitted in electronic PDF format, tabbed by specification section. The **OAR RPR** reserves the right to reject any or all equipment, materials or procedures, which, in the **OAR's RPR's** opinion, does not meet the system design and the standards and codes, specified herein.

- 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.

All LED light fixtures, with the exception of obstruction lighting (AC 150/5345-43) must be warranted by the manufacturer for a minimum of 4 years after date of installation inclusive of all electronics." Obstruction lighting warranty is set by the individual manufacturer.

2.2 CONDUIT/DUCT

Conduit shall conform to Specification Item L-110 Airport Underground Electrical Duct Banks and Conduits.

2.3 CABLE AND COUNTERPOISE

Cable and Counterpoise shall conform to Item L-108 Underground Power Cable for Airports.

2.4 TAPE

Rubber and plastic electrical tapes shall be Scotch Electrical Tape Numbers 23 and 88 respectively, as manufactured by 3M Company or an approved equal.

2.5 CABLE CONNECTIONS

Cable Connections shall conform to Item L-108 Installation of Underground Cable for Airports.

2.6 RETROREFLECTIVE MARKERS

Retroreflective markers shall be type L-853 and shall conform to the requirements of AC 150/5345-39.

2.7 RUNWAY AND TAXIWAY LIGHTS

Runway and taxiway lights shall conform to the requirements of AC 150/5345-46. Lamps shall be of size and type indicated, or as required by fixture manufacturer for each lighting fixture required under this contract. Filters shall be of colors conforming to the specification for the light concerned or to the standard referenced.

Lights

Type	Class	Mode	Style	Option	Base	Filter	Transformer	Notes
L-852C(L)	2	1	3		L-868B	BI-GREEN/GREEN	L-830	
L-852D(L)	2	1	3		L-868B	BI-GREEN/GREEN	L-830	
L-852T(L)	2	1	3		L-868B	BI-RED	L-830	
L-861T(L)		1			L-867B/D	BI-BLUE	L-830	14" MAX
L-861T(L)		1			L-868B	BI-BLUE	L-830	14" MAX

2.8 RUNWAY AND TAXIWAY SIGNS

Runway and Taxiway Guidance Signs should conform to the requirements of AC 150/5345-44.

Signs

Type	Size	Style	Class	Mode	Notes
L-858Y,R, L(L)	3	5 3	1	2	

2.9 RUNWAY END IDENTIFIER LIGHT (REIL) Not required.

2.10 PRECISION APPROACH PATH INDICATOR (PAPI) Not required.

2.11 CIRCUIT SELECTOR CABINET Not required.

2.12 LIGHT BASE AND TRANSFORMER HOUSINGS

Light Base and Transformer Housings should conform to the requirements of AC 150/5345-42. Light bases shall be Type L-867 or L-868, Class 1A, Size B or D, shall be provided as indicated or as required to accommodate the fixture or device installed thereon. Base plates, cover plates, and adapter plates shall be provided to accommodate various sizes of fixtures.

2.13 ISOLATION TRANSFORMERS

Isolation Transformers shall be Type L-830, size as required for each installation. Transformer shall conform to AC 150/5345-47.

PART 3 - INSTALLATION

3.1 INSTALLATION

The Contractor shall furnish, install, connect and test all equipment, accessories, conduit, cables, wires, buses, grounds and support items necessary to ensure a complete and operable airport lighting system as specified here and shown in the plans.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and state and local code agencies having jurisdiction.

The Contractor shall install the specified equipment in accordance with the applicable advisory circulars and the details shown on the plans.

3.2 TESTING

All lights shall be fully tested by continuous operation for not less than 24 hours as a completed system prior to acceptance. The test shall include operating the constant current regulator in each step not less than 10 times at the beginning and end of the 24-hour test. The fixtures shall illuminate properly during each portion of the test.

3.3 SHIPPING AND STORAGE

Equipment shall be shipped in suitable packing material to prevent damage during shipping. Store and maintain equipment and materials in areas protected from weather and physical damage. Any equipment and materials, in the opinion of the **OAR RPR**, damaged during construction or storage shall be replaced by the Contractor at no additional cost to the owner. Painted or galvanized surfaces that are damaged shall be repaired in accordance with the manufacturer's recommendations.

3.4 ELEVATED AND IN-PAVEMENT LIGHTS

Water, debris, and other foreign substances shall be removed prior to installing fixture base and light.

A jig or holding device shall be used when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Light fixtures shall be oriented with the light beams parallel to the runway or taxiway centerline and facing in the required direction. The outermost edge of fixture shall be level with the surrounding pavement. Surplus sealant or flexible embedding material shall be removed. The holding device shall remain in place until sealant has reached its initial set.

PART 4 - METHOD OF MEASUREMENT

- 4.1 Taxiway lights will be measured by the number of each type installed as completed units in place, ready for operation, and accepted by the **OAR RPR**. Guidance signs will be measured by the number of each type and size installed as completed units, in place, ready for operation, and accepted by the **OAR RPR**.

PART 5 - BASIS OF PAYMENT

- 5.1 Payment will be made at the Contract unit price for each complete taxiway light or guidance sign installed by the Contractor and accepted by the **OAR RPR**. This payment will be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

Payment will be made under:

Item L-125-5.1	L-852C(L) Bidirectional Green LED Taxiway Centerline Light (NE) L-852C(L), Bidirectional, green, LED, style 3, T/W centerline light, mounted on an existing L-868B deep light base utilizing existing spacer ring(s) (w/concrete ring), properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)
Item L-125-5.2	L-852C(L) Bidirectional Green LED Taxiway Centerline Light (N) L-852C(L), Bidirectional, green, LED, style 3, T/W centerline light, mounted on a L-868B deep light base with ¾" nominal spacer ring (w/concrete ring), properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)
Item L-125-5.3	L-852D(L) Bidirectional Green LED Taxiway Centerline Light (NE) L-852D(L), Bidirectional, green, LED, style 3, T/W centerline light, mounted on an existing L-868B deep light base utilizing existing spacer ring(s) (w/concrete ring), properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)

Item L-125-5.4	L-852D(L) Bidirectional Green LED Taxiway Centerline Light (N) L-852D(L), Bidirectional, green, LED, style 3, T/W centerline light, mounted on a L-868B deep light base with $\frac{3}{4}$" nominal spacer ring (w/concrete ring), properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)
Item L-125-5.5	L-852T(L) Omnidirectional, Red, LED In-Pavement, Taxiway Edge Light L-852T(L), Omnidirectional, red, LED, style 3, T/W edge light, mounted on an L-868B, 2 piece, deep light base with a properly sized spacer ring (w/concrete ring) and properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)
Item L-125-5.6	L-858(L) Sign – Single/Double Face, LED, Size 3 - 2 Module L-858(L), Y,R,L sign, size 3 with LED Light Source installed on a concrete base with a L-867D 24" deep light base, with 1/2" thick galvanized steel cover plate and gasket, properly sized L-830 transformer(s), L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)
Item L-125-5.7	L-858(L) Sign – Single/Double Face, LED, Size 3 - 3 Module L-858(L) Y,R,L sign, size 3 with LED Light Source installed on a concrete base with a L-867D 24" deep light base, with 1/2" thick galvanized steel cover plate and gasket, properly sized L-830 transformer(s), L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)
Item L-125-5.8	L-858(L) Sign – Single/Double Face, LED, Size 3 - 4 Module L-858(L) Y,R,L sign, size 3 with LED Light Source installed on a concrete base with a L-867D 24" deep light base, with 1/2" thick galvanized steel cover plate and gasket, properly sized L-830 transformer(s), L-823 connectors, and all incidentals. Align and level as required.	-- per Each (EA)

Item L-125-5.9	L-861T(L) Omnidirectional, Blue, LED, Taxiway Edge Light (NE) L-861T(L), omnidirectional, blue, LED, MITL, T/W edge light, column mounted on an existing L-867B/D deep light base installed with a "corten" or accepted equivalent base plate with gasket, properly sized L-830 transformer, L-823 connectors, and all incidentals. The overall height shall be 14". Align and level as required.	-- per Each (EA)
Item L-125-5.10	L-861T(L) Omnidirectional, Blue, LED, Taxiway Edge Light (N) L-861T(L), Omni-directional, blue, LED, MITL T/W edge light, column mounted on a L-867B/D deep light base with a "corten" or accepted equivalent base plate with gasket and properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required. The overall height shall be 14".	-- per Each (EA)
Item L-125-5.11	L-861T(L) Omnidirectional, Blue, LED, Taxiway Edge Light on L-868B Light base L-861T(L), Omni-directional, blue, LED, MITL T/W edge light, column mounted on a L-868B deep light base with a "corten" or accepted equivalent base plate with gasket and properly sized L-830 transformer, L-823 connectors, and all incidentals. Align and level as required. The overall height shall be 14".	-- per Each (EA)
Item L-125-5.12	L-868B Light base (N) L-868B 12" diameter 21" deep light base with a properly sized spacer ring (w/concrete ring) and a 3/4" galvanized steel blank cover and gasket secured with stainless steel bolts, and all incidentals. For use as light base for future in-pavement fixture. Align and level as required.	-- per Each (EA)
Item L-125-5.13	Field Lightning Arrestor Assembly This item includes all materials, labor, transportation, supervision and all incidentals to furnish and install a field lightning arrestor assembly in accordance with the Contract Documents.	-- per Each (EA)
Item L-125-5.14	Airfield Lighting Control System Modifications: Vendor	-- Allowance (AL)

This item includes vendor coordination and planning with contractor schedule for system upgrade and verify proper installation of A-RMS module and connection to existing A-RMS module. The vendor shall provide support as necessary to ensure scope is met and proper system operation. Vendor shall perform final System Acceptance Test (SAT) remotely with OAR and contractor.

- Item L-125-5.15 Airfield Lighting Control System Modifications: Contractor -- Lump Sum (LS)

This item includes all coordination, materials, labor, supervision, and all incidentals required to modify the existing Airfield Lighting Control System (ALCS) including the L-821 control panel modifications in the Air Traffic Control Tower (ATCT), interconnection of the existing tower, vault computers and new Constant Current Regulators (CCR) and monitors, provide and install all controls and monitoring and all modifications necessary for a complete and operational Airfield Lighting Control System to provide a fully functional system in accordance with the Contract Documents. As a part of this pay item the Contractor shall furnish to the Owner a 1,000 foot reel of Beldon 9842 cable. The Contractor may use a portion of this cable for the connection of the new CCRs with the balance of the cable being turned over to the Owner.

- Item L-125-5.16 RFID Fixture Association and Database: Vendor -- Allowance (AL)

This item includes RFID tags, the vendor being on site and associating each fixture in the project into the MALMS database, update the database in the GOAA Tablets and provide the SQL database for GOAA IT. Documentation, meeting time and commissioning of the MALMS updates are also included. Payment shall be made in accordance with completed vendor invoices.

- Item L-125-5.17 RFID Fixture Association and Database: Contractor -- Lump Sum

This item includes escort and support for the RFID work.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5340-18	Standards for Airport Sign Systems
AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems
AC 150/5345-39	Specification for L-853, Runway and Taxiway Retroreflective Markers
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5345-44	Specification for Runway and Taxiway Signs
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures
AC 150/5345-47	Specification for Series to Series Isolation Transformers for Airport Lighting Systems
AC 150/5345-51	Specification for Discharge-Type Flashing Light Equipment
AC 150/5345-53	Airport Lighting Equipment Certification Program

Engineering Brief (EB)

EB No. 67	Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures

END OF SECTION L-125

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Item T-901 Seeding

DESCRIPTION

901-1.1 This item shall consist of soil preparation, seeding **and/or hydroseeding** the areas shown on the plans or as directed by the RPR OAR in accordance with these specifications. ***Contractor is to adhere to FDOT SECTION 981 TURF MATERIALS.***

MATERIALS

901-2.1 Seed. The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the RPR duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be applied as follows:

Seed Properties and Rate of Application

Seed	Minimum Seed Purity (Percent)	Minimum Germination (Percent)	Rate of Application lb/acre (or lb/1,000 S.F.)
Pensacola Bahia Seed	95% Live	80%	75 lb/acre
Bermuda Seed	95% Live	85%	75 lb/acre
Annual Ryegrass	95% Live	90%	50 lb/acre

Seeding shall be performed during the period between **April 1st** and **November 15th** inclusive, unless otherwise approved by the RPR.

901-2.1.1 Hydroseeding

Equipment shall have a built-in agitation system and operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing organic mulching amendment plus fertilizer, chemical additives and solids.

a. <i>GeoPerm Bonded Fiber Matrix (100% virgin wood fibers)</i>	<i>4,000 lbs/AC</i>
b. <i>Aqua-pHix™ Hydro Formula– (for soils in excess of 8.5pH)</i>	<i>10 gal/AC</i>
c. <i>JumpStart™ - soluble growth stimulant.</i>	<i>1.25 gal/AC</i>
d. <i>BioPrime™ - nitrogen rich biostimulant.</i>	<i>40 lbs/AC</i>
e. <i>Pensacola Bahia seed – AOSCA certified, blue tag</i>	<i>75 lbs/AC</i>
f. <i>Annual Ryegrass seed – AOSCA certified, blue tag</i>	<i>50 lbs/AC</i>
g. <i>Bermuda seed – AOSCA certified, blue tag</i>	<i>75 lbs/AC</i>

Water

- a. ***Apply hydroseeding when no rainfall is expected for 12 hours after application.***
- b. ***Use clean, water free from substances which might inhibit plant growth. Water is to be provided or arranged for by the Contractor.***

Soils Test

The Contractor shall test soils for determining pH factor of soil. Submit results to Owner along with written plan to amend soil to pH suitable for selected seed mix design and designated amendments.

901-2.2 Lime. Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 (850 µm) mesh sieve and 50% will pass through a No. 100 (150 µm) mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate of **1,750 lbs. to 6,500 lbs. per acre**. All liming materials shall conform to the requirements of ASTM C602.

901-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or

- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be ***in compliance with FDOT Section 982*** commercial fertilizer and shall be spread at the rate of ***no more than 0.25 lbs P₂O₅/1,000 square feet per application prior to planting or as directed by OAR.***

901-2.4 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

901.-2.4 Hydroseed Mix Design

The hydroseeding mix shall consist of a slurry combination of seed, mulch, fertilizer, tackifier, green dye, and other additives that will remain under rainy conditions and reduce erosion problems and seal the soil moisture. The mix design and application rates shall be as follow:

1. GeoPerm Bonded Fiber Matrix	4,000 lbs/AC
2. Aqua-pHix™ Hydro Formula	10 gal/AC (if necessary)
3. JumpStart™	1.25 gal/AC
4. BioPrime™	40 lbs/AC
5. Pensacola Bahia seed	75 lbs/AC
6. Annual Ryegrass seed	50 lbs/AC
7. Bermuda seed	75 lbs/AC

Seeding shall be performed during the period between April 1 and November 15 inclusive, unless otherwise approved by the OAR.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry application method.

a. Liming. Lime shall be applied separately and prior to the application of any fertilizer or seed and only on seedbeds that have previously been prepared as described above. The lime shall then be worked into the top 3 inches (75 mm) of soil after which the seedbed shall again be properly graded and dressed to a smooth finish.

b. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity stated in paragraph 901-2.3.

c. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

d. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

901-3.3 Wet application method.

a. General. The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over

distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

c. Mixtures. Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Contractor shall identify to the RPR all sources of water at least two (2) weeks prior to use. The RPR may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the RPR following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the RPR, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

901-3.4 Maintenance of seeded areas. The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the RPR. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the RPR. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded. ***If at the time when the contract has been otherwise completed it is not possible to make an adequate determination of the color, density, and uniformity of such stand of grass, payment for the unaccepted portions of the areas seeded out of season will be withheld until such time as these requirements have been met.***

The Contractor will provide detailed, typewritten instructions and recommendations to be followed by the Owner for properly maintaining hydroseeding work for one full year following installation and maintenance period.

Begin maintenance as soon as each plant is in place and continue maintenance until all planting has passed final acceptance of the total facility by the Owner's Representative. Maintenance includes the following: spraying for insect control; watering; weeding; cultivating; removal of dead material; restoration of bare spots larger than one square foot; and other operations to keep seeded areas healthy while providing 100% coverage over bare soil.

Acceptance: Upon acceptance of hydroseeding operations, maintain all hydroseeded areas for a period of 90 calendar days as follows:

- 1. Germination Stage Irrigation: Approximately 25 hours after hydroseeding, initiate the watering sequence. Irrigate for a period of time that sufficiently moistens the soil to the depth of the slurry mulch, taking care not to wash away the slurry and seed. Perform frequent, light irrigation sessions until the seed has germinated. Repair all seed washings and erosion caused by irrigation.***
- 2. Establishment Stage Irrigation: After germination is visible over the entire hydroseeded area, begin to reduce the number of light irrigation sessions. The specific watering program must be approved by the Owner and Owner's representative.***

Fertilization: As allowed by the Owner, fertilize hydroseeded areas with an approved commercial fertilizer, 30 calendar days from the start of the maintenance period and continuing once every 60 calendar days until the completion of the 90 calendar day maintenance period.

Weeding: All concentrated developments of weed growth appearing in the hydroseeded planting areas during the maintenance period shall be removed at two (2) week intervals. The Contractor may elect to remove such concentrations of weeds manually or by an Owner-approved herbicide program.

Minimum Coverage and Acceptance:

- 1. Minimum Coverage: Final acceptance may be given at the end of the 90 calendar day maintenance period if an acceptable germination of turf and adequate plant establishment has been achieved, as determined by the Owner's Representative.***
- 2. Acceptance: Final approval and acceptance will be given in writing by the Owner's Representative following a final acceptance inspection. The Owner reserves the option to extend the maintenance period to achieve complete germination of all hydroseed areas with a uniform height, color, and density throughout.***

Site Layout

Stake out proposed hydroseeding locations and obtain approval of the Owner's Representative before beginning seeding operations.

Testing

- a. ***Test soil as often as necessary to determine pH factor of untreated soil.***
- b. ***Where test indicates adjustment of pH factor is required, adjust hydroseed amendments, as necessary, to adjust to proper pH factor. Submit final hydroseed mix design for approval prior to application.***
- c. ***Keep record of:***
 - i) ***Locations where tests are made.***
 - ii) ***Readings before corrections are made.***

Soil Preparation

- a. ***Apply specified herbicide at rates specified on product packaging.***
- d. ***Surface preparation: Mix soil and additives to a depth of not less than 5 inches, rake smooth, and leave clean and ready for seeding.***
- e. ***Water all hydroseed-designated areas thoroughly to saturate upper layers of soil prior to hydroseeding application.***
- f. ***Allow the hydroseed-designated areas' surface to dry for one day only prior to the hydroseeding application. Drying period should allow for residual moisture within the first 1/4 inch of the soil surface. There shall be no standing water on the soil's surface at the time of the hydroseeding application.***

Protect areas outside of designated hydroseeded areas, but within the Owner's property during this work.

METHOD OF MEASUREMENT

901-4.1 The quantity of seeding to be paid for shall be the number of units acre measured on the ground surface, completed and accepted.

BASIS OF PAYMENT

901-5.1 Payment shall be made at the contract unit price per acre or fraction thereof, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

Item 901-5.1 Seeding - per acre

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602 Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-901

Item T-904 Sodding

DESCRIPTION

904-1.1 This item shall consist of furnishing, hauling, and placing approved live sod on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the ~~RPR~~ **OAR**.

MATERIALS

904-2.1 Sod. Sod furnished by the Contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials that might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of ~~the species stated in the special provisions~~ **Pensacola Bahia grass**, and any vegetation more than 6 inches (150 mm) in height shall be mowed to a height of 3 inches (75 mm) or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness not less than that stated in the special provisions.

904-2.2 Lime. Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 (850 µm) mesh sieve and 50% will pass through a No. 100 (150 µm) mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate of ~~conforming to the requirements of 901-2.2~~. All liming materials shall conform to the requirements of ASTM C602.

904-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers ~~shall be commercial fertilizer and shall be spread at the rate of~~ **conform to the requirements of 901-2.3**.

904-2.4 Water. The water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass.

904-2.5 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the **RPR OAR** before being placed.

CONSTRUCTION METHODS

904-3.1 General. ~~Areas to be solid, strip, or spot sodded shall be shown on the plans.~~ ***All sod shall be laid solid and shall be done so in locations of disturbance as depicted in Contract Drawings.*** Areas requiring special ground surface preparation such as tilling and those areas in a satisfactory condition that are to remain undisturbed shall also be shown on the plans.

Suitable equipment necessary for proper preparation of the ground surface and for the handling and placing of all required materials shall be on hand, in good condition, and shall be approved by the **RPR OAR** before the various operations are started. The Contractor shall demonstrate to the **RPR OAR** before starting the various operations that the application of required materials will be made at the specified rates.

904-3.2 Preparing the ground surface. After grading of areas has been completed and before applying fertilizer and limestone, areas to be sodded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes occurs after grading of areas and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage. ~~This may include filling gullies, smoothing irregularities, and repairing other incidental damage.~~

904-3.3 Applying fertilizer and ground limestone. Following ground surface preparation, fertilizer shall be uniformly spread at a rate which will provide not less than the minimum quantity of each fertilizer ingredient, as stated in the special provisions. If use of ground limestone is required, it shall then be spread at a rate that will provide not less than the minimum quantity stated in the special provisions. These materials shall be incorporated into the soil to a depth of not less than 2 inches (50 mm) by discing, raking, or other suitable methods. Any stones larger than 2 inches (50 mm) in any diameter, large clods, roots, and other litter brought to the surface by this operation shall be removed.

904-3.4 Obtaining and delivering sod. After inspection and approval of the source of sod by the **RPR OAR**, the sod shall be cut with approved sod cutters to such a thickness that after it has been transported and placed on the prepared bed, but before it has been compacted, it shall have a uniform thickness of not less than 2 inches (50 mm). Sod sections or strips shall be cut in uniform widths, not less than 10 inches (250 mm), and in lengths of not less than 18 inches (0.5 m), but of such length as may be readily lifted without breaking, tearing, or loss of soil. Where strips are required, the sod must be rolled without damage with the grass folded inside. The Contractor may be required to mow high grass before cutting sod.

The sod shall be transplanted within 24 hours from the time it is stripped, unless circumstances beyond the Contractor's control make storing necessary. In such cases, sod shall be stacked, kept moist, and protected from exposure to the air and sun and shall be kept from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, approval to cut sod may be granted only after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

904-3.5 Laying sod. Sodding shall be performed only during the seasons when satisfactory results can be expected. Frozen sod shall not be used and sod shall not be placed upon frozen soil. Sod may be transplanted during periods of drought with the approval of the **RPR OAR**, provided the sod bed is watered to moisten the soil to a depth of at least 4 inches (100 mm) immediately prior to laying the sod.

The sod shall be moist and shall be placed on a moist earth bed. Pitch forks shall not be used to handle sod, and dumping from vehicles shall not be permitted. The sod shall be carefully placed by hand, edge to edge and with staggered joints, in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward. The sod shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment to provide a true and even surface, and ensure knitting without displacement of the sod or deformation of the surfaces of sodded areas. ***All sod shall be rolled within twenty-four (24) hours of placement.*** Where the sod may be displaced during sodding operations, the workmen, when replacing it, shall work from ladders or treaded planks to prevent further displacement. Screened soil of good quality shall be used to fill all cracks between sods. The quantity of the fill soil shall not cause smothering of the grass. Where the grades are such that the flow of water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately one inch (25 mm) below the pavement edge. Where the flow will be over the sodded areas and onto the paved surfaces around manholes and inlets, the surface of the soil in the sod after compaction shall be placed flush with pavement edges.

On slopes steeper than one (1) vertical to 2-1/2 horizontal and in v-shaped or flat-bottom ditches or gutters, the sod shall be pegged with wooden pegs not less than 12 inches (300 mm) in length and have a cross-sectional area of not less than 3/4 sq inch (18 sq mm). The pegs shall be driven flush with the surface of the sod.

904-3.6 Watering. Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth assured. In all cases, watering shall be done in a manner that will avoid erosion from the application of excessive quantities and will avoid damage to the finished surface.

904-3.7 Establishing turf. The Contractor shall provide general care for the sodded areas as soon as the sod has been laid and shall continue until final inspection and acceptance of the work. All sodded areas shall be protected against traffic or other use by warning signs or barricades approved by the **RPR OAR**. The Contractor shall mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. Weeds or other undesirable vegetation shall be mowed and the clippings raked and removed from the area.

904-3.8 Repairing. When the surface has become gullied or otherwise damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the **RPR OAR**, and shall then be sodded as specified in paragraph 904-3.5.

904-3.9 Warranty. ***All new sod shall be warranted through the end of the construction period and for sixty (60) days following final acceptance.***

METHOD OF MEASUREMENT

904-4.1 This item shall be measured on the basis of the area in square yards of the surface covered with sod and accepted.

BASIS OF PAYMENT

904-5.1 This item will be paid for on the basis of the contract unit price per square yard for sodding, which price shall be full compensation for all labor, equipment, material, staking, and incidentals necessary to satisfactorily complete the items as specified.

Payment will be made under:

Item T-904-5.1 Sodding - per square yard

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602 Standard Specification for Agricultural Liming Materials

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-904

Item T-905 Topsoil

DESCRIPTION

905-1.1 This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the ~~RPR~~ **OAR**.

MATERIALS

905-2.1 Topsoil. Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 μ m) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

905-2.2 Inspection and tests. Within 10 days following acceptance of the bid, the ~~RPR~~ **OAR** shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

CONSTRUCTION METHODS

905-3.1 General. Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the ~~RPR~~ **OAR** before the various operations are started.

905-3.2 Preparing the ground surface. Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the ~~RPR~~ **OAR**, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of

all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

905-3.3 Obtaining topsoil. Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the **RPR OAR**. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the **RPR OAR**. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the **RPR OAR**. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoil purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the **RPR OAR**. The Contractor shall notify the **RPR OAR** sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. ~~Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.~~

905-3.4 Placing topsoil. The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the **RPR OAR**. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

METHOD OF MEASUREMENT

905-4.1 Topsoil obtained on the site shall be measured by the number of cubic yards (cubic meters) of topsoil measured in its original position and stripped or excavated. Topsoil stockpiled by others and removed for topsoil by the Contractor shall be measured by the number of cubic

yards (cubic meters) of topsoil measured in the stockpile. Topsoil shall be measured by volume in cubic yards (cubic meters) computed by the method of end areas.

905-4.2 Topsoil obtained off the site shall be measured by the number of cubic yards (cubic meters) of topsoil measured in its original position and stripped or excavated. Topsoil shall be measured by volume in cubic yards (meters) computed by the method of end areas.

BASIS OF PAYMENT

905-5.1 Payment will be made at the contract unit price per cubic yard (cubic meter) for topsoil (obtained on the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

905-5.2 Payment will be made at the contract unit price per cubic yard (cubic meter) for topsoil (obtained off the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item T-905-5.1	Topsoil (Obtained on Site or Removed from Stockpile - per cubic yard (cubic meter)
Item T-905-5.2	Topsoil (Furnished from Off the Site) - per cubic yard (cubic meter)

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C117	Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing

Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-905

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

TOPSOIL
ITEM T-905

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ADDENDUM NO. 01

(Issued July 8, 2022)

**TO THE BID DOCUMENTS FOR
BP-S196, TERM C, PH 1X – AIRFIELD CIVIL, APRON & TAXIWAY PAVING**

ORLANDO INTERNATIONAL AIRPORT

July 8, 2022

BP-S196

ADDENDUM NO. 1

TO ALL HOLDERS OF CONTRACT DOCUMENTS

1. Your attention is directed to the following interpretations of, changes in, and/or additions to the contract documents for the above-named project
2. This addendum is part of the Contract Documents
3. Bidders are required to acknowledge receipt of this Addendum in the space provided on the Bid Form Section 00 41 13

Revised Bid Schedule

The following on the Bid Schedule have been modified by this addendum:

- Revise Item Description of Bid Item: C-105-6.1 to read: Mobilization (Not To Exceed 10% of Total Project Cost)
- Revise Item Description of Bid Item: D-705-5.1 to read: 6-inch Smooth High Density Polyethylene (HDPE) Pipe
- Revise Item Description of Bid Item: P-101-5.1 to read: Concrete Pavement Removal (variable depth) with a SY quantity of 870
- Revise Bid Item Number P-151-4.2 Clearing and Grubbing to P-151-4.1
- Revise Bid Item Number P-151-4.3 BP-S196 Landside Civil Demolition to P-151-4.2
- Inserted Pay Item: Item P-620-5.5 Marking Removal -per Square Foot (SF) with a quantity of 3,300
- Revise Bid Item Number 12 47 13-5.1 Cathodic Protection System to 13 47 13-5.1

- Revise Item Description of Bid Item: 26 05 12-5.7 to read: 4 W 6" Schedule 40 PVC OUC Concrete Encased Duct
- Inserted Pay Item: Item 28 43 20-5.1 EFSO System Modifications and Expansion - per Lump Sum (LS) with a quantity of 1
- Revise unit on Bid Item: 32 52 45-5.4 6"/10" Double Wall Pipe Connections to Existing 12"/16" Double Wall Pipe from LF to EA
- Revise quantity of Bid Item L-125-5.6 L-858(L) Sign - Single/Double Face, LED, Size 3 - 2 Module to quantity of 1
- Revise quantity of Bid Item L-125-5.7 L-858(L) Sign - Single/Double Face, LED, Size 3 - 3 Module to quantity of 6
- Revise quantity of Bid Item P-501-8.3 to quantity of 3,880 SY (ASC Only)
- Revise quantity of Bid Item L-108-5.3 to quantity of 270 EA
- Revise quantity of Bid Item L-110-5.3 to quantity of 3,150 LF
- Revise quantity of Bid Item L-110-5.4 to quantity of 0 LF
- Revise quantity of Bid Item L-115-5.2 to quantity of 10 EA

Revised Specifications

The following Specifications have been modified by this Addendum:

- 26 05 12 - Revised paragraphs 3.5K and 3.5U.
- 26 08 00 - Delete Specification. Specification is not applicable to project.
- 26 24 13 - New Specification - SWITCHBOARDS DRAW-OUT (RON).
- 26 24 17 - New Specification - DISTRIBUTION PANELBOARDS (RON).
- 26 57 00 - Added new section 2.4 Space Conditioning
- P-101 - Replace Pay Item P-101-5.1 with "Concrete Pavement Removal - Variable Depth" and remove Pay Item P-101-5.2
- P-501 - Add paragraphs 4.21 and 7.4
- P-620 - Add paragraphs 4.1E, 5.4D, and 5.4E. Add Pay Item P-620-5.5 " Marking Removal - per Square Foot"
- L-115 - Revised pay item descriptions for L-115-5.2 and L-115-5.3.

Revised Drawings

The following drawings have been revised by this Addendum and are included as attachments to this Addendum:

- IS0.00.01 - Index of Drawings updated to reflect new and removed sheets.
- IS0.00.03 - Added Fuel Consortium contact
- C8.01.09 - Extension of new concrete sidewalk pavement for high mast pole and updated construct point geometry
- C8.01.10 - Updated Northing and Easting for data points
- C9.01.04 - Updates callout to include specific Mooring Device model
- C12.01.09 - Revised grading to incorporate additional highmast light pole.
- C13.01.09 - Revised grading and pavement elevation callouts to incorporate additional highmast light pole.

- C13.01.14 - Revised grading and pavement elevation callouts to incorporate additional highmast light pole.
- C14.01.09 - Extension of new concrete sidewalk and updated additional reinforcement around sidewalk and new A1 boxes
- C14.01.14 - Extension of new concrete sidewalk and updated additional reinforcement around sidewalk
- C40.01.08 - Corrected intermediate hold position marking callout
- C40.01.09 - Corrected intermediate hold position marking callout and updated to show expansion of new concrete sidewalk pavement
- C60.01.01 - Updated drawing title, general, and removed phase number
- C60.01.02 - Updated drawing title, general, tables, added additional AOA fence, removed phase & duration and updated portion of VSR
- C60.01.03 - Updated drawing title, general, added additional AOA fence, removed phase and duration and updated portion of VSR
- C60.01.04 - Updated drawing title, general, added additional AOA fence and removed phase and duration
- C60.01.05 - Updated drawing title, general, added additional AOA fence and removed phase and duration
- CE0.00.01 - Revised legend, and notes for clarification. Added note 17 to OUC MANHOLE & DUCTBANK DISTRIBUTION NOTES
- CE1.00.01 - Screened back unrelated information and revised sheet numbers for sheet clarity.
- CE2.00.01 - Revised callouts and added notes for clarification. Removed duct 20' west of MH-AP-224 to align with GOAA requirements.
- CE2.00.02 - Revised callouts and added notes for clarification. Relocated MH-A1-16 and added MH-A1-16A.
- CE3.00.02 - Revised callouts and notes 2 and 5.
- CE3.00.06 - Revised "SOUTH ON DISTRIBUTION BUILDING PLANS" detail and notes 3 and 4.
- CE3.00.06A - Added EATON pedestal to sheet. Revised note1.
- CE3.00.06B - New sheet
- CE3.00.07 - Revised sheets with new pedestal information.
- CE3.00.08 - Revised sheets with new pedestal information.
- CE3.00.09 - Revised sheets with new pedestal information.
- CE3.00.10 - Revised sheets with new pedestal information.
- CE3.00.11 - Revised sheets with new pedestal information.
- CE3.00.12 - Revised sheets with new pedestal information.
- CE3.00.14 - Remove sheet from project. Not in Contract (NIC)
- CE3.00.15 - Revised callouts for clarification. Revised "SECTION A-A" detail
- CE3.00.16 - Revised callouts for clarification. Revised "SECTION A-A" detail
- CE3.00.18 - Revised callouts and note 2 for clarification. Revised sheet title and "LIGHTNING PROTECTION DOWN CONDUCTOR DETAIL".
- CE3.00.19 - Revised callouts for clarification. Revised sheet title.
- CE3.00.20 - Revised callouts for clarification. Revised sheet title.
- CE3.00.21 - Renumbered GENERAL notes 13-18. Revised PRE-ENGINEERED PRE-CAST BUILDING note 1 and GENERAL note 14 for clarification.
- CE3.00.22 - Reoriented all wall exterior details. Removed service meter and HVAC from new " SOUTH WALL EXTERIORELEVATION" detail and sheet references from

- all details. Added "FLOOR PLAN" detail, "UV RESISTANT SIGNS" detail and notes 3, 4, and 5. Added Band Model to east and west wall details. Revised note 1.
- CE7.00.07 - Renamed duct side view and top view details. Revised note 3 of "DIRECTIONAL BORE NOTES/DUCT INSTALLATION NOTES" and notes 1, 5, 7, 10, 14, 23, and 24 of "NOTES". Added notes 25, 26, 27, 28 and 29.
 - CE7.00.08 - Revised OUC TRENCH DETAIL ground wire callout and added callout to the communication duct. Removed counterpoise callout from 12 WAY 6" END VIEW and DETAIL "F". Revised callouts for CONNECTION OF CONDUIT/DUCT TO EXISTING MANHOLE.
 - CE7.00.08A - Revised note 6 and "4W4" DUCT BANK CONCRETE ENCASED" detail. Added notes 7, 8, 9, 10, detail "MANHOLE & DUCT BANK COUNTERPOISE PLAN VIEW DETAIL" and callouts to details. Removed details "2W4" DUCT BANK CONCRETE ENCASED" and "6W4" DUCT BANK CONCRETE ENCASED".
 - CE7.00.08B - Remove sheet from project. Not in Contract (NIC)
 - CE7.00.08C - Remove sheet from project. Not in Contract (NIC)
 - CE7.00.09 - Removed details "OUC PAD & PAD GROUNDING - THREE PHASE 15KV FOR S C PME-9 SWITCHGEAR" and "OUC PAD & PAD GROUNDING - THREE PHASE 15KV FOR S C PME-10 SWITCHGEAR" and corresponding notes. Revised note 1 and add note 9 to "TRANSFORMER PAD NOTES". Rearranged details on sheets.
 - CE7.00.11 - Removed sheet references and revised callout and note on detail "TYPICAL ADDITIONAL REINFORCING AT RISER IN PAVMENT".
 - CE7.00.12 - Removed sheet references and centered Drawing Title in title block
 - CE7.00.13 - Revised conduit layout to transformers to align with OUC requirements. Screened back RON duct and electrical room. Added callout for MH-A1-15 and callouts for further clarification. Revised 2W6" to 1W6" for both MH-AC and MH-AD to transformer.
 - CE7.00.15 - Removed callout and MH-A1-16 for relocation. Rearranged Manhole Butterflies for additional MH AC-223 and AD-223 Butterflies.
 - CE7.00.16 - Revised callouts and MH-AP-224 symbol for clarification. Removed duct 20' west of MH-AP-224 and revised conduit layout to transformers to align with GOAA requirements.
 - CE12.01.01 - Updated FDOT Index number is street lightning notes. Included box sizes on symbols legend
 - CE12.01.15 - Changed pull box name from "secondary pull box" to "OUC pull box"
 - CE12.01.16 - Changed pull box name from "secondary pull box" to "OUC pull box"
 - CE12.01.17 - Changed pull box name from "secondary pull box" to "OUC pull box"
 - E0.01.02 - Removed symbols not pertinent to project scope
 - ED2.01.01 - Update existing sign messages and indicate removal of existing signs to be replaced for signs
 - ED2.01.12 - Removal of "Additional Lightning Arrestor" table
 - E2.04.01 - Revised keymap.
 - E2.04.02 - Revised notes 15 and 18 for clarification.
 - E2.04.03 - Revised sheet title, note 1 and callouts for clarification. Updated HIGHMAST LIGHT POLE POINT TABLE with coordinates for pole #11. Updated sheet with High Mast fixture layout results from shadow study. Updated Key Plan.
 - E2.04.05 - Revised sheet title, note 2 and callouts for clarification. Revised conduit size between HM pole # 11 and 12 from "TWO AND ONE HALF INCH" to "THREE

INCH". Updated sheet with High Mast fixture layout results from shadow study. Updated Key Plan.

- E2.04.06 - Updated sheet with results from shadow study.
- E2.04.06A - Marked selected High Mast fixtures from shadow study.
- E2.04.07 - Updated sheet with results from shadow study.
- E2.04.07A - Updated sheet with results from shadow study.
- E2.05.01 - New sheet
- E2.05.04 - New sheet
- E2.05.09A - New sheet
- E2.05.09B - New sheet
- E2.05.09D - New sheet
- E2.05.10 - Revised note 2 and callouts for clarification. Added Jacking Bracket to side high mast pole view to match front pole view.
- E2.05.11 - Updated sheet with results from shadow study. Revised detail "100'PLAN" notes 1 and 2. Removed L-867 E can from detail "70' PLAN". Revised callouts for plan details.
- E2.05.12 - Updated sheet with results from shadow study.
- E2.05.13 - Revised "1 WAY 2" DUCT 1 WAY 3" DUCT 1 WAY 4" DUCT CONCRETE ENCASED HIGH MAST DUCT SECION" detail.
- E2.10.01 - Update proposed sign message for sign T34 and added proposed sign replacement for sign T32
- E2.12.01 - Update proposed sign message for sign T34 and added proposed sign replacement for sign T32
- E2.20.01 - Update proposed sign message for sign T34 and added proposed sign replacement for sign T32
- E2.20.12 - Removal of "Additional Lightning Arrestor" table
- E2.30.01 - Sign updates and fixture numbering revisions
- E2.30.02 - Fixture numbering updates
- E7.00.03 - Removed reference to asphalt, detail is intended for installation in concrete.
- E7.00.07 - Update proposed sign message for sign T34 and added proposed sign replacement for sign T32
- E7.01.15 - Updated box dimension. Indicate 14/3 TC to light fixture. Update pull box name is "OUC PULL BOX"

BID SCHEDULE

					Total Amount Per Item <i>Unit Price Times Est Qty</i>
Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	
AIRFIELD CIVIL, ELECTRICAL AND FUELING WORKS					
C-105-6.1	Mobilization (Not To Exceed 10% of Total Project Cost)				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	1	LS
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____
C-100-13.1	Contractor Quality Control Program (CQCP)				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	1	LS
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____
C-102-5.1	Temporary Air and Water Pollution, Soil Erosion, and Siltation Control				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	1	LS
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____
C-106-4.1	Temporary Fence (without Jersey Barrier)				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	4,310	LF
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____
C-106-4.2	Temporary Fence (with Jersey Barrier)				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	1,850	LF
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____
C-106-4.3	Temporary Swing Gate (30' Total Width)				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	4	EA
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____
C-106-4.4	Miscellaneous Maintenance of Traffic and Safety				
		<i>Dollars</i> _____ <i>Cents</i> _____	\$ _____	1	LS
		<i>Bid Price Per Unit In Words</i> _____	<i>In Numbers</i> _____		\$ _____

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
C-106-4.6	Shallow Foundation Bollard				
		Dollars _____ Cents _____ \$ _____	31	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.1	18-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	420	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.2	24-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	130	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.3	30-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	780	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.4	36-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	390	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.5	42-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	350	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.6	48-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	120	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
D-701-5.7	54-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	600	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.8	60-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	480	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.9	72-inch Reinforced Concrete Pipe				
		Dollars _____ Cents _____ \$ _____	230	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.10	6" PVC SDR 26 Pipe				
		Dollars _____ Cents _____ \$ _____	320	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-701-5.11	10" PVC SDR 26 Pipe				
		Dollars _____ Cents _____ \$ _____	240	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>D-705-5.1</u>	<u>6-inch Smooth High Density Polyethylene (HDPE) Pipe</u>				
		Dollars _____ Cents _____ \$ _____	1,640	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-751-5.1	Manholes				
		Dollars _____ Cents _____ \$ _____	10	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
D-751-5.2	Inlets				
		Dollars _____ Cents _____ \$ _____	23	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-756-6.1	12" Trench Drain				
		Dollars _____ Cents _____ \$ _____	1,030	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
D-756-6.2	18" Trench Drain				
		Dollars _____ Cents _____ \$ _____	550	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-100-5.1	Construction Survey				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>P-101-5.1</u>	<u>Concrete Pavement Removal (variable depth)</u>				
		Dollars _____ Cents _____ \$ _____	870	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>P-151-4.1</u>	<u>Clearing and Grubbing</u>				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>P-151-4.2</u>	<u>BP-S196 Landside Civil Demolition</u>				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
P-152-4.1	Embankment				
		Dollars _____ Cents _____ \$ _____	19,200	CY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-152-4.2	Unsuitable Excavation				
		Dollars _____ Cents _____ \$ _____	5,500	CY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-152-4.3	Subgrade Preparation				
		Dollars _____ Cents _____ \$ _____	171,000	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-211-5.1	6" Lime Rock Base Course				
		Dollars _____ Cents _____ \$ _____	145,320	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-211-5.2	13" Lime Rock Base Course				
		Dollars _____ Cents _____ \$ _____	10,450	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-211-5.3	14" Lime Rock Base Course				
		Dollars _____ Cents _____ \$ _____	7,830	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-211-5.4	24" Lime Rock Base Course				
		Dollars _____ Cents _____ \$ _____	210	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
P-306-8.1	6" Lean Concrete Base Course				
		Dollars _____ Cents _____ \$ _____	144,930	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-403-8.1	Asphalt Mixture Surface Course				
		Dollars _____ Cents _____ \$ _____	4,620	TN	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-501-8.1	18" Aircraft Rated Concrete Pavement				
		Dollars _____ Cents _____ \$ _____	143,760	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-501-8.3	6" Raised Sidewalk Concrete Pavement				
		Dollars _____ Cents _____ \$ _____	210	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-501-8.5	Hurricane Tie-Downs				
		Dollars _____ Cents _____ \$ _____	16	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-602-5.1	Emulsified Asphalt Prime Coat				
		Dollars _____ Cents _____ \$ _____	5,360	GAL	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-603-5.1	Emulsified Asphalt Tack Coat				
		Dollars _____ Cents _____ \$ _____	1,370	GAL	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
P-620-5.1	Markings - Yellow				
		Dollars _____ Cents _____ \$ _____	14,790	SF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-620-5.2	Markings – White				
		Dollars _____ Cents _____ \$ _____	9,790	SF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-620-5.3	Markings - Red				
		Dollars _____ Cents _____ \$ _____	9,790	SF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
P-620-5.4	Markings - Black				
		Dollars _____ Cents _____ \$ _____	35,640	SF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>P-620-5.5</u>	<u>Marking Removal</u>				
		Dollars _____ Cents _____ \$ _____	3,300	SF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
SP-104-6.1	Temporary Power & Temporary Airfield Lighting/Signage/Navigational Facilities				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
SP-105-5.1	Electrical Demolition				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
L-108-5.1	1/C L-824-Type C Unshielded #8 AWG 5 KV Stranded Copper Cable, Installed in Duct or Conduit				
	Dollars _____ Cents _____ \$ _____	40,000	LF	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			
L-108-5.2	1/C #2 AWG Solid Copper Counterpoise Cable, Installed over Duct or Conduit				
	Dollars _____ Cents _____ \$ _____	13,000	LF	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>L-108-5.3</u>	<u>3/4" Diameter by 10.00' Long Copper Clad Steel Sectional Ground Rod</u>				
	Dollars _____ Cents _____ \$ _____	270	EA	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			
L-110-5.1	1 Way 2" Schedule 40 PVC Concrete Encased Duct				
	Dollars _____ Cents _____ \$ _____	8,000	LF	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			
L-110-5.2	8 Way 2" Schedule 40 PVC Concrete Encased Duct				
	Dollars _____ Cents _____ \$ _____	1,200	LF	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>L-110-5.3</u>	<u>2 Way 4" Schedule 40 PVC Concrete Encased Duct</u>				
	Dollars _____ Cents _____ \$ _____	3,150	LF	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>L-110-5.4</u>	<u>4 Way 4" Schedule 40 PVC Concrete Encased Duct</u>				
	Dollars _____ Cents _____ \$ _____	0	LF	\$ _____	
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
L-110-5.5	1 Way 4" Split Duct				
	Dollars _____ Cents _____	\$ _____	200	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-115-5.1	Junction Can Plaza – Eight L-867D Cans				
	Dollars _____ Cents _____	\$ _____	4	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-115-5.2	Aircraft Rated Electrical Manhole Type A-1				
	Dollars _____ Cents _____	\$ _____	9	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-115-5.3	Aircraft Rated Electrical Manhole Type A-2				
	Dollars _____ Cents _____	\$ _____	2	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-115-5.4	Existing Aircraft Rated Electrical Manhole/Handhole/Junction Structure Elevation Adjustment up to and Including 5'x5' Inside Dimension				
	Dollars _____ Cents _____	\$ _____	9	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-125-5.1	L-852C(L) Bidirectional Green LED Taxiway Centerline Light (NE)				
	Dollars _____ Cents _____	\$ _____	22	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-125-5.2	L-852C(L) Bidirectional Green LED Taxiway Centerline Light (N)				
	Dollars _____ Cents _____	\$ _____	24	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
L-125-5.3	L-852D(L) Bidirectional Green LED Taxiway Centerline Light (NE)				
	Dollars _____ Cents _____	\$ _____	47	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-125-5.4	L-852D(L) Bidirectional Green LED Taxiway Centerline Light (N)				
	Dollars _____ Cents _____	\$ _____	47	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-125-5.5	L-852T(L) Omnidirectional, Red, LED In-Pavement, Taxiway Edge Light				
	Dollars _____ Cents _____	\$ _____	4	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>L-125-5.6</u>	<u>L-858(L) Sign – Single/Double Face, LED, Size 3 - 2 Module</u>				
	Dollars _____ Cents _____	\$ _____	<u>1</u>	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>L-125-5.7</u>	<u>L-858(L) Sign – Single/Double Face, LED, Size 3 - 3 Module</u>				
	Dollars _____ Cents _____	\$ _____	<u>6</u>	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-125-5.8	L-858(L) Sign – Single/Double Face, LED, Size 3 - 4 Module				
	Dollars _____ Cents _____	\$ _____	1	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
L-125-5.9	L-861T(L) Omnidirectional, Blue, LED, Taxiway Edge Light (NE)				
	Dollars _____ Cents _____	\$ _____	11	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
L-125-5.10	L-861T(L) Omnidirectional, Blue, LED, Taxiway Edge Light (N)				
	DollarsCents\$In Numbers		19	EA	\$
	Bid Price Per Unit In Words				
L-125-5.11	L-861T(L) Omnidirectional, Blue, LED, Taxiway Edge Light on L-868B Light base				
	DollarsCents\$In Numbers		16	EA	\$
	Bid Price Per Unit In Words				
L-125-5.12	L-868B Light base (N)				
	DollarsCents\$In Numbers		38	EA	\$
	Bid Price Per Unit In Words				
L-125-5.13	Field Lightning Arrestor Assembly				
	DollarsCents\$In Numbers		6	EA	\$
	Bid Price Per Unit In Words				
L-125-5.14	Airfield Lighting Control System Modifications: Vendor				
	Eleven ThousandDollarsZeroCents\$11,000.00		1	ALLOW	\$11,000.00
	Bid Price Per Unit In Words				
L-125-5.15	Airfield Lighting Control System Modifications: Contractor				
	DollarsCents\$In Numbers		1	LS	\$
	Bid Price Per Unit In Words				
L-125-5.16	RFID Fixture Association and Database: Vendor				
	Twenty-One ThousandDollarsZeroCents\$21,000.00		1	ALLOW	\$21,000.00
	Bid Price Per Unit In Words				

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
L-125-5.17	RFID Fixture Association and Database: Contractor				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
T-901-5.1	Seeding				
		Dollars _____ Cents _____ \$ _____	20	AC	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
T-904-5.1	Sodding				
		Dollars _____ Cents _____ \$ _____	18,700	SY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
T-905-5.1	Topsoil (Obtained on Site or Removed from Stockpile)				
		Dollars _____ Cents _____ \$ _____	1,100	CY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
T-905-5.2	Topsoil (Furnished from Off the Site)				
		Dollars _____ Cents _____ \$ _____	13,200	CY	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
13 47 13 -5.1	<u>Cathodic Protection System</u>				
		Dollars _____ Cents _____ \$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
22 37 00-4.1	Water Cabinet				
		Dollars _____ Cents _____ \$ _____	2	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
26 05 12-5.1	1 W 2" Schedule 40 PVC OUC Direct Buried Streetlight Duct				
		Dollars Cents \$	2,840	LF	\$
	Bid Price Per Unit In Words	In Numbers			
26 05 12-5.2	2 W 2" Schedule 40 PVC OUC Concrete Encased Streetlight Duct				
		Dollars Cents \$	120	LF	\$
	Bid Price Per Unit In Words	In Numbers			
26 05 12-5.3	1 W 6" Schedule 40 PVC OUC Concrete Encased Duct				
		Dollars Cents \$	1,500	LF	\$
	Bid Price Per Unit In Words	In Numbers			
26 05 12-5.4	2 W 6" Schedule 40 PVC OUC Concrete Encased Duct				
		Dollars Cents \$	1,500	LF	\$
	Bid Price Per Unit In Words	In Numbers			
26 05 12-5.5	4 W 6" Schedule 40 PVC OUC Concrete Encased Duct				
		Dollars Cents \$	1,500	LF	\$
	Bid Price Per Unit In Words	In Numbers			
26 05 12-5.6	8 W 6" Schedule 40 PVC OUC Concrete Encased Duct				
		Dollars Cents \$	1,700	LF	\$
	Bid Price Per Unit In Words	In Numbers			
26 05 12-5.7	12 W 6" Schedule 40 PVC OUC Concrete Encased Duct				
		Dollars Cents \$	1,300	LF	\$
	Bid Price Per Unit In Words	In Numbers			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
26 05 12-5.8	10' X 20' X 8' OUC Aircraft Rated Manhole - Complete				
		Dollars _____ Cents _____ \$ _____	4	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 05 12-5.9	10' X 20' X 8' OUC Aircraft Rated Manhole Elevation Adjustment, Existing Manhole to New Apron - Complete				
		Dollars _____ Cents _____ \$ _____	1	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 05 12-5.10	OUC LED Street Light Assembly, Inclusive of Fixture, Arm, Pole, Wiring, Pull Box - Complete				
		Dollars _____ Cents _____ \$ _____	16	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 05 12-5.11	OUC Street Service Point – Complete				
		Dollars _____ Cents _____ \$ _____	1	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 05 12-5.12	OUC Transformer Pad – 250 kVA to 3,000 kVA – Complete				
		Dollars _____ Cents _____ \$ _____	8	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 56 30-5.1	High Mast Lighting Pole Assembly 100 ft tall				
		Dollars _____ Cents _____ \$ _____	4	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 56 30-5.2	High Mast Lighting Pole Assembly 70 ft tall				
		Dollars _____ Cents _____ \$ _____	5	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Unit Price Times Est Qty
26 57 00-5.1	South RON Distribution Building – Complete				
	Dollars _____ Cents _____	\$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
26 57 01-5.1	South RON Electrical Distribution System				
	Dollars _____ Cents _____	\$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
33 11 00-5.1	2-Inch PVC SDR17 Pipe				
	Dollars _____ Cents _____	\$ _____	1,500	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
<u>28 43 20-5.1</u>	<u>EFSO System Modifications and Expansion</u>				
	Dollars _____ Cents _____	\$ _____	1	LS	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
34 11 00-5.2	1-Inch Type K Copper Pipe				
	Dollars _____ Cents _____	\$ _____	280	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 45-5.1	14”/18” Double Wall Pipe				
	Dollars _____ Cents _____	\$ _____	1,520	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 45-5.2	12”/16” Double Wall Pipe				
	Dollars _____ Cents _____	\$ _____	1,620	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
32 52 45-5.3	6"/10" Double Wall Pipe				
		Dollars _____ Cents _____ \$ _____	570	LF	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 45-5.4	6"/10" Double Wall Pipe Connections to Existing 12"/16" Double Wall Pipe				
		Dollars _____ Cents _____ \$ _____	10	<u>EA</u>	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 47-5.1	Hydrant Pit Assembly				
		Dollars _____ Cents _____ \$ _____	16	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 47-5.2	Hight Point Vent Pit Assembly				
		Dollars _____ Cents _____ \$ _____	2	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 47-5.3	Low Point Drain Pit Assembly				
		Dollars _____ Cents _____ \$ _____	7	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 47-5.4	Block Valve Pits				
		Dollars _____ Cents _____ \$ _____	3	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			
32 52 47-5.5	Modifications to Existing Block Valve Pit				
		Dollars _____ Cents _____ \$ _____	1	EA	\$ _____
	Bid Price Per Unit In Words _____	In Numbers _____			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
32 52 53-5.1	Fuel System Testing				
	Dollars Cents \$	1	LS	\$	
	Bid Price Per Unit In Words	In Numbers			
32 52 53-5.2	Fuel System Flushing and Pigging				
	Dollars Cents \$	1	LS	\$	
	Bid Price Per Unit In Words	In Numbers			
32 52 53-5.3	Fuel System Performance Testing				
	Dollars Cents \$	1	LS	\$	
	Bid Price Per Unit In Words	In Numbers			
SUB-TOTAL OF ALL AIRFIELD BID ITEMS					
	Dollars Cents \$				
Subtotal of all Bid items for MCO Term C BP-S196 (Written in Words)					
Owner's Allowance					
	Two Hundred Fifty Thousand	Dollars Zero Cents \$	250,000.00	1	ALLOW \$ 250,000.00
	Bid Price Per Unit In Words	In Numbers			

Bid Item Number	Item Description and Bid Price Per Unit (In Words)	Bid Price Per Unit (In Numbers)	Est Qty	Unit	Total Amount Per Item Unit Price Times Est Qty
TOTAL BID AMOUNT MCO STC TERM C BP-S196 (Written in Words)					

Total Bid Amount in Words Dollars Cents \$ In Numbers

NOTE:

Basis of payment will be in accordance with the technical specifications applicable to each Bid Item Number.

Name of Bidder:

(Typed or Printed)

Signature of Bidder:

(Same as Bid Form)

Title:

Date:

PROJECT MANUAL
INCLUDING CONSTRUCTION SPECIFICATIONS

for

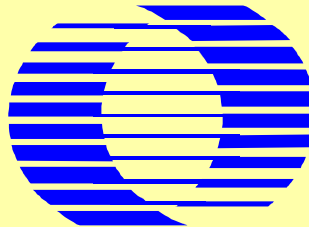
**BP-S196, TERM C, PH 1X - AIRFIELD CIVIL,
APRON & TAXIWAY PAVING**

ORLANDO INTERNATIONAL AIRPORT

**VOLUME 2 OF 2
(Divisions 13-33)
(C-100 – T-905)**

Orlando, Florida 32827

Issue Date
June 26, 2022



GREATER ORLANDO AVIATION AUTHORITY

Documents Prepared and Submitted by:

HNTB Corporation
11346 Terminal C Service Road
Phone: 407-825-1594

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

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* Represents Airfield Civil Specifications (MCO STC TERM C BP S196) included in the Airside Concourse Construction Package (MCO STC TERM C BP S195)

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SECTION 13 47 13 - CATHODIC PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. This Section covers the requirements for designing, furnishing, installing, and testing a complete cathodic protection system for underground fuel system piping.
- B. It is the intent of these Technical Specifications that the Contractor engages the services of a Cathodic Protection Specialist to prepare the design and direct the installation of the cathodic protection system.

1.3 SCOPE

- A. The Contractor shall furnish all labor, equipment and materials to design and provide a sacrificial anode cathodic protection system to protect all underground fuel piping installed under this Contract from corrosion. This shall include, but not necessarily be limited to, furnishing and installing all anodes, anode test stations, reference electrodes, wire and incidental items, and performing check out testing and providing written reports. The Contractor shall submit signed and sealed engineering drawings and detailed engineering specifications for the proposed system prepared by the CP Specialist.
- B. The Contractor shall engage the services of a corrosion specialist, certified by NACE International, subject to approval by the Owner's Authorized Representative, to design the cathodic protection system and supervise the installation and testing of the specified cathodic protection system in connection with the jet fuel piping system installed under this Contract and as specified and shown on the Plans. The CP Specialist shall have at least 10 years of applicable experience
- C. The Contractor shall be responsible for the design, installation, performance testing and certification of all the cathodic protection work performed under this Contract.
- D. Cathodic protection shall be provided by means of a sufficient number and size of connected sacrificial magnesium anodes to provide a not less than 30 year protection period before external corrosion may begin to occur.

1.4 APPLICABLE CODES AND STANDARDS

- A. The work shall be performed in accordance with the latest requirements of laws and codes governing this work, including but not limited to:
 - 1. National, State and Local Laws, Regulations and Codes.
 - 2. National Electrical Code (NEC).
 - 3. U.S. Department of Transportation Regulations for the transportation of liquids

by pipeline: Parts 180 and 195, Title 49 of the Code of Federal Regulations (DOT).

4. NACE International - NACE Standard RP0169-96, Recommended Practice - Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
5. National Electric Safety Code.

1.5 CATHODIC PROTECTION SYSTEM SPECIALIST QUALIFICATIONS

- A. The Cathodic Protection System Specialist shall be employed by a firm regularly involved in corrosion control work on aircraft fueling systems on a full-time basis for a period of at least ten (10) years, and shall submit to the Owner's Authorized Representative, before commencement of the work, the names and addresses of at least five (5) clients for whom he has satisfactorily performed cathodic protection services of a nature similar to the work proposed to be performed under this Contract.
- B. That portion of the work, which involves the installation of the cathodic protection system and the testing thereof, shall be performed under the direct supervision of the certified CP Specialist.
- C. An approved Cathodic Protection Specialist for this project is: Craig Meier, Corrosion Control Incorporated, 494 Fairplay Street, Rutledge, Georgia 30663, Phone 706-557-9624.

1.6 ACTION SUBMITTALS

- A. Installer's Qualifications: Verification of the cathodic protection installer's work experience and certification of the CP Specialist shall be submitted in writing to the Owner's Authorized Representative for approval prior to commencement of the work.
- B. The Contractor shall submit ten (10) copies each of design calculations, shop drawings, material list, and catalog cuts covering the following material:
 1. Chemical composition of anodes and lead wire material,
 2. Anode weight and total weight of anode package including backfill material.
 3. Reference electrode and lead wire material.
 4. Welding, coating and priming materials.
 5. Test station, shunt size and lead wire material.
 6. Electrical Isolation materials.
- C. After the installation is completed, the cathodic protection system shall be inspected and tested by the certified CP Specialist provided by and at the expense of the Contractor. Tests shall be performed by taking pipe-to-soil potentials and anode current outputs at each test station. Any deficiencies in the performance of the system revealed by the testing shall be corrected and retested until the system is performing as required herein. At the completion of

the testing, the Contractor shall provide certification(s) issued by the CP Specialist certifying that the system is capable of performing to the full extent meeting the requirements of these Specifications. The Contractor shall submit to the Owner's Authorized Representative six (6) certified copies of the final report, including all data and analysis provided by the CP Specialist, and "As-built" drawings of the installation. Such submittal shall show the accurate location of each test station and anode, pipe-to-soil potentials, anode output currents, and calculated anode service life.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall be the latest design, in new condition and the first quality standard product of manufacturers regularly engaged in the production of such materials. All materials shall be compatible and, where possible, be the product of one manufacturer.

2.2 ANODES

- A. Anodes shall be prepackaged magnesium high current output type, Maxmag or approved equal, each containing 20 pounds of galvanic (sacrificial) anode and having the following chemical composition:

Aluminum	0.003% Maximum
Manganese	0.8% Maximum
Zinc	0.002% Maximum
Silicon	0.002% Maximum
Copper	0.001 Maximum
Nickel	0.001% Maximum
Iron	0.025% Maximum
Other Impurities	0.005% Maximum
Magnesium	Remainder

- B. All galvanic anodes shall measure 2.75" x 3" (nominal size) and shall be cast with a perforated galvanized steel core. The weight of the core shall not exceed 0.10 pound per foot. One end of the anode shall be recessed so that one end of the strap is accessible for lead wire connection.
- C. The anode lead wire shall be thirty (30) feet minimum in length and shall be No. 10 AWG 7 strand copper wire with Type THWN insulation, red in color. The lead wire shall be connected to the core with silver solder. The connection shall be mechanically secured before soldering and shall have at least one and one-half turns of wire at the connection. The entire connection shall be insulated to a 600 volt rating

by filling the anode recess with an electrical sealing compound.

- D. The galvanic anodes shall be packaged in a permeable cloth bag 5.5 inches diameter by 66 inches long, with inert backfill material, containing not less than a 50-pound mixture of:

Ground Hydrated Gypsum	75%
Powdered Wyoming Bentonite	20%
Anhydrous Sodium Sulphate	5%

- E. Backfill shall have a grain size such that 100% is capable of passing through 20 mesh screen and 50% through a 100-mesh screen. The mixture shall be firmly packaged around the magnesium anode within the cloth bag by means of adequate vibration so that the magnesium anode is completely surrounded with a minimum $\frac{1}{2}$ inch of backfill material. The combined weight of the anode including backfill and sacrificial galvanic anode materials shall be not less than 70 pounds.

2.3 ANODE TEST STATIONS AND REFERENCE ELECTRODES

- A. Anode test stations shall have a cast iron head capable of withstanding a minimum average load of 250 P.S.I., 8 inches in diameter, stamped yellow with "CP-Test" with a 6 inch O.D. by 24 inches long, non-metallic conduit, Model 668 with locking lid, as manufactured by C.P. Test Services, Inc. or approved equal. All anode test stations shall provide 7 terminals with stainless steel hardware.
- B. A shunting bar shall be furnished for each test station and shall be 0.1 ohms.
- C. Each anode test station shall be provided with a 1.5-inch diameter brass tag. This tag shall have the test station number and associated structure stamped into the metal. Attach tag to anode lead wire inside test station.
- D. Copper to copper sulfate reference electrodes shall be of the permanent type designed for a 30-year life and an accuracy of ± 5 MV and shall be Model UL-CUG-SW as manufactured by Electrochemical Devices, Inc., or approved equal. It shall be packaged in a cloth bag containing special low resistivity backfill.
- E. The lead wire shall be 50 foot long; No. 14 AWG stranded copper wire with HMWPE (High Molecular Weight Polyethylene) insulation, black in color.
- F. All lead wire connections to the anode test station terminal block shall be made using appropriately sized, tinned solid copper, ring tongue, solder less crimp-type connectors, Burndy "HYLUG" type YAV, or approved equal.
- G. Lead wire connections from the anode test station terminal block to the pipelines shall be No. 10 AWG 19 strand copper wire with RHW-USE insulation, black in color.

PART 3 - EXECUTION

3.1 ANODES

- A. Anodes shall be installed as and where shown on the Plans.
- B. The cathodic protection system shall be installed prior to placing any fuel through the pipeline and the protective coating shall be repaired prior to testing the pipe as specified in SECTION 33 52 46.
- C. The Contractor shall install the anodes in a vertical position as shown on the Shop Drawings. The anode shall, unless otherwise shown on the Plans, be located below the pipe at a distance between the top of the anode and the bottom of the pipe of not less than 3 feet.
- D. Excavate hole to minimum 2 inches larger than the packaged anode diameter, to the depth indicated.
- E. Anode lead wire shall be installed in a trench; the lead wire shall be installed at a depth of not less than 24 inches. The trench bottom shall be smooth. Excavation and backfilling shall be as specified elsewhere in the Technical Specifications.
- F. The Contractor shall not lift or support the anode by the lead wire. Exercise care to prevent damage to cloth bag or lead wire insulation.
- G. Center the packaged anode in the hole and backfill with clean native natural sand soil materials in layers not exceeding 6 inches deep. Carefully tamp each layer to properly compact the backfill. When the backfill is level with the top of the anode, pour not less than five (5) gallons of water into the hole. The backfill material shall be completely saturated. Add additional backfilling material as necessary to compensate for soil shrinkage.
- H. The Contractor shall connect the structure test lead wire to the pipe on the topside after the pipe has been cleaned to bare metal by scraping, filing or other approved means. Connection of lead wires to underground pipe shall be made using a thermite brazing method applied in strict accordance with the manufacturer's published instructions and recommended procedures, and as shown on the Plans. Thermite brazing shall be accomplished using Cadweld CA-15 cartridges or approved equal. The connection area shall be primed with Royston No. 747 primer and covered with a Royston "Handy Cap", installed in accordance with the manufacturer's written instructions, and as shown on the Plans. Any damaged pipe coating, including its outer wrapping, shall be repaired as specified in SECTION 33 52 46.
- I. Place a 3-inch layer of select bedding material around lead wire in the trench. This select bedding material shall be clean native natural sand soil material obtained from the trench excavation in the immediate area only and shall be 100% passing No. 16 ASTM sieve. Carefully center lead wire in trench. Backfill over the wire, using select backfill material, shall be placed in layers not exceeding six inches deep and each layer thoroughly compacted. Tree roots, wood scrap, organic matter and refuse shall not be allowed in the backfill. Exercise care to avoid damaging the lead wire or its connections.

3.2 ANODE TEST STATIONS AND REFERENCE ELECTRODES

- A. Anode test stations shall be installed as and where shown on the Shop Drawings, complete with prepackaged copper-to-copper sulfate permanent reference electrode and anode.
- B. All permanent reference electrodes shall be installed horizontally in native soil, 6 inches below the bottom of the pipe and a minimum of 20 feet to the closest anode. The reference electrodes shall be backfilled with clean native natural sand soil material in layers not exceeding 6 inches deep. Backfill material shall be obtained from the trench excavation in the immediate area only and shall be 100% passing No. 16 ASTM sieve. Carefully tamp each layer to properly compact the backfill. When the backfill is level with the top of the reference electrode, pour not less than five gallons of water into the hole. The backfill material shall be completely saturated. Add additional backfill material as necessary to compensate for soil shrinkage.
- C. The Contractor shall install anode test stations in pavement or in concrete pads, as shown on the Plans.
- D. Lead wire connections from the anode test station terminal block to the pipelines shall be as described under paragraph 3.1H above.
- E. Lead wire connections from the pipelines to the anode test station terminal block shall be shown on the Plans.
- F. Lead wire connectors as described under paragraph 2.3F above, shall be installed using the proper crimping tools and in strict accordance with the manufacturer's instructions.

3.3 ENERGIZING AND TESTING

- A. The Contractor shall notify the Owner's Authorized Representative at least one week in advance of the test to permit arrangements for the presence of the Owner's Authorized Representative and/or airline representatives to witness such tests.
- B. After installation of the cathodic protection system the entire system shall be tested by the CP Specialist, in accordance with the recommended procedures of NACE International, to assure its proper operation.
- C. Testing shall include a determination of proper operation of anodes at all test stations and adequacy of test stations and insulating joints. Testing shall also include measurement of galvanic anode current output, measurement of pipe-to-soil potential and all tests deemed necessary to verify proper operation of the cathodic protection system.
- D. Upon completion of the tests, the CP Specialist shall submit six (6) copies of the detailed report to the Owner's Authorized Representative recording and describing test results and deficiencies detected. Any and all deficiencies shall be corrected by and at the expense of the Contractor and retested prior to final acceptance.

3.4 TESTING OF INSULATED FLANGES AND JOINTS

- A. Each insulating flange and joint assembly shall be tested with an approved isolation checker.

- B. Each insulating flange assembly shall be field tested after installation.

3.5 ISOLATION OF CONDUITS AND OTHER POTENTIAL LOCATIONS FOR SHORTS

- A. Provide isolation of conduits and other metallic components to remove any possible path of shorting the cathodic protection system to ground.

3.6 ISSUE A COMPLIANCE REPORT

- A. The report must include all test data, confirmation that all test points meet NACE criteria, calculated anode life and as-built drawings.

PART 4 - - METHOD OF MEASUREMENTMETHOD OF MEASUREMENT

Method of measurement for work in this section shall be a lump sum for all work completed and accepted, including design, procurement, installation, testing and commissioning of the Cathodic Protection System.

PART 5 - BASIS OF PAYMENTBASIS OF PAYMENT

Payment for the Cathodic Protection System design, procurement, installation, testing and commissioning shall be made at the contract unit price for the bid item.

Bid Item 13 47 13 -5.1	Cathodic Protection System	per Lump Sum

END OF SECTION 13 47 13

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SECTION 22 37 00 – POTABLE WATER CABINET

PART 1 – GENERAL

1.1 GENERAL DESCRIPTION

- A. This section of the specifications covers the following components:
 - 1. Potable Water Cabinet

1.2 REFERENCES

- A. Applicable Standards:
 - 1. National Fire Protection Association (NFPA):
 - 2. National Electrical Manufacturer's Association (NEMA).
 - 3. Occupational Safety and Health Act (OSHA).
 - 4. Underwriters Laboratories (UL).
 - 5. Florida Building Code (FBC).

1.3 SUBMITTALS

- A. See section 01 3323 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

1.4 QUALITY ASSURANCE

- A. NFPA Compliance.
- B. NEMA Compliance.
- C. UL Compliance: All internal components shall be UL-listed and labeled.
- D. Comply with all applicable Local Building Codes.

PART 2 - PRODUCTS

2.1. CABINET

- A. Manufacturer: Semler Industries, Inc. Model SI-1500 or approved equal.
- B. Material: Stainless steel, Type 304, 16-gauge, #4 finish interior and exterior.
- C. Construction: Welded double wall construction throughout, including bottom and doors with 1" polystyrene insulation. Welded and ground joints, rounded corners, brushed and polished interior and exterior. Cabinet to be provided with:
 - 1. 1-1/2" NPS fitting for drain (located at the bottom center of cabinet)
 - 2. Penetration for 1" water connection (located at back wall of cabinet)
 - 3. Penetration for 1" electrical connection (located at back wall of cabinet)No support braces or equipment to be mounted on bottom of cabinet to impede drainage or cabinet cleaning.

2.2. DOORS

- A. Material: Stainless steel, Type 304, 16-gauge, #4 finish interior and exterior.
- B. Construction: Double wall construction, welded and ground joints, rounded corners, polished interior and exterior with 1" insulation between inside and outside walls.

Two-point door latch with stainless steel recessed locking D-ring handle and full-length stainless-steel piano hinge with top mounted stainless steel door holder/closer.

2.3. MOUNTING

- A. Shall be mounted on the Passenger Boarding Bridge wheel bogie or on the concrete pavement at the locations shown on the plans, per manufacturers recommendations.

2.4. ELECTRICAL

All components mounted within the cabinet shall be UL listed or recognized, weatherproof, suitable for service at 120 volts.

- A. Light: 100-watt equivalent LED fixture, weatherproof-vapor proof, with guard and on-off switch.
- B. Heaters: None
- C. 15 A. 120 VAC GFCI duplex service outlet with waterproof cover.
- D. All wiring enclosed in flexible "Sealtite" conduit or rigid galvanized conduit. Provide one (1) 115 Volt, 1 Phase, 15-amp circuit for each cabinet.
- E. Hose Reel: Hannay Model RXX60-0046-D or approved equal, 1" bronze swing joint, bronze internal piping, aluminum drum, stainless steel disks and poly-coated frame. Reel includes ½ HP 115-volt, explosion-proof electric rewind motor with horsepower rated momentary contact control switch. Auxiliary hand rewind crank to be provided. Adjustable reel drag brake. Reel mounted to back wall of cabinet. Reel capacity ¾" x 300'.
- F. Potable Water Cabinet shall be NRTL listed and marked as required by federal regulations.
- G. Circuits to be provided at face of building by others. Materials, devices and equipment for electrical connection of Potable Water Cabinet shall meet Florida Building Code and U.L. requirements.

2.5. PIPING COMPONENTS

- A. Nozzle: Semler model #PWC-1-MNZ or approved equal, long barrel coupler with plug/drag cushion, stainless steel nylon coated security cable, control valve and protective bumpers.
- B. Shut-off Valve: 1" bronze ball valve with Teflon seat and stainless-steel ball.
- C. Pressure Regulator: Conbraco, 1" bronze adjustable 25-75 PSI or approved equal.
- D. Pressure Gauge: 2-1/2" 0-100 PSI bronze internals and brass case.
- E. Pipe Fittings: Bronze, threaded ANSI B16.15.
- F. Integrated Backflow Preventer.
- G. Piping: 1" schedule 40 Brass ASTM Specification B43-91.
- H. Connector: 1" x 8" 304 stainless steel flexible connector to relieve piping stress on hose reel swivel joint.
- I. Hose: ¾" x 300' drinking water hose Model 075-3150 with FDA-CFR title #2 parts #170-199 or approved equal.

- J. Water connection shall be the equivalent nominal pipe size copper tubing as provided water service connection point.

PART 3 - METHOD OF MEASUREMENT

3.1. METHOD OF MEASUREMENT

- A. The quantity of Water Cabinets will be measured by the completed in place and accepted unit per each.

PART 4 - BASIS OF PAYMENT

4.1. BASIS OF PAYMENT

- A. Water Cabinets will be paid for at the contract unit price for each water cabinet installed and accepted. This payment shall be inclusive of all materials, appurtenances, labor, equipment, tools, and incidentals necessary to complete the item.
- B. Payment will be made under:
Item 22 37 00 – 4.1 Water Cabinet – Each

END OF SECTION 22 37 00

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SECTION 26 01 00 - OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.
- B. General: Refer to Section 01 78 00, Closeout Submittals for requirements related to the preparation and contents of Operation and Maintenance manuals/CDs.

1.2 OPERATION AND MAINTENANCE MANUALS

- A. The various specification sections of Division 26 contain specific information to be included in the O&M manuals/CDs in addition to the general requirements outlined in Section 01 78 00.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 01 00 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 01 00. The work described in Specification 26 01 00 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 01 00

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SECTION 26 01 01 – GENERAL PROVISIONS AND REQUIREMENTS FOR ELECTRICAL
WORK

PART 1 – GENERAL

1.1 SPECIAL REQUIREMENTS FOR ELECTRICAL WORK

- A. This item shall apply to all electrical work contained within the Contract Documents. Where the contract general conditions, special provisions or other parts of the Contract Documents also apply, the stricter of the documents shall govern.

1.2 AUXILIARIES AND ACCESSORIES

- A. Include all auxiliaries and accessories for a complete, fully functional and properly operating system in accordance with the Contract Documents.
- B. Provide and install all electrical systems and any necessary appurtenances as per National Electrical Code (NEC), federal, state and local codes whether specified or shown in the Contract Documents or not. The content of the Contract Documents in general only refers to work required above and beyond the requirements of the NEC and applicable federal, state and local codes.

1.3 PROJECT PAY ITEMS

- A. The project pay items are provided to be inclusive of all work to be performed as shown in the Contract Documents. All work not identified with a specific pay item shall be considered required work to complete the project and shall be considered subsidiary to the cost of the project pay items provided.

1.4 CONTRACTOR EXPERIENCE

- A. All Contractors used to perform work of this contract shall be licensed to perform electrical work in the state in which the project is located at the time bids are submitted. At least one member of the electrical contracting firm shall hold a state certified electrical contractor's license.

1.5 EXPERIENCE AND SUPERVISION OF CONTRACTOR PERSONNEL

- A. Provide a resident on-site supervisor to manage work at the job site whenever electrical work is being performed or affected. Electrical work is defined as any work described, included, depicted or contained within the Construction Specifications Institute (CSI) Division 26 specifications, E- series drawings and all other work within the Contract Documents dealing with the distribution of electrical power/light, communication and control.

- B. When work is being performed within the Aircraft Operations Area the on-site supervisor shall also be within the Aircraft Operations Area, except for incidental absences. Incidental absences shall not exceed 45 minutes in length. The Contractor is encouraged to keep the same on-site supervisor(s) from commencement to completion of work.
- C. Each on-site supervisor shall have a minimum of 5 years of successful experience either constructing or maintaining airfield lighting systems. At least 3 of these years of experience shall have occurred in the last 5 years on projects of comparable size and complexity. On-site supervisor shall have passed a proctored H.H. Block Journeyman Electrician's exam with 75% grade or better and be a licensed Journeyman Electrician, by the City in which the project is located. Equivalent experience and training may be considered by the Engineer. Records of on-site supervisor's experience demonstrating compliance with these requirements shall be submitted to the Engineer for verification and review before starting work. Experience records shall include references (personnel and phone number) from airports where the electrical system installations have performed in a satisfactory manner. Only on-site supervisors whose experience records have been confirmed by the Engineer shall supervise work.
- D. If at any time the Engineer believes that work is being performed without the presence of an on-site supervisor the Engineer will request that the workman in question demonstrate that the on-site supervisor is present. If the on-site supervisor's presence cannot be verified within 45 minutes the Engineer may direct the Contractor to suspend work until proper supervision is made available. The Contractor shall not be remunerated for costs associated with suspension of work under these conditions.
- E. It is agreed and understood that, if requested in writing by the Engineer, the Contractor shall replace any on-site supervisor with another meeting the required qualifications within seven (7) days of receipt of request.
- F. Electrical workman performing work shall have a Journeyman license and shall be a "Qualified Person" as defined in NFPA 70E. A copy of each Journeyman's license shall be submitted to the Engineer. Electricians installing raceways and fittings; pulling, splicing and terminating wire/cable; installing light bases, light fixtures; connecting signs; performing electrical testing or other work contained in the documents described in 1.5(A) above shall be Journeyman with a minimum record of 6000 hours of experience. An apprentice/helper/laborer may assist the Journeyman with the above tasks as directed by the on-site supervisor. A licensed Journeyman may supervise a maximum of three apprentices/helpers/laborers. At the request of the Engineer the Contractor shall submit the experience record of any electrician. Any workman who does not have the required experience or who demonstrates a lack of knowledge appropriate for the task they are performing shall be dismissed from the project for remainder of the contract.

PART 2 – SUMMARY OF WORK

2.1 GENERAL

- A. In support of this project this contract includes installation of street lighting and other electrical work as shown in the Contract Documents. The above is not intended to be all inclusive, but is provided as an aid to the Contractor. It is the intent of the Contract Documents that the Contractor is to furnish and install all materials and provide the necessary supervision, transportation, preparation, assembly, survey and installation of these materials, and for all labor, equipment, tools, incidentals, and appurtenances necessary to provide a fully functional and operational system as described by these Contract Documents. All items are new and unused unless specifically noted otherwise.

2.2 RECORD DOCUMENTS

- A. The Contractor shall maintain the Contract Documents, Shop Drawings and samples at the site, in good order and annotated daily to show all changes made during the construction process. These shall be available to the Engineer for examination.

2.3 ENGINEERING OBSERVATIONS

- A. Items noted by Engineer during construction and before final acceptance, which does not comply with the Contract, will be listed in accordance with the general conditions. These items will be sent to the Contractor for action. The Contractor shall have these items corrected.
- B. The Contractor shall check items noted after acceptance during the warranty/guarantee period in the same manner as above.

2.4 EXISTING CONDITIONS

- A. Investigate site thoroughly and reroute all conduit/duct and wiring in area of new construction in order to maintain continuity of existing circuitry. Existing conduit/duct shown in the Contract Documents show approximate locations only. Contractor must verify and coordinate existing site conduit/ducts, wiring and piping. The bids shall include hand digging and all required rerouting in areas of existing conduit/ducts and/or pipes.
- B. Check site and existing conditions thoroughly before bidding. Advise Engineer of discrepancies or questions noted. If any difference is discovered between the existing conditions and the Contract Documents, the Engineer shall be notified in writing immediately.
- C. The Electrical Contractor shall investigate all existing systems within the construction limits and complete the performance verification prior to the beginning of any work, which could affect these existing systems.

- D. Advise Engineer in writing of all deficiencies in existing system(s) prior to work. All systems will be assumed to be fully operational if written notification is not received by Engineer prior to work on system.
- E. The work involved is in connection with existing systems/facilities, which must remain in operation while work is being performed. Work must be done in accordance with the schedule specified in the Contract Documents. Schedule all work to minimize the period when systems are inoperable. Request written permission and receive written approval from Engineer a minimum of 2 weeks in advance of any shutdown of existing systems. (FAA requires 45 days minimum notice.) Perform work required at other than standard working hours where outages cannot be accepted during regular working hours. Protect existing buildings and equipment during construction as required.
- F. There may be piping, fixtures or other items, which must be removed or relocated in order to perform the alteration work. All conduit/duct, wiring, boxes, etc. that do not comply with the Contract Documents shall be removed or corrected to comply with the Contract Documents. All unused conduit/duct not removed shall be identified and a pull line shall be installed. Bid shall include all removal and relocation required for completion of the alterations and the new construction.
- G. Special attention is directed to relocation of the existing power conduits and duct bank and communication systems. Cable counts, location, and function must be field verified before starting work.
- H. The Contractor shall verify the areas, conditions, and features necessary to tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities. This requirement assumes that existing items comply with current codes and standards.

2.5 SYSTEMS WARRANTY

- A. The work required under this division shall include a one (1) year warranty from the date of final acceptance unless required otherwise by the Contract Documents. This warranty shall be by the Contractor/Manufacturer to the Owner for any defective workmanship or material, which has been furnished under this contract. The Contractor/Manufacturer at no cost to the Owner shall perform replacement of defective workmanship or material for a period of one (1) year from the date of final acceptance of the system. This warranty shall not include light bulbs in service after one (1) month from date of substantial completion of the system. Explain the provisions of the warranty to the Owner during project close out.

2.6 SUBSTANTIAL COMPLETION

- A. All specified work shall be complete prior to final observation of work, and all forms and other information requested, including Operation and Maintenance Manuals, shall be submitted to the Engineer for approval one (1) week before the request for substantial completion of the work.

2.7 CONTRACTORS RESPONSIBILITIES

- A. Provide necessary layout, labor, material, equipment, tools, transportation, full time supervision and services required for the satisfactory and timely completion of the work in accordance with the Contract Documents.
- B. Unload, store, protect and re-handle the materials required for this Contract until such time that material is in place. Provide protection of materials required of this contract after installation.
- C. Provide all required transportation, erection, maintenance, dismantling and removal of temporary facilities and equipment required by this contract.
- D. Provide all transportation, unloading, distribution, hoisting, rigging, material handling and scaffolding required installing the work of this contract.
- E. Provide all engineering and layout required to perform the work from established base lines and benchmarks.
- F. Provide temporary electrical power and temporary water and sanitary sewer for this Contractor's field office, if required. Pay all utility company charges. Provide temporary power required for this Contractor's work.
- G. Prior to start of his work this Contractor is to inspect work performed by others on which this work is to be placed on or adjacent to, and report in writing to the Engineer, any condition found to be unacceptable. Failure to make said report shall constitute acceptance of the conditions found and any claims made thereafter due the unacceptable conditions will not be considered by the Engineer.
- H. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this work. Work required under other items of the Contract Documents to be performed by Specification 26 05 12 shall be coordinated with the respective Contractor, and such work performed at no additional cost to the Owner including but not limited to electrical work in support of other trades as shown in the Contract Documents.
- I. It is the responsibility of the Contractor to coordinate the exact required location of any electrical or electronic equipment, system, or cabinets to be installed or relocated. No existing equipment may be relocated without prior coordination and with approval of the Engineer.

- J. Provide and pay for all permits, licenses, fees and inspections required for the performance of the work. The Contractor shall pay all sales, consumer, use and other taxes required in accordance with the law of the place of the project.
- K. Provide all tests as required, per the Contract Documents and submit all test reports to the Engineer.
- L. Provide all excavation, backfill, compaction, shoring and dewatering required for performance of the work.
- M. Provide sleeves for all conduit/duct required as specified.
- N. Protect all work of this Contract from damage and intrusion of dirt and foreign objects. Close off open ends of conduit/duct and sleeves on work, which is to be completed at a later date. Remove closure material prior to continuance of work.
- O. Prior to Final Inspection, submit to the Engineer, all Record Drawings and Operation and Maintenance Manuals as specified. Instruct Owner's maintenance personnel in the operation and maintenance of the systems as required by the Contract Documents. Hands on training" will be required prior of final inspection and 6 months follow up after the system has been accepted.
- P. The above is not all inclusive of the work described by the Contract Documents, which form the basis for this Contract, but is presented for the Contractor's convenience.

2.8 EXISTING UTILITIES

- A. The Contractor is solely responsible for the location of all existing utilities within the project limits.
- B. The Contractor is solely responsible for the protection of all existing utilities within the project limits. All manholes, hand holes, light bases, conduits and ducts shall be kept tightly closed and sealed during all phases of construction. The items may be opened in support of the work but shall be resealed or closed or covered immediately upon completion of the specific task that required them to be opened.

PART 3 – BASIC MATERIAL & METHODS

3.1 REQUIREMENTS OF BASIC MATERIALS AND METHODS

- A. The work shall include the furnishing of the systems, equipment and material specified in this Division and as called for in the Contract Documents, to include: supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation. Provide the necessary inter-trade/Contractor coordination for the installation to be in a neat and work person like manner.

Drawings for the work are diagrammatic, intended to convey the Scope of the Work and to indicate the general arrangement and locations of the work. The drawings shall not be scaled for exact sizes or locations. Because of the scale of the drawings, certain basic items such as: conduit/duct fittings, access panels, sleeves, pull and junction boxes may not be shown. Where such items are required by Code or by other items or where they are required for proper installation of the work, such items shall be included. Coordinate final equipment locations with governing architectural, civil and structural drawings as applicable. Layout equipment before installation so that all trades may install equipment in the space available. Provide and submit a 1/4" scale drawing with the proposed location of the electrical equipment and or conduit routing.

- B. Equipment Specifications may not deal with minute items such as components, parts, controls and devices, which may be required to produce the equipment performance specified, or as required to meet the equipment warranties. Where such items are required, the Contractor/Supplier of the equipment shall include them, whether or not specifically called for.
- C. Conduit/duct routed through the building/structure that interferes with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit/duct, and fixtures shall fit into available spaces in the building/structure; do not introduce these into the building/structure at such times or in such manner as to cause damage to the structure. Equipment that requires servicing shall be readily accessible.
- D. Locate all openings required for work performed under this item. Provide sleeves, guards or other acceptable methods to allow passage of items installed under this item.
- E. Keep cutting and patching to a minimum. Insofar as possible, determine in advance the proper chase size and openings necessary for the work.
- F. Where cutting and patching are required due to an error of the Contractor, or where the Contractor has not given enough advance notice of the need for holes, recesses, and chases, patching shall be performed by those trades skilled in the use of the materials involved and shall be done at the Contractor's expense.
- G. Any cutting of work in place shall be patched and decorated by such mechanics and in such a manner that the quality of workmanship and finish shall be compatible with that of adjacent construction.
- H. The location of electrical work is indicated on the drawings. The Engineer may adjust exact locations of new work as work progresses. Before any item is installed, the indicated location may be changed by twenty five (25) feet in any direction without additional cost.
- I. All materials utilized shall be suitable for the environment encountered. No combination of materials shall be used that forms an electrolytic coupling of such nature that in the presence of moisture corrosion is accelerated.
- J. Where the requirements of another division, item, or part of these Contract

Documents exceed the requirements of this division, those requirements shall govern.

- K. Provide supports, braces, and anchor bolts as necessary for all work called for under the Contract Documents.
- L. All galvanized materials shall be hot-dip galvanized after fabrication, conforming to ASTM A-386 and/or A-153, unless noted otherwise (UNO).
- M. All bolted connections and equipment mountings shall utilize two flat washers, lock washer and hex head bolting hardware, unless noted otherwise.
- N. Unless noted otherwise, all wire sizes are based on a 90 Deg. C., THWN-2, 600 volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600 volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.
- O. Use Ideal NOALOX antioxidant compound or accepted equivalent on all aluminum to aluminum mechanical or electrical connections. Use Thomas and Betts KOPR-SHIELD or accepted equivalent on all rigid galvanized steel conduit connections and all copper grounding connections using mechanical lugs. Use an approved anti-seize compound on all bolted connections.

3.2 ELECTRICAL REFERENCE SYMBOLS

- A. Symbols used in the Contract Documents are defined in the Electrical Legend. Not necessarily will all symbols defined be applicable to the project.

3.3 ACTIVE SERVICES

- A. Existing active services; water, gas, sewer, electric, communication, jet fuel, etc. when encountered, shall be protected against damage. Do not prevent or disturb operation of active services, which are to remain. If active services are encountered which require relocation, make request to Authorities Having Jurisdiction (AHJ) for determination of procedures. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the AHJ, Utility or Municipality having jurisdiction.

3.4 CODES AND FEES

- A. Install in accordance with latest edition of the National Electrical Code and the regulations of governing Federal, State, County, local and other applicable codes, including the Utility Companies. Where a conflict in code requirements occurs the most stringent requirement shall govern. The Contractor shall be responsible to obtain and pay for all required licenses, fees and inspections including meter installation fee. The cost for such shall be included in the bid price.
- B. The work shall meet the requirements and recommendations of applicable portions of the latest editions of these standards:
 - 1. NFPA 70, National Electrical Code
 - 2. NFPA 70E, Standard for Electrical Safety in the Workplace
 - 3. NFPA 101, Life Safety Code
 - 4. NFPA 409, Standard on Aircraft Hangars
 - 5. NFPA 780, Standard for the Installation of Lightning Protection Systems (UL 96, UL 96A)
 - 6. FAA Advisory Circulars
 - 7. Applicable local building code
 - 8. Florida Building Code
 - 9. ANSI C2, National Electrical Safety Code
 - 10. NEMA Standards (NEMA)
 - 11. Underwriter's Laboratories (UL)
 - 12. Institute of Electrical and Electronics Engineers (IEEE)
 - 13. FDOT - Standard Specifications for Road and Bridge Construction
 - 14. FDOT – Design Standards Index
 - 15. AWS D1.1, Structural Welding Code - Steel

The above is not all inclusive of applicable codes and standards, but is presented for the Contractors convenience.

The advisory circulars are available on line at:

http://www.faa.gov/airports_airtraffic/airports/resources/advisory_circulars/index.cfm?template=Document_Listing.

3.5 STANDARDS

- A. All materials shall be new and free of defects and shall be U.L. listed, bear the U.L. label or be labeled or listed with an accepted, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards. All U.L. listed material shall be used only for the intended purpose.

3.6 UTILITY COMPANY FEES, CHARGES, AND COSTS

- A. It is the Contractor's responsibility to contact the applicable Utility Company(s) to determine if any fees, charges or costs will be due the Utility Company(s) as required by the Utility Company(s) for temporary power, installations, hook-ups, etc. This fee, charge or cost shall be included in this Contractor's price.

3.7 TESTING – QUALITY CONTROL

- A. Systems shall be tested by the Contractor, in the presence of the Engineer, and placed in proper working order prior to demonstrating systems to the Owner. Refer to the requirements in each item for other applicable standards.
- B. Provide all tests as required, per the Contract Documents and submit all test reports to the Engineer. Costs of all testing shall be borne by the Contractor and shall be considered incidental to the respective pay item of the tested item. The Contractor shall perform all Quality Control in accordance with the Contract Documents and the Contractor's Quality Control Plan. The Owner will perform Quality Assurance/Acceptance.
- C. Testing methods shall be acceptable to the Engineer and shall be submitted to the Engineer for review, a minimum of thirty (30) days prior to the scheduled test.

3.8 LAMINATED PHENOLIC PLASTIC NAMEPLATES

- A. Contractor shall provide nameplates for wiring systems and equipment as called for herein. All nameplates shall have beveled edges and one-half inch (1/2") lettering. If equipment is smaller than ten inches by six inches (10"x 6"), one-quarter inch (1/4") lettering may be used. Smaller lettering may be used with permission of the Engineer.
- B. Nameplates shall be laminated phenolic plastic, black front and back with white core, with lettering etched through the outer covering. White engraved letters on black background. Emergency systems shall use red front and back with white core for nameplates. Attach nameplates with stainless steel pop rivets, sealed with clear silicon caulk. Adhesive may be used only on panelboard interiors. Where conditions do not warrant piercing the enclosure "LOCTITE" brand adhesive or accepted equivalent may be used with permission of the Engineer.

- C. Coordinate nameplates with Contract Documents and submit 1 to 1 scale detail of all nameplates to Engineer for review.
- D. All electrical equipment, enclosures, pull boxes and all similar items in the sole opinion of the Engineer shall be equipped with nameplates. Examples are; all constant current regulators, motors, pushbutton stations, hand holes, pull boxes, junction boxes, manholes, control panels, system cabinets, terminal cabinets, time switches, disconnect switches, panelboards, circuit breakers, contactors, relays, high voltage boxes and cabinets. Special electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- E. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed in the Contract Documents, inscription and size of letters shall be as shown. Nameplates for panelboards and switchboards shall include the panel designation, panel name, source(s) of power and voltage and phase of the supply. For example, "Equip YY, Panel A, fed from Panel XYZ, 480/277V, 3-phase, 4-wire." The unique name of a particular piece of equipment shall be used consistently on all nameplates referencing that particular piece of equipment. Equipment name/numbers utilized shall be consistent throughout the entire system.

When equipment has multiple sources of power, all sources of power shall appear on the nameplate. Power source descriptions shall contain as a minimum the information listed above. Color coding should comply with owners specs for emergency branch separation (EH,EC,EQ,EX) and normal power for all voltage systems. Nameplates shall include as a minimum the following:

- 1. Equipment Number
 - 2. Equipment Name
 - 3. Power Source(s)
 - 4. Voltage Level and number of phases (for each power source)
- F. Panelboard and distribution panels shall have the breaker positions identified with phenolic labels.
- G. All major pull and junction boxes in service areas, tunnels, above accessible ceilings and in accessible chases shall have nameplates identifying the feeder or system. This shall include the access cover on lighting pole bases.
- H. Systems with conductors exceeding 100 volts to ground shall have voltage identification nameplates with one-half inch (1/2") high letters on all panels, switches, pull boxes and junction boxes.

3.9 ADHESIVE BACKED CLOTH MARKERS

- A. All raceways containing conductors exceeding 150 volts to ground shall have adhesive backed cloth/vinyl markers installed at each end and every thirty feet (30') in between identifying the voltage level (Example: "480 VOLTS"). If the conduit/duct is less than ten feet (10') in length one marker is acceptable. The markers shall be installed so they are visible from floors and walkways. Normal power system shall use black letters; emergency systems shall use red letters.
- B. The markers shall be "Brady" brand or accepted equivalent with one-half inch (1/2") letters.
- C. The markers shall be suitable for the environmental conditions encountered.

3.10 CONCRETE WORK

- A. Concrete bases and pads for all equipment furnished by Contractor shall be the responsibility of Contractor unless noted otherwise.
- B. Furnish and install reinforced concrete pads for transformers, switchgear, and motor control centers, etc. of size as shown in the Contract Documents. Chamfer the top edges 1". Trowel all surfaces smooth, provide broom finish where noted. Reinforce the pads as shown in the Contract Documents.
- C. Concrete equipment pads shall be installed by tradespersons skilled in concrete work. Equipment pads shall be level within one-eighth inch (1/8") in 10 feet (10'). Equipment pads not meeting the previous requirements shall be removed and replaced at the Contractor's expense.
- D. The Contractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

3.11 EXCAVATING, TRENCHING AND BACKFILLING

- A. This Contractor shall do excavating necessary for light bases, underground wiring, conduit, duct banks and other underground work and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a footing, pad or other structural item. Where a line must pass under a footing, pad or other structural item the crossing shall be made by the smallest possible trench to accommodate the conduit/duct. Excavations shall be kept free from water. No greater length of trench shall be left open in advance of conduit/duct installation than that, which is authorized or directed by the Engineer.
- B. Roots shall be removed to a level of eighteen (18") below finished grades and deeper as required for conduit/duct runs, manholes and light pole bases. No roots shall be allowed to remain under the work.

- C. Backfill about the work shall be placed, where practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of conduit/duct lines shall progress as rapidly as the testing and acceptance of the finished items of the work will permit and shall be carried to a crown approximately six inches (6") above the existing grades. In backfilling around conduit/duct lines, selected material shall be compacted firmly around the conduit/duct. Fill and backfill shall be clean and free from vegetable matter and refuse.
- D. All loose materials shall be removed from all excavations for electrical items. The bottom of the excavation shall be compacted to the following criteria:

SOIL TYPE	DESIGN AIRCRAFT GROSS WEIGHT	TEST STANDARD	UNDER PAVEMENT	IN TURF
<30% RETAINED ON ¾" SIEVE	>60,000 LBS	ASTM D1557	100%	95%
<30% RETAINED ON ¾" SIEVE	≤60,000 LBS	ASTM D698	100%	98%
>30% RETAINED ON ¾" SIEVE	>60,000 LBS	AASHTO T-180	100%	95%
>30% RETAINED ON ¾" SIEVE	≤60,000 LBS	AASHTO T-99	100%	95%

Backfill shall comply with the same compaction requirements.

- E. All trenches and other excavation left open by necessity shall be barricaded and guarded as required by OSHA or applicable codes and regulations.

3.12 WELDING

- A. All welding and weld procedures shall be in accordance with AWS D1.1, Latest Edition. Qualifications of welders and welding operators shall be in accordance with AWS D1.1, Latest Edition. The welder qualification test shall be performed on a 1" A-36 Test Coupon in the 3G and 4G positions. The welder qualification shall be current within 12 months of the work being performed. Weld inspections shall be per the criteria set forth in AWS D1.1 for visual weld inspection.

PART 4 – DESIGNATION OF MATERIALS

4.1 DESIGNATION OF MATERIALS

- A. Where equipment or materials are specified by the use of the name and catalog number of one manufacturer, that equipment or material specified shall set the quality and functionality of the item. Equivalents accepted by the Engineer will be acceptable.
- B. Where equipment or materials are specified by the use of the name and catalog

number of more than one manufacturer, that equipment or material shall be one of those specified. No alternative will be acceptable.

- C. Where no brand name is specified, the source and quality shall be subject to the Engineer's review and acceptance.
- D. When a product is specified to be in accordance with a trade association or government standard, at the request of Engineer, Contractor shall furnish a certificate that the product complies with the referenced standard. Upon request of the Engineer, the Contractor shall submit supporting test data to substantiate compliance.
- E. The Engineer shall be the sole judge of whether the proposed "equivalent" is suitable for use in the work.
- F. The Engineer reserves the right to reject any and all equipment, materials or procedures, which, in the Engineer's opinion, does not meet the system design and the standards and codes, shown in the Contract Documents.
- G. Each Bidder represents their bid is based upon the materials and equipment described in the Contract Documents.

PART 5 – PROTECTION OF MATERIALS, EQUIPMENT AND WORK

5.1 PROTECTION OF MATERIALS, EQUIPMENT AND WORK

- A. Materials shall be stored so as to assure the preservation of their quality and fitness for the work. Stored materials, even though accepted before storage, shall be subject to reinspection prior to their use in the work. The Contractor shall coordinate the storage of all materials with the Engineer.
- B. The Contractor shall protect electrical raceway, cable, lighting fixtures, associated support systems and all other electrical items against damage from movement of equipment and material, welding, flame cutting, and other construction damage. Raceways and supporting structures for raceway and lighting fixtures shall not be used as access scaffolding at any time. Whenever welding or flame cutting operations occur above or near raceways, cables lighting fixtures, etc not shielded from such operations by concrete floor or other protective covers, the Contractor shall protect the items from damage by means of fireproof boards or blankets. Damaged materials shall be repaired or replaced, by and at the Contractor's expense, subject to the Engineer's direction and acceptance.
- C. Surfaces of most equipment, such as panels, switchgear, transformers, and circuit breakers, are finished at the factory. Great care shall be exercised to prevent damage to this original finish during installation of the equipment and during construction work.
- D. If the factory finish is damaged during the course of construction, the entire surface of the damaged component shall be refinished by and at the expense of the Contractor.

- E. The refinished surface shall be equivalent in every respect to the original surface, including color, texture and smoothness. Refinishing paint, if furnished with the equipment, may be used; otherwise, the paint shall be obtained from the equipment manufacturer.
- F. All cut edges of galvanized materials and marred or scratched galvanized surfaces shall be repaired using LPS-1G cold galvanizing compound or accepted equivalent.

PART 6 – GENERAL CONSTRUCTION REQUIREMENTS

6.1 GENERAL CONSTRUCTION REQUIREMENTS

- A. Provide the bracing, shoring, rails, guards, and covers necessary to prevent damage or injury. Do not leave energized electrical items unnecessarily exposed or unprotected. Protect personnel from exposure to contact with electricity. Deliver equipment and materials to the job site in their original, unopened, labeled containers. Store ferrous materials so as to prevent rusting. Store finished materials and equipment so as to prevent staining and discoloring.
- B. Maintain separation between stainless steel items and carbon steel items to prevent contamination of stainless steel item and subsequent rust stains on stainless steel item.
- C. All sheeting, shoring, dewatering and cleaning necessary to keep trenches and their grades in proper condition for the work to be continued, including the removal of water by mechanical means, shall be the Contractor's responsibility.

PART 7 – METHOD OF MEASUREMENT

7.1 METHOD OF MEASUREMENT

- A. The items described in Item 26 01 01 (Civil) are incidental to other pay items and shall not be measured for payment.

PART 8 – BASIS OF PAYMENT

8.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Item 26 01 01 (Civil). The work described in Item 26 01 01 (Civil) is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

END OF SECTION 26 01 01

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SECTION 26 01 03 - MINOR ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the requirements for Electrical Demolition.
- B. Provide all equipment, labor, material, accessories, and mounting hardware for minor electrical demolition.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work as specified in individual sections. PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on field observation and existing record documents. Report discrepancies to OAR before disturbing existing installation.
- D. Beginning of demolition means acceptance of existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with Utility Company and OAR, per section 01 31 14.13.

- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service for Escalators, Elevators, Moving Walks, Sump Pumps, Public Area Lighting and Building Controls: Maintain existing circuitry in service until new circuitry is complete and ready for energizing. Disable circuits and equipment only to make switchovers and connections. Submit Utility Outage Notification (UON) and obtain permission from OAR appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system devices in service until new system devices are installed. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify OAR and local fire management service appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. A safety fireman's watch is required to be provided by approved personnel to enact a fire watch for areas that experience a loss of fire protection and notification coverage due to the modifications, for the full period of time the system is deactivated.
- F. Existing Security System: Maintain existing system devices in service until new system devices are installed. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify OAR and Operations Department appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. A security watch is required to be provided by approved personnel to enact a watch for areas that experience a loss of security protection due to the modifications, for the full period of time the system is deactivated.
- G. Existing Telephone System: Maintain existing system devices in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify OAR and GOAA's Telecommunications Department appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- H. Existing Sound and Paging System: Maintain existing system devices and equipment in service until new sound and paging system is installed and ready for service. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify the OAR appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove all abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceilings. Cut conduit flush with floors and provide firestopping at all abandoned penetrations in rated assemblies.
- D. Disconnect abandoned outlets and remove devices, boxes and raceways.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- G. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate and as required to comply with the requirements of the NEC.
- H. Extend existing installations using materials and methods compatible with existing electrical installations, however extension must meet or exceed the materials/methods specified in the Contract Documents.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement. Directory shall be typed original manufacturer's card stock.
- C. Luminaries: Clean existing luminaries. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps and broken electrical parts on all luminaries and ballast removed. Reuse and replace components as indicated in the Construction Documents.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 01 03 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 01 03. The work described in Specification 26 01 03 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 01 03

SECTION 26 01 05 - INVESTIGATION OF EXISTING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the requirements for investigation and reporting on conditions of existing electrical systems.

1.3 DESCRIPTION

- A. Test the essential features of the following existing electrical systems:
 - 1. Alarm and bells.
 - 2. Clock system.
 - 3. Emergency and non-emergency lighting fixtures.
 - 4. Controls and alarms.
 - 5. Outlets: convenience.
 - 6. Switches: regular, time.
- B. Each system shall be tested once only, and after completion of testing, results given to the OAR. Point out any non-operational function noticed during testing.
- C. Document the existing conditions and operation of the existing electrical systems prior to any work.
- D. Contractor shall be responsible for all non-working systems and their components unless non- working status is verified prior to work on system.

1.4 TIME

- A. The testing shall be held at a date to be agreed upon in writing by the OAR.

1.5 ATTENDING PARTIES

- A. The testing shall be held in the presence of the OAR, and Contractor.

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION

3.1 PERFORMANCE VERIFICATION

- A. Test the operation of each of the following existing devices and associated systems:
 - 1. Lighting and Exit Lighting Fixtures in Areas of Renovation:
 - a) Test all lighting fixtures and exit lights for proper operation, list bad ballasts, lamps or broken lenses. Record location of fixtures tested.
 - b) Test light switches, relay controls, and photo cell controls for proper operation and record location of tested device and note operational or non-operational.
 - 2. Clock System:
 - a) Test each clock for proper operation and automatic connection feature.

3.2 MEMO OF INVESTIGATION (TESTING)

- A. Submit Existing Facilities Investigation Memo and advise OAR of all deficiencies in system(s) prior to work. All systems will be assumed to be fully operational if Memo is not received by OAR prior to work on system.
- B. Submit five copies of Existing Facilities Investigation Memo of tested devices and equipment, memo signed by the Contractor, Subcontractor and OAR. Submit each test result to the OAR.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 01 05 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 01 05. The work described in Specification 26 01 05 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 01 05

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SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and other Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes Basic Electrical Requirements specifically applicable to Division 26 Sections.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material and accessories, and mounting hardware for a complete and operating system as described within these Division 26 Specification Sections.
- B. Furnish, perform, or provide all labor including planning, purchasing, transporting, storing, installing, testing, cutting and patching, trenching, excavating, backfilling, coordination, field verification, equipment (installation and safety), supplies, and materials necessary for the installation of complete electrical systems (as described or implied by these specifications and the applicable drawings) in strict accordance with applicable codes, which may not be repeated in these specifications, but are expected to be common knowledge of qualified Bidders.
- C. All work shall comply with all applicable codes as a minimum and with the additional requirements called for in these Contract Documents.
- D. Only trained and licensed personnel shall perform work. No Work shall be performed which violates applicable Codes, even if called for in the Contract Documents.
- E. Coordinate requirements with Utility Company and all applicable GOAA Testing, Certification and repair contractor prior to bid. Bid to include all work required.
- F. Make connections of all items in the Work using electric power including wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment.

- G. The Contractor shall provide and install panic hardware on all electrical room doors where the electrical room houses switchboards or MCC's rated 800 amps or more per NEC 110.26. All electrical room doors shall open in the direction of egress.

1.4 QUALITY ASSURANCE

- A. Install Work in locations shown or described in the Contract Documents, unless prevented by Project conditions.
- B. Install all equipment so that all Code and Manufacturer recommended working and servicing clearances are maintained. Properly arrange and install all equipment within designated spaces. If a departure from the Contract Documents is necessary, submit to the OAR for approval, detailed drawings of the proposed changes with written reasons for the changes. No change shall be implemented without the issuance of a change order or other directive permitted by the General Conditions.
- C. The Contractor shall verify finish dimensions at the project site in preference to using dimensions noted on Contract Documents.

1.5 INVESTIGATION OF SITE

- A. Investigate the site and existing conditions thoroughly before bidding. Advise OAR of discrepancies or questions noted.
- B. During the course of the site visit, electrical bidder shall become familiar with all aspects of the proposed work and existing field conditions of the work. No compensation or reimbursement for additional expenses for failure to investigate the existing facilities will be authorized. This shall include rerouting around existing obstructions.
- C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.
- D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions probably exist and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Notify OAR if deviations are found.
- E. All existing electrical is not shown. The Contractor shall become familiar with all existing conditions prior to bidding, and include in his bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is abandoned due to renovation.
- F. Protect all existing electrical raceways within concrete slabs, below concrete slabs, overhead raceways, equipment, etc. from damage due to renovation. Repair or replacement of utilities or other property damaged by operations in conjunction with the work will be at no cost to the Owner.

- G. Remove existing power, lighting, systems, material and equipment which are made obsolete or which interfere with the construction of the project. Reinstall power, lighting, systems, materials and equipment which are required to remain active for the facility to be fully functional.
- H. Reroute conduit and wiring in area of construction remaining active. Include temporary connections necessary to maintain continuity of existing circuitry required to remain active during renovation. Existing conduits indicated in Contract Documents are approximate locations only. Determine routing of existing conduits and pipes prior to any excavation, cutting or demolition.
- I. Occupied existing buildings must remain in operation while work is being performed. Schedule work for a minimum outage to Owner. Notify the OAR appropriately for any shut- down of existing systems.
- J. Bid shall include all removal and relocation of all piping, fixtures or other items required for completion of alterations and new construction.
- K. Refer to Section 26 01 03 Minor Electrical Demolition for Remodeling for additional requirements associated with existing conditions.

1.6 CONTRACT DOCUMENTS

- A. The drawings are diagrammatic and are not intended to include every detail of construction, materials, methods, and equipment. They indicate the result to be achieved by an assemblage of various systems. Coordinate equipment locations with Architectural and Structural drawings. Layout equipment before installation so that all trades may install equipment in spaces available. Coordinate installation in a neat and workmanlike manner. Provide 1/4" scale coordination drawings per specifications prior to start of work.
- B. Contractor shall provide 1/4" scale coordination drawings for all electrical, mechanical and communications rooms during the shop drawing submittal phase, utilizing detailed dimensions from equipment actually submitted (all disciplines) and field-measured/verified existing conditions. These drawings are also required for any room where conduits equal to or over 1-1/4" in size, equipment (panels, HVAC, disconnects, comm. racks) or other large objects are being installed. Drawings shall show all electrical, mechanical, plumbing, fire protection, structural, etc. coordinated so that problems are discovered/prevented prior to installation. Claims during construction for additional funding in rooms where properly coordinated drawings were not submitted will not be considered.
- C. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. All such items incidental to a complete and operating system shall be provided.
- D. Submit specific shop drawings which indicate the fabrication, assembly, installation, and erection of particular systems' components. Drawings that are part of the Contract Documents shall not be considered a substitute for required shop drawings, field installation drawings, code requirements, or applicable standards.

- E. Locations indicated for outlets, switches, and equipment are approximate and shall be coordinated with the Contract Documents. Where instructions or notes are insufficient to locate the item, notify the OAR.

1.7 MATERIALS AND EQUIPMENT

- A. Unless otherwise noted, all material shall be new and UL listed or labeled. In lieu of UL listing or labeling, a statement or data demonstrating compliance with contract documents from a nationally recognized testing agency shall be submitted to the OAR.
- B. All materials shall comply with the requirements for Low Emitting Materials. This shall include:
 - 1. Low Emitting Materials for Paints and Coatings
 - 2. Low Emitting Materials for Adhesives and Sealants
 - 3. Low Emitting Composite Wood
- C. Reference section 01 8113.14 "Sustainable Design Requirements – LEED V4 BD+C for additional information.
- D. Where Contract Documents list design selection, manufacturer or type, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Designers/OAR review and approval. Where Contract Documents list approved substitutions, these items shall comply with Division 01 requirements for substitutions.
- E. When a product is specified to be in accordance with a trade association or government standard and at the request of Designers/OAR the Contractor shall furnish a certificate that the product complies with the referenced standard and supporting test data to substantiate compliance.
- F. Where multiple items of the same equipment or materials are required, they shall be the product of the same Manufacturer.
- G. Prior to placing equipment orders, verify the physical size of specified equipment to fit spaces allotted on the drawings and with NEC working clearances. Internal access for proposed equipment substitutions shall be provided. Provide 1/4" scale drawings showing that this coordination has taken place.
- H. Electrical equipment shall be protected from the weather, during shipment, storage, and construction per manufacturer's recommendations. Should any apparatus be subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the Contractor, to ascertain the suitability of the apparatus, or it shall be replaced without additional cost to the Owner.

- I. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair and test damaged equipment in compliance with industry standards at no additional cost to the Owner. Equipment required for the test shall be provided by the Contractor.
- J. Material and equipment shall be provided complete and shall function up to the specified capacity/function. Should any material or equipment as a part or as a whole fail to meet performance requirements, replacements shall be made to bring performance up to specified requirements. Damages to finish by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Owner.
- K. Where tamperproof screws are specified or required, Phillips head or Allen head devices shall not be accepted. For each type used, provide OAR with three tools. OAR will designate the specific hardware design to correspond with existing devices elsewhere in the building, to limit special tool requirements.
- L. Communications backboards shall be 3/4" A/B grade, Class A, flame spread, painted with light gray fire retardant paint. Neatly mask off a minimum of one (1) plywood manufactures pre-printed certified fire rating stamp per section of board prior to application of paint. Remove masking after paint has cured. Plywood shall comply with the requirements of Low Emitting Materials for composite wood.

1.8 SUPERVISION OF THE WORK

- A. Reference the General Conditions for additional requirements.
- B. A qualified and experienced electrical superintendent shall be in charge of the work in progress at all times. If, in the judgement of the OAR, the electrical superintendent is not performing his duties satisfactorily, the Contractor shall immediately replace him upon receipt of a letter of request from the OAR. Once a satisfactory electrical superintendent has been assigned to the work, he shall not be withdrawn by the Contractor without the written consent of the OAR.
- C. Provide field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected. All work performed by a non-licensed Journeyman shall be under the direct supervision (in the presence of) of a Licensed Journeyman as specified herein. Increase the quantity of licensed Journeymen as required for supervision of all areas where direct contact is not possible. Project Superintendent and supervising Journeyman shall have passed a proctored H.H. Block Journeyman Exam with 75% grade or better and shall be a licensed Journeyman within the State of Florida. A resume of the Project superintendent's experience shall be submitted to OAR before starting work. At least one member of the electrical contracting firm shall hold a State Master Certificate of Competency. Each Journeyman shall have possession of licensing documentation at all times during work. Display to designer/OAR when requested.

- D. Superintendent shall be employed by a State Registered (Type "E.R." License) or State certified (Type "E.C." License) electrical contractor.

1.9 COORDINATION

- A. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:
 - 1. Door hardware
 - 2. Roll-up doors
 - 3. Roll-up grilles
 - 4. Signage
 - 5. Fire shutters
 - 6. Elevators
 - 7. Escalators
 - 8. Sliding doors
 - 9. Mechanical Division of the Specifications
 - 10. Landscape Architect drawings
 - 11. Lifts
 - 12. Lift Station
 - 13. Kitchen equipment
 - 14. Conveyors
 - 15. Flight information display systems
 - 16. Interior design drawings
 - 17. Fountains
 - 18. Millwork design drawings and shop drawings
 - 19. Parking control equipment
- B. Provide electrical subcontractor a set of Contract Documents for all areas of Electrical Work.
- C. Installation studies shall be made to coordinate the electrical work with other trades. Work shall be preplanned. Unresolved conflicts shall be referred to the OAR prior to installation of the equipment.
- D. Coordination drawings shall be prepared prior to the start of work. Drawings shall show the actual physical dimension required for the installation to assure proper integration of equipment with building systems and NEC required clearances. Location of conduit racking, etc., shall be provided. Coordination drawings shall be provided for all areas. Comply with the requirements of Division 01.

- E. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed. Adjustments to contract value will not be considered due to lack of coordination.
- F. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.
- G. Coordinate the exact location of floor outlets, floor ducts, floor stub-ups, etc. with OAR and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.
- H. The Contract Documents describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, conduit, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.

1.10 PROVISION FOR OPENINGS

- A. Locate openings required for work. Provide sleeves, guards or other approved methods to allow passage of items installed.
- B. Coordinate with roofing Contractor on installation of electrical items which penetrate the roof. Roof penetrations shall be installed so as to not void roof warranty.
- C. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types with Contractor.

1.11 CONCRETE PADS

- A. Furnish and install reinforced concrete pads for transformers, switchgear, generators, motor control centers, and other free-standing equipment. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by three (3) inches each side, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment. Pads shall be reinforced with W1.4 x 1.4 6 x 6 welded wire mesh. Chamfer top edges 1/2". Trowel all surfaces smooth. Provide 3000 psi concrete.

1.12 SURFACE MOUNTED EQUIPMENT

- A. Surface mounted fixtures, outlets, cabinets, conduit, panels, etc. shall have finish or shall be painted as directed by designer. Paint shall be in accordance with applicable sections and/or divisions of these specifications.

1.13 CUTTING AND PATCHING

- A. Reference Division 01 - General Requirements.
- B. New Construction:
 - 1. Cutting of work in place shall be cut, drilled, patched and refinished by trade responsible for initial installation.
 - 2. Backfill new grades to match adjacent undisturbed surface.
- C. Remodeling:
 - 1. See Section 26 01 03 Minor Electrical Demolition.

1.14 INSTALLATION

- A. Erect equipment to minimize interference and delays with the execution of the Work.
- B. Take care in erection and installation of equipment and materials to avoid marring finishes or surfaces. Any damage shall be repaired or replaced as determined by the designer/OAR at no additional cost to the Owner.
- C. Equipment requiring electrical service shall not be energized or placed in service until OAR is notified and is present or have waived their right to be present. Where equipment to be placed in service involves service or connection from another Contractor or the OAR, notify the OAR in writing as appropriate when the equipment will be ready.
- D. Equipment supports shall be secured and supported from structural members unless written approval is granted by OAR.
- E. Plywood material shall not be used as a backboard for mounting panel boards, disconnects, motor starters, and dry type transformers. Provide "cast in place" type inserts or install expansion type anchor bolts. Electrical equipment shall not be mounted directly to dry wall for support without additional channels as anchors. Channels shall be anchored to the floor and structure above. Panelboards and terminal cabinets shall be provided with structural framing located within drywall partitions.

- F. Inserts, pipe sleeves, supports, and anchorage of electrical equipment shall be provided. Where items are to be set or embedded in concrete or masonry, the items shall be furnished and layout made for setting or embedment thereof so as to cause no delay.
- G. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the OAR.

1.15 AS-BUILT DOCUMENTS

- A. As-Built Documents: As-built Documents include Drawings, Shop Drawings, Specifications, Addenda, Change Orders, and other modifications permitted by the General Conditions.
- B. Comply with all requirements of Division 01
- C. Verify aspects of redlined as-builts for accuracy. As-Built Documents shall show all components including but not limited to:
 - 1. All raceways 1-1/4" and above, cable tray systems, and grouped raceway racking as installed, including dimensions from fixed building lines such as column lines.
 - 2. All site underground raceways and duct banks indicating burial depths and distances from fixed building lines or global tracking coordinates.
 - 3. Underground pull boxes and manholes including elevations. Detail manhole and pull boxes, conduit terminations (butterfly layout) including conduit sizes, designated systems and cabling description.
 - 4. General conduit routing from receptacle to receptacle, fixture to fixture, device to device. (Exact routing is not required for raceways 1" and smaller.)
 - 5. Lighting: Diagrammatically show junction boxes that are located above accessible ceiling with flexible conduit connections to luminaries.
 - 6. All junction boxes for Sections 28 31 11, 27 13 00 / 27 15 00, 27 13 00 / 27 15 00 and 27 51 16 shall be shown exactly where installed.
 - 7. Junction box splices shall be shown in exact location and clearly noted referring to the written authorization by the OAR.
 - 8. The first junction box within each homerun, regardless of size shall be shown in the installed location.
 - 9. All junction boxes and pull boxes located above non-accessible ceilings shall be shown in exact location. All junction boxes 6"X6" and larger shall be shown in exact location.
 - 10. Any combining of circuits (which is only allowed by specific permission) or change in homerun outlet box shall be indicated.
 - 11. Any circuit number changes.
 - 12. All conductors and cables, conductors and cable sizes, raceway sizes, etc. not shown on contract documents and any changes from the documents.
 - 13. Any switchboard, panelboard, motor control center, relay panel, or dimming control panel schedule changes, including load changes.

14. All access panels.
 15. All existing conditions.
 16. Location of lighting control devices such as photocell controls, space occupancy sensors, etc.
 17. Exact quantity of conductors and cables shall be shown for all raceway systems.
 18. All devices, wall outlet boxes, and control components.
 19. All wireway and cable tray systems.
 20. Exact location of all driven grounding electrodes including burial depths and dimensions from fixed building lines. Location of all grounding system busbars.
 21. All building automation system (BAS) control panels and associated electrical devices, connections, power supplies, and dampers.
 22. Riser diagrams exactly as installed.
 23. Motor control devices, terminal cabinets, equipment racks, disconnects and switches and surge protection devices.
 24. Change the equipment schedules (i.e., symbol legends, light fixture schedule, etc.) to agree with items actually furnished.
 25. Change plan notes to agree with items actually furnished, actual installation methods, etc. respectfully.
 26. Cross-out all items, circuitry, devices, etc. not applicable.
- D. As-Built red line information shall not compromise the clarity of the Contract Documents and Shop Drawings. Major components such as grouped raceway assemblies, cable tray systems, larger conduits, duct banks, racking, elevations, dimensions, etc. shall be shown on a clean architectural base plan(s) separate from the Contract Electrical Documents, as required to clearly delineate work. Obtain electronic base plan file from OAR.

1.16 "OBSERVATION OF WORK" REPORT

- A. Reference the General Conditions.
- B. Items noted by designer/OAR during construction and before final acceptance which do not comply with the Contract Documents will be listed in an "Observation of Work" report which will be sent to the Contractor for action. Correct all deficiencies in a prompt concise manner. After completion of the outstanding items, provide a written confirmation report for each item. The report shall indicate each item noted, and method of correction. Enter the date on which the item was corrected, and return the signed reports so items can be rechecked. Failure to correct the deficiencies in a prompt concise manner or failure to return the signed reports shall be cause for disallowing request for payments.
- C. The electrical project superintendent shall be present at all required observation of work reviews as project progresses. Provide the OAR with equipment for access and review of all Work in place, as well as personnel fully familiar with all aspects of the work. Provide access to all electrical components such as junction boxes, panelboards, switchboards, devices and fixtures for their review by the designer/OAR.

- D. Prior to start of Substantial Completion inspection, provide access to and prepare all electrical equipment and related components complete and ready for review by designer/OAR including but not limited to the following :
1. All panelboard covers removed
 2. Switchboard and distributions panelboards readily for immediate removal of covers
 3. Terminal cabinet covers open or removed.
 4. Wireway covers open or removed
 5. Underground pull boxes ready for immediate removal of cover(s)
 6. Access to all grounding/bonding terminations
 7. Access to rated wall and through floor fire stopping
 8. Access to all control systems for the CCTV, Voice, Data, Fire Alarm, and Sound/Paging.
 9. Access to mechanical equipment, electrical connection points, and control devices
 10. Access to elevator and escalator machine rooms, hoistway, pits, etc.
 11. Access to all raceways crossing structural expansion/deflection joints.
 12. Access to all components of the fire alarm control system including control devices and fire dampers.
 13. Access to power company equipment
 14. Removal of access panels
 15. Removal of a minimum of one (1) acoustical lay-in ceiling tile throughout each area of work. Larger areas shall have one (1)-ceiling tile removed for every 30 square foot of ceiling area.
 16. Each and every item deemed necessary by A/E to perform a comprehensive review of the work as installed relative to the contract documents.
- E. Items noted after acceptance during one-year guarantee period shall be checked by the Contractor in the same manner as above. The signed reports are to be returned by him when the items have been corrected.

1.17 SYSTEMS WARRANTY

- A. Reference the General Conditions.
- B. Warranty shall be by the Contractor to the Owner and shall cover for a period of one year from the date of the Substantial Completion. Warranty shall not include light bulbs lamps in service after one month from date of substantial completion of the System.
1. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the OAR upon project completion.
- C. Where items of equipment or materials carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material.

- D. Where extended Guarantees are called for herein, furnish three copies to be inserted in Operation and Maintenance Manuals.
- E. All preventative maintenance and normal service will be performed by the Owner's maintenance personnel after final acceptance of the work which shall not alter the Contractor's warranty.

1.18 WASTE MATERIALS DISPOSAL

- A. Include in base bid the transport and disposal or recycling of all waste materials generated by this project in accordance with all rules, regulations and guidelines applicable. Comply fully with Florida Statute 403.7186 regarding mercury containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at time of disposal. Provide OAR with written certification of approved disposal.

1.19 PROHIBITION OF ASBESTOS AND PCB

- A. Prior to the Final Review field visit the Contractor shall certify in writing that the equipment and materials installed in this Project under this Division 26 contain no asbestos or PCB. Additionally, all manufacturers shall provide a statement with their submittal that indicates that their product contains no asbestos or PCB. This statement shall be signed by a duly authorized agent of the manufacturer.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 00 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 00. The work described in Specification 26 05 00 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 00

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SECTION 26 05 10 - ELECTRICAL SYMBOLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this section.

1.2 SYMBOLS

- A. In general, the symbols used on the drawings conform to the Standard Symbols of the Institute of Electrical and Electronic Engineers with the exception of special systems or agencies as hereinafter noted.
 - 1. Corps of Engineers.
 - 2. Special Symbols as shown in schedules or legends.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 10 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 10. The work described in Specification 26 05 10 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 10

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SECTION 26 05 12 - OUC UNDERGROUND ELECTRIC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Conditions/Provisions of Contract, including Contractual Conditions and other Division 1 specification Sections, apply to this Section.

1.2 PROJECT DESCRIPTION

- A. These specifications are for the construction of certain Orlando Utilities Commission (OUC) underground facilities and street lighting systems as shown in the contract documents. These facilities shall be more particularly described in later paragraphs of these specifications and by attached drawings. The nature and location of these facilities shall be further described on drawings, which are part of the contract documents. In general, these specifications shall cover the construction of, but not necessarily be limited to, the following general types:
 - 1. Manholes, hand holes, pull boxes, and junction boxes
 - 2. Direct buried duct line, concrete encased duct lines and conduit runs
 - 3. Street lighting poles, fixtures, bracket arms, controllers, services etc.
- B. All manholes pull boxes, junction boxes, conduit, street lighting components, electrical service components, etc. shall be fabricated and installed in accordance with current OUC requirements and specifications. All materials, equipment and installations shall comply and be fabricated in accordance with current OUC requirements and specifications. All materials shall be submitted to the OAR for review by OUC and the Engineer.
- C. The requirements of specification SP-100-1.4 and SP-100-1.5 are applicable to the work performed on the 26 05 12 installations.
- D. Establishing Grade and Right of Way: In undeveloped, developing or road right-of-way areas where street grades and other final grades have not been established, it shall be the Contractor's responsibility to obtain this information from the appropriate group or individual so that completed installations shall be at required depths and final grades. It shall also be the Contractor's responsibility to establish the boundaries of right-of-way areas such that completed installations shall be within the proper right-of-way areas.
- E. The Contractor shall perform and include in the price bid for the work all work shown on the plans.

- F. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of 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.
- G. Where required, all items shall be installed by the specific FDOT Standard Indexes referenced in the Contract Documents.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 METHOD OF PERFORMANCE

- A. The Contractor shall perform all work in accordance with the contract documents and shall comply with the latest directives of the State of Florida Department of Transportation, Orange County, the City of Orlando, OUC, Greater Orlando Aviation Authority (GOAA) Standards, NEC and other governmental authorities having jurisdiction.

3.2 MANHOLES

All manholes shall be precast concrete manholes consisting of two (2) sections, top and bottom, with bell ends cast in place in each end wall, 1" pulling eyes and drilled ½" zinc inserts.

Design loading shall include dead load, live load, impact load, load due to water table, and any other loads which may be placed upon the structure. Live loading design shall conform to AASHTO H20 and/or H20-S16 specifications. Live load shall be the loading, which produces the maximum shear and bending moments in the structure. All concrete aggregates, fine or course, shall conform to ASTM C-33 specifications. Written certification, of these strengths, sealed by a Professional Engineer, shall be submitted to the OAR for review prior to ordering the manhole. Mating surfaces shall be flush between top and bottom manhole halves, resulting in a flush interior surface. A tolerance no greater than 3/8" shall be permissible. The complete manhole submittal shall be reviewed, signed and sealed by a registered professional engineer licensed in the state of Florida. Test results certifying the concrete used to cast the manhole complies with the strength required by the registered professional engineer shall be delivered with each manhole.

No. 5, Grade 60 reinforcing steel rods shall be provided on a maximum of eight (8) inch centers in both directions for top, bottom and walls for reinforcement. Pulling eyes shall be galvanized steel rod 1" inch minimum diameter. Install pulling eyes on each end wall ABOVE and BELOW the duct entrance as shown in the contract documents. See plans and details for required quantity per manhole wall.

A fourteen (14) inch diameter by five (5) inch deep sump is to be located approximately in the center of the manhole floor. The sump is to have a watertight bottom. Install two (2) inch wide channel sloped towards the sump from the four corners.

The size, number and location of conduits shall be ten (10) six (6) inch and two (2) two (2) inch PVC Schedule 40 bell ends centered in each end wall and two (2) six (6) inch PVC Schedule 40 bell ends in both upper corners of each end wall, minimum, unless otherwise specified. Refer to plan sheets for specific additional conduit entries. Contractor shall provide additional size, number and location of conduits as shown in the plans. Bell ends shall be "LONG BELL ENDS" manufactured by Carlon or OUC accepted equivalent.

Manhole lids shall have 3" high embossed letters "OUC ELECTRIC." Design shall be approved by OUC. OUC Manhole lids shall be Neenah Foundry R-3498-TS2 with spring assist or accepted equivalent.

Built-in-place type manholes may be used or required in lieu of the precast manholes. Manholes shall comply with the design contained in the drawing package titled "OUC AIRCRAFT RATED MANHOLE".

OUC via the OAR shall be contacted for exact location of windows and/or conduit entrances in existing manholes.

3.3 CONCRETE ENCASED CONDUIT RUNS

- A. All conduit/duct shall be concrete encased except as noted in Paragraph 3.4. The conduit run shall consist of electrical grade Schedule 40 or Schedule 80 polyvinyl chloride conduit or rigid galvanized steel conduit, as noted. Rigid galvanized steel conduit shall be used for the first ten feet of all pole risers. The conduit shall be encased in concrete with 2 inch spacing between ducts and 3 inches of concrete cover on top, bottom and sides. Concrete or plastic spacers shall be used. The concrete envelope shall be P-610 or FDOT Class II concrete with 1 inch maximum size coarse aggregate (FDOT #57 stone) with a minimum 28 day compressive strength of 3,400 PSI or equivalent. The concrete encasing the ducts shall be free of voids and air pockets; a vibrator or other mechanical means of consolidation shall be used. The concrete encasement for the duct line shall have a minimum cover of 36 inches measured from final grade, unless specifically noted otherwise. Bell end fittings shall be used on each conduit where it terminates in a manhole or pull box and as required by the Authority Having Jurisdiction. The PVC conduit used in the duct line shall be solvent welded to prevent water from entering around the couplings. The Contractor shall install a 4/0 bare copper ground wire and terminations as part of the duct, pull box and manhole installation with no separate measurement or payment. The Contractor shall use an

exothermic type welding process for 4/0 conductor terminations/splicing. The OAR shall inspect all welds with random inspections performed by OUC. A close fitting duct plug shall be installed in each duct end. A polyolefin jet line pulling string, 200 pound test, shall be installed in each conduit in a duct run. Schedule 80 PVC duct and rigid galvanized steel conduit shall not be paid for separately and shall be incidental to the respective size Schedule 40 PVC duct pay item.

- B. Encasement of primary power voltage duct banks shall have a red dye added to the PCC to achieve a distinguishable red color of the encasement for identification in the field if encountered in a future excavation.

3.4 DIRECT BURIED STREET LIGHT CONDUIT RUNS

- A. Street lighting conduit shall have a minimum cover of 30" and a maximum cover of 36", unless specifically approved on a case by case basis by OUC. Street lighting conduit shall not be concrete encased except where installed under roadways or where the 30" minimum cover cannot be obtained. When concrete encasement is required for street lighting conduits, as noted above, the additional cost of the concrete encasement shall be considered incidental to the respective size direct buried street lighting conduit installation. The conduit run shall consist of electrical grade Schedule 40 or Schedule 80 polyvinyl chloride conduit or rigid galvanized steel conduit, as noted. Rigid galvanized steel conduit shall be used for the first ten feet of all pole risers and under roadways. The direct buried street light conduit shall be encased in sand or natural earth, no part of which is retained by a 0.25" sieve, with 2 inch spacing between ducts and 4 inches of sand cover on top, bottom and sides. Concrete or plastic spacers shall be used. The fill encasing the ducts shall be free of voids and air pockets and vegetation. The direct buried duct line shall have a minimum cover of 36 inches measured from final grade. Bell end fittings shall be used on each conduit where it terminates in a manhole or pull box and as required by the Authority Having Jurisdiction. The conduit used in the duct line shall be solvent welded to prevent water from entering around the couplings. A close fitting duct plug shall be installed in each duct end. A polyolefin jet line pulling string, 200 pound test, shall be installed in each conduit in a duct run. Schedule 80 PVC duct and rigid galvanized steel conduit shall not be paid for separately but shall be paid for under the respective size Schedule 40 PVC duct pay item.

3.5 CONDUIT REQUIREMENTS

- A. The route, nature and size of the conduits and the location of the conduit runs shall be as indicated in the contract documents. All conduits used shall be designated as electrical grade, have 5° chamfered ends and shall comply with OUC requirements. OUC data sheets are included at the end of this Item.
- B. All ducts shall be securely fastened in place during construction and progress of the work and shall be plugged to prevent seepage of grout, water, or dirt. Any duct section having a defective joint shall not be installed.

- C. All conduits shall be installed with joints properly mated and glued. All conduit ends shall be chamfered 5° with an OUC approved chamfering tool. Any burrs or sharp projections at conduit ends or within the conduit shall be removed.
- D. All exposed ends of conduit shall be plugged during construction to prevent the entrance of foreign matter and moisture into the conduit.
- E. All rigid galvanized steel conduits installed below grade shall be coated with 12 mil of asphaltum paint.
- F. All directional bore ducts shall be schedule 80 electrical utility grade PVC with 5 degree chamfered ends.
- G. OUC approved restrained-joint schedule 40 conduit manufacturers:
 - 1. Carlon; Bore-gard
 - 2. Certainteed; Certa-Com
- H. Bore-guard duct is stiffer than conventional HDPE duct. The contractor shall comply with the Bore-gard manufacturer's requirements.
- I. Maintain 10 foot horizontal clearance and 5 foot vertical clearance between directional bore duct banks and all other underground utilities and structures, unless noted otherwise.
- J. Maintain 20 feet minimum clearance between the bottom of a pond/canal and the top of any directional bore duct. Any blow-out of the drill mud shall be immediately corrected and cleaned up by the contractor at no additional cost to the owner.
- K. Conduit to meet all applicable ASTM testing and be UL listed. Conduit to be chamfered on inside diameter male ends to minimize cable damage. The "in trench" bending radius for 4" PVC pipe should be no smaller ~~greater~~ than 100' as recommended by the PVC Pipe Industry, and 150' for 6" pipe. Installation bend radius should be kept at a minimum to reduce the tensile pull forces displaced onto the pipe. Pipe installation and joint assembly shall be per manufacturer recommendations.
- L. Conduits terminating at a pole or a building shall be rigid galvanized steel, Schedule 40 walls, with one (1) full length (10 foot) up the structure preceded by a galvanized ell. Bell ends shall be "LONG BELL ENDS" manufactured by Carlon and shall be used on each conduit where it terminates in a manhole, pull box, or hand hole. Conduits terminating in the ground to be used for future extensions shall be closed up with a PVC cap and glued to the conduit stub out. Conduits at the base of a riser pole shall be terminated using a galvanized rigid coupling and a threaded PVC plug. A subgrade location marker provided by OUC shall be buried in line with the stubbed conduit. Contractor shall contact OUC to obtain markers and install markers in accordance with OUC requirements. Acquisition and installation of subgrade location markers is incidental to the respective duct installation.

- M. Where conduits pass under driveways or other paved areas, a permanent marker (an 'E' cut in the concrete curb) shall be installed in the curb or in the edge of pavement when curbing is not used above the conduit installation. Street lighting conduits installed under roadways shall be rigid galvanized steel conduit.
- N. A 200-pound test polyolefin pulling string furnished by the Contractor shall be installed in each and every conduit.
- O. Where necessary, pipe bending should be utilized for offsets, "dog-legs", back- sided risers, or other such runs in galvanized conduits. The cost of bending these pipes and the installation of these pipes is the responsibility of the Contractor. Bending of PVC pipe shall not be allowed without prior approval of the usage and bending technique by OUC. Bends, fittings, offsets/rolling of ducts around/over/under obstructions, etc. are an incidental component of the raceway pay items.
- P. The use of "split" couplings or other such fittings shall be used only in those locations where it is extremely difficult to negotiate and where additional excavation or relocation of existing facilities is impractical and/or unreasonable. OUC shall approve the use of "split" couplings or other such fittings on a case- by-case basis. Approval for one instance does not constitute a blanket approval. Where these type fittings are used, it is the responsibility of the Contractor to insure a watertight fit and take required steps in water-proofing by sealing and grouting or by adapting the galvanized conduit and using a PVC fitting for this connection.
- Q. A 4/0 bare copper ground wire shall be installed by the Contractor where specified. Maintain 3" minimum between the 4/0 copper cable above and the concrete encasement of the duct bank. The Contractor shall use an exothermic type welding process for conductor splicing. The OAR shall inspect all welds with random inspections performed by OUC's Inspector. Bare copper wire for counterpoise installations shall be #4/0 AWG stranded wire conforming to ASTM Specifications B-1 and B-8 or B-3 and B-8, as required by the plans and details. The Contractor shall install a 4/0 bare copper ground wire as part of the duct, pull box and manhole installation with no separate measurement or payment.
- R. The OUC duct bank size between manholes is designated on the plan sheets. Due to existing conditions, elevation changes, directional changes, clearance from objects and route. Each of the multiple duct installations shall be the same physical length. Contractor is responsible for "means and methods" and shall account for this installation condition for the OUC duct bank. Each additional duct bank requires an additional 4/0 copper ground wire installed alongside each duct bank.
- S. All conduits and fittings shall be of electrical grade only, Schedule 40 or 80, or rigid galvanized steel conduit as specified, and furnished by the Contractor.
- T. All conduit runs shall have 4 mil thick, polyethylene, 6" wide, red color, black printing warning tape OUC stock # 048-03819 installed directly over the conduits, 18 inches below final grade. Multiple duct bank trenches shall have tape provided over each duct. OUC data sheets are included at the end of this Item.

Marked		
Buried Electric Line Below		1-1/4" High
Caution Caution Caution		1-1/4" High
Call Orlando Utilities Commission	407-434-4247	3/4" High
Buried Electric Line Below		1-1/4" High

- U. **Manholes and ducts shall be thoroughly cleaned. Installation of manholes ducts, etc. shall pass OUC acceptance test for compliance with OUC requirements and cleanliness. Contractor is required to provide support for OUC inspection and remedial action in the appropriate bid item. The Contractor shall mandrel each duct. A 6" diameter wire brush by Greenlee, Cat # 39286 followed by a Greenlee piston Cat # 619 shall be pulled through each 6" duct to thoroughly clean duct. Multiple passes in both directions will be required. Cleaning of other sized ducts shall be completed in a similar manner. The OAR and OUC will check each component for compliance with the Contract Documents.**

- V. All conduit shall be inspected, mandrel tested, pulling string installed, and accepted by OUC prior to any cable being installed or any meters being installed.

3.6 ASPHALTUM PAINT

- A. All iron, steel, galvanized steel and similar metallic items (not intended to be a grounding electrode) installed underground or within 12 inches of the earth shall be protected by a 12-mil thick layer of asphaltum coating. Apply coating in strict accordance with the manufacturer's instructions. Apply to clean dry surfaces. Asphaltum coating shall be applied in two applications/coats minimum. Observe the manufacturer's minimum cure time between applications/coats. Each application of the coating shall be given ample time to dry and harden before the next application is applied. Touch up areas damaged during installation, wrench marks, tooling, bonding clamps, exothermic welds, etc. Apply the proper consistency of asphaltum coating uniformly. The finished coating shall be free from sags, holidays, and smears. Asphaltum coating shall be Carboline Bitumastic 50 or Sumter Coatings Coal Black Asphaltum 100N8507 or accepted equivalent.
- B. Where steel conduit is threaded in the field the threads shall be coated with an approved electrically conductive, corrosion resistant compound in accordance with NEC Section 300.6(A). Use TNB KOPR_SHIELD or accepted equivalent.

3.7 TRENCHING AND BACKFILLING

- A. The Contractor shall do all trenching and backfilling. Backfill shall comply with civil specifications. Consideration shall be given to the property at all times. Restoration shall be to the original condition. All restoration is incidental to the respective pay item of which it is a component part.
- B. The Contractor shall install underground ducts at the locations indicated in the plans.

If necessary, the OAR shall indicate specific locations as the work progresses. Ducts shall be of the size, material, and type indicated in the plans or specifications. All duct lines shall be laid so as to grade toward hand holes, manholes and duct ends for drainage. 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 lines shall be graded from the center in both directions toward manholes, hand holes, or duct ends. Pockets or traps where moisture may accumulate shall be avoided.

- C. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.
- D. Trenches for ducts may be excavated manually or with mechanical trenching equipment. Walls of trenches adjacent to the duct bank and encasement shall be essentially vertical and may act as a side form if approved by inspector. Collapsed sidewalls shall be repaired to maintain minimum encasement coverage shown on the plans. Otherwise, additional back slopes or forms may be required. so that a minimum of shoulder surface is disturbed. Blades of road patrols or graders shall not be used to excavate the trench. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All excavation shall be unclassified.
- E. Dewatering necessary for manhole, pull box, conduit, duct bank and street light installation, erosion and turbidity control, in accordance with Federal, State, and Local requirements is incidental to the respective pay item of which it is a component part. The cost of all excavation regardless of type of material encountered, shall be included in the 26 05 12 Item. The cost of all area restoration, grading, sodding, paving, etc., shall be included in and is incidental to the 26 05 12 Item. All rigid galvanized steel conduit, fittings, etc. furnished and installed, as required, for 26 05 12 items shall be incidental to and included within the respective 26 05 12 PVC duct.

3.8 RESURFACING AND RESTORATION

- A. All trenching and street openings shall be made by the Contractor. Back filling, compacting and resurfacing shall be done by the Contractor in strict accordance with the latest directives of the Greater Orlando Aviation Authority, City of Orlando, Orange County, and the latest edition of the Florida Department of Transportation standard specification for Road and Bridge Construction and the contract documents.
- B. It shall be the responsibility of the Contractor to be thoroughly familiar with these directives and to notify the respective departments at least two weeks prior to starting any construction or any related segment of construction. It is a requirement of these agencies that newly sodded areas be watered until they are established.
- C. All work shall be done in reasonable harmony with the respective property owners and all disturbed areas shall be restored to their satisfaction. All materials and equipment shall be subject to inspection by the Authority, City, County and/or State Inspector.

3.9 MISCELLANEOUS

- A. The Contractor shall have all manholes, pull boxes, hand holes, and junction boxes clean and free of trash, dirt and other debris.
- B. The Contractor shall adhere to the following OUC Safety Procedures:
- C. When entering OUC manholes, the following equipment shall be utilized -
 - 1. Air blower per OSHA Guidelines.
 - 2. Ladder, non-metallic, with a minimum of 3 feet extending out of the top of the manhole.
 - 3. Gas detection meter (Continuous monitoring).
- D. Water removal from the manholes is the responsibility of the Contractor.
- E. Where manholes, pull boxes, etc. have OUC facilities already installed, where line covers are required, or where existing lines need protection the Contractor shall notify the OUC construction office for scheduling an OUC stand-by crew, (407) 434-4011. A minimum of 72-hour notice shall be given.

3.10 ACCESS TO FACILITIES

- A. For emergency power restoration, maintenance and any other necessary construction activities, OUC vehicles shall be able to access electric facilities at all times. A stabilized road bed is required for access to all OUC manholes, transformers and switch gear. Landscaping or other permanent structures placed in close proximity to OUC facilities shall be approved by OUC engineering prior to installation.
- B. Manhole covers and junction box covers shall remain visible at all times.
- C. Clearances:
 - 1. Manholes - A 20' horizontal radius of unobstructed area and a 18' vertical clearance is required.
 - 2. Transformers and Switch Gear – Contact OUC for minimum unobstructed horizontal clearance required. Vertical clearance shall vary depending on the size of the equipment. This clearance shall be determined by OUC engineering.
 - 3. Meters - A minimum 3' clearance shall be maintained in front of meters. Mounting height shall be a minimum of 4' to a maximum of 6'.

3.11 DIRECTIONAL BORE DUCTS

- A. Directional Bored Ducts shall be installed in accordance with OUC requirements and Item SP-110S-02310, however no separate payment shall be made for directional bore duct. Directional bore duct shall be considered a component part of the respective 26 05 12 duct pay items.

- B. Provide boring to place new duct banks under existing utilities, roadways and structures. Boring shall not weaken the roadbed or structures, or interfere with their operation. Boring tolerances shall be 2 percent in the lateral alignment and one percent in vertical grade. Jetting of ducts is not permitted.
- C. The diameter of the excavation shall conform to the outside diameter of the pipe as close as practical. Any voids developed outside of the diameter of the bore shall be pressure grouted with an approved mix.
- D. Submit for approval a plan showing proposed method of boring, boring equipment, dewatering method, material removal, pit excavation and shoring.

3.12 STREET LIGHTING

- A. OUC street lighting luminaire, horizontal cutoff type (flat lens), LED light source, with photocell receptacle, photocell shorting device, painted with a semi-gloss enamel paint, standard gray. LED roadway lighting luminaires shall be 4000K as noted on plans, with multi-volt (120/208/240/277v/480v) ballast. Part numbers and approved manufacturers are listed on the plans.
- B. The furnishing and installation of the fixture and appurtenances is incidental to the 26 05 12 street light pay item.
- C. OUC street lighting brackets shall be truss style, tapered with 2" slip-fitter at luminaire end, capable of supporting a 60-pound luminaire, for mounting on a flat surface concrete pole. Part numbers and approved manufacturers are listed on the plans.
- D. The furnishing and installation of the truss bracket is incidental to the 26 05 12 street light installation.
- E. OUC Street lighting poles shall be as shown on the plans.
 - 1. Poles shall be 606S- T4 ALUMINUM ALLOY TUBE, manufactured in accordance with OUC specifications. Approved manufacturer is VALMONT INDUSTRIES INC.
 - 2. Poles shall be pre-stressed concrete, manufactured in accordance with OUC specifications. Approved manufacturer is ACCORD INDUSTRIES, Winter Park, Florida. Poles shall be Type 3 concrete street light pole.
 - 3. Poles shall comply with OUC requirements.
- F. The furnishing and installation of the pole is incidental to the 26 05 12 street light installation.
- G. Cable used for street lighting shall comply with OUC Engineering requirements. Power and control Type TC (tray cable) with THHN/THWN insulated conductors, UL listed, 600 volt. Cable shall be #14 AWG, 3 conductor, 7 strand soft copper per ASTM B3, class B

concentrically stranded; have one black, one white and one green insulated conductor (solid colors); have an overall PVC jacket of approximately 45 mils; be sunlight resistant and suitable for direct burial. Manufacturer's wire shall conform to IEAC T-29-520 or T-30-520 and be in accordance (for installation) with Article 340 and other applicable parts of the National Electrical Code.

Cable shall be packaged in 1000-foot lengths on non-returnable wooden reels. The arbor hole centered in each hub shall be a minimum of 2-3/4 inches in diameter. OUC shall terminate and determinate all OUC cable, except 14/3 TC cable in the fixture. OUC shall install and remove all OUC cable, except the 14/3 TC cable in the pole.

Conductors for OUC systems shall be as previously specified. OUC wire and cable shall be as listed below:

#14-3 TC cable, OUC stock # 018-21143. OUC data sheets are included at the end of this Item.

Bare copper wire for grounding and bonding use shall be #4 AWG stranded wire conforming to ASTM Specifications B-1 and B-8 or B-3 and B-8, as required by the plans and details.

The Contractor shall coordinate all work with OUC. OUC shall perform all splicing, termination and determination of all OUC cables except connection to the pole-mounted fixture. Contractor shall be responsible for providing and installing the 14-3 TC cable and ground conductor within the pole, termination of the 14-3 cable in the fixture, bonding the #4 AWG ground wire to the bracket arm and coiling 10' minimum of each cable in the pull box. Connection to the fixture and bracket arm shall be the responsibility of the Contractor and shall be performed in accordance with OUC requirements.

Conductors shall be continuous and unspliced where located within conduit. Splices shall only occur within pull boxes installed for the purpose.

Allow adequate conductor lengths in all pull boxes, 10' minimum. In fixtures all termination of conductors in which conductor is in tension shall be rejected and shall be replaced with conductors of adequate length. A calibrated torque wrench shall be used for all bolt tightening.

The furnishing, installation and termination of the 14-3 TC cable and #4 AWG ground wire is incidental to the L-112 streetlight pay item.

- H. The OUC power cable between each streetlight shall be provided and installed by OUC.
- I. 13" X 24" flush to ground secondary service junction box and cover shall be light traffic rated (minimum 5000-pound wheel bearing weight). Junction box shall be tapered, have open flanged bottom, and the cover shall fasten down with at least one (1) pentahead stainless steel bolt. A polymer concrete ring and cover (or preapproved overhang device of another type) around the top shall act a concrete (side walk) lock in device. Covers shall have a non-skid surface and the "OUC ELECTRIC" logo

- permanently embedded into the top. Each junction box shall have the cover bolted into place when shipped. The covers and pentahead bolts shall not be shipped separately. Boxes shall be OUC stock # 046-08000. Order per OUC specifications. OUC data sheets are included at the end of this Item. The 13" X 24" secondary service pull box and cover shall be considered incidental to its respective 26 05 12 conduit installations.
- J. 10" X 15" flush to ground street light junction box and cover shall be light traffic rated (minimum 5000-pound wheel bearing weight). Junction box shall be tapered, have open flanged bottom, and the cover shall fasten down with at least one (1) pentahead stainless steel bolt. A polymer concrete ring and cover (or preapproved overhang device of another type) around the top shall act a concrete (side walk) lock in device. Covers shall have a non-skid surface and the "OUC ELECTRIC" logo permanently embedded into the top. Each junction box shall have the cover bolted into place when shipped. The covers and pentahead bolts shall not be shipped separately. Boxes shall be OUC stock #036-26039. Order per OUC specifications. OUC data sheets are included at the end of this Item. The 10" X 15" street light junction box and cover shall be considered incidental to the OUC Street Light 26 05 12 street light installation.
- K. 13" X 24" flush to ground secondary service junction box and cover shall be light traffic rated (minimum 5000 pound wheel bearing weight). Junction box shall be tapered, have open flanged bottom, and the cover shall fasten down with at least one (1) pentahead stainless steel bolt. A polymer concrete ring and cover (or preapproved overhang device of another type) around the top shall act a concrete (side walk) lock in device. Covers shall have a non-skid surface and the "OUC ELECTRIC" logo permanently embedded into the top. Each junction box shall have the cover bolted into place when shipped. The covers and pentahead bolts shall not be shipped separately. Boxes shall be OUC stock # 046-08000. Order per OUC specifications. OUC data sheets are included at the end of this Item. The 13" X 24" secondary service pull box and cover shall not be paid for separately and shall be considered incidental to its respective L-112 2" duct pay item.
- L. Street light controller shall be provided and installed by OUC. Post and other support materials by Contractor.
- M. Install all fixtures in accordance with manufacturers' written instructions, and the requirements of GOAA, OUC, NEC, IES and National Electrical Safety Code.
- N. Install lighting poles at locations indicated. Install poles plumb. On aluminum poles, provide double nuts to adjust plumb and grout around each base using non-shrink grout specified elsewhere. Install lamps in each luminaire. Bond luminaires, metal accessories and metal poles to branch circuit equipment grounding conductor as required by OUC standards. All grounding required by FDOT, GOAA, NEC and OUC is incidental to the OUC Street Light 26 05 12 (Civil) pay item. Provide supplementary grounding electrodes at each pole as required by FDOT and OUC standards. Grounding conductors and electrodes shall be considered incidental to the OUC Street Light 26 05 12 installation. Pole installation shall comply with wind loading criteria

stated on the plans. Duct sealing compound shall be installed to seal all conduits entering exterior light fixtures from underground.

- O. Street light pole ground rods shall be copper clad steel sectional type, 3/4" in diameter. 20' of ground rod shall be installed at each street light pole and 40' of ground rod at each street light service. Additional length of the rod shall be determined by earth resistance testing. Each rod shall be individually tested for a not to exceed earth resistance of 25 ohms prior to connection of the grounding conductors. Additional sections shall be added until the not to exceed value of 25 ohms is obtained. The Contractor shall perform the necessary inspection and test for these items concurrently with the installation because of subsequent inaccessibility of some components. Earth resistance test method shall be by the "Three Point Method" and the proposed method shall be submitted to the OAR for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the OAR. All grounding materials and installation is incidental to the 26 05 12 installation of which it is a component part.

3.13 ELECTRIC UTILITY SERVICES

- A. Electric Utility Service: Provide service post, primary disconnect, meter base, and secondary service fused disconnect per OUC requirements. Contractor shall confirm these requirements with OUC prior to start of work. OUC to provide high voltage transformers, primary cabling, and transformer grounding. Contractor shall furnish and install transformer pads and switch pads, all trenches and conduit from primary power manhole/pull box to transformer/switch and metering post. Utility to install transformers, primary feeders and transformer grounding. Contractor shall provide and install all transformer secondary cable, meter base, meter post equipment and electrical distribution equipment.
- B. The Contractor's installation shall comply with the requirements of GOAA, OUC, NEC, IES, National Electrical Safety Code and the Authority Having Jurisdiction. Contractor is responsible for obtaining all electrical permits and required inspections. The costs for permits and inspections shall be considered incidental to the respective pay item of which it is a component part. Contractor is responsible to furnish and install all materials and equipment to provide a fully operational electrical service in accordance with the contract documents and acceptable to the OAR.
- C. Ground rods shall be copper clad steel sectional type, 3/4" in diameter. The length of the rod shall be determined by earth resistance testing. Each rod shall be individually tested for a not to exceed earth resistance of 5 ohms prior to connection of the counterpoise or grounding conductors. Additional sections shall be added until the not to exceed value of 5 ohms is obtained. The Contractor shall perform the necessary inspection and test for these items concurrently with the installation because of subsequent inaccessibility of some components. Each ground rod shall be located and dimensioned on the As-built Drawings. Earth resistance test method shall be by the "Three Point Method" and the proposed method shall be submitted to the OAR for approval. Earth resistance testing results shall be recorded on an approved form

and testing shall be performed in the presence of the OAR. All grounding materials and installation is incidental to the 26 05 12 (Civil) pay item of which it is a component part.

PART 4 – METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The quantity of units to be paid for under this item (except duct) shall be the number of each type installed, complete and in place, ready for operation, and accepted by the OAR. Each unit shall include the installation of all incidentals and appurtenances as detailed in the Contract Documents.
- B. The quantity of duct to be paid for under this item shall be the linear feet of each type installed, complete and in place, ready for operation, and accepted by the OAR. Each duct installation shall include all incidentals and appurtenances as detailed in the Contract Documents.

PART 5 – BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

A. General

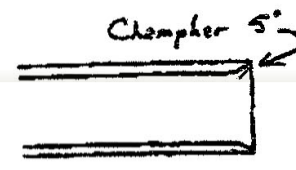
- 1. All work identified on the plans and described herein shall be the responsibility of the Contractor. The Contractor shall coordinate all work for underground OUC electric, street lighting and electrical service facilities. GOAA emergency generator primary power manholes, duct, grounding and all incidentals shall be paid for within the OUC pay items provided below. The following pay items have been developed for payment purposes to the Contractor. **The Contractor shall install a 4/0 bare copper ground wire as part of the 6" duct, pull box and manhole installation with no separate measurement or payment.** This price shall include all concrete, rebar, markers, tags, sealants, adhesives, gravel, sodding, excavation, backfill, dewatering, incidentals and appurtenances, etc., necessary for the complete installation of the item to the satisfaction of the OAR and OUC. This price shall be full compensation for furnishing all materials and for all preparation, assembly and installation of these materials, and for all appurtenances necessary to complete these items. Any incidental work items not specifically identified and not provided by OUC shall be part of the Contractor's work effort, and included as part of the pay items below with no separate identification and payment.

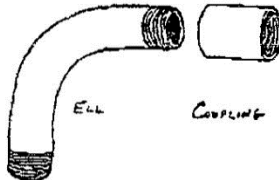
Item 26 05 12-5.1	1 W 2" Schedule 40 PVC OUC Direct Buried Streetlight Duct	- per Linear Foot (LF)

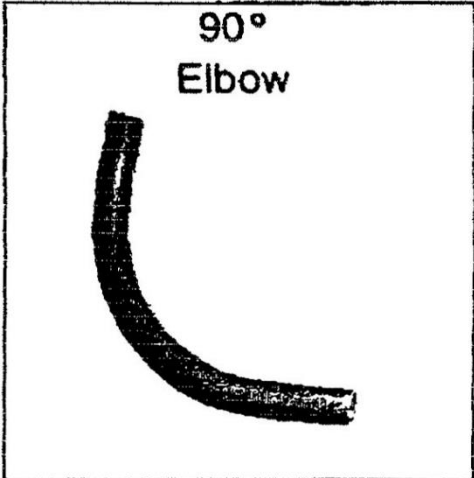
ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

OUC UNDERGROUND ELECTRIC
SECTION 26 05 12

Item 26 05 12-5.2	2 W 2" Schedule 40 PVC OUC Concrete Encased Streetlight Duct	- per Linear Foot (LF)
Item 26 05 12-5.3	1 W 6" Schedule 40 PVC OUC Concrete Encased Duct	- per Linear Foot (LF)
Item 26 05 12-5.4	2 W 6" Schedule 40 PVC OUC Concrete Encased Duct	- per Linear Foot (LF)
Item 26 05 12-5.5	4 W 6" Schedule 40 PVC OUC Concrete Encased Duct	- per Linear Foot (LF)
Item 26 05 12-5.6	8 W 6" Schedule 40 PVC OUC Concrete Encased Duct	- per Linear Foot (LF)
Item 26 05 12-5.7	12 W 6" Schedule 40 PVC OUC Concrete Encased Duct	- per Linear Foot (LF)
Item 26 05 12-5.8	10' X 20' X 8' OUC Aircraft Rated Manhole - Complete	- per Each (EA)
Item 26 05 12-5.9	10' X 20' X 8' OUC Aircraft Rated Manhole Elevation Adjustment, Existing Manhole to New Apron - Complete	- per Each (EA)
Item 26 05 12-5.10	OUC LED Street Light Assembly, Inclusive of Fixture, Arm, Pole, Wiring, Pull Box - Complete	- per Each (EA)
Item 26 05 12-5.11	OUC Street Service Point – Complete	- per Each (EA)
Item 26 05 12-5.12	OUC Transformer Pad – 250 kVA to 3,000 kVA – Complete	- per Each (EA)

Description / Requirements				SCHEDULE 40 AND 80 PVC CONDUIT																																																															
Conduit, PVC (Polyvinyl Chloride) Gray Electrical Grade - Schedule 40 is ordered in ten and twenty foot lengths - Schedule 80 in only 10 foot lengths. A coupling at one end is required and may be either a glued-on or expanded type (if expanded type is supplied, min. socket depth dimensions must comply with ASTM F512-95 Table 2). The end without coupling must have the inside lip edge chamfered 5 degrees to remove any sharpness from the edges (this requirement applies to both Schedule 40 and Schedule 80 conduit and all of the various diameter sizes). - Conduit must be shipped in bundles in a manner which allows unloading by a forklift (preferably on an open flatbed truck or trailer). - Order by type and size per above specifications.																																																																			
Bell End Dimensions (Inches): <table border="1"> <thead> <tr> <th rowspan="2">Size</th> <th colspan="2">Avg. Entrance</th> <th rowspan="2">Tolerance</th> <th rowspan="2">Out of Round</th> <th colspan="2">Socket Depth</th> </tr> <tr> <th>Diameter</th> <th>Diameter</th> <th>Min.</th> <th>Max.</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1.331</td> <td>1.320</td> <td>+/- 0.005</td> <td>0.060</td> <td>1.000</td> <td>1.750</td> </tr> <tr> <td>1 1/2</td> <td>1.921</td> <td>1.906</td> <td>+/- 0.006</td> <td>0.060</td> <td>1.375</td> <td>2.125</td> </tr> <tr> <td>2</td> <td>2.400</td> <td>2.381</td> <td>+/- 0.006</td> <td>0.060</td> <td>1.750</td> <td>2.500</td> </tr> <tr> <td>3</td> <td>3.538</td> <td>3.508</td> <td>+/- 0.008</td> <td>0.060</td> <td>2.875</td> <td>3.625</td> </tr> <tr> <td>4</td> <td>4.544</td> <td>4.509</td> <td>+/- 0.009</td> <td>0.100</td> <td>3.375</td> <td>4.125</td> </tr> <tr> <td>5</td> <td>5.614</td> <td>5.573</td> <td>+/- 0.010</td> <td>0.100</td> <td>4.000</td> <td>4.750</td> </tr> <tr> <td>6</td> <td>6.687</td> <td>6.636</td> <td>+/- 0.011</td> <td>0.100</td> <td>5.000</td> <td>5.750</td> </tr> </tbody> </table>								Size	Avg. Entrance		Tolerance	Out of Round	Socket Depth		Diameter	Diameter	Min.	Max.	1	1.331	1.320	+/- 0.005	0.060	1.000	1.750	1 1/2	1.921	1.906	+/- 0.006	0.060	1.375	2.125	2	2.400	2.381	+/- 0.006	0.060	1.750	2.500	3	3.538	3.508	+/- 0.008	0.060	2.875	3.625	4	4.544	4.509	+/- 0.009	0.100	3.375	4.125	5	5.614	5.573	+/- 0.010	0.100	4.000	4.750	6	6.687	6.636	+/- 0.011	0.100	5.000	5.750
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				Revision Date: 08 / 25 / 99 Category CONDUIT Page Identification No. CO-40																																																															

Description / Requirements	GALVANIZED CONDUIT ACCESSORIES	
- Couplings, galvanized conduit, 1 inch diameter to 6 inch diameter sizes. - Ells, 90 degree, galvanized conduit, 1 inch diameter to 6 inch diameter sizes. - Ells, 45 degree, galvanized conduit, 2 - 4 inch diameters only. - Ells, 11 and 22.5 degree, galv., in 4 inch and 6 inch diameters. - Sweep ells, galv., 3 ft. radius. Specify diameter and length. * All galvanized ells must have threads which will accept common PVC to galvanized female adapters.		
Details & OUC Stock No.	Manufacturer & Catalog No.	
Approved Manufacturers for galvanized conduit and conduit accessories are: Conduit Pipe Products, Picoma, Pittsburgh Nipple, Robroy, Shamrock and Wheatland.		
1 inch coupling	046-25110	See above -
2 inch coupling	046-25120	See above -
3 inch coupling	046-05130	See above -
4 inch coupling	046-05140	See above -
5 inch coupling	046-05150	See above -
6 inch coupling	046-05160	See above -
1 inch 90 degree ell	046-25210	See above - (min. radius 5 3/4")
2 inch 90 degree ell	046-05220	See above - (min. radius 9 1/2")
2 inch 45 degree ell	046-05320	See above - (min. radius 9 1/2")
2 1/2 inch 90 degree ell (St. Cloud)	046-55225	See above (radius 48")
3 inch 90 degree ell	046-05230	See above - (min. radius 13")
3 inch 45 degree ell	046-05330	See above - (min. radius 13")
4 inch 90 degree ell	046-05240	See above - (min. radius 16")
4 inch 45 degree ell	046-05340	See above - (min. radius 16")
4 inch 22.5 degree ell	046-05540	See above -
4 inch 11 degree ell	046-05440	See above -
5 inch 90 degree ell	046-05250	See above - (min. radius 24")
6 inch 90 degree ell	046-05260	~~See above - (min. radius 36")~~
6 inch 45 degree ell	046-05360	~~See above - (min. radius 36")~~
6 inch 22.5 degree ell	046-05560	~~See above -~~
6 inch 11 degree ell	046-05460	~~See above -~~
Conduit, 6 inch sweep ells	046-07031	See above - (36" radius)
DISCONTINUED		60" Radius <i>48" Radius</i> → See CO-705
ORLANDO UTILITIES COMMISSION Electric Engineering Standards Approved Material List	Date June 8, 1998 Category CONDUIT Page Identification No. CO-30 ✓	

DESCRIPTION / REQUIREMENTS	Sweep - SCH 40 PVC
	90° Elbow 
DETAILS & OUC STOCK NO.	MANUFACTURER & CATALOG NO.
Non-metallic SCH 40 PVC sweep with 90 degree bend.	
Size: 1" Radius: 5-3/4" (std) <u>046-26210</u>	See page CO-80
Size: 2" Radius: 9-1/2" (std) <u>046-26220</u>	See page CO-80
Size: 2" Radius: 24" <u>046-56221</u>	Cantex 5121019 Carlton UA9DJ
Size: 2" Radius: 48" <u>046-56222</u>	Cantex 5121075 Carlton UA9HJ
Size: 2-1/2" Radius: 24" <u>046-56225</u>	Cantex 5121028 Carlton UC9DKB
Size: 2-1/2" Radius: 36" <u>046-56226</u>	Cantex 5121016 Carlton UC9FKB
Size: 2-1/2" Radius: 48" <u>046-56227</u>	Cantex 5121030 Carlton UA9HK
Size: 3 Radius: 13" (Std) <u>046-06230</u>	See page CO-80
Size: 5" Radius: 48" <u>046-56251</u>	Cantex 5121025 Carlton UA9HP
Size: 6" Radius: ~~48"~~ <u>60"</u> <u>046-56261</u>	Cantex 5121026 <u>60" Radius</u> Carlton UA9HR
OUC / ST. CLOUD ELECTRIC ENGINEERING STANDARDS APPROVED MATERIAL LIST	DATE MAY 1, 1997 CATEGORY CONDUIT PAGE IDENTIFICATION NO. CO-705 ✓

Revision Date:

Description:

TAPE
WARNING
"RED"

Specs/Remarks:

Warning Tape for buried "Electric" cables - placed in ground as a warning device a short distance above underground cables and ducts, 4 mils thick, polyethylene, 6" wide x 1000' long. AREDA in color with Black printing. Marked: BURIED ELECTRIC LINE BELOW - CAUTION CAUTION CAUTION = (1 1/4" high) Call Orlando Utilities Commission 407-823-9150 = (3/4" high) BURIED ELECTRIC LINE BELOW (1 1/4" high)

Available Spec Sheets Online:

Manufacturer	Catalog # Revision Date	Revised By
MICHAEL ARNOLD REEF INDUSTRIES THOR ENTERPRISES	PER SPEC PER SPEC TERRA TAPE PER SPEC SHIELDTEC	AURSI AURSI AURSI
Engineering Contact(s)		
Mark Hoover Ric Dy-Liacco	mhoover@ouc.com rdyliacco@ouc.com	407-384-4173 407-384-4028
Purchasing Contact(s)		
Harvey Lippa Mark Ausley	hlippa@ouc.com mausley@ouc.com	407-737-4290 407-384-4080

[Provided by www.aursi.com](http://www.aursi.com)

Revision Date:

Description:

SHORTING CAP TWIST-LOCK

Specs/Remarks:

Available Spec Sheets Online:

Manufacturer	Catalog #	Revised By	Revision Date
FISHER PIERCE GE LAMPAS RIPLEY	S1039 C403G003 6120-SC 6005	AURSI AURSI AURSI AURSI	
Engineering Contact(s)			
Mark Hoover Ric Dy-Liacco	mhoover@ouc.com rdyliacco@ouc.com		407-384-4173 407-384-4028

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

OUC UNDERGROUND ELECTRIC
SECTION 26 05 12

Purchasing Contact(s)

Harvey Lippa
Mark Ausley

hlipa@ouc.com
mausley@ouc.com

407-737-4290
407-384-4080

[Provided by www.auris.com](http://www.auris.com)

Description:

BOX, FLUSH TO GROUND STREET LIGHT 10 X 15 INCH

Specs/Remarks:

Box and Cover, for streetlight cable connections, 10K "parkway" load rated. Approximate dimensions: 10 inches wide x 15 inches long (top measurements) x 12 inches deep. Box will be tapered and have an open flanged bottom and the cover will fasten down with at least one pentahead stainless steel bolt. A poly-mer concrete ring and cover around the top will act as a concrete (sidewalk) lock-in device. Covers will have a non-skid surface and the "OUC ELECTRIC" logo and "10K" (load rating) permanently embedded into the top. Each box will have the cover bolted (pentahead bolts) into place when shipped.

Available Spec Sheets Online:

Manufacturer	Catalog #	Revised By	Revision Date
ARMORCAST	A6001923AX12	Mark Hoover	11/7/2002

CARSON INDUSTRIES CDR SYSTEMS	1419-12-HP-PR-BL PA40-1015-12	AURSI AURSI

Engineering Contact(s)

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Ric Dy-Liacco

mhoover@ouc.com
rdyliacco@ouc.com

407-384-4173
407-384-4028

Purchasing Contact(s)

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Mark Ausley

hlipa@ouc.com
mausley@ouc.com

407-737-4290
407-384-4080

[Provided by www.auris.com](http://www.auris.com)

**AURSI - Online Approved Materials
Manual Orlando Utilities**

Commission

Stock #: 046-08000

Revision Date: 11/18/2002

Description:

BOX, FLUSH TO GROUND SECONDARY JUNCTION 13 X 24 INCH

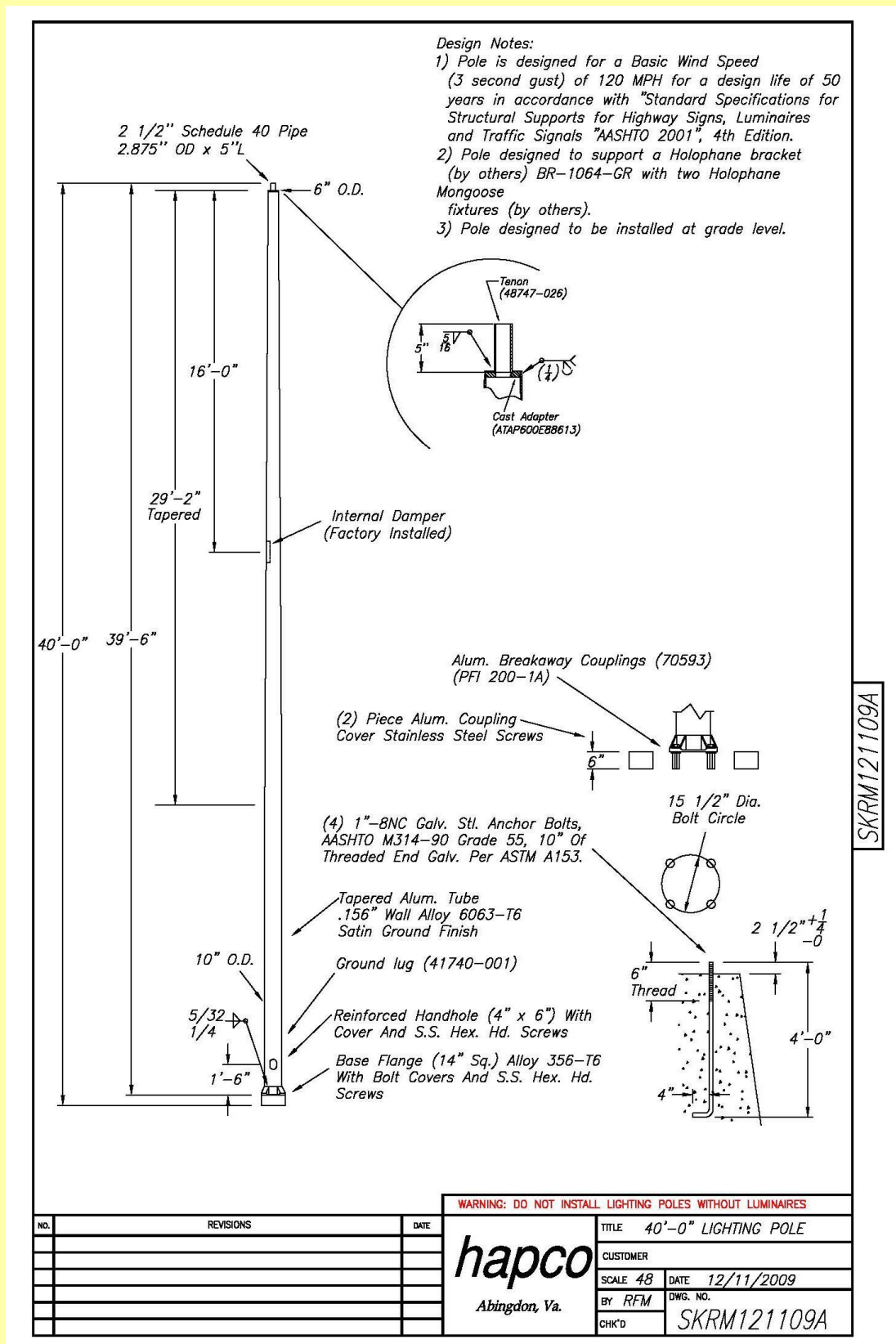
Specs/Remarks:

Box and cover - for secondary services, 10K "Parkway" load rated. Approximate dimensions: 13 inches wide x 24 inches long (top measurements) x 18 inches deep. Box will be tapered, have an open flanged bottom and the cover will fasten down with at least one pentahead stainless steel bolt. A polymer concrete ring and cover around the top will act as a concrete (sidewalk) lock-in device. Covers will have a non-skid surface and the "OUC ELECTRIC" logo and "10K" (load rating) permanently embedded into the top. Each box will have the cover bolted (with pentahead bolts) into place when shipped.

Available Spec Sheets Online:

Manufacturer	Catalog #	Revised By	Revision Date
ARMORCAST	A6001946AX18	Mark Hoover	11/7/2002
CARSON INDUSTRIES	1324-15-HP-BL	AURSI	
CDR SYSTEMS	PA10-1324-18	AURSI	
QUAZITE	PG1324BA18	AURSI	
Engineering Contact(s)			
Mark Hoover	mhoover@ouc.com	407-384-4173	
Ric Dy-Liacco	rdyliacco@ouc.com	407-384-4028	
Purchasing Contact(s)			
Harvey Lippa	hlipa@ouc.com	407-737-4290	
Mark Ausley	mausley@ouc.com	407-384-4080	

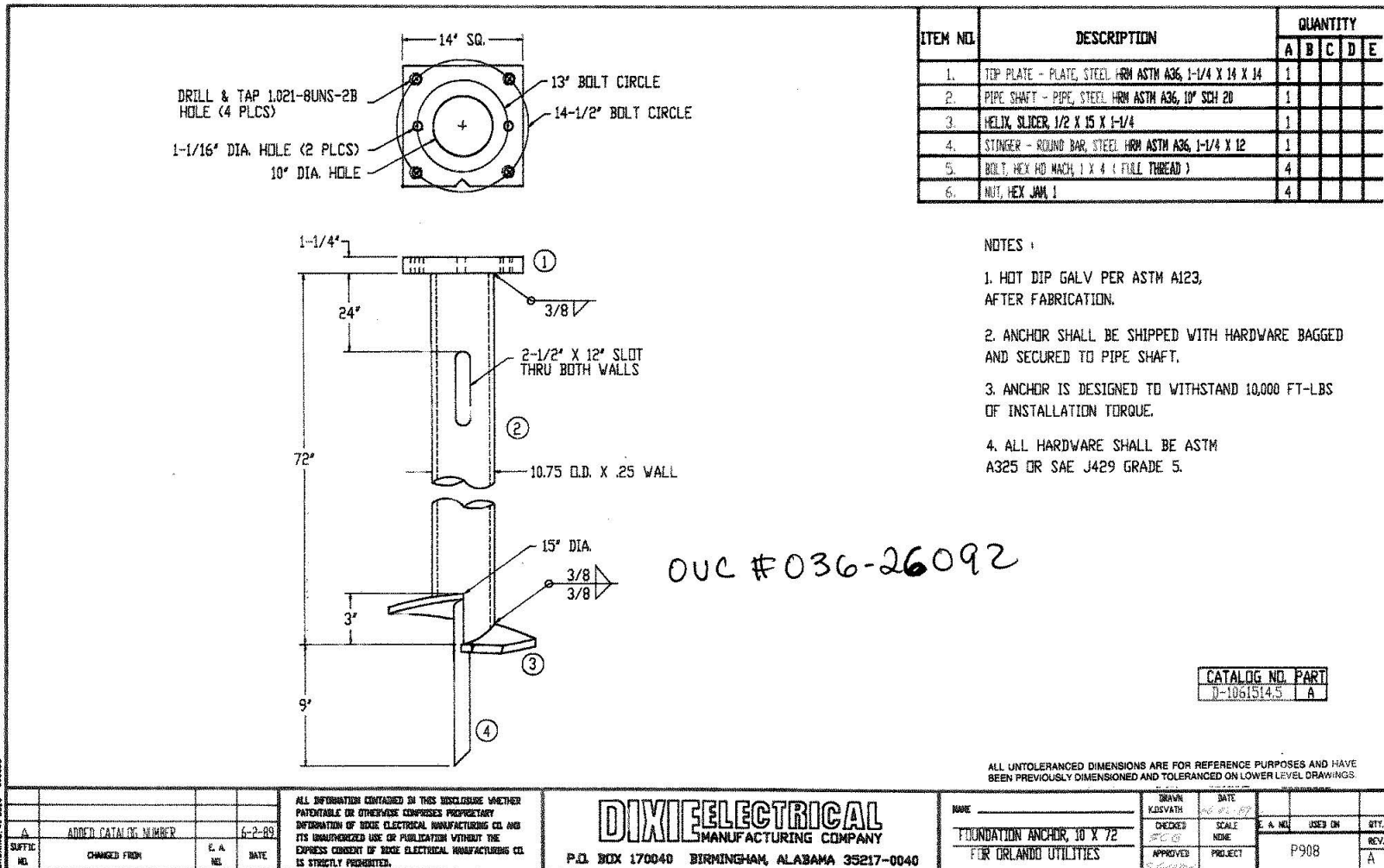
[Provided by www.aursi.com](http://www.aursi.com)



ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

OUC UNDERGROUND ELECTRIC
SECTION 26 05 12

USE WITH F-BASE 036-26089 ONLY



**Curlee
Machinery
Company, Inc.**

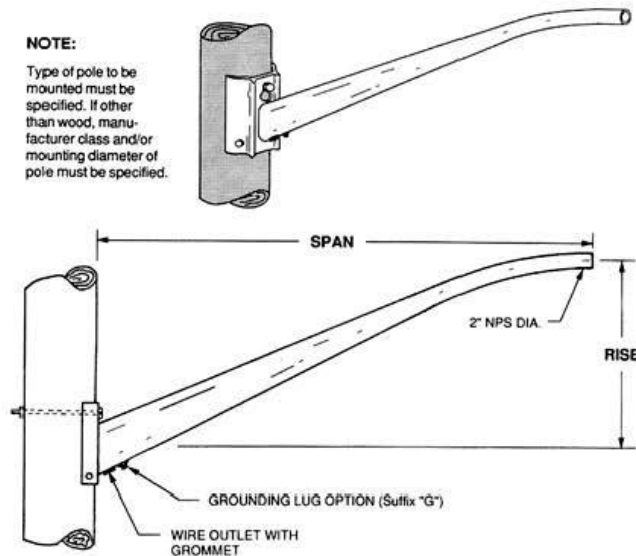
Home
What's New
Company
Information
Mounting
Specifications
**Tapered
Brackets**
Pipe Brackets
Floodlighting
"A" Frames &
Truss Designs

▶ Tapered Brackets

"Tapertruss" - Fabricated Aluminum Brackets for Wood, Concrete or Fiberglass Poles

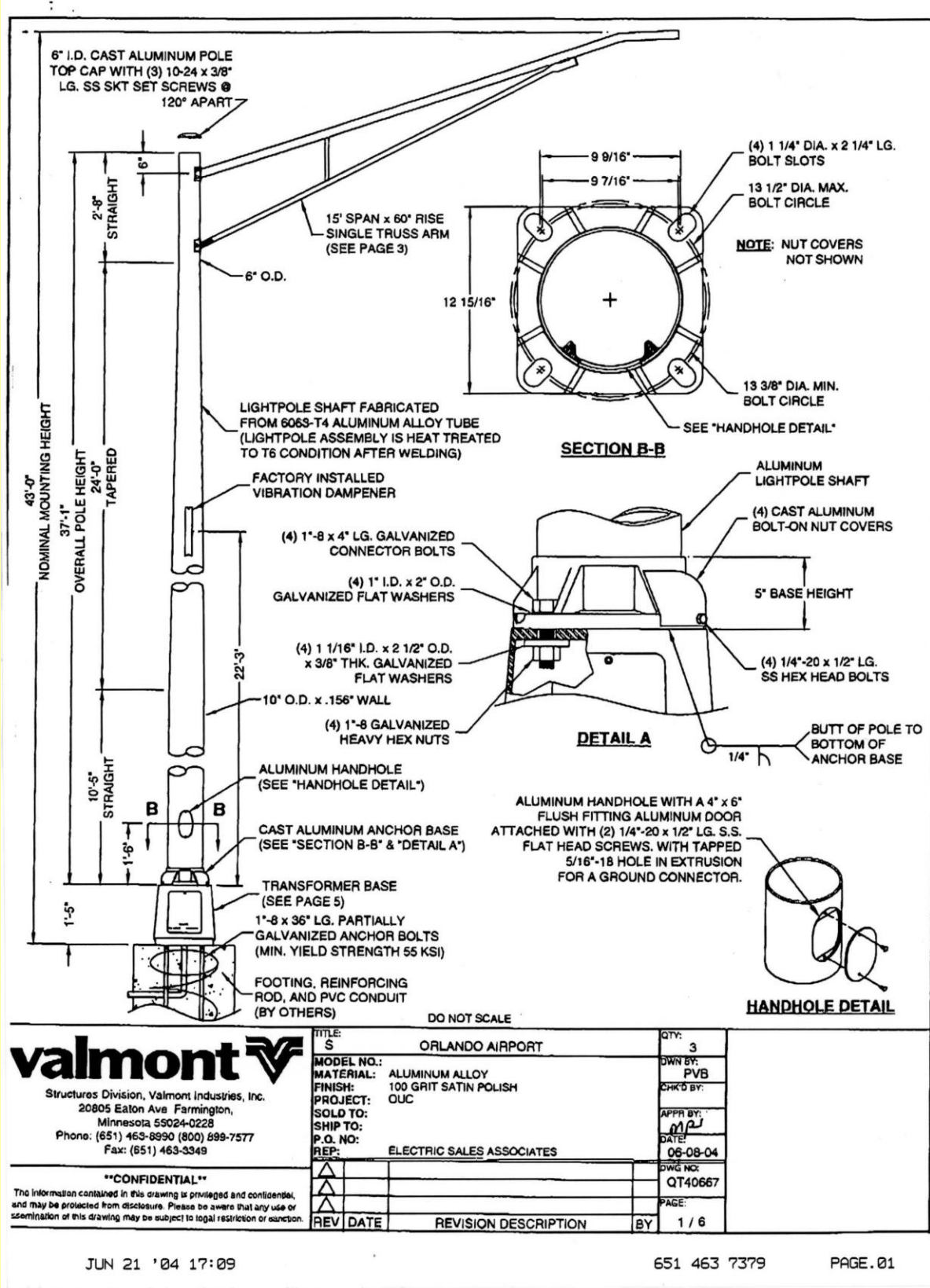
NOTE:

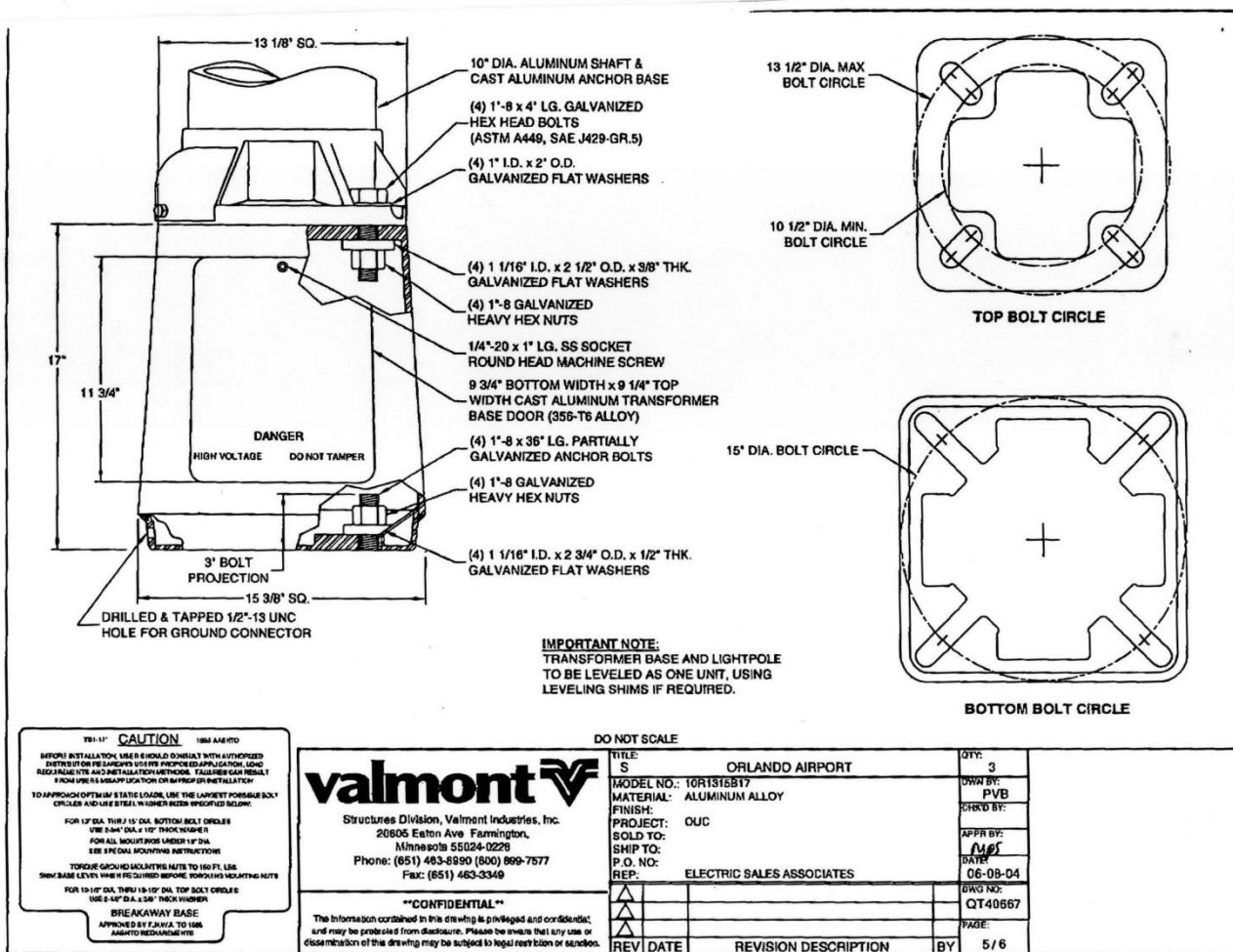
Type of pole to be mounted must be specified. If other than wood, manufacturer class and/or mounting diameter of pole must be specified.



CATALOG NO.	TYPE	SPAN	RISE
2004515T(G)	4 FT.	45"	15"
2006824T(G)	6 FT.	68"	24"
2009032T(G)	8 FT.	90"	32"
20011439T(G)	10 FT.	114"	39"
20013846T(G)	12 FT.	138"	46"

"Tapertruss" - Fabricated Aluminum Brackets





END OF SECTION 26 05 12

SECTION 26 05 19 – BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of Building Wire and Cable.

1.3 DESCRIPTION

- A. Provide all equipment, labor, material, accessories, and mounting hardware to properly install all conductors and cables rated 600 volts and less for a complete and operating system for the following:
 - 1. Building wire and cable.
 - 2. Wiring connectors and connections.
- B. No aluminum conductors shall be permitted.
- C. All sizes shall be given in American Wire Gauge (AWG) or in thousand circular mils (MCM/KCMIL).

1.4 SUBMITTALS

- A. Product Data: Submit catalog cut sheet showing, type and UL listing of each type of conductor, connector and termination.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

- B. Conform to the requirements of ANSI/NFPA 70.

1.7 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Record actual routing on red lined as-builts.
- E. Conductors with different voltages (i.e., 120 volt and 277 volt) shall not be combined in the same conduit without prior written approval from OAR and Engineer.
- F. Conductors for each branch of power (Normal, Life safety, Critical, Security, and Equipment) shall be installed in its own dedicated raceway system.

1.8 COORDINATION

- A. Determine required separation between cable and other work.
- B. Coordinate cable routing to avoid interference with other work disciplines.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

- A. Description: Single conductor insulated wire.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: ANSI/NFPA 70, Type THHN/THWN-2 and XHHW-2.
- E. Cable supports shall be O Z/Gedney Type "S" or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- C. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).
- D. Conductors #12 AWG and #10 AWG shall be 600 volt type THHN/THWN-2, solid unless specifically noted otherwise, rated 90 degrees C. dry.
- E. Use conductor not smaller than 12 AWG for power and lighting circuits.
- F. Provide dedicated neutral conductor for each branch phase conductor for 120V and 277V circuits (power and lighting). Multi-pole breakers to comply with NEC 210.4 are not permitted.
- G. Use 10 AWG conductors minimum for 20 ampere, 120 volt branch circuits longer than 75 feet (23 m). See General Notes on drawings for additional requirements.
- H. Use 10 AWG conductors minimum for 20 ampere, 277 volt branch circuits longer than 200 feet (61 m). See General Notes on drawings for additional requirements.
- I. All conductors shall be installed in raceway.
- J. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit unless noted otherwise on the drawings or in these specifications.
- K. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.
- L. Where oversized conductors are called for due to voltage drop, etc., provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.
- M. For all service entrance feeders (Normal and Emergency Transformers feeding drawout switchgear), provide current limiter at both ends of each phase conductor.

3.2 EXAMINATION

- A. Verify that interior of building has been protected from weather.

- B. Verify that mechanical work likely to damage wire has been completed.

3.3 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.4 WIRING METHODS

- A. Use only building wire, 90° C THHN (dry locations) and THWN-2 (wet or dry locations) for ampacity adjustments purposes, using NEC Section 310.15.
- B. Wiring in vicinity of heat producing equipment: Use only XHHW-2 insulation, in raceway.
- C. Conductors installed within fluorescent fixture channels shall be Type THHN or XHHW-2, rated 90 degrees C dry. Conductors for all other light fixtures shall have temperature ratings as required to meet the UL listing of the fixture; however, in no case shall the temperature rating be less than 90 degrees Centigrade. Remove incorrect insulation types in new work.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 26 05 53 Identification for Electrical Systems.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.
- C. Identify neutrals with its associated circuit number(s) per NEC Article 210.4(D).

3.6 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of the General Requirements of the Contract Documents and Section 26 08 13 Tests and Performance Verification.
- B. Inspect wire for physical damage and proper connection.
- C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- D. Verify continuity of each branch circuit conductor.
- E. Submit "Conductor Insulation Resistance Test" form as required in Section 26 08 13.

3.7 VERTICAL RISERS

- A. Provide vertical cable riser supports per Article 300-19 in NFPA 70. These shall be located in accessible pullboxes of adequate size. Provide for adequate structural connection of cable supports to pullbox, which will transfer cable weight to building.

3.8 PULLING

- A. No wire shall be pulled until the conduit system is complete from pull point to pull point and major equipment terminating conduits have been fixed in position.
- B. Mechanical pulling devices shall not be used on conductors sized #8 and smaller. Pulling means which might damage the raceway shall not be used.
- C. Use only powdered soapstone or other pulling lubricant acceptable to the Designer/OAR. Compound or lubricant shall not cause the conductor or insulation to deteriorate.
- D. All conductors to be installed in a common raceway shall be pulled together. The manufacturer's recommended pulling tensions shall not be exceeded.
- E. Bending radius of insulated wire or cable shall not be less than the minimum recommended by the manufacturer.
- F. Where coaxial type conductors are installed, special requirements shall apply as outlined under that specific system detail specifications.
- G. Where control or signal circuits with a lower insulation rating enter an enclosure with conductors having a 600 volt or higher insulation rating, a separate wire way will be installed or proper clearance distance will be maintained per NEC.
- H. All conductors shall be pulled in conduits by industry approved cable pulling "tuggers" equipment. The use of construction equipment such as fork lifts, tractors and other vehicles will not be allowed. All conductors will be routed and protected by using the proper pulleys and sheaves.

3.9 CONTROL AND SIGNAL CIRCUITS

- A. For control and signal circuits above 50 VAC, conductors shall be #14 AWG minimum size, Type XHHW-2 or THHN/THWN-2 as permitted by NFPA 70, within voltage drop limits, increased to #12 AWG as necessary for proper operation.
- B. For control and signal circuits 50 VAC and below, conductors, at the Contractor's option, may be #16 AWG, 300 volt rated, PVC insulated, except where specifically noted otherwise in the contract documents.

- C. Conductor insulation for fire alarm systems shall be as approved by Code Inspection Authority only. Wire approvals by the Designer/OAR shall not supersede this final approval for conditions of this specific project.
- D. Install circuit conductors in conduit.
- E. Circuit conductors #8 AWG and larger to be stranded.

3.10 COLOR CODING

- A. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape in all junction boxes and panels. Tape shall completely cover the full length of conductor insulation within the box or panel.
- B. Unless otherwise approved or required by DESIGNER to match existing, color-code shall be as follows: Neutrals to be white for 120/208V system, natural grey for 277/480V system; ground wire green, bare or green, insulated ground conductor green with yellow tracer. 120/208V, Phase A - black; Phase B - red; Phase C - blue. 480/277V, Phase A brown; Phase B - orange; Phase C - yellow. All switch legs, other voltage system wiring, control and interlock wiring shall be color-coded other than those above.

3.11 TAPS/SPLICES/CONNECTORS/TERMINATIONS

- A. Taps and splices are not acceptable unless specifically noted otherwise on drawings or special written approval is granted by Designer/OAR. (See 3.1K) Submit locations, sizes, etc., where taps will be necessary to coordinate with lug sizes/quantities for review and approval prior to installation.
- B. Clean conductor surfaces before installing lugs and connectors.
- C. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- D. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes, or equipment enclosures where sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without special written approval of OAR).
- E. Splices in lighting and power outlet boxes, wireway, and troughs shall be kept to a minimum, pull conductors through to equipment, terminal cabinets, and devices.
- F. No splices shall be made in junction box, and outlet boxes (wire No. 8 and larger) without written approval of OAR.

- G. No splices shall be made in communications outlet boxes, pull boxes or wireways (i.e., fire alarm, computer, telephone, intercom, sound system, etc.) without written approval of OAR. Pull cables through to equipment cabinets, terminal cabinets and devices.
- H. No splices shall be made in circuits of #8 AWG conductors or larger of 1000 feet or less without written approval of the OAR.
- I. Allow adequate conductor lengths in all junction boxes, pull boxes and terminal cabinets. All termination of conductors in which conductor is in tension will be rejected and shall be replaced with conductors of adequate length. This requirement shall include the providing by the Contractor of sleeve type vertical cable supports in vertical raceway installations provided in pullboxes at proper vertical spacings.
- J. A calibrated torque wrench shall be used for all bolt tightening. A torque mark should be used after torqueing is performed. Torque mark should consist of a permanent mark over the mechanical lug, bolt, nut, etc.
- K. Interior Locations:
 - 1. All (non-electronic systems) copper taps and splices in No. 8 or smaller shall be fastened together by means of "Screw-on spring type (wire nut)" connectors. All "Push-in" or "Stab-in" type connectors are prohibited. All taps and splices in wire larger than No. 8 shall be made with compression type connectors approved by OAR and taped to provide insulation equal to wire.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 19 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 19. The work described in Specification 26 05 19 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 19

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SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of grounding and bonding.

1.3 DESCRIPTION

- A. Provide all labor, materials, and equipment necessary to properly install a grounding system conductor in all new branch wiring and feeder installations that shall be in full compliance with all applicable Codes as approved by the authorities having jurisdiction. The secondary distribution system shall include a grounding conductor in all raceways in addition to the return path of the metallic conduit.
- B. In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated or bare copper system grounding conductor in accordance with specific rules of Article 250 of the N.E.C. and State codes. Bonding conductor through the raceway system shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel grounding bar of each panelboard to branch circuit equipment and devices.
- C. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed with-in conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders in PVC conduit outside of building(s) shall be bare only.
- D. Section Includes
 - 1. Grounding electrodes and conductors.
 - 2. Equipment grounding conductors.
 - 3. Bonding.
 - 4. Counterpoise System
 - 5. Ground Ring.

1.4 SUBMITTALS

- A. Submit catalog cut sheet showing brand and selection for all conductors, test wells, components, etc., as specified herein showing that all materials are UL listed and labeled as applicable and manufactured in the United States.
- B. Product data shall prove compliance with Contract Documents, National Electric Code, Underwriters Laboratories, manufacturer's specifications, manufacturer's written installation data and compliance with all performance criteria.
- C. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.
- D. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
- E. Show all dimensions, colors, configurations, covers and applicable labeling/stamping.
- F. Record actual locations of grounding electrodes on red lined as-built documents.
- G. Submit test results of each ground rod. See Section 26 08 13.

1.5 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- B. Conform to requirements of ANSI/NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 ROD ELECTRODE

- A. Material: Copper-clad steel.
- B. Diameter: 3/4 inch.
- C. Length: 30 feet minimum. Increase lengths as required to achieve specified resistance.

2.2 MECHANICAL CONNECTORS

- A. All grounding connectors shall be in accordance with UL 467 and UL listed for use with rods, conductors, reinforcing bars, etc., as appropriate.

- B. Connectors and devices used in the grounding systems shall be fabricated of copper or bronze materials, and properly applied for their intended use. Specified items of designated manufacturers indicate required criteria and equal products may be provided if approved. All connectors and devices shall be compatible with the surfaces being bonded and shall not cause galvanic corrosion by dissimilar metals. Materials in items not listed herein shall be of equal quality to the following specified items:
 - 1. Lugs: substantial construction, of cast copper or cast bronze, with "ground" (micro-flat) surfaces equal to Burndy QQA-B Series, two hole, T&B, or approved substitution. Light weight and "competitive" devices shall be rejected.
 - 2. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or approved substitution.
 - 3. Piping Clamps: Burndy "GAR-TC series" with two hole compression lug under U-Bolt nut, or T&B, or approved substitution.
 - 4. Grounding Screw and Pigtail: Raco No. 983 or approved substitution.
 - 5. Fastening hardware: Grade 5 silicone bronze with beveled washers. Copperplate is not acceptable
- C. Mechanical lugs or wire terminals shall be used to bond ground wires together or to junction boxes and panel cabinets and shall be manufactured by Anderson, Buchanan, Thomas and Betts Co., or Burndy.

2.3 WIRE

- A. Material: Stranded copper.
- B. Size: Size to meet NFPA 70 requirements as a minimum, increase size if called for on drawings, in these specifications, or as required for voltage drop.
- C. Insulated THWN (or bare as noted elsewhere).

2.4 GROUNDING WELL COMPONENTS

- A. Grass Non-Traffic Areas:
 - 1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with open.
 - 2. Well Cover: High density plastic, composolite, or cast iron with legend "GROUND" embossed on cover.
 - 3. Material: Structural Plastic, composolite, or concrete.
 - 4. Manufacturer: Brooks Products 70 Series or equal by Quazite or approved substitution.
 - 5. Increase depth, diameter or size as required to provide proper access at installed location.

B. Paving and Low Traffic Areas:

1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with open bottom.
2. Well Cover: Traffic rated for use with "GROUND" embossed on cover.
3. Material: Composolite.
4. Manufacturer: Quazite or approved substitution.
5. Increase depth, diameter or size as required to provide proper access at installed location.

2.5 GROUNDING BARS/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BARS AND GROUND BUS BARS)

- A. Ground bars shall be copper of the size and description as shown on the drawings. If not sized on drawings, bus bar shall be minimum 1/4" x 2" bus grade copper, spaced from wall on insulating 2" polyester molded insulator standoff/supports, and be 12" or greater minimum overall length, allowing 2" length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2" spacing. Size of bus bar used in main electrical room shall be similar except minimum of 4" high and 24" long.
- B. Provide bolt tapping lug with two hex head mounting bolts for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2 inches on center spacing. Lugs to be manufactured by Burndy, T&B or approved substitution.
- C. Bus bar shall have rows of holes in accordance with NEMA Standards for specified lugs.
- D. Standoff supports to be 2" polyester as manufactured by Glastic #2015-4C or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding electrodes conductor, bonding conductors, ground rods, etc. with all required accessories.
- C. Grounding shall meet (or exceed as required to meet these specifications) all the requirements of the N.E.C., the NFPA, and applicable standards of IEEE.
- D. Where there is a conflict between these specifications and the above applicable codes or standards, or between this section and other specifications sections then the most stringent or excessive requirement shall govern. Where there is an omission of a code/standard requirement in these specifications then the code/standard requirements shall be complied with.

- E. Requirement in these specifications to comply with a specific code/standard article, etc. is not to be construed as deleting of requirements of other applicable codes/standards and their articles, etc.
- F. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 GROUNDING ELECTRODES

- A. All connections shall be exothermic welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by bracing or clamping with devices UL listed as suitable for use except in locations where exothermic welding is specifically specified in these specifications or called for on drawings.
- B. Each rod shall be die stamped with identification of manufacturer and rod length.
- C. Install rod electrodes at locations indicated and/or as called for in these specifications.
- D. Ground Resistance:
 - 1. Main Electrical Service (to each building and Site) and Generator Locations:
 - a) Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.
 - 2. Lightning Protection Ground Locations:
 - a) Lightning Protection system ground locations shall not exceed 5 ohms measured at ground electrode.
 - 3. Site Distribution Counterpoise Ground Locations:
 - a) Counterpoise system ground locations shall not exceed 25 ohms measured at ground electrode.
 - 4. Other Locations:
 - a) Resistance to ground of all non-current carrying metal parts shall not exceed 25 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.
 - 5. Resistance called for above shall be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two (2) or more ground rod electrodes at each location, then the resistance specified above shall be the maximum resistance with two (2) or more rods connected together but not connected to the grounding electrode conductor.

- E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor).
- F. Provide grounding well with cover at each rod location, with the only exception being a site distribution counterpoise ground rod. Install grounding well top flush with finished grade.
- G. Install ground rods not less than 1 foot below grade level and not less than 2 feet from structure foundation.

3.3 GROUND RESISTANCE AT LOCATION OTHER THAN LOCATION OF GROUNDING ELECTRODES.

- A. Resistance to ground of all non-current carrying metal parts shall not exceed 25 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

3.4 GROUNDING ELECTRODE CONDUCTOR

- A. Conductor shall be sized to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.66.

3.5 EQUIPMENT GROUNDING CONDUCTOR

- A. Grounding conductors shall be provided with every circuit to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.122.
- B. At every voltage level, new portions of the electrical power distribution system shall be grounded with a dedicated copper conductor which extends from termination back to power source in supply panelboard.
- C. Provide separate, insulated (bare if with feeder in PVC conduit) conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- D. Except as otherwise indicated, each feeder raceway on the load side of the service entrance shall contain a ground conductor sized as indicated and where not shown shall be sized to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.122. Conductor shall be connected to the equipment grounding bus in switchboards and panelboards, to the Grounding Bus in all motor control centers, and as specified, to lighting fixtures, motors and other types of equipment and outlets. The ground shall be in addition to the metallic raceway and shall be connected, using a lug device located within each item enclosure at the point of electric power connections to permit convenient inspection.

- E. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect receptacle ground terminal to the box.
- F. All plugstrips and metallic surface raceway shall contain a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.
- G. Where integral grounding conductor is specified elsewhere in bus duct construction, provide equivalent capacity conductor from supply switchboard or panelboard grounding bus to the bus duct grounding conductor. Bond integral conductor to bus duct enclosure at each tap and each termination.
- H. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with approved connectors regardless of conduit size or type. This shall include "Equipment by Owner" to which an electric conduit is provided under this Division.

3.6 MAIN ELECTRICAL SERVICE

- A. Complete installation shall meet or exceed the requirements of the NEC 250.
- B. Artificial electrodes shall be provided for the main service in sufficient number and configuration to secure resistance specified.
- C. Provide and bond to all of the following:
 - 1. Ground rods.
 - 2. Metal water pipe.
 - 3. Building metal frame, structural steel or reinforced structural concrete.
 - 4. Encased Electrodes.
 - 5. Ground ring.
 - 6. Site distribution counterpoise ground system.
 - 7. Lightning protection system.
- D. A main ground, bare copper conductor, sized per NEC Table 250.66, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to the building steel in respective building. This ground conductor shall also be run individually from the main switchgear and be bonded to the main water service ahead of any union in pipe and must be metal pipe of length and location as acceptable by authorities having jurisdiction. Provide properly sized bonding shunt around water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:

1. Three 30 ft. ground rods in a delta configuration at no less than 30 ft. spacing driven to a minimum depth of 30 feet, one foot below grade.
 2. Bond ground rod electrodes together with a bare copper ground conductor that matches size required by NEC Table 250.66, but in no case less than #2/0.
 3. Provide additional rod electrodes as required to achieve specified ground resistance.
- E. Ground/bond neutral per NEC 250.
- F. A main ground, bare copper conductor, sized per applicable Table in NEC 250, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to a concrete encased electrode per NEC 250.52(3).
1. For New Buildings: Provide and install and bond to concrete encased electrode in compliance with the NEC.
 2. For Existing Buildings: Bond to existing concrete encased electrode when available.
- G. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.
- H. Provide and install ground bus bar on wall near main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per NEC Table 250.66.

3.7 TRANSFORMER GROUNDING

- A. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.
1. Ground per NEC 250 and these specifications.
 2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per NEC Table 250.66.
 3. Connect transformer neutral/ground to grounding electrode per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
 4. In addition to connection to grounding electrode conductor called for above, provide supplemental grounding electrode as follows:
 - a) Where grounding required per NEC 250.30 is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
 - b) Where grounding connection required per NEC 250.30 is to grounded metal water pipe, supplement with connection to building steel/structure in addition to any other available electrodes specified in NEC 250.50 and 250.52.

- c) Where supplemental grounding electrodes required above is a ground rod electrode, provide two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven full length into the earth one foot below grade.
 - 5. Where neither building steel nor water pipe grounding electrodes are available (i.e., exterior locations with no available water pipe electrode) provide two (2) ground connections: each 30 ft. ground rod electrodes at not less than 30 ft. spacing, driven full length into the earth one foot below grade.
 - 6. Where transformer is mounted to exterior of building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system.
- B. Provide additional ground electrodes as required to achieve specified ground resistance.
- C. Where two or more ground electrodes are used at any required ground location, they shall be bonded together with a copper ground conductor, sized to meet NEC Table 250.66, but in no case less than #2/0.
- D. Complete installation shall meet or exceed the minimum requirements of NEC 250.
- E. Equipment ground conductors shall be provided in addition to above grounding. See 'EQUIPMENT GROUNDING CONDUCTOR', NEC 250.122.
- F. Provide ground bus bar on wall near transformer (or in associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per NEC Table 250.66.
- G. Multiple separately derived systems may be grounded as allowed in NEC 250.-30(A)(4).

3.8 GENERATOR GROUNDING

- A. Separately derived systems (i.e., systems where generator neutral is not solidly interconnected to service supplied system neutral such as 4 pole switched neutral transfer switch systems).
- 1. Ground per NEC 250.20, 250.30, 250.66 and these specifications.
 - 2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per NEC Table 250.66.
 - 3. Connect generator neutral/ground to grounding electrodes per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
 - 4. In addition, provide supplemental grounding electrode as follows:
 - a) Where grounding required per NEC 250.30 is to building steel/structure, supplement with connection to nearest available effectively grounded metal water pipe.

- b) Where grounding connection required per NEC 250.30 is to grounded metal water pipe, grounding with connection to other electrodes specified in NEC 250.50 and 250.52.
 - c) Where supplemental grounding electrode required above is a ground rod electrode, provide two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 foot below grade.
- 5. Where neither building steel nor water pipe grounding electrodes are available provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 foot below grade.
 - 6. Where generator is mounted to exterior of building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in Paragraph 3.8 A.5. This ground rod electrode shall also be connected to counterpoise system.
- B. Provide additional ground electrodes as required to achieve specified ground resistance.
 - C. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet NEC Table 250.66, but in no case less than #2/0.
 - D. Complete installation shall meet or exceed the minimum requirements of NEC 250.
 - E. Equipment ground conductors shall be provided in addition to above grounding. See 'EQUIPMENT GROUNDING CONDUCTOR'.

3.9 LIGHTNING PROTECTION SYSTEMS

- A. Ground per Section 26 41 13 – Lightning Protection for Structures, NFPA 780, and as specified herein. The most stringent requirements shall govern.
- B. Bond lightning protection system grounds to electrical service system ground, and counterpoise system ground where provided.

3.10 EXTERIOR GRADE (OR FREE STANDING ABOVE GROUND) MOUNTED EQUIPMENT

- A. General:
 - 1. All equipment mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.

2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by NEC Table 250.66 based on equipment feeder size, but in no case shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.
- B. Main electrical service rack mounted equipment.
1. Ground per "MAIN ELECTRICAL SERVICE".
 2. Bond all metal parts as noted in this section.
- C. Electrical sub service rack mounted equipment.
1. Ground per "MAIN ELECTRICAL SERVICE", except do not bond neutral to ground.
 2. Bond all metal parts as noted in this section.
- D. Electrical equipment connection rack mounted equipment.
1. Bond all metal parts as noted in this section.
- E. Grounding electrodes (ground electrodes system) shall be:
1. Located at each rack location.
 2. For service equipment: Ground electrode required per "MAIN ELECTRICAL SERVICE".
 3. For equipment connection: Two or more 30 ft. ground rods at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade. Bond ground rods together with a size to meet NEC Table 250.66, but no less than a #2 copper ground conductor. Provide additional rod electrodes as required to achieve specified ground resistance.
- F. Complete installation shall meet or exceed the minimum requirements of NEC 250 and, when applicable, NFPA 78.

3.11 ROOF MOUNTED EQUIPMENT

- A. Bond all roof mounted electrical equipment to lightning protection system (when provided) per NFPA 780.

3.12 LIGHTING FIXTURES

- A. All new and reinstalled fixtures shall be provided with green grounding conductor, solidly connected to unit. Individual fixtures grounds shall be with lug to fixture body, locate at point of electrical connection to the fixture unit.

- B. All suspended fixtures and those supplied through flexible metallic conduit shall have green ground conductor from outlet box to fixture. Cord connected fixtures shall contain a separate green ground conductor.

C. Pole Light Fixtures:

1. Metal Pole Light Fixtures:

- a) Freestanding pole mounted lighting fixtures shall each have a - Class I or Class II Materials - lightning protection main copper down conductor connected to grounding electrodes at base of pole.
- b) Conductor shall be bonded to metal pole via UL Listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).

2. Concrete or Non-Metallic Pole:

- a) Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
- b) Conductor shall be extended from grounding electrode to top of pole and terminate at the top of pole in a Class I or Class II copper lightning protection air terminal.
- c) Each metal part of light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to pole shall be bonded to down conductor.

3. Fixtures located on elevated roadway ramps: provide with a connection to lightning counterpoise grounding system.

4. Grounding electrode(s) at each pole shall be bonded to site distribution counterpoise system.

5. Grounding Electrodes:

- a) Two or more 30 ft. ground rods at no less than 30 ft. spacing shall be driven full length into the earth one foot below grade.
- b) Bond ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.
- c) Provide additional rod electrodes as required to achieve specified ground resistance.
- d) Two (2) or more grounding rod electrodes shall be installed at each light pole.

6. Installation shall exceed minimum requirements of NFPA 780.

3.13 PULLBOX, MANHOLE, HANDHOLE GROUNDING.

- A. One 30 ft. ground rod electrode shall be driven vertically to a minimum depth of 30 ft. plus 1 ft. below grade in each manhole, handhole or pullbox (in ground).

- B. The complete installation shall exceed the minimum requirements of the NEC.
- C. Provide additional ground rod electrodes as required to provide resistance called for herein.
- D. Where more than one ground rod electrode is required bond the two or more ground rod electrodes together with a copper ground conductor as called for under 'Counterpoise System.'
- E. Bond to counterpoise system.
- F. Bond grounding electrode to all exposed metal parts of manhole, handhole, pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or UL approved grounding clamp. Provide minimum 3 ft. slack ground cable on cover connection to facilitate removal of cover.

3.14 HAZARDOUS LOCATIONS

- A. Grounding in hazardous locations shall be done in accordance with applicable portions of Articles 500, 501, 502, 503, 511 and 514 of the National Electrical Code.

3.15 GROUND RING

- A. Provide complete underground building perimeter ground ring system, completely encircling building.
- B. Install minimum 24" depth into earth.
- C. Install ground rods (minimum 30 ft. long) every 150 feet section of ground ring conductor.
- D. Bond ground ring to building steel every 150 feet of building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.
- E. Bond to building service and counterpoise ground systems.

3.16 MISCELLANEOUS GROUNDING CONNECTIONS

- A. Provide bonding to meet regulatory requirements.

- B. Required connections to building steel shall be with UL approved non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will affect the structural properties of the steel.
- C. Install grounding conductors to permit shortest and most direct path from equipment to ground; install in conduit; bond to conduit at both ends when conduit is metal; have connections accessible for inspection; and made with approved solderless connectors brazed (or bolted) to is bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrodes conductor shall be exothermically welded to ground rods, water pipe, and building steel.
- D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point shall be painted.
- E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.
- F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.
- G. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all subdistribution and branch circuit panels with conductors in accordance with Table 250.122 of NEC for parallel return with respective interior grounding conductor.
- H. Grounding provisions shall include double locknuts on all heavywall conduits.
- I. Install grounding bus in all existing panelboards of remodeled areas, for connection of new grounding conductors, connected to an approved ground point.
- J. Bond together reinforcing steel and metal accessories in pool and fountain structures and bond to electrical system per NEC.
- K. Where reinforced concrete is utilized for building grounding system, proper reinforced bonding shall be provided to secure low resistance to earth with "thermite" type devices, and #10AWG wire ties shall be provided to not less than ten (10) full length rebars which contact the connected rebar. Provide size and length of rod to meet NEC requirements.

3.17 GROUNDING BAR/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BAR ON GROUND BUS/BAR) INSTALLATION

- A. Where indicated on the drawings, provide grounding bar/ground bus (bus bar). Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.
- B. Mount bolt tapping lugs with hex head bolts to bus bar at 2" o.c. spacing, one for each ground conductor.
- C. Mount bus bar to wall using 2" polyester molded insulator stand-off.
- D. Extend a #2/0 (minimum size) or larger THWN insulated copper ground conductor (if larger size is called for on drawings or required by N.E.C. for service ground, etc.) in PVC conduit to approved service ground installation or ground bus/bar in main service equipment enclosure.
- E. Extend #6 insulated copper ground wire from respective bus/bar to each 'local' ground bus/bar in each cabinet for system.
- F. 'SYSTEMS' grounding bus/bar must be connected with #2/0 insulated copper conductor to grounding electrodes system as defined in NEC "Article 800.40.

3.18 COUNTERPOISE SYSTEM

- A. Install counterpoise and ground over all sections of underground ductbanks, conduits, or cables outside (exterior) to building.
- B. No. 2 bare stranded copper counterpoise shall be run 6 inches above all underground duct banks, conduits and cables outside (exterior) to building.
- C. Provide one counterpoise conductor for ductbanks (or conduit groupings) 12 inches wide or less. Provide two counterpoise conductors above outside edge of ductbank (or conduit groupings) over 12 inches wide.
- D. Counterpoise shall run to building and be grounded at each building to the main building electrical service ground rod electrode (exterior to building). Counterpoise shall be bonded to ground rod at all light poles, pullboxes, manholes, handholes and at each building. Provide and install appropriate ground rod every 150 foot length of counterpoise conductor (see "Grounding Electrodes"). Counterpoise conductor shall not be run into interior of building. Route counterpoise underground around exterior perimeter of building to main service ground rod installation.

3.19 TESTING AND REPORTS

- A. Raceway Continuity: Metallic raceway system as a component of the facilities ground system shall be tested for electrical continuity. Resistance to ground throughout the system shall not exceed specified limits.
- B. Ground resistance measurements shall be made on each system utilized including:
 - 1. Building structural steel.
 - 2. Driven grounding system.
 - 3. Water pipe grounding system.
 - 4. Other approved systems.
- C. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.
- D. Upon completion of testing, the testing conditions and results shall be certified by the Contractor and submitted to the Designer as called for in Section 26 08 13 - Test and Performance Verification.

3.20 INTERFACE WITH OTHER PRODUCTS

- A. Interface with site grounding system.
- B. Interface with lightning protection system installed under Section 26 41 13.

3.21 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instruments to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 26 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 26. The work described in Specification 26 05 26 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 26

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SECTION 26 05 29 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of supporting devices.

1.3 DESCRIPTION

- A. Furnish and install all supports, anchors, fasteners, hangers and inserts required to mount fixtures, conduit, cables, pullboxes and other equipment furnished under this Division.

1.4 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:
 - 1. NECA - National Electrical Contractors Association.
 - 2. ANSI/NFPA 70 - National Electrical Code.

1.5 SUBMITTALS

- A. Submit catalog cut sheet showing brand of conduit supporting hardware to be used and (where applicable) showing that conduit supporting hardware is UL listed and labeled.
- B. Submit catalog cut sheet on all types of conduit support fittings, hardware, straps, and hangers.
- C. Product data shall be submitted for approval on:
 - 1. Mounting hardware and inserts.
 - 2. Conduit straps, hangers and fittings.
 - 3. Supporting channel.

- D. Product data shall prove compliance with Contract Documents, National Electric Code, National Board of Fire Underwriters, manufacturer's specifications and written installation data.
- E. Submit shop drawing showing routing and location of all conduit racking systems. Provide coordination drawings.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation."
- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not use spring steel clips and clamps and metal banding straps.
- E. Do not fasten supports to sides or bottom of pre-cast structural beams.
- F. Obtain permission from Owner before using powder-actuated anchors.
- G. Obtain permission from OAR before drilling, or cutting structural members.
- H. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- I. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- J. In wet and damp locations use stainless steel channel supports to stand cabinets and panelboards one inch (25) mm) off wall.

- K. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- L. All items shall be supported from the structural portion of the building, except standard ceiling- mounted lighting fixtures. Small devices may be supported from ceiling system where permitted by ceiling system manufacturer, however, no sagging of the ceiling will be permitted. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels.
- M. Lay out and install work in advance of the laying of floors or walls, and provide all sleeves that may be required for openings through floors, walls, or other assemblies. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.
- N. All conduits shall be securely fastened in place on maximum of 8 foot intervals. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits will not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.
- O. Where two or more conduits are ran parallel or in a similar direction, they shall be grouped together and supported by means of 1½" x 1½", 12 gauge, pre-galvanized zinc (B-Line or approved substitution), conduit channel trapeze hanger system (racking) consisting of concrete inserts, threaded rods, washers, double nuts for each rod, locknut washers and galvanized "L" angle iron, or Unistrut cross members. Where galvanized "L" angle iron is used, conduits shall be individually fastened to the cross members with malleable iron hangers listed and approved for use on "L" angle iron, bolted with proper size cadmium machine bolts, washers and nuts. Conduits supported to unistrut channel shall be individually fastened with two piece unistrut straps with bolts and nuts listed and approved for such use. Mineralak hangers or one hole type straps fastened to Kindorf racking is not acceptable. Beam clamps shall be malleable iron. All single panelboard, switchboard and motor control center feeder raceway runs shall be supported by means of a trapeze channel hanger support system with provisions for future as specified.
- P. All hangers and mounting hardware clamps shall be made of durable material suitable for the application involved. Where excessive corrosive conditions or exterior and damp conditions are encountered, hanger assemblies shall be malleable iron or protected after fabrication by hot dipped galvanizing and where written approval is authorized by the OAR, special paint or other suitable preservative methods may be used.

- Q. On concrete or brick construction, an electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, same shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts and washers used for supporting conduit or outlets shall be fabricated from rust-resisting metal. Self-tapping power driven fasteners are acceptable on block or brick construction only. Plastic anchors are not acceptable.
- R. Spring type conduit clip devices are not acceptable for conduit support.
- S. Threaded rod hangers shall be galvanized continuous thread type, minimum 3/8" diameter. Increase size as required to support assembly. Bending of rod hangers is not permitted.
- T. Concrete anchors, thread rods, or similar fasteners installed on side or bottom of pre-stressed beams are not acceptable.
- U. Group related conduits; support using conduit rack. Construct rack using steel channel in dry locations and galvanized channel or aluminum channel in damp or wet locations (minimum of 24", increase, distance as required for quantity of conduits and spare capacity) provide space on each rack for Building Automation Systems (BAS) raceways and 25 percent additional conduits. Group conduits on channel racking adjacent to each other at one side, allowing all remaining unused space as spare capacity. Spacing between conduits shall not exceed 1" unless written permission is granted by OAR.
- V. Each rack shall be provided with minimum of two (2) threaded rod hangers located at the ends of the channel. Increase number of hangers as required to support the assembly.
- W. Rack Mounted Equipment: Use channel support system for all rack mounted equipment including all free standing rack mounted equipment. Exterior rack support system to be stainless steel channel. See details on drawings where available. Exterior units shall be thoroughly inspected after installation.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 29 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 29. The work described in Specification 26 05 29 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 29

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SECTION 26 05 33 - CONDUIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of conduit.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
 - 1. Rigid Metal Conduit (RMC) NEC 344
 - 2. Aluminum Rigid Metallic conduit (RMC) NEC 344
 - 3. Intermediate Metal Conduit (IMC) NEC 342
 - 4. PVC coated Metal Conduit.
 - 5. Flexible metal conduit (FMC) NEC 348
 - 6. Liquid tight flexible metal conduit (LFMC) NEC 350
 - 7. Electrical metallic tubing (EMT) NEC 358
 - 8. Rigid Polyvinyl Chloride Conduit (PVC) (RNC) NEC 352
 - 9. Flexible Metal Clad Cable (MC/HCF)
 - 10. Fittings and conduit bodies.
- B. Raceways and conduits shall begin at an acceptable enclosure and terminate only in another such enclosure except conduit/raceway stub-outs.
- C. A raceway shall be provided for all electrical power, lighting and electrical systems.
- D. Where the Contract Documents refer to the terms "raceway" or "conduit" the materials shall be as listed above in conjunction with NEC 100 definition of "raceway" MC and HCF flexible metal cables shall not be considered a substitute for raceway or conduit.

1.4 SUBMITTALS

- A. Submit catalog cut sheet showing brand of conduit to be used and showing that conduit is UL listed and labeled, and manufactured in the United States.
- B. Submit catalog cut sheet on all types of conduit bodies, and fittings.

C. Submit product data on:

1. Conduits.
2. Fitting entering and leaving the ground or pavement.
3. Expansion/deflection fittings.
4. Conduit straps, hangers, fittings, PVC solvent and bending box.

D. Submit UL listed fire and smoke stopping assemblies for each applicable application. Provide details from UL Fire Directory and manufacturer's corresponding product data and details.

E. Product data shall prove compliance with Specifications, National Electrical Code, National Board of Fire Underwriters, manufacturer's specifications and written installation data.

1.5 PROJECT AS-BUILT DOCUMENTS

A. As-built documents shall accurately record actual routing of conduits.

1.6 REFERENCE AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

B. Conform to the following:

1. ANSI/NFPA 70 - National Electrical Code
2. ANSI C80.1 - Electrical Rigid Steel Conduit
3. ANSI C80.3 – Steel Electrical Metallic Tubing
4. ANSI C80.5 – Electrical Rigid Aluminum Conduit
5. ANSI C80.6 – Electrical Intermediate Metal conduit
6. ANSI/UL 651 – Schedule 40, 80, Type EB and A Rigid (PVC Conduit and Fittings)
7. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable Assemblies
8. NECA National Electrical "Installation Standards"
9. ANSI C80.1/NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
10. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) conduit
11. NEMA TC 3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
12. ANSI/Federal Specification A-A-59544 Cable and Wire, Electrical (Power Fixed Installation)
13. ANSI/Federal Specification J-C-30B – Flexible Metal Cables, Galvanized steel jacket

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All conduits shall bear UL label (or other nationally recognized testing agency and shall be manufactured in the United States).
- B. Conduit systems and all related fittings, boxes, supports, and hangers must meet all the requirements of national, state, requirements and all related FAA codes and other Federal codes where applicable.

2.2 MINIMUM TRADE SIZE

- A. Power/Lighting Homeruns 3/4 inch.
- B. Power/Lighting Branch Circuits between Devices and Fixtures 1/2 inch.
- C. Flexible and Seal-tite metallic conduit 1/2 inch C (maximum 6 feet long).

2.3 RIGID METAL CONDUIT(RMC)

- A. Comply with:
 - 1. ANSI C80.1.
 - 2. UL 6.
 - 3. NEC 344.
 - 4. Fed. Specification WW-C-581e.

B. Conduit material:

1. Hot galvanized steel.

C. Fittings:

1. Threaded.
2. Insulated bushings shall be used on all rigid metal conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
3. Hot galvanized malleable iron or steel.

D. Conduit Bodies:

1. Comply with ANSI/NEMA FB 1.
2. Threaded hubs.
3. Hot galvanized malleable iron.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Comply with:

1. ANSI C80.5.
2. UL 6.
3. NEC 344.
4. Federal Specification WW-C-540A.

B. Conduit material: Aluminum.

C. Fittings:

1. Threaded.
2. Aluminum.
3. Insulated bushings on terminations.

D. Conduit bodies:

1. Comply with ANSI/NEMA FB 1
2. Threaded hubs.
3. Aluminum.

2.5 INTERMEDIATE METAL CONDUIT (IMC)

A. Comply with:

1. UL Standard 1242
2. ANSI C80.3

3. NEC 342
4. Fed. Specification WW-C-581e

B. Conduit material: Zinc coated steel.

C. Fittings:

1. Threaded.
2. Zinc plated malleable iron.
3. Insulated bushings on terminations.

D. Conduit bodies:

1. Comply with ANSI/NEMA FB 1.
2. Threaded hubs.
3. Hot galvanized malleable iron

2.6 PVC COATED METAL CONDUIT

A. Comply with:

1. UL 6.
2. NSI C80.1.
3. NEC 344.
4. NEMA RN 1.
5. Fed. Specification WW-C-581E.

B. Conduit material: Hot galvanized rigid steel with external PVC coating, 20 mil. thick.

C. Fittings:

1. Threaded.
2. Insulated bushings on terminations.
3. Hot galvanized malleable iron or steel with external PVC coating, 20 mil. thick.

D. Conduit bodies:

1. Comply with:
 - a) ANSI/NEMA FB 1.
 - b) Threaded hubs.
 - c) Hot galvanized malleable iron.

2.7 FLEXIBLE METAL CONDUIT(FMC)

A. Comply with:

1. NEC 348.
2. ANSI/UL.
3. Fed. Specification WW-C-566.

B. Conduit material: Hot galvanized Steel, interlocked.

C. Fittings:

1. ANSI/NEMA FB 1.
2. ANSI/UL 514B.
3. Malleable iron, zinc plated.
4. Direct flexible conduit bearing set screw type not acceptable.
5. Insulated throat on terminations.
6. Compression EMT to flexible conduit coupling is not acceptable unless special written permission is granted by OAR.
7. Comply also with Fed. Specification W-F-406.

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Comply with:

1. NEC 350.
2. ANSI/UL 360.

B. Conduit material:

1. Flexible hot galvanized steel core, interlocked.
2. Continuous copper ground, built into core up to 1-1/4 inch size.
3. Extruded polyvinyl gray jacket.

C. Fittings:

1. Threaded for IMC/rigid conduit connections.
2. Approved for hazardous locations where so installed.
3. Provide sealing washer in wet/damp locations.
4. Compression type.
5. ANSI/NEMA FB 1
6. ANSI/UL 514B
7. Hot galvanized malleable iron or steel.
8. Insulated throat on terminations.
9. Comply with Fed. Specification W-F-406.
10. Connections to vibrating equipment and transformers.

- a) Connectors to have wire mesh conduit grip.

2.9 ELECTRICAL METALLIC TUBING (EMT)

A. Comply with:

1. UL 797.
2. ANSI C80.3.
3. NEC 358.
4. ANSI/UL 797.
5. Fed. Specification WWC-563.

B. Conduit material: Hot Galvanized steel tubing (Electrogalvanized zinc is not acceptable).

C. Fittings:

1. ANSI/NEMA FB 1.
2. Compression type.
3. Insulated throat on terminations.
4. Hot galvanized malleable iron or steel.
5. Fed. Specification WF 408.

2.10 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) (RNC)

A. Comply with:

1. NEMA TC-2.
2. UL 651.
3. NEC 352.
4. Fed. Specification WC 1094A.

B. Conduit material:

1. Shall be high impact PVC - tensile strength 55 PSI, flexural strength 11000 PSI.

C. Fittings:

1. Comply with: NEMA TC-3 and UL 514B

D. General:

1. Shall be UL listed.
2. Fittings and elbows shall be by the same manufacture as conduit.

2.11 FLEXIBLE METAL CLAD CABLE (MC/HCF-90)

A. Comply with:

1. NEC 330.

2. NEC 517.
3. NEC 250.96.
4. ANSI/UL 4.
5. ANSI/UL 83.
6. UL 1479.
7. Federal Specification J-C-30B.

B. Cable material:

1. Jacket material:

- a) Galvanized Steel, interlocked.

2. Conductor covering: Paper wrap.

3. Conductor Material:

- a) Copper, Solid, THHN.
- b) Minimum #12 gauge.
- c) Maximum #8 gauge.
- d) 90 degree C, 600 volt.
- e) Full size insulated grounding conductor, green.
- f) 16 AWG integral bond wire in combination with armor jacket.
- g) Conductor color coding to match system voltage. Comply with Section 26 05 19 Building Wire and Cable, "Color Coding".

C. Fittings:

1. ANSI/NEMA FB 1
2. ANSI/UL 514B
3. Zinc plated Malleable iron, or steel.
4. Direct flexible conduit bearing set screw type not acceptable.
5. Install insulated bushings or equivalent protection (i.e., anti-short) between core conductors and outer jacket.

2.12 EXPANSION FITTINGS

A. For all exterior locations as defined by the National Electrical Code and these specifications, Expansion/deflection fittings shall be:

1. Listed, hot dipped galvanized inside and outside providing a 4 inch expansion chamber and deflection (where applicable) when used with rigid conduit, intermediate metal conduit and electrical metallic conduit.
2. Expansion fittings shall be UL listed, polyvinyl chloride providing a minimum 6 inch expansion chamber when used with non-metallic conduit (PVC), and shall meet the requirements of and as specified elsewhere for non-metallic conduit.
3. Fittings shall be provided with an external braided grounding and bonding jumper with approved clamps UL Listed for the application.

4. Expansion fittings with an internal bonding jumper that are UL Listed for the application and in compliance with the National Electrical Code may be considered for dry location use only. Submit fitting with manufacturer's data and UL Listing for approval prior to installation.
5. Expansion/deflection fittings installed in interior/dry locations as defined by the National Electrical Code and these specifications shall comply with all of the above and outside when used with electrical metallic conduit.
6. Where expansion fittings are installed under an expansion joint which is exposed to the weather from floor above, expansion fittings shall be exterior type.
7. Sleeves intended for use for expansion fittings shall be flagged and inspected by O.A.R. prior to pour to verify size/alignment.

PART 3 - EXECUTION

3.1 LOCATION REQUIREMENTS

A. Underground Installations:

1. Use Schedule 40 thickwall nonmetallic conduit only unless local authority having jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.
2. Encase conduit in a concrete envelope of not less than 3 inch thickness on all sides and not less than 1-1/2 inches between conduits (where more than one conduit is installed together) for:
 - a) All conduits installed under roads, taxiways, and runways.
 - b) All conduits installed for primary electric circuits, main feeders, and data/communications systems (i.e., Telephone, data, parking revenue, radio, flight information, air traffic control systems, security, fiber optic).
3. All conduits or elbows entering or leaving any slab or the ground shall be rigid steel conduit coated with asphalt paint.
4. Where rigid metallic conduit is installed underground as noted above it shall be coated with waterproofing black asphaltum paint before installation, and all joints shall be re-coated after installation.
5. All PVC runs over 100 feet in length shall utilize rigid steel 90 degree elbows at each horizontal change in direction. All PVC risers shall utilize rigid steel 90 degree elbows. Elbows shall be coated with black asphaltum paint or PVC coating. Bond all metal elbows per NEC 250.80 and NEC 300.5
6. Underground raceway systems shall conform to all national, state, local and FAA regulations, in general and NEC 300.5
 - a) Depth of conduits shall be not less than 18 inches with the following exceptions:

- 1) Conduits installed in concrete floors of buildings to have a minimum concrete cover not less than 2 inches.
 - 2) Conduits passing under taxiways, runways, ramps, holding areas, and docking areas, must be installed below the concrete pour, in the sub base, and shall be encased in not less than 3 inches of concrete, the specifications of which shall meet the same standards required for runways and taxiways except that slump shall be 3 inches to 4 inches.
 7. Verify finished lines in areas where raceways will be installed underground before the grading is complete.
- B. In Slab, Above or On Grade:
1. Use coated rigid steel conduit, coated intermediate metal conduit (if approved) or thickwall nonmetallic conduit.
 2. In slab conduit is permitted only where written consent is granted by Architect and Structural Engineer, regardless of that shown or noted by drawings. Install as directed by Architect/Structural Engineer.
- C. Penetration of Slab:
1. Exposed Location:
 - a) Where penetrating a floor in an exposed location from underground or in slab, a black coated galvanized rigid steel conduit shall be used.
 2. Concealed Location:
 - a) Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, non-metallic conduit may be used up to first outlet box, provided outlet box is at a maximum height of 40 inches above finished floor.
 - b) Where penetrating a floor from underground or in slab, a coated galvanized rigid steel conduit shall be used.
- D. Outdoor Location:
1. Above Grade:
 - a) Where penetrating the finished grade, a coated galvanized rigid steel conduit shall be used.
 - b) All exterior conduit runs shall be rigid conduit and threaded connectors as specified elsewhere.
 - c) All areas subject to exterior conditions such as overhangs, galvanized rigid steel conduit shall be used.

2. Roofs:

- a) Conduit is not to be installed on roofs, without written authorization by OAR for specific conditions.
- b) When approved by written authorization conduit shall comply with the following:
 - 1) Be PVC coated rigid galvanized metal conduit.
 - 2) All fittings, etc. are to be PVC coated.
 - 3) Conduit shall be supported above roof at least 6 inches using approved conduit supporting devices. Refer to applicable roofing specifications.
 - 4) Fasten supports to roof per roofing manufacturer's recommendations.

3. Cooling Towers:

- a) Conduit installed at cooling towers shall be PVC coated rigid galvanized conduit.

E. Interior Dry Locations:

1. Concealed:

- a) Use rigid galvanized steel and electrical metallic tubing. Thickwall non-metallic conduit (PVC) may be used inside block walls up to first outlet to a maximum of 40 inches AFF except where prohibited by the NEC.
- b) The use of metal clad cables and HCF-90 armored cables are permitted in very limited applications as specified herein, provided acceptable by the local inspecting authority having jurisdiction and applicable codes and standards. Refer to "Additional Requirements for Metal Clad/Armor HCF-90 Cables" below

2. Exposed:

- a) Use rigid galvanized steel and electrical metallic tubing. EMT may only be used where not subject to damage which is interpreted by this specification as within Electrical Rooms, Mechanical Rooms, and Communication Rooms, or where otherwise installed, to be above 96 inch AFF and exiting the top of panelboards, terminal cabinets, and control panels. In Electrical, Mechanical and Communications Rooms, Rigid Conduit shall extend 18" above finished floor before being changed over to EMT.

3. Concealed or exposed flexible conduit:

- a) Concealed: Flexible steel conduit or seal tight flexible steel conduit shall be in lengths not longer than 6 feet in length with a ground conductor firmly attached to the terminating fitting at the extreme end of the flex. Direct change over from conduit to flexible conduit is not acceptable

unless written permission is granted by OAR or specifically noted on drawings.

- b) Exposed: Liquid tight flexible steel conduit shall be used for connections to motors, movable equipment, or vibration equipment (transformers, pumps, AHU's, loading bridges, etc.) as specified herein. Lengths shall not exceed 6 feet in length unless written authorization by OAR for specific conduits is granted. Connections to vibration equipment, motors, etc., shall be made with wire mesh grip fittings as specified herein. Flexible steel conduit is not acceptable in exposed locations. All exposed flexible metal conduit shall be liquid tight.

F. Interior Wet and Damp Locations:

- 1. Use rigid galvanized steel in interior wet and damp locations. Areas which are subject to direct exterior conditions such as parking garages, open ramp overhangs and other Areas within 100 feet of building openings, etc., shall be classified "Wet Exterior Location." Areas containing equipment requiring wash-down with hose, such as trash-compactors, shall be considered a "Wet Interior Location" for all space within four (4) feet of the equipment and under eight (8) feet above finished floor (AFF).

G. Concrete Columns or Poured in-place Concrete Wall Locations:

- 1. Use thickwall non-metallic conduit. Penetration shall be by approved metal raceway (i.e., metal conduit as required elsewhere in these specifications).
- 2. Locations Near 400 Hz Distribution Systems
- 3. Metal ferrous conduit or support equipment is not to be installed within 6 inches of any 400 Hz distribution system conduit or wire. Increase distance if so required by 400 Hz system manufacturer.

H. Corrosive Locations:

- 1. Comply with all codes and standards.
- 2. Retail Concession Spaces
- 3. The use of metal clad cable for the wiring of power, lighting, control and signal circuits in these spaces is permitted except where otherwise specified.

3.2 ASPHALTUM PAINT

- A. All iron, steel, galvanized steel and similar metallic items (not intended to be a grounding electrode) installed underground or within 12 inches of the earth shall be protected by a 12-mil thick layer of asphaltum coating. Apply coating in strict accordance with the manufacturer's instructions. Apply to clean dry surfaces. Asphaltum coating shall be applied in two applications/coats minimum. Observe the manufacturer's minimum cure time between applications/coats. Each application of the coating shall be given ample time to dry and harden before the next application is applied. Touch up areas damaged during installation, wrench marks, tooling, bonding clamps, exothermic welds, etc. Apply the proper consistency of asphaltum coating uniformly. The finished coating shall be free from sags, holidays, and smears. Asphaltum coating shall

be Carboline Bitumastic 50 or Sumter Coatings Coal Black Asphaltum 100N8507 or accepted equivalent.

- B. Where steel conduit is threaded in the field the threads shall be coated with an approved electrically conductive, corrosion resistant compound in accordance with NEC Section 300.6(A). Use TNB KOPR_SHIELD or accepted equivalent.

3.3 ADDITIONAL REQUIREMENTS FOR RIGID METAL STEEL CONDUIT

- A. Rigid metal conduit shall be cut and threaded with tools approved for the purpose and by qualified personnel.
 - 1. Approved pipe vise.
 - 2. Roller/bade type cutter or band saw.
 - 3. Reamer capable of completely removing al ridges or burrs left by the cutter. Reaming with pliers is not acceptable.
- B. Hangers shall be installed 8 feet apart.
- C. Conduits stubbed through floor slabs, above grade and not contained inside walls, shall be rigid galvanized metallic conduit.
- D. One hole pipe straps shall be malleable iron. Wet location applications shall include malleable iron back clamp spacers.
- E. Use of two piece threaded union fittings and rigid set screw fittings are not permitted. Threaded unions may be acceptable where required for special field conditions only when special written permission is granted by OAR.

3.4 ADDITIONAL REQUIREMENTS FOR INTERMEDIATE METAL CONDUIT (IMC)

- A. May be installed only by special written permission.
- B. If written approval is received then IMC may be used in locations acceptable by NEC and elsewhere in these specifications, whichever is most stringent.

3.5 ADDITIONAL REQUIREMENTS FOR ELECTRICAL METALLIC TUBING (EMT)

- A. Electric metallic tubing (thin wall) may be installed inside buildings above ground floor where not subject to mechanical injury.
- B. All cuts shall be reamed smooth and free of sharp and abrasive areas by use of an approved reamer.
- C. Cut conduit square using approved hacksaw with 32 tooth per inch blade; de-burr cut ends. Roller/blade type pipe cutter is not acceptable.

- D. One- hole pipe straps, where specified herein, shall be heavy duty type.

3.6 ADDITIONAL REQUIREMENTS FOR ALUMINUM CONDUIT

- A. May be used only for 400 Hz electrical distribution system.

3.7 ADDITIONAL REQUIREMENTS FOR FLEXIBLE STEEL CONDUIT AND LIQUID-TITE FLEXIBLE METAL CONDUIT

- A. Shall be properly grounded.
- B. Shall be installed with approved fittings.
- C. Shall be used for final connections to vibrating equipment such as motors, pumps, transformers, etc.
- D. Liquid-tight conduit termination connectors at vibration equipment (i.e. pumps, AHU's, motors, moveable equipment, etc.) shall be provided with wire mesh grips.

3.8 ADDITIONAL REQUIREMENTS FOR NON METALLIC CONDUIT (PVC)

- A. PVC conduit is not allowed anywhere inside building(s) except underground, in slab, in poured in place concrete, and in block wall up to first outlet box (if not over 40 inches AFF) if allowed by codes. In elevated slabs, conduit is permitted only where written consent is granted by Structural Engineer, regardless of that shown or noted by drawings. Install as directed by Architect/Structural Engineer.
- B. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- C. Threads will not be permitted on PVC conduit and fittings, except for rigid steel to PVC couplings.
- D. Installation of PVC conduit shall be in accordance with manufacturer's recommendations.
- E. PVC conduit shall not be used to support fixture or equipment.
- F. Field bends or direction changes shall be by manufactured bends only. Heating with flame and hand held dryers are prohibited.
- G. PVC fittings and elbows shall be by same manufacturer as conduit.

3.9 ADDITIONAL REQUIREMENTS FOR METAL CLAD/ARMOR HCF-90 CABLES

- A. Metal Clad Cables may be used only as specified, where permitted by NEC, and if approved by the local inspecting Authority Having Jurisdiction.
- B. Type HCF-90 cable, where permitted, may be used in retail concession leases or part thereof (i.e., multifunction buildings, etc.) and where permitted by NEC 517, and where redundant grounding path are not required by NEC 250.118 Armor HFC-90 cables shall not be used in Places of Assembly.
- C. Cables, where permitted, shall be used only in interior dry locations of stud wall partition framing (vertical wall construction only) and for final connections to lighting luminaries from conduit system/junction box above each fixture, (looping cables from fixture to fixture is not permitted).
- D. MC cable shall not be used for any other building wiring or for branch circuit homeruns to panelboards or similar equipment. Branch circuit homeruns and branch electrical distribution wiring system shall utilize conduit system (i.e. GRC, IMC, EMT, etc.) as specified elsewhere in this document.
- E. MC cable shall not extend more than 10 feet from the point the cable exits the wall partition framing. Extend conduit system (i.e. EMT, GRC, etc as specified herein) to a junction box at the wall for transition to MC cable.
- F. Cables shall not be installed where subject to mechanical injury or exposure to heat.
- G. Multi-conductor home run cable is prohibited.
- H. Cables for use other than power and lighting branch circuits are not permitted.
- I. Cables shall not be used for Life Safety Emergency Branch Circuits (NEC 700) or legally required branch circuits (NEC 701).
- J. For branch circuit lighting and power circuits only, maximum #8 gauge permitted. Cables shall not be used for feeder circuits or for systems, Each Section of Divisions 27 and 28, (i.e., fire alarm, voice, data, television, etc.).
- K. Connectors and supporting components shall be UL listed for such use.
- L. Cut cables with UL listed tools intended for such use. Ream smooth and free of sharp and abrasive areas. Install bushing between conductors and outer jacket. The use of slide cutters or dikes to cut cables is not acceptable.
- M. Maintain minimum 1/2 inch separation between each cable and support per NEC 334. The practice of bundling cables is not acceptable.
- N. Support maximum of 1 foot-0 inches from every box, cabinet, etc., secure at intervals not to exceed 5 feet-0 inches.

- O. Install parallel and perpendicular to building lines. Required metal stud openings shall be made with an approved stud punch tool.
- P. Install metal sleeves where cables pass through rated walls, one sleeve per cable with minimum 2 inches between each. Increase spacing as required per applicable UL fire stopping detail/assembly.
- Q. Install cables minimum of 1 foot-0 inches from communications cables.
- R. The use of standard type A/C cables in lieu of MC cables is not permitted unless cable is HCF-90 as specified herein.
- S. Attachment of cables to ceiling system is prohibited. Secure cables in strict accordance with NEC 300.11.
- T. Attachment of cables to, on, or from mechanical (HVAC) equipment, supports, etc., is not permitted.
- U. Install cables parallel and perpendicular to building structure.
- V. Install additional supports as necessary to omit cable sagging.
- W. Complete installation shall be in a neat and workmanlike manner to the satisfaction of the OAR per NEC 110.12.
- X. Zigzagging cables through building elements, as method of support is not acceptable.
- Y. Cable with outer metal sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to owner.
- Z. Cables shall be securely fastened with UL listed devices and methods intended for such use. AA. Observe fire-rating requirements for quantity of cables in wall cavities.

3.9 ADDITIONAL REQUIREMENTS FOR PVC COATED CONDUIT

- A. All cuts, pinholes and ends shall be sealed using liquid PVC patch. PVC coated conduit shall be thoroughly inspected after installation to assure all voids, cuts, pinholes or other violation of the integrity of the PVC coating are sealed.

3.10 SUPPORTS

- A. Comply with the requirements of Section 26 05 29 Hangers and Supports.
- B. Arrange supports to prevent misalignment during wiring installation.

3.11 EXPANSION/DEFLECTION FITTINGS

- A. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.
- B. Expansion fittings shall be installed in the following cases:
 - 1. In each conduit run wherever it crosses an expansion joint in the concrete structure.
 - 2. On one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion/deflection equal to at least three times the normal width of joints.
 - 3. In each conduit run which mechanically attaches to separate structures to relieve strain caused by shift on one structure in relation to the other.
 - 4. In straight conduit run above ground that is more than one hundred feet long and interval between expansion/deflection fittings in such runs shall not be greater than 100 feet.

3.12 GROUNDING

- A. All raceways shall have a copper system grounding conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC codes.
- B. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings.
- C. Grounding conductors run with exterior/ underground feeders shall be bare only.
- D. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground bushings.
- E. See other sections of these specifications for additional requirements.
- F. Grounding conductors (including lightning protection down conductors) run in metal conduit shall be bonded to metal conduit at both ends.

3.13 CONDUITS PENETRATING TWO HOUR ASSEMBLIES OR GREATER

- A. Conduits with conductors penetrating the wall shall have blow out patches on each side of the wall.
- B. Multiple conduits run through rated walls side by side shall have blow out patches on each side of the wall.
- C. Data or telephone conductors run exposed and penetrating a wall rated 2 hour for fire, smoke or smoke/fire shall be sleeved with steel conduits 30 inches each side of the wall and conduit ends packed with approved fire sealant.

3.14 FIRE AND SMOKE STOPPING

- A. Contractor is to provide fire stopping and smoke sealing for all penetrations of existing (or new if applicable) fire or smoke assemblies as required to maintain rating of assembly.
- B. All penetrations shall be fire stopped in strict accordance with UL Fire Directory.
Submit applicable details for acceptance. Prepare and install as delineated by UL detail(s).
- C. Each penetration shall be identified with the corresponding UL fire assembly number. Labels shall be typed or computer generated minimum 1/2 inch high black lettering, self-adhesive type.
- D. Comply with UL Fire Directory "F" and "T" ratings respectfully.

3.15 FIRE PROTECTION

- A. Emergency life safety feeder-circuit wiring shall be installed either in spaces fully protected by an approved automatic fire suppression system or shall be a listed electrical circuit protection system with a 1-hour fire rating. Fire circuit protection shall be in accordance with UL Fire Protection equipment Directory and UL Building Materials Directory (latest edition).

3.16 VERTICAL RACEWAYS

- A. Cables in vertical raceways shall be supported per NEC 300.19. Provide supporting devices for cables, including any necessary accessible pull boxes as required regardless if shown on drawings or not. Provide and install access panels as required. Coordinate location of pull box and access panel with designer prior to installation. This includes empty raceways for future use.

3.17 GENERAL

- A. Install conduit in accordance with NECA 1-2009 Standard Practice of Good Workmanship in Electrical Contracting" Contractor shall lay out all work prior to rough-in.
- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Arrange conduit to maintain headroom and present neat appearance.
- D. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point to point.

- E. Route conduit in and under slab from point-to-point.
- F. Do not cross conduits in slab.
- G. Maintain adequate clearance between conduit and piping.
- H. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
- I. Maintain minimum of 3 inch separation between power and communications raceways. Increase separation if so required to comply with EIA/TIA referenced standards.
- J. Systems raceways shall be installed in accordance with ANSI/EIA/TIA Communications Standards.
 - a) Maintain proper separation between PDS system cables and all power and unshielded cables, as required to prevent noise or crosstalk interference.
 - b) Raceway bends shall have minimum inside radius of 6 times the internal diameter. Increase bend radius to 10 times for raceway larger than 2 inch size. Provide proper bend for all changes of direction. Pull and splice boxes shall not be used in lieu of a bend.
 - c) Install raceways so no more than two 90 degree bends are in any raceway section without a pullbox. Install additional pull boxes as required to maintain maximum of two 90 degree bends between pull boxes and termination points.
 - d) Install boxes in straight sections of raceway.
- K. Cut conduit square using saw or pipecutter; de-burr cut ends.
- L. Bring conduit to shoulder of fittings; fasten securely.
- M. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp locations and to cast boxes. Use threaded conduit hubs to fasten conduit to sheet metal boxes, disconnects switches and equipment control panels in wet and exterior locations.
- N. Install no more than equivalent of three 90-degree bends between boxes for power and lighting systems. Use conduit bodies to make sharp changes in direction, as around beams, Use appropriate boxes and conduit bodies for fire alarm, voice/data and sound/paging systems. Use factory elbows for bends in metal conduit larger than 2- inch size.
- O. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- P. Provide pull boxes, junction boxes and fire barrier at fire rated walls as required by NEC 300, whether shown on drawings or not.

- Q. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. This includes all raceways which do not have furnished conductors. Pull cords must be fastened to prevent accidental removal. A phenolic or brass nameplate shall be attached to each end indicating the location of both ends of conduit as follows: THIS END = "LOCATION," OTHER END = "LOCATION."
- R. Use suitable seals to protect installed conduit against entrance of dirt and moisture and insects.
- S. Ground and bond conduit under provisions of Section 26 05 26 Grounding and Bonding.
- T. Identify conduit under provisions of Section 26 05 53 Identification for Electrical Systems.
- U. Install all conduit concealed from view unless specifically shown otherwise on drawings
- V. Rigid steel box connections shall be made with double locknuts and bushings.
- W. All wire raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said plumbing fixtures without disturbing wire raceways. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- X. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- AA. All raceways shall be run from outlet to outlet as shown on the drawings, unless permission is granted, to alter arrangement shown. If permission is granted arrangement shall be marked on red lined As-Built drawings as previously specified.
- BB. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade. Marker shall be 6" round x 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.
- CC. All conduit stubbed above floor shall be strapped to a metal channel supported by conduit driven into ground or tied to steel. Spare conduit stubs shall be capped with a UL listed and approved cap or plug for the specific intended use and identified with ink markers as to source and labeled "Spare".
- DD. All connections to motors or other vibrating equipment including transformers or at other locations where required shall be made with not less than 12" nor more than 36" of flexible liquid-tight steel conduit, with nylon insulated throat connectors and wire mesh grip fittings at both terminations of conduit. Use angle connectors wherever necessary to relieve angle strain on flex conduit.

- EE. Provide a conduit sealing fitting or pliable compound wherever conduit system is exposed to widely temperature changes which may cause condensation within the raceway; as from the inside to the outside of coolers or freezers.
- FF. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified under other Sections of these specifications.
- GG. All raceways shall be run in neat and workmanlike manner per NEC 110.12 and shall be properly installed in accordance with the latest edition of NEC with approved conduit clamps, hanger rods and structural fasteners.
- HH. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.
- II. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.
- JJ. Raceways, boxes, etc., shall not be attached to an acoustical grid ceiling system or support wire per NEC 300.11. Support all components directly from building structure.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 33 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 33. The work described in Specification 26 05 33 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 33

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SECTION 26 05 34 - OUTLET BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of all boxes used as outlet, device, junction, or outlet.

1.3 DESCRIPTION

- A. Provide and install all outlet boxes (flush or surface) complete with all accessories as required to facilitate installation of electrical system and as required by the NEC.

1.4 SUBMITTALS

- A. Submit catalog cut sheet/product data on:
 - 1. Outlet and device boxes
 - 2. Junction and pull boxes
 - 3. Surface, flush and in ground boxes
 - 4. Surface cast boxes
 - 5. All outlet boxes to be used on project.

1.5 PROJECT AS-BUILT DOCUMENTS

- A. Record actual locations and junction boxes not covered in Section 26 05 35 pull and junction boxes (surface, flush or in ground mounted). Submit product data showing dimensions, covers, and construction.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:
 - 1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes and Conduit Bodies Supports for

- Conduit, Electrical Metallic Tubing and Cable Assemblies.
- 2. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- 3. ANSI/NFPA 70 - National Electrical Code.
- 4. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.7 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of outlets in offices and work areas prior to rough-in.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, outlet boxes, and corrosion-resistant knockout closures compatible with outlet boxes being used and meeting requirements of individual wiring situations.
- B. All boxes shall be of the size and shape required by NFPA 70 for their respective locations.
- C. Boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size and number of conduits connecting thereto.
- D. Handy boxes shall not be used.
- E. Outlet Boxes for outlets and devices shall be one-piece drawn boxes.
- F. 4 inch x 4 inch boxes and 4 11/16 inch x 4 11/16 inch boxes used as junction boxes shall be one piece.

2.2 SHEET METAL OUTLET BOXES:

- A. ANSI/NEMA OS 1, Galvanized Steel.
- B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.

- C. Concrete Ceiling Boxes: For concrete location installation, providing fire resistance rating as required.
- D. Interior flush outlet boxes shall be galvanized steel constructed with stamped knockouts in back and sides, and threaded holes with screws for securing box coverplates or wiring devices. T & B, Steel City, Racor or approved substitution.
- E. Ceiling outlet boxes shall be 4 inch octagonal or 4 inch square X 1 1/2 inch deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them one piece.
- F. Switch, wall receptacle, telephone and other recessed wall outlet boxes in drywall shall be 4 inch square X 1 1/2 inch deep one piece. For recessing in exposed masonry, provide one piece 4 inch square x 1 1/2 inch deep wall boxes with appropriate 4 inch square cut tile wall covers Steel City series #52-C-49/52-C-52 or approved substitution. For recessing in furred-out block walls, provide one piece 4 inch square box with required extension for block depth and required extension for drywall depth.
- G. For Communication/Systems Telephone, Data, TV, CCTV, Video, and Computer device outlet boxes shall be one piece 4 inch square x 2 1/8 inch deep, minimum. Increase outlet box to 4- 11/16 inch with single gang plaster ring as required for special devices respectfully.

2.3 CAST BOXES:

- A. NEMA FB 1
- B. Interior surface outlet boxes and conduit bodies installed from 0 inch AFF to 90 inch AFF (including fire alarm device backbox) shall be heavy cast aluminum or iron with external threaded hubs for power devices and threaded parts for low voltage devices - Appleton, Crouse Hinds or approved substitution. Trim rings shall also be of one piece construction.
- C. Weatherproof outlet boxes shall be constructed of corrosion-resistant cast iron suited to each application and having threaded conduit hubs, cast metal face plate with spring-hinged waterproof cap suitable configured, gasket, and corrosion-proof fasteners.
- D. Boxes to be Type FD unless otherwise noted on drawings.
- E. Free standing cast boxes are to be type FSF (with flange). Other cast zinc boxes are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- C. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- D. Above ceiling outlet and junction boxes shall be install to permit readily accessible access from ladder or staging from corresponding floor without the need to extend ladder up through ceiling system to facilitate ease of maintenance.
- E. Install boxes to preserve fire resistance rating of partitions and other elements.
- F. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- G. Outlets for 120V clocks shall be recessed so that the clock will hang flush with the finished surface of the wall.
- H. Use flush mounting outlet boxes in finished areas.
- I. Do not install flush mounting boxes back-to-back in walls; provide minimum 6 inch separation. Provide minimum 24 inches (one stud space) separation in acoustic and rated walls.
- J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- K. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- L. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- M. Lighting control switches shall be located at the latch side of door. If the drawings indicate otherwise, issue a request for clarification prior to rough-in.
- N. Support all outlet boxes from structure with minimum of one 3/8 inch all-thread rod hangers. Boxes larger than 25 square inches shall be supported with two all-thread rod hangers, minimum.
- O. Do not fasten boxes to ceiling support wires.
- P. Support boxes independently of conduit.

- Q. Use gang box where more than one device is mounted together. Do not use sectional box.
- R. Use gang box with plaster ring for single device outlets.
- S. Comply with applicable portions of the National Electrical Contractors Association (NECA) Standard of Installation.
- T. Install outlets in the locations shown on the drawings; however, the OAR shall have the right to make, prior to rough-in, slight changes in locations to reflect room furniture layouts.
- U. Coordinate each electrical box so that the type is suitable for the wall or ceiling construction anticipated and suitable fireproofing is built into fire rated assemblies.
- V. Relocate electrical boxes as required so that electrical devices, once installed, will be symmetrically located with respect to the room layout.
- W. All boxes shall be installed in a flush rigid manner with box lines at perpendicular and parallel angles to finished surfaces. Boxes shall be supported by appropriate hardware selected for the type of surface from which the box shall be supported. For example, provide metal screws for metal, wood screws for wood, and expansion devices for masonry or concrete. No surface mounted boxes will be allowed without OAR approval.
- X. For damp and wet locations provide weatherproof boxes and accessories.
- Y. As a minimum, provide pull boxes in all raceways over 150 feet long. The pull box shall be located near the midpoint of the raceway length.
- Z. Provide knockout closures to cap unused knockout holes where blanks have been removed, and plugs for unused threaded hubs.
- AA. Provide conduit locknuts and bushings of the type and size to suit each respective use and installation.
- BB. Boxes and conduit bodies shall be located so that all electrical wiring is accessible.
- CC. Avoid using round boxes where conduit must enter box through side of box which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.
- DD. All flush outlets shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or approved for the purpose. Add- a-Depth rings or switch box extension rings (Steel City #SBEX) are not acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry

when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8 inch of finish wall surface.

EE. Outlet Boxes mounted in metal stud walls, are to be supported to studs with minimum of two self- tapping screws inside, at the back of outlet box, to a horizontal stud brace between vertical studs or pre-manufactured heavy duty box bracket equal to Caddy Corporation # SGB/TSGB series, to prevent movement of outlet box after wall is finished.

FF. All outlet boxes that do not receive devices in this contract are to have blank plates installed matching wiring device plates.

GG. Mount Height.

1. Height of wall outlets to bottom above finished floors shall be as follows, unless specifically noted otherwise, or unless otherwise required by applicable codes including ADA. Verify with the Architectural plans and shop drawings.
 - a) Switches: 4'-0" AFF to top
 - b) Receptacles: 1'-4" AFF to bottom
 - c) Lighting Panels: 6'-6" AFF maximum to centerline of highest breaker/fuse
 - d) Phone Outlets: 1'-4" AFF to bottom
 - e) ADA Wall Phones: (See part 3.1, Item HH.(4.) below)
 - f) Fire Alarm Pull Stations: 4'-0" AFF to top
 - g) Fire Alarm Strobe Lights: 80" AFF to bottom of globe or 6" below ceiling to top, whichever is lower
2. Bottoms of outlets and switches above counter tops or base cabinets shall be minimum 2 inch above counter top or backsplash, whichever is highest. Outlets and switches may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at the same height. Coordinate outlet locations in relation to all casework shown on Architectural plans, prior to rough-in, regardless of height shown on Electrical drawings.
3. Height of wall-mounted fixtures shall be as shown on the drawings. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.
4. Coordinate locations and mounting heights of outlet boxes for all phones with architect, phone system installer and approved shop drawings prior to rough-in. Install as directed, including requirements of ADA. In general, ADA wall phones shall be at a maximum of 54 inch to highest operable part essential to basic operation of telephone with side reach and maximum of 48 inch forward reach as defined by 3.1 HH.1.

HH. Special Purpose Outlets.

1. Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. Coordinate roughing-in locations. Provide plug for each outlet.

II. Outlets in Rated Assemblies and Smoke Barriers.

1. Metallic and approved non-metallic electrical outlet boxes may be installed in vertical fire resistive assemblies or smoke barriers without affecting the classification, provided such openings occur on one side only in each framing space and that openings do not exceed 16 sq. inches.
2. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound or other approved materials.
3. The wall must be built around outlets of larger size so as not to interfere with the integrity of the wall rating.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate installation of outlet box for products furnished under all Sections of these specifications.
- B. Coordinate locations and sizes of required access doors with applicable sections in these specifications.
- C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- D. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
- E. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.3 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closure in unused box opening.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 34 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 34. The work described in Specification 26 05 34 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 34

SECTION 26 05 35 - PULL AND JUNCTION BOXES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide and install pull and junction boxes as shown on drawings or as required by the NEC.
- B. Provide and install pull and junction boxes wherever required for a complete and operating distribution system whether shown on drawings or not.
- C. Where outlet boxes are used for pull and/or junction boxes, they shall meet the requirements of Section 26 05 34 Outlet Boxes.

1.3 REFERENCES

- A. ANSI/NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies
- B. ANSI/NEMA OS 1 Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- C. ANSI/NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- D. ANSI/NFPA 70 National Electrical Code
- E. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

- A. Submit actual shop drawings of all pull boxes showing:
 - 1. Covers.
 - 2. Dimensions - inside and out.

- 3. Rating of concrete or gauge of metal.
- 4. Manufacturer.

1.6 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and mounting heights of pull and junction boxes.

1.7 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of pull and junction boxes prior to rough-in.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose and to maintain required access.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Dimensions of pull and junction boxes shall meet dimensions shown on Drawings or dimensions required by NEC, whichever is largest.
- B. Pull and junction boxes shall meet all requirements of UL and NEC.
- C. Small pull boxes (i.e. 4" x 4") shall meet the requirements of these Specifications for outlet boxes as a minimum.
- D. All boxes (above ground) of 100 cubic inches or more shall be constructed of 14 gauge steel with hot dip galvanized coating.

2.2 SHEET METAL BOXES

- A. NEMA OS 1, galvanized steel.
- B. Box to be fully weatherproof and watertight where installed outside.

2.3 SURFACE-MOUNTED CAST METAL BOX

- A. NEMA 250, Type 4; flat-flanged, surface-mounted junction box.
- B. Material: Cast aluminum.
- C. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

- D. Provide all hubs as required for conduit connections.

2.4 IN-GROUND PULL BOXES

- A. Material: Precast concrete, or composolite.
- B. Bottom: Open with 6" of gravel for drainage.
- C. Cover: Meet Florida Dept. of Transportation requirements for installed location (pedestrian, heavy traffic, light traffic).
- D. Solid sides constructed to facilitate conduit entries.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install per NEC.
- B. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- C. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.
- F. Install boxes to preserve fire resistance rating of partitions and other elements.
- G. Align adjacent wall-mounted boxes with each other.
- H. Use flush mounting boxes in finished areas.
- I. Do not install flush mounting boxes back-to-back in walls; provide minimum 6" separation. Provide minimum 24" separation in acoustic rated walls.
- J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- L. Pull and junction boxes larger than 25 square inches shall be supported with two 3/8" all-thread rod hangers minimum.
- M. Pull and junction boxes used for Systems Divisions 27, 28 larger than 25 square inches shall be hinged cover type.

- N. Do not fasten boxes to ceiling support wires.
- O. Support boxes independently of conduit.
- P. Large Pull Boxes:
 - 1. Boxes larger than 100 cubic inches in volume or 12" in any dimension:
 - a) Interior dry locations per NEC with screw covers.
 - b) Other locations use hinged enclosure under provisions of Section 26 27 16 Cabinets and Enclosures.
- Q. Outdoor Locations: All boxes installed outdoors to be NEMA 4, fully weatherproof and watertight.

3.2 IN-GROUND PULL BOXES

- A. Provide and install ground rod in each pull box. Connect #2 copper ground wires (counterpoise) to ground rod, run out pullbox 6" over conduits to next pull box; tie to respective building electrical ground rod at each building.
- B. Install pull boxes flush with finished grade. Provide extensions as required.
- C. In-ground pullboxes to have interior watertight pull box mounted inside in-ground pull box as required by Local Authority Having Jurisdiction.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations and sizes of required access doors with applicable sections in these Specifications.
- B. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

3.4 ADJUSTING

- A. Install knockout closure in unused box opening.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 35 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 35. The work described in Specification 26 05 35 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 35

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

PULL AND JUNCTION BOXES
SECTION 26 05 35

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SECTION 26 05 43 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of underground ducts and raceways for electrical systems.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material, accessories and mounting hardware for a complete and operating duct bank system including, but not limited to:
 - 1. Plastic conduit.
 - 2. Metal conduit.
 - 3. Rigid Metal.
 - 4. Duct.
 - 5. Manholes.
- B. System to include PVC conduit with asphaltum coated rigid galvanized sweeping elbows for all changes in direction, all encased in 3 inch red concrete envelope.
- C. Manholes are to be size and type as required for use. Manholes for primary power must comply with requirements of local utility company (OUC).
- D. Provide and install ductbank, can plaza, manhole, conduit systems for all electrical for airfield primary electric, electrical feeders & branch circuits, communications and fiber optics.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings and accessory locations for manholes.
- B. Product Data: Provide for nonmetallic conduit and manhole accessories
- C. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

1.5 PROJECT AS-BUILT DOCUMENTS

- A. Record actual locations of exact routing of duct bank, dimension from known landmarks (Survey Points).
- B. Record actual locations of each manhole, dimension from known landmarks (Survey Points).

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified with minimum three years experience.

1.7 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. and testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:
 - 1. AASHTO - Standard Specification for Highway Bridges.
 - 2. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
 - 3. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - 4. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
 - 5. ANSI/IEEE C2 - National Electrical Safety Code.
 - 6. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 7. ANSI/NFPA 70 - National Electrical Code.
 - 8. ASTM A48 - Gray Iron Castings.
 - 9. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.
 - 10. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 - 11. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - 12. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
 - 13. NEMA TC 8 - Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
 - 14. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
 - 15. NEMA TC 10 - PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
 - 16. NEMA TC 14 - Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings.

1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.
- D. Manhole and can plaza locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete duct bank system.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Comply with Division 26 Section Conduits

2.2 ACCESSORIES

- A. Underground Warning Tape: 4 inch wide plastic tape, detectable type, colored in accordance with American Public Works Association Uniform Color Code with suitable warning legend describing buried electrical lines.

2.3 CONCRETE

- A. Concrete shall be as required by other divisions of these specifications, but in no case shall concrete be less than 3000 psi.
- B. Reinforced precast concrete, as specified in Division 03.
- C. Construction: Modular sections with tongue-and-groove joints.
- D. Reinforcing: AASHTO Classification H-20.

2.4 CAST-IN-PLACE MANHOLE ACCESSORIES

- A. Frames and Covers: ASTM A48; Class 30B gray cast iron, 30 inch size, machine finished with flat bearing surfaces. Provide cover marked ELECTRIC to indicate utility.
- B. Cable Pulling Irons: Use galvanized rod and hardware.
- C. Cable Rack Inserts: Minimum load rating of 800 pounds (365 kg).

- D. Cable Rack Mounting: All cables in manholes shall be properly supported on cable supports a minimum of every 36". Provide new cable supports in existing manholes as required for proper support of both the new and existing cables. Supports shall be fastened to manhole wall with approved concrete anchors.
- E. Cable Racks: Shall be nonmetallic saddle type that is nonconductive and will never rust or corrode. Cable saddle rack shall be at least 32" long, 3" wide, incorporate three cable saddles that are 5" deep with a 3" throat opening and four elongated mounting holes. At least one spare hook shall be available at each cable rack position for future use.
- F. Manhole Steps: Ladder: Aluminum rung with top hook to engage manhole step. Provide one ladder for each manhole.
- G. Sump Covers: ASTM A48; Class 30B gray cast iron with hinged lift assist.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that excavation, base material installation, and compaction is completed.

3.2 PREPARATION

- A. Prepare excavation in accordance with manhole manufacturer's instructions.

3.3 DUCT BANK INSTALLATION

- A. Install duct in accordance with manufacturer's instructions.
- B. Install duct to locate top of duct bank at depths as indicated on drawings.
- C. Install ducts with minimum slope of 4 inches per 100 feet. Slope away from building entrances.
- D. Cut duct square using saw or pipe cutter; de-burr cut ends.
- E. Insert duct to shoulder of fittings; fasten securely.
- F. Join nonmetallic duct using adhesive as recommended by manufacturer.
- G. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- H. Install no more than equivalent of three 90-degree bends between pull points.

- I. Provide suitable fittings to accommodate expansion and deflection where required.
- J. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- K. Use suitable separators and chairs installed not greater than 4 feet on centers.
- L. Band ducts together before placing concrete.
- M. Securely anchor duct to prevent movement during concrete placement.
- N. Place concrete under provisions of Division 03. Use mineral pigment to color concrete red.
- O. Provide minimum 3 inch concrete cover at bottom, top, and sides of duct bank.
- P. Provide suitable pull string in each empty duct except sleeves and nipples.
- Q. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- R. Backfill trenches under provisions of Division 02.
- S. Interface installation of underground warning tape with backfilling. Install tape 6 inches below finished surface.
- T. All excavation for underground feeders shall be performed in accordance with all State of Florida standards and regulations for trench safety.
- U. Maintain a minimum of 7.5 inches center-to-center spacing between all raceways.
- V. Fill medium shall be compacted to eliminate air pockets and to assure uniform heat dissipation. Concrete shall be carefully spaded to eliminate voids. All trenches shall be free of cans, bottles, scrap lumber, trash and obstructions prior to back filling.
- W. All iron, steel, galvanized steel and similar metallic items (not intended to be a grounding electrode) installed underground or within 12 inches of the earth shall be protected by a 12-mil thick layer of asphaltum coating. Apply coating in strict accordance with the manufacturer's instructions. Apply to clean dry surfaces. Asphaltum coating shall be applied in two applications/coats minimum. Observe the manufacturer's minimum cure time between applications/coats. Each application of the coating shall be given ample time to dry and harden before the next application is applied. Touch up areas damaged during installation, wrench marks, tooling, bonding clamps, exothermic welds, etc. Apply the proper consistency of asphaltum coating uniformly. The finished coating shall be free from sags, holidays, and smears. Asphaltum coating shall be Carboline Bitumastic 50 or Sumter Coatings Coal Black Asphaltum 100N8507 or accepted equivalent.
- X. Where steel conduit is threaded in the field the threads shall be coated with an

approved electrically conductive, corrosion resistant compound in accordance with NEC Section 300.6(A). Use TNB KOPR_SHIELD or accepted equivalent.

3.4 PRECAST MANHOLE INSTALLATION

- A. Install and seal precast sections in accordance with manufacturer's instructions.
- B. Install manholes plumb.
- C. Use precast neck and shaft sections to bring manhole cover to finished elevation.
- D. Attach cable racks to inserts after manhole installation is complete.
- E. Install drains in manholes and connect to site drainage system 4-inch pipe terminating in 1/3 cu. yd. crushed gravel bed under provisions of Division 22.
- F. Damp proof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days, under provisions of Division 07.

3.5 COUNTERPOISE

- A. Install counterpoise ground over all sections of duct banks.
- B. No. 2 bare stranded copper counterpoise shall be run 6 inches above all duct banks. Provide one counterpoise conductor for duct banks 12 inches wide or less. Provide two counterpoise conductors above outside edge of duct banks over 12 inches wide. Counterpoise shall run to building and be grounded at each building service ground.

3.6 COORDINATION

- A. Coordinate duct bank routing (and manhole locations) with all underground utilities and building structure. Modify location/routing shown on drawings as required to facilitate installation.

3.7 CONDUIT

- A. Install plastic conduit in concrete envelope with rigid steel sweeping elbows with largest possible factory radius for all changes in direction.
- B. Minimum bend in conduits 2" and larger shall be equal to or greater than ten (10) times the internal diameter of the conduit. Provide larger radius as necessary to achieve acceptable pulling tension or as required by cable installers.

3.8 CONDUCTORS

- A. All duct bank and manhole systems shall completely isolate Normal Utility Power and Emergency Power Systems into two separate systems.
- B. Attach cables to nonmetallic cable racks on manhole walls in a neat and orderly way.
- C. Wire other than current carrying conductors such as control or signal wiring shall be run in a separate conduit within the duct bank. Secure wires separately at the maximum distance within the manhole from all current carrying conductors.
- D. Slack cable shall be provided in manholes by routing the cables by the longest path possible through the manholes.
- E. All cables will be secured to cable racks with nylon cable ties, no tie wire, tape or substitutes will be allowed.
- F. No metal objects such as unistrut, tie wire or angle iron that can rust and become sharp objects will be allowed in manhole.
- G. Cable splicing in manholes will not be allowed without prior written permission from owner. Submittals for all cable splicing products will be required before permission is given.
- H. All conductors shall be pulled in conduits by industry approved cable pulling "tuggers" equipment. The use of construction equipment such as fork lifts, tractors and other vehicles will not be allowed. All conductors will be routed and protected by using the proper pulleys and sheaves.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 43 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 43. The work described in Specification 26 05 43 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

ORLANDO INTERNATIONAL AIRPORT
BP-S196: TERM C, PH 1X -
AIRFIELD CIVIL, APRON & TAXIWAY PAVING

UNDERGROUND DUCTS AND RACEWAYS
FOR ELECTRICAL SYSTEMS
SECTION 26 05 43

END OF SECTION 26 05 43

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of identification for electrical equipment.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor and material for a complete identification system, including but not limited to:
 - 1. Nameplates and labels.
 - 2. Wire and cable markers.
 - 3. Conduit markers.
 - 4. Identify all new and existing conduits, boxes, equipment, etc. as specified herein.

1.4 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:
 - 1. ANSI/NFPA 70 - National Electrical Code.
 - 2. Americans with Disabilities Act — 1990.

1.5 ACTION SUBMITTALS

- A. Sustainable Design Documentation Submittals: Refer to section 01 8113.14 "Sustainable Design Requirements – LEED V4 BD+C".
 - 1. Product Data: Documentation for Low Emitting Materials
 - a) Low Emitting Materials for Paints and Coatings
 - b) Low Emitting Materials for Adhesives and Sealants

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Nameplates for Life Safety Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Orange phenolic plastic border to be added around nameplate to denote branch.
- B. Nameplates for Critical (Legally Required) Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Green phenolic plastic border to be added around nameplate to denote branch.
- C. Nameplates for Security Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Purple phenolic plastic border to be added around nameplate to denote branch.
- D. Nameplates for Equipment Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Blue phenolic plastic border to be added around nameplate to denote branch.
- E. Nameplates for Normal Branch Power shall be laminated black phenolic plastic with chamfered edges and white engraved lettering.
- F. Letter Size:
 - 1. 1/8 inch for identifying individual equipment and loads.
 - 2. 1/4 inch for identifying grouped equipment and loads.
- G. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the drawings, inscription and size of letters shall be as shown and shop drawing submitted for approval. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 120/208V, 3- phase, 4-wire". In addition, provide phenolic label in panel to describe where the panel is fed from. For example, "Fed from MDP-1:3:5". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine.
- H. The following items shall be equipped with nameplates: All motors, motor starters, motor-control centers, push-button stations, control panels, time switches, disconnect switches, transformers, panelboards, circuit breakers (i.e., all 2 pole, 3 pole C.B.'s), contactors or relays in separate enclosures, power receptacles where the nominal voltage between any pair of contacts is greater than 150V, wall switches controlling outlets that are not located within sight of the controlling switch, high voltage boxes and cabinets, large electrical, and electrical systems junction and pull boxes (larger than 4 11/16"), terminal cabinets, terminal boards, and equipment racks. Nameplates shall also describe the associated panel and circuit number (if applicable).

- I. All Electrical System panels, transfer switches, etc. shall be labeled per branch, i.e.: "Panel ABC- Life Safety Branch" (similar for critical or equipment branch).
- J. All receptacles shall be clearly labeled with panel/circuit designation.
- K. All junction/pull boxes shall receive phenolic labels clearly labeling circuitry/cabling/etc., within.

2.2 WIRE MARKERS

- A. Description: Cloth, tape, split sleeve, or tubing type wire markers.
- B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings including neutral conductor.
 - 2. Low voltage circuits (circuits under 120V):
- D. Control wire number indicated on schematic and interconnection diagrams on shop drawings.

2.3 CONDUIT/JUNCTION BOX COLOR CODE

- A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

Color Code for Junction Boxes

System Emergency 277/480 volt
System Emergency 120/208 volt
Fire Alarm
Normal Power 277/480 Volt
Normal Power 120/208 Volt
Fiber Optics
Sound System
Clock
Intercom
PDS/WIFI

Krylon Paint Number

Cherry Red K02101
Zinger Pink S01150
Popsicle Orange K02410
Leather Brown K02501
Glossy Black K01601
Plum Purple K01929
Daisy Yellow K01813
Light Blue S01540
True Blue K01910
Gold K01701

<u>Color Code for Junction Boxes</u>	<u>Krylon Paint Number</u>
TV	Glossy White K01501
BAS	Cameo White K04129
FIDS/BIDS	Saddle Tan K03554
Security/CCTV	John Deer Green K01817
Telephone	Clover Green K02012
Grounding	Fluorescent Green K03106
Access Control System	John Deer Green K01817
Lightning Detection & Notification	Global Blue K03546
<u>Color Code for Junction Boxes</u>	<u>Krylon Paint Number</u>
Elevator Status	Georgia Clay K03531
800 Mhz Radio	Copper Metallic K02203
FCIC	Clover Green K02012
Positron	Clover Green K02012
DC Controls	Clover Green K02012
Duress	Fresh Salmon K03536
Fire Pump Status	Popsicle Orange K02410
Emergency Generator Status	Zinger Pink S01150

- B. Conduits (not subject to public view) longer than 20 feet shall be painted with above color paint band 20 ft. on center. Paint band shall be 4" in length. Where conduit are parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniformed. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.
- C. Emergency (Backed by Generator). Conduit shall be painted red 20 ft. on center. Paint band shall be 4" in length. A smaller band, 1" in length, centered over the 4" red band shall be applied to denote Emergency Branch as follows:

<u>Emergency Branch</u>	<u>Color Band</u>
Life Safety	Orange
Critical	Green
Security	Purple
Equipment	Blue

- D. Junction boxes and conduit located in public areas (i.e., areas that can be seen by the public) shall be painted to match surface attached to. Provide written request to DESIGNER for interpretation of those public areas which may be in question.
- E. Where two colors apply to the same raceway, paint on opposite corners leaving room for panel/ckt./system/etc., labeling in center.
- F. The Contractor may utilize conduit banding tape instead of paint, on interior conduits only, where specified colors are available. Surface of conduits shall be thoroughly cleaned prior to tape application, and tape shall be applied in a neat and workmanlike manner. Tape to be manufactured by Seton Identification Products only.

2.4 CONDUIT/JUNCTION BOX MARKER

- A. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately identify its associated systems panel and circuit number. Identification shall be by means of black permanent marker. (Paint one-half cover plate with appropriate color above, and one-half with associated panel/circuit or system as described above.)

2.5 DEVICE COVER PLATE IDENTIFICATION

- A. Description: Self-adhesive clear printed labels with Black typed letters (pre-printed, dot matrix, or laser).
- B. Locations:
 - 1. Each new receptacle cover plate.
 - 2. Each existing receptacle cover plate in areas of remodel/renovation.
- C. Legend:
 - 1. Receptacle plates shall adequately describe its associated panelboard and circuit reference.
 - 2. System plates shall adequately describe its terminal board, or terminal cabinet, termination cable identifier and assigned user code number.

2.6 UNDERGROUND WARNING TAPE

- A. Description: 6 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines, one strip per 24" of duct.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

- A. Install nameplate parallel to equipment lines.
- B. Secure nameplate to equipment front using stainless steel pop rivets.
- C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

- D. Nameplates installed inside on dead front cover shall be self adhesive tape. (Do not drill or install screws in dead front.)
- E. Identify new and existing conduit, junction boxes, and outlet boxes using field painting.
- F. Identify new underground conduits using underground warning tape. Install one tape per 24 inches of trench at 3 inches below finished grade.
- G. Install wire markers at all new and existing connections and terminations.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 53 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 53. The work described in Specification 26 05 53 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 53

SECTION 26 05 73 – POWER SYSTEMS STUDY WITH ARC FLASH ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Std. 1584-2002 equations that are presented in NFPA70E- 2009, Annex D.
- C. The scope of the studies shall include all new distribution equipment supplied by the equipment manufacturer under this contract as well as all directly affected existing distribution equipment associated with the Project.

1.3 DESCRIPTION

- A. Provide all labor, materials, and equipment necessary to properly and completely perform a Power Systems Study for the electrical distribution and control equipment and submit results in a report.
- B. Electrical distribution and control equipment is to include all equipment installed under this contract and all existing equipment that this project is connecting to, complete from new equipment to existing power company transformer(s) via all applicable existing power distribution and control equipment.
- C. Provide an up to date electrical system single-line diagram as required by NFPA 70E, "Standard for Electrical Safety in the Workplace," as referenced in OSHA 29 CFR 1910 Subpart S, Appendix A. This information shall include nameplate data for electrical components (e.g., transformers, medium voltage switchgear, panelboards, switchboards, motor control centers, etc.) for all portions of the electrical system from the utility intertie through the lowest rated panel or piece of equipment.
- D. Cable sizes, types and lengths between electrical equipment components and up to date utility source data shall be provided for an accurate single-line representation of the electrical system. Unique characteristics of the equipment installation shall be provided which may impact the magnitude of the potential hazard (e.g., open space versus enclosure). Overcurrent device settings shall be verified.

- E. Data collection may require removal of barriers, opening of front panels, etc. while equipment is energized. The Contractor must provide proof (written documentation) that its employees working on the premises of the Landside Building have been properly trained in the use and application of personal protective equipment (PPE) and the hazards of working on or near energized equipment. The Contractor must provide its own PPE protection with a minimum arc thermal performance rating (ATPV) of 40 calories/cm².
- F. The contractor shall be responsible for obtaining all required data of all equipment.
- G. The study shall verify adequacy of all equipment implemented under these specifications and to verify the correct application of circuit protective devices and other system components specified completely coordinated with the existing system.
- H. A comprehensive analysis of the electrical system shall be performed for all equipment up to 480 volts and by a 125kVA or larger transformer based on the up to date single-line diagram provided from "Section A". This analysis shall include the following:
 - 1. Short Circuit Study – A short circuit analysis shall be performed in accordance with ANSI standard C37 and IEEE standard 141-1993 (Red Book) for each electrical component as defined in "Section A. "
 - 2. Coordination Study – A coordination study shall be performed in accordance with IEEE 242- 2001 "Buff" to determine the proper overcurrent device settings that will balance system reliability through selective coordination while minimizing the magnitude of an electrical arc flash hazard incident.
 - 3. Incident Energy Study – An incident energy study shall be done in accordance with the IEEE 1584-2004a, "IEEE Guide for Performing Arc Flash Hazard Calculations" as referenced in NFPA 70, "Standard for Electrical Safety in the Workplace", latest revision, in order to quantify the hazard for selection of personal protective equipment (PPE). Tables that assume fault current levels and clearing time for proper PPE selection are not acceptable.
- I. Reconcile arc flash protective device setting recommendations with the protective device time-current coordination study.
- J. Adjust the System Design to optimize the results of the study as it relates to safety and reliable electrical system operation (e.g., overcurrent device settings, working distances, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm². A qualified engineer with power systems design experience shall provide this assistance.
- K. The intent/goal of the protective system included herein is to establish arc flash levels that result in PPE levels of Category 2 or less.**
- L. Identify locations where Category 2 cannot be achieved.
- M. The study shall address the case when the system is being powered from the normal source as well as from the on-site generating source.
- N. Minimum as well as maximum possible fault conditions shall be covered in the study.

- O. Fault conditions of all motors shall be considered.

1.4 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.5 SUBMITTALS FOR REVIEW/APPROVAL

- A. The short-circuit and protective device coordination results shall be submitted prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment drawings for manufacturing. This preliminary submittal of study data shall be sufficient to ensure that the selection of device and characteristics will be satisfactory.

B. SUBMITTALS FOR CONSTRUCTION

- C. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. For large system studies,

submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

D. For large system studies with more than 200 bus locations, the contractor is required to provide the study project files to the Owner in electronic format. In addition, a copy of the computer analysis software viewer program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, oneline diagrams, etc.

E. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout
6. Details of the incident energy and flash protection boundary calculations
7. Recommendations for system improvements, where needed
8. One-line diagram

F. Arc flash labels shall be provided in hard copy and label images shall be provided in electronic format. Vinyl arc flash labels shall be placed on all pieces of equipment. Separate vinyl label shall show available fault current, date of calculation, and contact information for all panels/ switchboards.

G. Report shall include:

1. Available fault current at each equipment location with comparison to equipment rating
2. Overcurrent device settings (e.g. pick-up, time delay, curve), "as found" and "as recommended"
3. Incident energy level (calories/cm²) for each equipment location and recommended PPE
4. Overcurrent device coordination curves including related section of the single-line diagram
5. List of prohibited energized work locations based on arc flash results.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the

equipment manufacturer or an approved engineering firm.

- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER ANALYSIS SOFTWARE

- A. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program or prior approved equal.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

3.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination shall include present and future motors and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor when available.
- D. Include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

3.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- B. Minimum transformer design impedances shall be used when test impedances are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics
 - 5. Tabulations of calculated quantities
 - 6. Results, conclusions, and recommendations.
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming switchgear
 - 3. Unit substation primary and secondary terminals
 - 4. Low voltage switchgear
 - 5. Motor control centers
 - 6. Standby generators and automatic transfer switches
 - 7. Branch circuit panelboards
 - 8. Other significant locations throughout the system.
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
 - 3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

3.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 - 1. Electric utility's overcurrent protective device
 - 2. Medium voltage equipment overcurrent relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points, where applicable
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. The largest feeder circuit breaker in each motor control center and applicable panelboard.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

3.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE Std. 1584-2002 equations that are presented in NFPA70E-2009, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed

to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE Std. 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

3.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:
 - 1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
 - 2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, %

- taps and phase shift.
 - 3. Reactor data, including voltage rating, and impedance.
 - 4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance ($X'd$), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
 - 5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
- 1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a) Voltage
 - b) Calculated fault current magnitude and angle
 - c) Fault point X/R ratio
 - d) Equivalent impedance
 - 2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a) Voltage
 - b) Calculated symmetrical fault current magnitude and angle
 - c) Fault point X/R ratio
 - d) Calculated asymmetrical fault currents
 - 1) Based on fault point X/R ratio
 - 2) Based on calculated symmetrical value multiplied by 1.6
 - 3) Based on calculated symmetrical value multiplied by 2.7
 - e) Equivalent impedance
 - 3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a) Voltage
 - b) Calculated symmetrical fault current magnitude and angle
 - c) Fault point X/R ratio
 - d) No AC Decrement (NACD) Ratio
 - e) Equivalent impedance
 - f) Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
 - g) Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis
- C. Recommended Protective Device Settings:
- 1. Phase and Ground Relays:

- a) Current transformer ratio
 - b) Current setting
 - c) Time setting
 - d) Instantaneous setting
 - e) Recommendations on improved relaying systems, if applicable.
 - 2. Circuit Breakers:
 - a) Adjustable pickups and time delays (long time, short time, ground)
 - b) Adjustable time-current characteristic
 - c) Adjustable instantaneous pickup
 - d) Recommendations on improved trip systems, if applicable.
 - D. Incident energy and flash protection boundary calculations
 - 1. Arcing fault magnitude
 - 2. Protective device clearing time
 - 3. Duration of arc
 - 4. Arc flash boundary
 - 5. Working distance
 - 6. Incident energy
 - 7. Hazard risk category
 - 8. Recommendations for arc flash energy reduction
- 3.7 FIELD ADJUSTMENT
- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the contractor and/or electrical equipment manufacturer's field service personnel.
 - B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
 - C. Notify Owner in writing of any required major equipment modifications.
- 3.8 ARC FLASH WARNING LABELS
- A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
 - B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
 - C. The label shall include the following information, at a minimum:
 - 1. Location designation

2. Nominal voltage
 3. Flash protection boundary
 4. Incident energy or energy range corresponding to reported Hazard risk category.
 5. Working distance
 6. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
1. For each 600, 480 and applicable 208 volt panelboard, at least one arc flash label shall be provided.
 2. For each motor control center, one arc flash label shall be provided.
 3. For each switchboard, one arc flash label shall be provided.
 4. For each main switchboard with Utility Service, one flash label shall be provided for each section.
- F. Labels shall be field installed by the contractor.

3.9 ARC FLASH TRAINING

- A. The contractor of the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 73 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 73. The work described in Specification 26 05 73 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 73

SECTION 26 05 83 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of wiring devices.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
 - 1. Wall switches.
 - 2. Wall dimmers.
 - 3. Receptacles.
 - 4. Device plates and decorative box covers.

1.4 SUBMITTALS

- A. Submit Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations including all types of wiring devices, plates and engraving.
- B. Submit Manufacturer's Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
 - 2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable

for purpose specified and shown.

B. Conform to the requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code
2. NEMA WD 1 - General Color Requirements for Wiring Devices.
3. NEMA WD 6 - Wiring Devices Dimensional Specifications.
4. UL 20 - General Use Snap Switches
5. UL 498 - Standard For Attachment Plugs and Receptacles
6. UL 1472 - Solid State Dimming Controls

1.7 EXTRA MATERIALS

A. Provide a minimum of two (2) screw drivers of each type of tamper proof screw used on project. Turn over to OAR. Include receipt in O&M manual.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All devices shall be Specification Grade as minimum.
- B. General and Special purpose wiring devices shall meet NEMA standard WD 1 and WD 6.
- C. All wiring devices shall bear UL labels.
- D. All devices of one type shall be by the same Manufacturer.
1. "Hazardous Location" and special purpose devices as may not be available from the same manufacturer shall constitute the only exception to this requirement of single source.
- E. Corrosion resistant devices shall be as specified for normal usages, and fabricated of yellow color melamine plastic. Where "Weatherproof" type is indicated for exterior or wet locations, provide matching self-closing cover, with gasketed seals at plate/wall junctions and for cover.
1. Provide factory packaged wiring devices having high impact strength molded plastic bodies.
- F. Except where specifically required, the use of interchangeable type or combination switch- receptacle-pilot devices are not acceptable.

2.2 WALL SWITCHES

A. General:

1. Snap switches for general use shall be maintained contact types, and shall be single-pole, double-pole, three-way, or four-way as required for the specific switching arrangements shown on the drawings. They shall be quiet tumbler operation types, having silver alloy contacts, and meeting all NEMA performance standards. Color to match plates unless specifically noted otherwise.
2. Switches shall be toggle or key-operated types, as indicated on the drawings. All key-operated switches shall be keyed alike.
3. Where switches are denoted as having pilot lights, pilot lights shall glow when the switches are "ON". Provide pilot light switch with lamp and miniature step-down transformer. The pilot light shall have a red lens, and the lamp shall be long-life type.
4. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be amber. All units shall be front relampable.
5. Snap switches installed in hazardous locations shall be UL listed for the type of location (class and division).
6. Switches connected to emergency power shall have red lighted handles which shall illuminate when the switches are "Off".
7. Voltage and ampere rating of switches shall be marked on switch, and shall conform to voltage of system to which applied.
8. Switches shall have back and side wired screw pressure terminals.

B. Description: Heavy-duty, AC only general-use snap switch.

C. Voltage Rating: 120-277 volts, AC.

D. Current Rating: 20 amperes minimum.

E. Ratings: Match branch circuit and load characteristics.

F. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements including UL 20 and NEMA WD 1 and 6.

2.3 WALL DIMMERS

A. Description: Semiconductor dimmer for incandescent lamps, type as indicated on Drawings.

B. Device Body: Present, linear slide as called for on drawings.

C. Voltage: 120 volts or 277 volts as required to match application.

D. Power Rating: Match load shown on Drawings; 600 Watts minimum.

E. Accessory Wall Switch:

1. Match dimmer appearance.

F. Same manufacturer and style as dimmer switch.

G. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements including UL 1472

2.4 RECEPTACLES

A. General:

1. All receptacles shall be of standard NEMA configuration, as indicated on the drawings, and shall comply with the respective ANSI C73 series standard for the NEMA configuration. Color to match plates unless specifically noted otherwise.
2. Duplex receptacles shall have integral UL listed self-grounding clips. Similar, single receptacles shall be provided for plug-in connections of industrial fluorescent light fixtures on the same switching circuit. Receptacle face to be impact resistant nylon.
3. Weatherproof duplex receptacles shall be provided in all exterior locations, and shall be Ground Fault Circuit Interrupting (GFCI) types, with weatherproof stainless steel cover plates.
4. Special purpose receptacles for specific equipment shall be grounding types, having the number of poles, voltage and ampere ratings, and NEMA configurations required by the equipment. For each special purpose receptacle, provide an identical mating plug equipped with cord grip, secured to cord.
5. Duplex receptacles shall have back and side wired screw pressure terminals.
6. Receptacles to be installed in shower rooms, locker rooms, toilet rooms, janitors closets, exterior, elevator pit and machine rooms, escalator pits, within six (6) feet of a sink, and other areas as required by NEC, and OSHA Standards shall be ground fault circuit interrupting (GFCI) type, whether specified or not.
7. Receptacles installed for water coolers shall be GFCI type, or a single receptacle as permitted by NEC.

B. Description: Heavy-duty general use receptacle.

C. Configuration: Heavy-duty, general use type as specified and indicated.

D. Convenience Receptacle: NEMA Type 5-20.

E. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter, and automatic "self-testing feature" to meet regulatory requirements.

F. Controlled Receptacle: Convenience receptacle automatically controlled with NEMA approved controlled receptacle marking pad printed on the face of receptacle for superior abrasion resistance. Half or dual controlled.

- G. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements including UL 498 and NEMA WD 1 and 6.

2.5 COVER PLATES

- A. All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.
- B. Metallic cover plates shall be used in interior spaces, except as noted below, and shall be fabricated of corrosion-resistant #302 stainless steel, having a nominal thickness of .04", and a brushed finish. Screws securing the plates shall have flush (when installed) heads with finish to match plates. Metallic cover plates shall meet all requirements of the National Electrical Code and Federal Specifications.
- C. Cover plates for switches located in corrosive atmospheres (where vaporproof is not indicated) shall consist of a one piece neoprene boot with matching pressswitch.
- D. Cover plates for exterior receptacles shall be gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed..
- E. Cover plate engraving, where required, shall be accomplished by cover plate manufacturer in accordance with instructions given on the drawings. Metallic plates and nylon plates in ivory, beige, gray, and white shall be engraved with black fill. Red, brown, and black nylon plates shall be engraved with white fill.
- F. Plates for devices connected to emergency power shall be as specified for devices connected to normal circuits, but shall be engraved reading "Emergency", see drawings for other engraving requirements.
- G. Plates for devices connected to computer power panels shall be engraved reading "Computer". Devices connected to emergency computer power panels shall be red in color.
- H. Plates for devices connected to UPS power systems shall be as specified for devices connected to normal circuits, but shall be engraved reading "UPS POWER", see drawings for other engraving requirements.
- I. Unless specifically noted otherwise in specs or on drawings all outlets for telephone and other communications and data systems shall be provided with standard size one-piece cover plates having a minimum 3/4 inch diameter, with bushing, in the center unless specifically noted otherwise. Where telephone conductors are installed, plates shall contain telephone type, polarized plug-in receptacles.
- J. Device plates located in secure areas, as noted on drawings, shall have security wall plates (10 gauge) with 12 gauge galvanized steel backplate. All device plates shall have tamperproof screws.

- K. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

2.6 COLOR

- A. Wiring devices connected to normal power shall be gray unless specifically noted otherwise.
- B. All devices and coverplates in paneled walls shall have finish to match paneling.
- C. Devices connected to emergency power shall be red color. (Including devices connected to emergency computer power panels).
- D. Devices connected to separate computer power panels shall be black in color.
- E. Modify any given catalog numbers as required to procure devices and plates of the proper color.
- F. Devices connected to UPS systems shall be orange (isolated ground).
- G. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

2.7 FLUORESCENT DIMMERS

- A. Dimmers shall be electronic type and include a remote control where required. Special dimming ballasts shall be included on fixtures to be dimmed. Ballasts shall be compatible with dimmer being provided.
- B. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

2.8 LED DIMMERS

- A. Dimmers shall be electronic and compatible with light fixtures and drivers provided.
- B. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and will be completely covered by wall plates.
- C. Verify floor boxes are adjusted properly.
- D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. In general, lighting control switches shall be located at the lock/strike plate side of door(s). If the drawings indicate otherwise, issue a request for clarification prior to rough-in.
- E. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- F. Do not share neutral conductor on load side of dimmers.
- G. Install receptacles with grounding pole on bottom.
- H. Where 2 or more switches or receptacles are to be installed adjacent to one another, provide a multi-gang coverplate. Provide proper NEC barriers in boxes which serve devices for both the Normal and Emergency Systems or a combined system voltage of 480 volt.
- I. Provide device coverplates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch.

- J. In finished areas, provide same type of plate for all surface mounted devices as for recessed mounted devices.
- K. In any room, where new and existing construction is present, all receptacles, switches, and coverplates which are existing to remain shall be changed, to match new work.
- L. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.
- M. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.
- N. All wiring devices, relays, contactors, pushbuttons, selector switches, pilot lights, etc. shall be installed in approved enclosures rated for the appropriate NEMA classified environment.
- O. All devices shall be installed so that only one wire is connected to each terminal.
- P. Once construction is substantially completed, replace all damaged, burned, or scorched wiring devices.
- Q. Receptacles shown to be floor mounted shall be installed in floor boxes (with coverplates) which are approved for this use.
- R. Connect wiring devices by back wiring conductor into compression terminal.
- S. Install protective rings and split nozzle on active flush cover service fittings.

3.4 NEUTRAL CONDUCTOR CONNECTIONS

- A. At each receptacle "in" and "out" phase and neutral conductors shall have an additional conductor "pigtail" for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable.
- B. Provide and install a neutral conductor for each circuit in all wall switch outlet locations.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes to obtain specified mounting heights.

3.6 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.

- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 05 83 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 05 83. The work described in Specification 26 05 83 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 05 83

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SECTION 26 08 00 - CX OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.
- B. Owner's Project Requirements (OPR) and the Basis of Design (BOD) documentation are included by reference for information only.
- C. Division 01 Section 01 81 13 Sustainable Design Requirements – LEED v4 BD+C for additional LEED v4 requirements related to commissioning.
- D. ASHRAE standard 90.1-2010 and ASHRAE Guideline 0-2005 (The Commissioning Process) and ASHRAE Standard 202-2013 Commissioning Process for Buildings and Systems.

1.2 SUMMARY

- A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittal Procedures" for specific requirements. In

addition, provide the following:

- C. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Test reports

1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractor will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractor, the CxA will prepare construction Verification Checklists for all commissioned components, equipment, and systems, the contractor shall execute the Verification Checklists.
- B. Redlined Drawings:
1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on redlined drawings.
 2. Preliminary redlined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the redlined drawings.
 4. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data:
1. The CM at Risk will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
 2. The CxA and the A/E will review the O&M literature once for conformance to project requirements.
 3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the CM at Risk and the Contractor.
- D. Demonstration and Training:
1. CM at Risk and the subcontractor will provide demonstration and training as required by the specifications.
 2. A complete training plan and schedule must be submitted by the CM at Risk and the Subcontractor to the CxA a minimum of four (4) weeks prior to any training.
 3. A training agenda for each training session must be submitted by the CM at Risk and the Subcontractor to the CxA, the A/E and the OR a minimum of one (1) week prior the training session.

4. The CxA shall be notified at least 72 hours in advance of scheduled tests so that testing may be observed by the CA and Owner's representative. A copy of the test record shall be provided to the CxA, the A/E, and the OR.
 5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
 6. Train Owner's maintenance personnel on procedures and schedules for starting and stop- ping, trouble shooting, servicing, and maintaining equipment.
 7. Review data in O&M Manuals.
- E. Systems Manual Requirements:
1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 2. The CM at Risk shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Schematics
 - b. Verified Record Drawings
 - c. Test Results (not otherwise included in Cx Record)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
 3. This information shall be organized and arranged by building system, such as electrical panels, etc.
 4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.
- F. CM at RISK & SUBCONTRACTOR'S RESPONSIBILITIES
- G. Perform commissioning tests at the direction of the CxA.
- H. Attend construction phase controls coordination meetings.
- I. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- J. Provide information requested by the CxA for final commissioning documentation.
- K. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

- L. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to the CM at Risk and the CxA.
- M. Update schedule as required throughout the construction period.
- N. During the startup and initial checkout process, execute the related portions of the verification checklists for all commissioned equipment.
- O. Assist the CxA with all verification and functional performance tests.
- P. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- Q. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to the A/ E and the CxA within 45 days after submittal acceptance.
- R. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- S. Notify the CxA and the A/E a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
- T. Participate in, and schedule vendors and contractors to participate in the training sessions.
- U. Provide written notification to the CxA and the A/E that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - 1. Electrical equipment including switchgear, panel boards, motor control centers, lighting, receptacles, and all other equipment furnished under Division 26.
 - 2. Lighting control systems
 - 3. ATS switches and emergency power systems.
 - 4. Fire / Smoke alarm system
- V. The equipment supplier shall document the performance of his equipment.
- W. Provide a complete set of red-lined drawings to the CxA and the A/E prior to the start of Functional Performance Testing.
- X. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- Y. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 2. Assist in equipment testing per agreements with contractors.
 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
- Z. Refer to Division 01 Section "General Commissioning Requirements" for additional Contractor responsibilities.

3.2 OWNER'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Owner's Responsibilities.

3.3 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Design Professional's Responsibilities.

3.4 Cx AUTHORITY'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.

3.5 TESTING PREPARATION

- A. Certify in writing to the A / E and the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- C. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut- down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.6 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA, along with the CM at Risk, the Electrical contractor and other contracted subcontractors, including the fire alarm & controls Subcontractor, shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.7 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CxA.

- B. Electrical Instrumentation and Lighting Control System Testing: Field testing plans and testing requirements are specified in Division 26 Section "Lighting Control Devices". Assist the CxA with preparation of testing plans.
- C. Emergency Power Testing and Acceptance Procedures: Provide technicians, load banks, infra- red cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each piece of equipment.
- D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:
 - 1. Automatic temperature controls integrated with the electrical systems
 - 2. Coordination and functionality with the Building Automation System / DDC Controls System
 - 3. Emergency Generator(s)
 - 4. Lift-Net
 - 5. Lighting Controls
 - 6. Power Xpert
 - 7. Security access control systems
 - 8. Transfer Switches – Automatic and Manual
 - 9. Smoke / Fire Alarm interfaced with HVAC & Life Safety systems
 - 10. Video surveillance systems

3.8 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.9 APPROVAL

- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.

3.10 DEFERRED TESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.

3.11 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

- B. Refer to Division 01 Section "General Commissioning Requirements" for the A/E and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.12 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to training. All training shall be videotaped for future use.
- B. Electrical Contractor. Shall have the following training responsibilities:
 - 1. Provide the CM at Risk with a training plan for review by the CxA, the A/E, and the OR a minimum of two (2) weeks before the planned training.
 - 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
 - 3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
 - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 - 5. The appropriate trade or certified factory manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise, as well as in-depth knowledge of all modes of operation of the specific piece of equipment, is required. More than one party may be required to execute the training.
 - 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 - 7. Training shall include:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discuss relevant safety issues and concerns.
 - d. Discuss warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discuss any peculiarities of equipment installation or operation.

8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance of all pieces of equipment.
9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
10. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 08 00 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 08 00. The work described in Specification 26 08 00 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 08 00

SECTION 26 08 03 - DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for demonstration of completed electrical system.

1.3 DESCRIPTION

- A. Demonstrate to Owner/Designer/OAR the essential features of the following electrical systems:
 - 1. Systems specified in Divisions 27 and 28
 - 2. Electrical Entrance Equipment
 - a) Circuit breakers
 - b) Fuses and fuseholders
 - c) Meters (where applicable)
 - 3. Miscellaneous Electrical Equipment
 - a) Kitchen exhaust hood shut down
 - b) Electrical systems controls and equipment
 - c) Electrical power equipment
 - d) Motor control centers
 - e) Motor control devices
 - f) Relays
 - g) Special transformers
 - h) Starting devices
 - i) Surge suppression equipment
 - 4. Lighting Fixtures (include relamping and replacing lenses)
 - a) Exit and safety fixtures
 - b) Fixtures, indoor and outdoor
 - 5. Lightning Protection System

6. Distribution Equipment

- a) Lighting and appliance panelboards
- b) Distribution panels
- c) Switchboard
- d) Voltage stabilizers

7. Standby Electrical Equipment

- a) Batteries
- b) Battery chargers
- c) Controls and alarms
- d) Emergency generators, transfer switches
- e) UPS systems

8. Wiring Devices

- a) Low-voltage controls
- b) Switches: regular, time, occupancy

- B. After the completion of testing, each system shall be demonstrated to operate successfully as intended.

1.4 TIME

- A. The demonstration shall be held upon completion of all systems at a date to be agreed upon in writing by the OAR.

1.5 ATTENDING PARTIES

- A. Provide the demonstration in the presence of the Owner, OAR and the manufacturer's representative.

1.6 DEMONSTRATION

- A. Demonstrate the function and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.
- B. Demonstrate by "start-stop operation" how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.

C. Certificate of Completed Demonstration

1. Submit Performance Verification and Demonstration to Owner Form in Section Project Closeout, signed by the Contractor, Subcontractor and OAR for "each" type of equipment and system. Complete an individual form for each item, equipment and system. Insert one copy in each O & M Manual.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 08 03 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 08 03. The work described in Specification 26 08 03 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 08 03

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SECTION 26 08 13 - TESTS AND PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for the furnishing of all labor, materials, equipment and services necessary to test and prove performance of the electrical system.

1.3 DESCRIPTION

- A. Operate system for a 3-day period. Do performance verification work as required to show that the system is operating correctly in accordance with design. Supply instruments required to read data. Adjust system to operate at the required performance levels.

PART 2 - PRODUCTS – (not applicable)

PART 3 - EXECUTION

3.1 TESTS

- A. System:
 - 1. General: After installation of all conductors, and before final acceptance, make required tests to determine proper function of all circuits. Furnish all necessary instruments required to make tests, and correct any deficiencies found. Prior to energizing, circuits shall be tested to verify opens, intentional and non-intentional grounds, and continuity and detect short circuits by approved constant "megger".
 - 2. Procedure:
 - a. Insulation resistance of all circuit conductors shall be tested. This is to include all new conductors and all existing conductors that are connected or extended. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps, and connections are made except connection to source and point of final termination at distribution or utilization equipment.

- b. Insulation resistance of conductors that are to operate at 600 volts or less shall be tested by using a megohmmeter at not less than 1000 volts DC. Resistance shall be measured from each conductor to all other conductors and from each conductor to conduit (ground). Test duration shall be one minute. Investigate any values which deviate from similar connections by more than 50 percent of the lowest value. Testing methodology shall conform to National Electrical Testing Association (NETA). Acceptable insulation resistance of conductors rated at 600 volts shall not be less than the recommended wire manufactures accepted values and test equipment manufacture, or 50 megohms, whichever is greater.
 - c. Conductors that do not satisfy test requirements (b. above) shall be removed, replaced, and testing repeated on new cable, at no additional costs to the Owner. All tests shall be performed by a licensed electrician trained in the use of the test instrument.
 - d. Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed and complete "Conductor Insulation Resistance Test" form (found in Division 01) and submit five (5) copies to Designer/OAR for approval. Test shall be witnessed by OAR and designer (if designer so desires). Final approval data is to be submitted in O&M Manual.
 - e. Test reports shall identify each feeder conductor tested, date, time, and result of test, weather conditions, and range, test voltage, and serial number of the megger instrument used. Any conductor or splice that is found defective shall be promptly removed and replaced, and additional test shall be performed.
 - f. Observe all safety instructions set by testing equipment manufacturer to minimize risk of electric shock and sparking.
3. Take readings of voltage and amperage at building main disconnect switch and at main for each panel (panelboard, distribution panel, switchboard), at primary and secondary side of each transformer, at each major item of equipment, and at the end of the longest branch circuit at each panel. The above readings shall be taken (1) "no load" conditions and (2) "full load" conditions with all equipment using electricity. Tabulate readings, complete "TABULATED DATA VOLTAGE AND AMPERAGE READINGS" form included in Division 01. Final approved data is to be submitted in O & M manual.

B. Motors:

1. Test run each motor via motor's control unit in both manual mode and automatic mode. Verify proper operation and voltage.
2. Test run each motor furnished in the Work and all existing motors specifically noted in the Contract Documents to be tested:
 - a. With the system energized, line-to-line voltage and line current measurements shall be made at the motors under full load conditions. Should measured values deviate +/- 5% from the nameplate ratings, the condition shall be corrected. Notify the designer immediately should deviations occur.

- b. Record results of existing motors tested and submit values to OAR in writing.
- c. Tabulate readings, complete "Motor Test Information" form included in Division 01 of the General Requirements. Final approved data is to be submitted in O & M manual.

C. Grounds:

- 1. Test each raceway for raceway continuity as called for in Section 26 05 26.
- 2. Test each grounding system used in the project as called for in Section 26 05 26
- 3. Submit "GROUND TEST INFORMATION" form included in Division 01 of the General Requirements for each and every grounding system in the project including but not limited to: each ground rod installation; each water pipe and ground installation (test water pipe to ground and test water pipe to building service equipment); and each building steel ground connection (test building steel to ground and test building steel to building service equipment). Final approved data is to be submitted in O & M manual.
- 4. Grounding resistance shall be as called for in Section 26 05 26.
- 5. Testing shall be three (3) point method in accordance with IEEE recommended practice.

D. Communications:

- 1. See specific sections of these specifications for requirements.

E. Equipment:

- 1. Equipment items requiring check-out memos are all major items of equipment such as (but not limited to):
 - a. Panelboards, switchboards.
 - b. Paralleling Low-Voltage Switchgear.
 - c. Transformers.
 - d. UPS equipment.
 - e. Generator equipment.
 - f. Checkout and test any other equipment the designer/OAR deems necessary to insure system integrity and safety during construction, regardless if previous testing has been performed.
- 2. At completion of construction after all performance verification and testing information has been gathered, submitted, and approved, provide one copy of this information to the authorized manufacturer's representative of the equipment.
 - a. Manufacturer's authorized representative must be trained by the manufacturer and authorized to inspect, adjust, test, and repair equipment.
- 3. Manufacturer's authorized representative shall examine the performance verification information, check the equipment in the field while it is operating, and sign a check-out memo for a record.

- a. Check out of equipment is to include examining performance and certifying equipment has been installed per manufacturer's recommendations, that all necessary adjustments have been performed and that equipment is operating properly.
4. Submit memo on each major item of equipment. Approved memos shall be scanned and copied onto each O & M CD with the performance verification information and submittal data. Memos shall be submitted and approved before instruction to Owner or a request for final inspection.
5. Do not submit Check-out Memo form at the time Submittal Brochures are submitted.
6. Completion of Construction "Check Out Memo" form included in Division 01.

3.2 DATA PROCESSING

- A. Tabulate data for submission.
- B. Submit data on 8 1/2" x 11" sheets with date and name of checker with one copy for each operation and maintenance CD.
- C. Where specific performance verification information is called for in the specifications, use copies of the sheets provided for recording readings.
- D. Data shall be submitted and approved before Check Out memos are signed or a request for final inspection is made.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 08 13 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 08 13. The work described in Specification 26 08 13 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 08 13

SECTION 26 22 13 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of dry type transformers.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for dry type transformers.

1.4 SUBMITTALS

- A. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.5 QUALIFICATIONS

- A. Manufacturer: Same as for products specified in Section 26 24 16 Panelboards.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and tested by UL as suitable for purpose specified and shown.
- B. Conform to requirements of the following:
 - 1. ANSI/NFPA 70 - National Electrical Code
 - 2. NECA - Standard of Installation
 - 3. NEMA ST 1 - Specialty Transformers
 - 4. NEMA ST 20 - Dry Type Transformers for General Applications

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect, and handle products per manufacturer's recommendations.
- B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

- C. Accept transformers on site; inspect for damage.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Landside Building
- B. Westinghouse/Cutler Hammer, or approved substitutions.

2.2 TWO-WINDING TRANSFORMERS

- A. Description:
 - 1. NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated.
 - 2. Transformers serving computer loads (whether shown on drawings or not) shall be Non- Linear load K-13 rated.
 - 3. Other Non-Linear load transformers shall be as scheduled and noted on drawing.
 - 4. Isolation and shielded type transformers (if applicable) shall be as scheduled and noted on drawings.
- B. Insulation system and average winding temperature rise for rated kVA as follows:
 - 1. 1-15 kVA: Class 185 with 115 degrees C rise.
 - 2. 16-500 kVA: Class 220 with 115 degrees C rise.
- C. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point.
- D. Winding Taps:
 - 1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
 - 2. Transformers 15 kVA and Larger: NEMA ST 20.
- E. Sound Levels: NEMA ST 20.
- F. Basic Impulse Level: 10 kV.

- G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- H. Mounting: Suitable for wall, floor, or trapeze mounting, except transformers larger than 30 kVA, suitable for floor or trapeze mounting.
- I. Coil Conductors: Continuous windings with terminations brazed or welded.
- J. Transformer windings shall be continuous wound copper (98% conductivity) construction.
- K. Enclosure: NEMA ST 20; Type 1 or Type 3R ventilated as indicated. Provide lifting eyes or brackets.
- L. Isolate core and coil from enclosure using vibration-absorbing mounts.
- M. Nameplate: Include transformer connection data.
- N. Lugs: Suitable for terminating conductors sized for full load ampacity of transformer unit. Transformer lugs and mounting hardware shall be furnished by Manufacturer of transformer and shall be grade 5 with beveled washers. Hardware shall be of suitable size of pad opening per NEMA Standards.

2.3 SOURCE QUALITY CONTROL

- A. Provide production testing of each unit in accordance with NEMA ST 20.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify site condition. Do not install NEMA 1 equipment until building has reached the "dried-in" stage.
- B. Verify that surfaces are suitable for installing transformer supports.

3.2 PREPARATION

- A. Concrete Pad: Design per manufacturer's requirements plus three inches on all sides.

3.3 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Set transformer plumb and level.
- C. Maintain clearances around enclosure for ventilation in accordance with

manufacturer's instructions.

- D. Use flexible conduit, under the provisions of Section 26 05 33 Conduit, 1 foot minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- F. Provide grounding and bonding in accordance with Section 26 05 26.
- G. Ground per NEC 250.26 and to meet local codes as applicable. Grounding lugs shall be multi-conductor type UL listed for quantity and size of conductors terminated.
- H. Wall Mounted Transformers: Wall brackets shall be securely attached to concrete or masonry construction only and have supplemental support by means of all-thread rod hangers from superstructure above. Wall mounted transformers at non-structural walls shall be supported from superstructure above with all-thread rod hangers, angle iron channel site manufactured structural stand, or combination thereof.
 - 1. Installation of wall mounted transformers shall be installed to maintain clear space about/above panels as defined by NEC.
- I. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.4 FIELD QUALITY CONTROL

- A. Install field inspect and test per manufacturer recommendations prior to energizing.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 22 13 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 22 13. The work described in Specification 26 22 13 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 22 13

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

DRY TYPE TRANSFORMERS
SECTION 26 22 13

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SECTION 26 24 13 – SWITCHBOARDS-DRAW OUT (RON)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of switchboards.
- B. Normal switchboards shall comply with these specifications.

1.3 DESCRIPTION

- A. Factory-assembled, metal-enclosed switchboard for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.
- B. Switchboard shall include all protective devices and equipment as listed on drawings or as included in these specifications, with necessary interconnections, instrumentation and control wiring.
- C. The terms switchgear and switchboard are used synonymously with each other. Switchgear shall be considered switchboard(s) and vice versa.

1.4 SUBMITTALS

- A. Product data shall be submitted on each basic switchboard construction type, showing manufacturer's standard construction data, including:
 - 1. Cabinet construction/dimensions.
 - 2. Bus construction.
 - 3. UL labeling.
 - 4. Each overcurrent device.
 - 5. Each component.
 - 6. Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
 - 7. Provide data on trip units, and all metering/monitoring components, devices, equipment, etc.
 - 8. Installation information.
 - 9. Certified production test reports.

B. Shop drawings shall be submitted for all switchboards. Indicate the following information:

1. Label.
2. Each circuit breaker amperage rating, circuit number and position/location in Switchboard.
3. Electrical characteristics of switchboard.
4. Mains rating.
5. Main device rating.
6. Mounting.
7. Dimension, width, depth, height.
8. Bus material.
9. Schematic diagram.
10. Wiring diagrams of all devices complete with terminal strips, controls, wire marking/identification, showing interior connections and external connections.
11. Interrupting capacity of minimum rated breaker.
12. Switchboard type.
13. Component list.
14. Locations of all components including breakers, metering, monitoring, terminal strips, etc.
15. Nameplate legend for each overcurrent device.
16. Front and side views of enclosures with overall dimensions shown.
17. Conduit entrance locations and requirements.
18. Frame sizes and interrupting capacity of each breaker, and total assembly.
19. Horsepower ratings at rated voltage of fused switches and/or breakers.
20. Switchboard instrument details.
21. Type of labels and labeling for every device and what it feeds.
22. Nameplate on main panelboard giving name of project; Architect, Engineer and Contractor.
23. Bus bar size, arrangement and spacing.
24. Surge Protective Device Equipment
25. Metering/Monitoring Equipment.
26. Layouts showing concrete pad dimensions, conduit entrance and available space, bus duct connections, electrical ratings, nameplate nomenclature, and single-line diagrams in accordance with ANSI Y32.2 indicating connections and controls.
27. Submit coordination drawings of all electrical rooms, showing all electrical (and mechanical) equipment. Comply with requirements of Section 26 05 00 Common Work Results for Electrical.
28. Busway connections.
29. Composite front view and plan view of close-coupled assemblies.
30. Secondary contact configuration for each breaker type and cubicle type.

C. Manufacturer's Instructions indicating application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 PROJECT AS-BUILT DOCUMENTS

- A. Record actual locations of switchboards on red lined as-built documents indicating actual circuit arrangement.
- B. The drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing and installation process.

1.6 OPERATION AND MAINTENANCE DATA

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.
- B. Submit spare parts data including source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum 10 years of experience.

1.8 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:
 - 1. ANSI/NFPA 70 - National Electrical Code.
 - 2. ANSI/IEEE C12.1 - Code for Electricity Metering.
 - 3. ANSI C39.1 - Electrical Analog Indicating Instruments.
 - 4. ANSI C56.13 - Instrument Transformers.
 - 5. ANSI C37.20 - Switchgear Assemblies
 - 6. ANSI C37.13 - Low Voltage Power Circuit Breakers
 - 7. ANSI C37.17 - Trip Devices
 - 8. NEMA SG-5 - Switchgear Assemblies
 - 9. NEMA SG-3 - Low Voltage Power Circuit Breaker
 - 10. UL 1558 – Metal Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in 48 inch maximum width (or dimension required to fit section through doors), individually wrapped for protection and mounted on shipping skids.

- B. Accept switchboards on site. Inspect for damage.
- C. Store in a clean, dry space as designated by OAR. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA SG-5 service conditions during and after installation of switchboards.

1.11 FIELD MEASUREMENTS

- A. Coordinate field measurements with manufacturer's requirements.

1.12 MAINTENANCE MATERIALS

- A. Provide two of each key (if applicable).
- B. Provide two fuse pullers (if applicable).

1.13 EXTRA MATERIALS

- A. Provide three of each size and type of fuse installed (if applicable).
- B. Provide one spare breaker of each combination of trip unit and frame size used in project. Complete with trip units, options, etc., as specified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS.

- A. Normal Distribution Switchboards/switchgear (All switchgear/switchboards connected only to normal power distribution system)
 - 1. Eaton, or accepted equivalent.

2.2 GENERAL

- A. Switchboards with circuit breaker branch protective devices shall comply with NEMA SG-5 as a minimum requirement. Switchboard shall meet Underwriter's Laboratories enclosure requirements for service conditions.
- B. Each cubicle shall have UL Label affixed, unless special construction prohibits, and no labeling or listing is available.
- C. The sides and tops shall be covered with removable screw-on code gauge steel plates.
- D. Switchboards shall be completely self-supporting structures, not greater than 96" high.
- E. Minimum integrated short circuit rating: 65,000 amperes RMS symmetrical for 480 volt. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity. Minimum short circuit rating shall be increased to meet the following requirements:
 - 1. Individual C.B. AIC Rating shown on panel schedules indicate lowest AIC rating allowed for individual circuit breaker in panel.
 - 2. Circuit breakers shall be based on a fully rated system. Circuit breaker types are not shown or called for. The contractor must provide breakers in panel or feeder breakers in upstream breakers to comply with the required AIC specified.
- F. Main section devices shall be individually mounted and compartmented, draw-out construction.

2.3 SWITCHBOARD

- A. Description: NEMA SG-5 with electrical ratings and configurations as indicated.
- B. Main Section Devices: Individually mounted and compartmented, draw-out construction.
- C. Distribution Section Devices: Individually mounted and compartmented,
- D. Auxiliary Section Devices: Individually mounted and compartmented.
- E. Bus Material: Copper with tin plating, standard size.
- F. Bus connections: Bolted, accessible from front only for maintenance.
- G. Fully insulate bus bars.
- H. Ground bus: Extend length of Switchboard, braced for 65,000 amps symmetrical short circuit current.

- I. All protective devices shall be low voltage power circuit breakers. Basis of design is Eaton Type Magnum DS. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.
- J. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.
- K. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.
- L. Breakers shall be electrically operated (EO) with 120V AC motor operators. The charging time of the motor shall not exceed 6 seconds.
- M. Trip Units:
 - 1. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The basis of design is Eaton type Digitrip 1150 Plus on mains and Digitrip 1150 on feeders and ties.
 - 2. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
 - a) All circuit breakers shall have adjustments for long delay pickup and time.
 - b) All circuit breakers shall have individual adjustments for short delay pickup and time and include I^2t settings and adjustable instantaneous pickup.
 - c) All circuit breakers shall have individually adjustable ground fault current pickup and time and include I^2t settings or ground alarm only.
 - 3. The trip unit shall be equipped to permit communication via twisted pair for remote monitoring and control.
 - 4. An internal relay shall be programmable to provide contacts for remote ground alarm indication.
 - 5. The display for the trip units shall be a 24 character LED display.
 - 6. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.
 - 7. The unit shall be capable of monitoring the following data:

- a) Instantaneous value of phase, neutral and ground current.
 - b) Instantaneous value of line-to-line voltage.
 - c) Minimum and maximum current values.
 - d) Watts, vars, VA, watthours, var hours, and VA hours.
8. The trip unit shall display the following power quality values:
- a) Crest Factor.
 - b) Power Factor.
 - c) Percent total harmonic distortion.
 - d) Harmonic values of all phases through the 31st harmonic.
9. The main breaker trip unit shall have the following advanced features integral to the trip unit:
- a) Adjustable undervoltage release.
 - b) Adjustable overvoltage release.
 - c) Reverse load and fault current.
 - d) Reverse sequence voltage alarm.
 - e) Underfrequency.
 - f) Overfrequency.
 - g) Voltage phase unbalance and phase loss during current detection.
10. Each breaker shall be provided with arc-flash reduction switches with visual indicator.
11. All breakers of common frame size shall have trip units wired to secondary contacts in a consistent manner, including spares, so that breakers are fully interchangeable once settings are updated.

N. Enclosure: Type 1 -- General Purpose.

- 1. Align sections at front and rear.
- 2. Switchboard Height: Not to exceed 96 inches, excluding floor sills, lifting members and pull boxes.
- 3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
- 4. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using black color plastic strips, fastened flat against the panel face with screws or rivets.
- 5. Provide IR windows for infrared scanning.

2.4 RATINGS

- A. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service.

- B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of minimum of 65,000 amperes symmetrical at rated voltage unless higher amperage is shown on the drawings.
- C. The bus system shall have a minimum ANSI 4-cycle short-circuit withstand rating of 65,000 amperes symmetrical.
- D. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.
- E. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

2.5 CONSTRUCTION

- A. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills providing the floor is level to 1/8 inch per 3-foot distance in any direction. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position.
- B. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells and be front accessible and removable.
- C. The stationary part of the primary disconnecting devices for each power circuit breaker shall be breaker mounted and consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus

and the breaker line side studs. Load studs shall be equipped with insulated copper load extension buses terminating in solderless type terminals in the cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached.

- D. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.
- E. The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The secondary disconnecting devices shall be gold-plated and engagement shall be maintained in the "connected" and "test" positions.
- F. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, "connected," "test," "disconnected" and "removed." The breaker drawout element shall contain a worm gear levering "in" and "out" mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "in" or "out" of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.
- G. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.
- H. The switchgear shall be Eaton Magnum DS low voltage metal-enclosed switchgear, utilizing Magnum DS power circuit breakers as herein specified.
- I. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.
- J. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.
- K. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.
- L. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.

2.6 BUS

- A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

1. In addition to full UL air clearances, the phase bus shall be insulated with a minimum of 5 mil thickness of epoxy resin coating. Removable boots shall be provided to give access to the cross bus joints for inspection and maintenance.
- B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.
- C. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.
- D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers.

2.7 WIRING/TERMINATIONS

- A. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer's wiring diagrams.
- B. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.
- C. All control wire shall be type SIS. Control wiring shall be 14 ga. for control circuits and 12 ga. for shunt trip and current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections. Each control wire shall be marked to the origin zone/wire name/destination zone over the entire length of the wire using a UV cured ink process. Provide wire markers at each end of all control wiring. Plug-in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker.
- D. NEMA 2-hole mechanical type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size indicated on the drawings.
- E. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- F. Reusable insulating boots shall be provided to cover all power cable terminations.

2.8 SURGE PROTECTIVE DEVICES

- A. Each lineup of switchgear shall include a door mounted surge protector(s). Between the bus and the surge protective device(s) shall be mounted a 30 amp, 3 pole, 480 V circuit breaker type HFD. Surge protective devices shall be mounted in an open section nearest to the main incoming power source section with lead length kept to a minimum. The display unit shall be connected via ribbon cable to the main unit and mounted so as to be visible when the door is closed.
- B. See specification Section 26 43 00 Surge Protective Devices for additional information.
- C. Provide surge protective devices for each feeder connected between buildings and on each service feeder.
- D. Provide disconnect, connections, etc. for surge protective devices as recommended by surge protective devices manufacturer.

2.9 POWER QUALITY METER AND ANALYZER METERS

- A. Each lineup of switchgear shall include an Eaton PXM6000 wired with a category 5 data cable. Belden 9463 (blue hose) family in a daisy chain and connected to the Digitrip trip units on each circuit breaker capable of future connection to the existing EATON PowerNet System. All communications cabling is to be factory installed and terminated to a terminal block for future continuation to the EMMS Power Xpert System.
- B. Provide meters with appropriate multiplier tags.

2.10 ACCESSORIES

- A. Circuit Breaker Lifting Device: Carriage and track on top of each switchboard with lifting device to serve draw-out circuit breakers in switchboard.
- B. Provide integrally mounted transient voltage surge suppression as specified in Section 26 43 00 Surge Protective Devices.
- C. Provide remote racking device, Eaton MRR 1000

2.11 SERVICE ENTRANCE EQUIPMENT

- A. Switchboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

2.12 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.
- B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer's name.
- C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's drawings

2.13 FINISH

- A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be ANSI 61

PART 3 - EXECUTION

3.1 PREPARATION/INSPECTION/EXAMINATION

- A. Verify that surface is suitable for switchboard installation.
- B. Check that concrete pads are level and free of irregularities
- C. Examine area to receive switchboard to assure adequate clearance for switchboard installation.
- D. Verify that National Electrical Code clearances will be maintained after installation. Rework equipment locations as required to provide required clearances.
- E. Start Work only after unsatisfactory conditions are corrected.
- F. All magnum DS breakers shall be internally wired in similar fashion for interchangeability.

3.2 INSTALLATION

- A. Install all switchboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.
- B. Mount switchboard on 3" concrete base extending 3" outside all sides.

- C. Provide rubber insulating mats on floor in front of board for entire length of board, minimum 4 feet wide.
- D. Install switchboards plumb. Provide supports in accordance with Section 16190.
- E. Provide doors for unused spaces in switchboards.
- F. Install switchboards so that proper working clearances shall be maintained at every switchboard location.
- G. Clean the interior of each switchboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the switchboard free of rust and debris. Repaint finishes if necessary.
- H. Coordinate all raceways and conductors with their respective switchboards so that all connections and conductors routing present an orderly appearance. Conductors in the switchboards shall be laced and arranged in orderly manner.
- I. Provide a separate 120 volt, 20 AMP circuit as required to power any shunt-trip function/device for normal switchboards. Provide complete 120 Vac to 24 Vdc system in each switchboard, including batteries, UPS and charger system to power shunt trip system.
- J. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- K. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:
 - 1. Checking to ensure that the pad location is level to within 0.125 inches per three foot of distance in any direction.
 - 2. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
 - 3. Assembling all shipping sections, removing all shipping braces and connecting all shipping split mechanical and electrical connections.
 - 4. Securing assemblies to foundation or floor channels.
 - 5. Measuring and recording Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four wire systems only).
 - 6. Inspecting and installing all circuit breakers in their proper compartments.
- L. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.3 FACTORY TESTING

- A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the

wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.

- B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.
- C. A certified test report of all standard production tests shall be shipped with each assembly.

3.4 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of one working day. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.
- C. Provide complete testing of all components including but not limited to metering, monitoring, ground fault systems, interlocking systems, remote operation/tripping features of breakers, etc.
- D. Measure steady state load currents at each switchboard feeder; rearrange circuits to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
- E. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- F. All circuits shall be operated to establish a good working order and checked for shorts.
- G. All panel directory circuit numbers shall be checked to verify accuracy of the number.
- H. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms. Disconnect all electronic circuitry and Surge Protective Device units prior to test.
- I. Check tightness of accessible bolted bus joints using calibrated torque wrench.
- J. Physically test key interlock systems to insure proper function.
- K. Tests:

1. Test Switchboards and switchboard feeders per requirements of Section 26 08 13 Tests and Performance Verification.
2. Test all operational features of switchboard including interlocking, remote controls, touch screen, remote computer PC control, etc.
3. Feeder conductors shall be checked by approved means to establish the absence of shorts to ground; insulation value, etc. and the result recorded and submitted to the Designer.
4. Submit Conductor Insulation Resistance Test per requirements of Section 26 08 13 Tests and Performance Verification.
5. Submit Tabulation Data Voltage and Amperage Readings per requirements of Section 26 08 13 Tests and Performance Verification.

L. Equipment Checkout:

1. When requested by Designer/OAR provide (during construction):
 - a) Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.
2. Submit Equipment Checkout Memo per Section 26 08 13 Tests and Performance Verification.

3.5 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment.

3.6 TRAINING

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for 1 normal workday at a jobsite location determined by the owner.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, metering, monitoring, and major components within the assembly.

3.7 IDENTIFICATION

- A. Refer to Section 26 05 53 Identification for Electrical Systems for products and content.

- B. Provide engraved plastic nameplates under the provisions of Section 26 05 53 Identification for Electrical Systems.

3.8 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Adjust circuit breaker trip and time delay settings to values as instructed by the Designer to manufacturer's recommendation.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 24 13 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 24 13. The work described in Specification 26 24 13 is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

END OF SECTION 26 24 13

SECTION 26 24 17 DISTRIBUTION PANELBOARDS (RON)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specifications sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of distribution panelboards.

1.3 DESCRIPTION

- A. Factory-assembled, metal-enclosed panelboard for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.
- B. Distribution panelboard shall include all protective devices and equipment as specified, with necessary interconnections, accessories and control wiring.

1.4 SUBMITTALS

- A. Product data shall be submitted on each basic Distribution Panelboard construction type, showing manufacturer's standard construction data, including:
 - 1. Cabinet construction/dimensions.
 - 2. Bus construction.
 - 3. UL labeling.
 - 4. Each overcurrent device.
 - 5. Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
 - 6. Provide data on trip units and breaker interface module.
- B. Shop drawing shall be submitted for all distribution panelboard for this project clearly indicating the following:
 - 1. Label.
 - 2. Each circuit breaker amperage rating, circuit number and position/location in distribution panelboard.
 - 3. Electrical characteristics of distribution panelboard.
 - 4. Mains rating.
 - 5. Main device rating.

6. Mounting.
 7. Dimension, width, depth, height.
 8. Bus material.
 9. Interrupting capacity of minimum rated breaker.
 10. Distribution panelboard type.
 11. Engraved nameplate for each overcurrent device.
 12. Front and side views of enclosures with overall dimensions shown.
 13. Conduit entrance locations and requirements.
 14. Frame sizes and Interrupting Capacity of each breaker, and total assembly.
 15. Horsepower ratings at rated voltage of fused switches and/or breakers.
 16. Labels and labeling.
 17. Nameplate on main panelboard only giving name of project; Architect, Engineer and Contractor.
 18. Bus bar size, arrangement and spacing.
 19. Breaker interface module.
 20. Surge Protective Device Equipment
 21. Metering/Monitoring Equipment for future connection.
- C. Submit Manufacturer's Instructions indicating application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- D. Submit Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- E. Submit Spare Parts Certification Memo signifying that the spare parts required by the drawings and/or specifications have been turned over to the Owner.

1.5 PROJECT AS-BUILT DOCUMENTS

- A. Record actual locations of distribution panelboards on red lined as-built documents indicating actual circuit arrangement.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years experience.

1.7 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code.
2. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA KS 1 - Enclosed Switches.
4. NEMA PB 1 - Panelboards.
5. NEMA PB 1.1 - Instructions for safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
6. UL 67 - Panelboards
7. UL 50 - Cabinets and Boxes
8. Fed. Spec. W-P-115C

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in 48 inch maximum width or depth (or dimension required to fit section through doors), individually wrapped for protection and mounted on shipping skids.
- B. Accept distribution panelboards on site. Inspect for damage.
- C. Store in a clean, dry space designated by OAR. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with NEMA PB 1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to distribution panelboard internal components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA PB 1 service conditions during and after installation of distribution panelboards.

1.10 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated and comply with instructions by manufacturer.

1.11 MAINTENANCE MATERIALS

- A. Provide two of each key (where applicable).
- B. Provide two fuse pullers (where applicable).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Eaton/Cutler Hammer (Basis of Design), or accepted equivalent.

2.2 GENERAL

- A. Distribution Panelboards shall have circuit breaker branch protective devices complying with NEMA PB1 as a minimum requirement. Panelboards shall be NEMA 1 and shall meet Underwriter's Laboratories enclosure requirements for service conditions.
- B. Distribution panelboards shall have UL label affixed, unless special construction prohibits and no labeling or listing is available.
- C. Short-Circuit Rating:
 - 1. Minimum integrated short circuit rating: 22,000 amperes rms symmetrical for 240 volt; 65,000 amperes rms symmetrical for 480 volt. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity. Minimum short circuit rating shall be increased to meet the following requirements:
 - a) Individual circuit breaker AIC Rating shown on panel schedules indicate lowest AIC rating allowed for individual circuit breaker in panel.
 - b) Circuit breakers shall be based on a fully rated system.
 - c) Circuit breaker types are not shown or called for. The contractor must provide breakers in panel or feeder breakers in upstream breakers to comply with the required AIC specified.
 - d) Distribution panelboards to be freestanding type construction unless specifically specified otherwise.
 - 2. Short-Circuit Rating Label:
 - a) Panelboards shall be labeled with a UL short-circuit rating.
 - b) Series ratings shall not be used to achieve short circuit ratings.
- D. Enclosure:
 - 1. Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
 - 2. Enclosures shall be provided with blank ends.
 - 3. Where indicated on the drawings, branch circuit panelboards shall be column width type.
 - 4. Regulatory Requirements:
 - a) NEMA PB 1, Type 1, Interior dry locations.
 - b) NEMA BP 1 Type 3R, Interior damp locations
 - c) NEMA PB 1, Type 4X stainless steel watertight, Exterior locations including those notes on drawings to be NEMA 3R
 - d) NEMA PB 1, Type 4X stainless steel watertight, interior wet locations, and washdown areas, regardless of that noted on drawings.

e) UL 50

2.3 DISTRIBUTION PANELBOARDS

- A. Description: NEMA PB 1 with electrical ratings and configurations as indicated.
- B. Overcurrent Devices: Panel mounted.
- C. Bus Material: Copper standard size.
- D. Bus Connections: Bolted, accessible from front for maintenance.
- E. Ground Bus: Extend length of board.
- F. Molded Case Circuit Breakers - 1200A and Below:
 - 1. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
 - 2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position.
 - 3. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings and as specified herein.
 - 4. Circuit breakers 225 ampere and below shall have thermal-magnetic trip units and inverse time-current characteristics.
 - 5. Circuit breakers above 225 ampere shall have microprocessor based programmable RMS sensing trip units.
 - 6. Ground fault protection shall be provided where indicated.
 - 7. Where indicated circuit breakers shall be current limiting.
 - 8. Where indicated provide UL listed circuit breakers for applications at 100% of their continuous ampere rating in their intended enclosure.
 - 9. Additional requirements may be shown on one-line diagram.
- G. Programmable Trip Units: (Circuit Breakers Above 225 Ampere)
 - 1. Each circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. Basis of Design is Cutler-Hammer type OPTIM 1050.
 - 2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - 3. System coordination shall be provided by the following microprocessor-based programmable time/current curve shaping adjustments:

- a) Programmable long-time pickup settings in 1% increments, with +/- 5% band tolerance
 - b) Programmable long-time delay with selectable I^2t or I^4t curve shaping.
 - c) Programmable short-time settings (dependent on long-time setting) in 1% increments, with +/- 5% band tolerance.
 - d) Programmable short-time delay with selectable flat or I^2t curve shaping.
 - e) Programmable instantaneous pickup settings in 1% increments.
 - f) Programmable ground fault pickup settings trip or alarm in 1% increments.
 - g) Programmable ground fault delay with selectable flat or I^2t curve shaping.
4. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
5. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.
6. Internal ground fault protection or alarm settings, if specified, shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.
7. The trip unit shall have an information system that utilizes battery backed up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. The LEDs shall be complemented by trip event information stored in non-volatile memory after a trip event. A trip reset button shall be provided to turn off the LED indication and reset the memory after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.
8. A red LED shall be provided on the face of the trip unit and pre-set to flash on and off when an adjustable high-load level is exceeded. A time-delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:
 - a) Instantaneous value of phase, neutral and ground current.
 - b) Minimum and maximum current values.
 - c) Average demand current.
 - d) System diagnostic information such as alarms and cause of trip.
 - e) Approximate level of fault current that initiated an automatic trip operation.
9. The trip unit shall contain test capability. Testing shall be carried out by using a hand-held programmer, a breaker interface module or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the "Trip" or "No Trip" test mode.
10. A hand-held programming unit shall be provided to set/change the network communication breaker address for each device, set the stem baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time/current set points and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide two (2) hand-held programming units. Contractor shall submit Spare Parts Certification Memo certifying two hand-held programming units have been turned over to the Owner.

11. The monitored data shall be displayed by a hand-held programmer, a breaker interface module and a remote computer.
 12. Circuit breakers, 1200 ampere frame and below, shall be provided with a 24 volt DC power supply mounted within the assembly. In addition, provide a minimum of one (1) auxiliary switch and one (1) bell alarm, each with form C contacts in each breaker. Provide additional auxiliary switches, bell alarms, shunt trips, and undervoltage releases where indicated on the drawings.
 13. The trip unit shall be capable of two-way communication via a network twisted pair for remote monitoring and control. The trip unit shall be provided with an address register for identification on the network. All monitored values shall be transmittable over the network.
 14. The trip unit shall include zone interlocking capability for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream circuit breaker, and allow the circuit breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the pre-set time delay. Factory wire zone interlocking system for breakers within each assembly.
 15. Molded case circuit breakers shall be provided with a potential transformer, suitable for operation up to 600 volts. The potential transformer shall be mounted externally to the circuit breakers and provided with a dielectric disconnect fuse.
 16. For enhanced system analysis, the following additional parameter values shall be monitored:
 - a) Peak demand (kW)
 - b) Present demand (kW)
 - c) Reverse energy (kWh)
 - d) Forward energy (kWh)
 - e) Total energy (kWh)
 - f) Power factor
 - g) Percentage harmonic content
 - h) Total Harmonic Distortion (THD).
- H. Ground Fault Sensor (where called for on drawings): Zero sequence of ground return type.
- I. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.
- J. Enclosure: Type 1 - General Purpose for interior locations. Type 2 - Rain tight for damp locations.
1. Align sections at front and rear.
 2. Finish:
 - a) Interior dry locations: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

- b) Interior damp locations: Coat interior and exterior of enclosure with rust inhibiting primer and paint over with epoxy paint.
- c) Exterior, wash-down areas, and Interior wet locations: NEMA 4X stainless steel, watertight.

2.4 DISTRIBUTION ENTRANCE EQUIPMENT

- A. Panelboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

PART 3 - EXECUTION

3.1 PREPARATION, INSPECTION, EXAMINATION

- A. Verify that surface is suitable for panelboard installation. Do not install NEMA 1 equipment until building has been "dried-in" stage.
- B. Examine area to receive panelboard to assure adequate clearance.
- C. Verify National Electrical Code clearances will be maintained after installation. Rework equipment locations as required to provide Electrical code clearances.
- D. Start Work only after unsatisfactory conditions have been corrected.
- E. Submit coordination drawings of all electrical rooms, showing all electrical (and mechanical) equipment. Comply with requirements of Section 26 05 00 Common work Results for Electrical.

3.2 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1. Install all panelboards and distribution panelboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.
- B. Install panelboards plumb. Install recessed distribution panelboards flush with wall finishes. Provide supports in accordance with Section 26 05 29 Hangers and Supports.
- C. Panelboards and terminal cabinets shall be provided with structural framing located within gypsum board partition. All enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting (unistrut type) channels on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Attach channels to framing provided within gypsum board partitions

- D. Install enclosures so that the top is 6'-6" above finished floor. Where the size of the enclosure is such that the top cannot be installed at 6'-6", the top of the enclosure shall be kept as low as possible.
- E. Provide filler plates for unused spaces in distribution panelboards.
- F. Provide spare conduits out of each recessed distribution panelboard to an accessible location above ceiling. Minimum spare conduits: 4 empty 1 inch. Identify each as SPARE.
- G. Install distribution panelboards so that proper working clearances shall be maintained at every distribution panelboard location.
- H. Clean the interior of each distribution panelboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the distribution panelboard free of rust and debris. Repaint finishes if necessary.
- I. Coordinate all raceways and conductors with their respective distribution panelboards so that all connections and conductors routing present an orderly appearance. Conductors in the distribution panelboards shall be laced and arranged in orderly manner.
- J. Provide a separate neutral conductor for each GFI breaker. These shall not be combined to serve more than 1 circuit, even where on different phases. Increase plan indications of conductors for neutral wires required, as necessary.
- K. Provide 3" concrete housekeeping pad.
- L. Provide and install separate 120 volt, 20 AMP circuit complete with circuit breaker, transformer, conduit, and wire as required to power any shunt-trip function specified.
- A. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.3 IDENTIFICATION

- A. Refer to Section 26 05 53 Identification for Electrical Systems.
- B. Provide engraved plastic nameplates under the provisions of 26 05 53 Identification for Electrical Systems.

3.4 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each distribution panelboard feeder; rearrange circuits in the distribution panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- C. All circuits shall be operated to establish a good working order and checked for shorts.
- D. All panel directory circuit numbers shall be checked to verify accuracy of the number.
- E. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms.
- F. Check tightness of accessible bolted bus joints using calibrated torque wrench.
- G. Physically test key interlock systems to insure proper function.
- H. Tests:
 - 1. Test Distribution panelboards and distribution panelboard feeders per requirements of Section 26 08 13 Tests and Performance Verification.
 - 2. Feeder conductors shall be checked by approved means to establish the absence of shorts to ground; insulation value, etc. and the result recorded and submitted to the Designer.
 - 3. Submit Conductor Insulation Resistance Test per requirements of Section 26 08 13 Tests and Performance Verification.
 - 4. Submit Tabulation Data Voltage and Amperage Readings per requirements of Section 26 08 13 Tests and Performance Verification.
- I. Equipment Checkout:
 - 1. When requested by Designer provide (during construction):
 - a) Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.
 - b) Submit Equipment Checkout Memo per Section 26 08 13 Tests and Performance Verification.

3.5 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Adjust circuit breaker trip and time delay settings to values per manufacturer's recommendation.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 24 17 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 24 17. The work described in Specification 26 24 17 is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

END OF SECTION 26 24 17

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SECTION 26 27 16 – ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of cabinets and enclosures.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
 - 1. Hinged cover enclosures.
 - 2. Cabinets.
- B. Cabinets and enclosures are to include:
 - 1. Terminal blocks,
 - 2. Mounting panel,
 - 3. Ground bus/bar, and
 - 4. All accessories as required for a complete and operating system.
- C. Provide cabinets and enclosures for all systems specified in Divisions 27, 28.

1.4 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 2. NEMA ICS 4 - Terminal Blocks
 - 3. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

- A. Submit Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- B. Submit Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Submit shop drawings on all cabinets and enclosures showing:
 - 1. Covers.
 - 2. Dimensions - inside and out.
 - 3. Gauge of metal.
 - 4. Manufacturer.
 - 5. Terminal mounting plate, construction, etc.
 - 6. Ground bus/bar.

1.6 EXTRA MATERIALS

- A. Provide two keys for each type of lock.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless specifically called for otherwise on contract drawings, provide "CABINETS" as specified herein for terminal cabinets mounted indoor. Similarly, provide "HINGED COVER ENCLOSURES" as specified herein for terminal cabinets mounted outdoors or in locations other than NEMA 1 locations. Also, provide "HINGED COVER ENCLOSURES" for locations where size required is not available in "CABINET" construction, or if specifically specified as "enclosure" on contract documents.
- B. Size.
 - 1. Dimensions of cabinets and enclosures shall meet the dimensions shown on drawings, dimensions required by NEC, or dimensions sized as required to facilitate all equipment/connections involved installation, whichever is largest.
 - 2. Coordinate sizes required and assure that equipment cabinets or enclosures will house and facilitate proper installation and access to equipment.
- C. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring or where wiring from separate systems of Normal and Emergency Power are required to be in one enclosure.
- D. Provide accessory feet or mounting brackets for free-standing equipment.

2.2 HINGED COVER ENCLOSURES

- A. Construction:
 - 1. Interior Dry Locations: NEMA Type 1 (unless otherwise noted), steel.
 - 2. Exterior and Interior Wet Locations: NEMA Type 4X: Stainless steel.
- B. Covers: Continuous hinge.
- C. Enclosure Finish:
 - 1. NEMA 1: Manufacturer's standard metallic gray enamel over phosphatized surfaces.
 - 2. NEMA 4X: Stainless steel.
- D. Lock/handle.
 - 1. Provide key lock handle on all enclosures mounted in areas that are not dedicated electrical or mechanical rooms. Enclosures installed in electrical rooms are not required to be lockable.
- E. Interior mounting plate.
 - 1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.
 - 2. Plate/panel is to be metal.
- F. Ground bus/bar.
 - 1. Each enclosure housing surge suppression equipment or other equipment shall have "local" ground bar/bus installed. See Article "Local Ground Bus/Bar".

2.3 CABINETS

- A. Construction: Specified gauge steel with removable enwalls.
- B. Finish:
 - 1. Boxes:
 - a) Surface mounted: Gray baked enamel.
 - b) Flush mounted: Galvanized steel.
 - 2. Fronts: Gray baked enamel.
- C. Fronts:
 - 1. Electrical or Mechanical Room Locations: screw cover with hinged door and flush handle or as noted below.

2. Other Locations: Mono-flat with concealed trim clamps, concealed hinges, flush lock lockable handle, and custom color finish in interior public areas to match mounting surface.
3. Flush or surface type as shown or called for in Contract Documents.

D. Interior mounting plate.

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.
2. Panel/plate shall be metal.

E. Ground bus/bar.

1. Each cabinet housing surge suppression equipment or other equipment shall have "local" ground bar/bus installed. See specification for "Local Ground Bus/Bar" included within this section.

2.4 TERMINAL BLOCKS

- A. Terminal Blocks: ANSI/NEMA ICS 4.
- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.5 LOCAL GROUND BUS/BAR

- A. Size to handle #6 through #14 AWG copper ground wire.
- B. Length as required for circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Install enclosures and cabinets plumb. Anchor securely to wall and structural supports at each corner.
- C. Install cabinet fronts plumb.
- D. Install per NEC and as required for proper clearance. Coordinate with panels.
- E. Provide and install terminal cabinets as shown on drawings or as required by the NEC.
- F. Provide terminal cabinets wherever required for a complete and operating distribution system whether shown on drawings or not.
- G. Install local ground bus/bar in each terminal cabinet/enclosure that houses surge suppression equipment or other equipment and bond to cabinet enclosure via mounting screws or #6 AWG copper ground wire.
- H. Ground local ground bus to "SYSTEMS" ground bus/bar with minimum #6 AWG copper ground wire. Increase size if so required on drawings.
- I. Install enclosures.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 27 16 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 27 16. The work described in Specification 26 27 16 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 27 16

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ELECTRICAL CABINETS
AND ENCLOSURES
SECTION 26 27 16

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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of enclosed switches and circuit breakers.

1.3 DESCRIPTION

- A. Provide all labor, materials, and equipment necessary to properly install switches as shown on the drawings and as required by codes.
- B. Coordinate with Division 23 for disconnect switches for mechanical equipment. Provide all other disconnect switches required for a complete operating system.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver switches in factory wrapped packaging. Handle switches carefully to prevent damage. Store in a clean, dry space protected from dirt, water, and physical damage. Reject damaged switches.

1.5 QUALIFICATIONS

- A. Manufacturer: Same manufacturer as that for products specified in Section 26 24 13.

1.6 SUBMITTALS

- A. Submit catalog cut sheet on each type of disconnect switch to be used on this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Eaton/Cutler Hammer, or approved substitutions.

2.2 CONSTRUCTION

- A. Switches shall be heavy-duty type with visible, quick-make, quick-break blades.
- B. Units for 2-speed motors shall be 6-pole in a single enclosure. Use of 2, 3-pole units will not be acceptable.
- C. Provide ground bus and where required, a solid neutral bus.
- D. Switches shall be fusible or non-fusible as noted on the drawings or as required by the equipment served from the switch. Fusible switches shall have rejection type fuse holders.
- E. Terminal lugs shall be rated for 75 degrees Centigrade.
- F. Enclosures, unless otherwise noted, shall be:
 - 1. Interior dry locations shall be NEMA 1.
 - 2. Wash-down areas, interior wet locations or similar shall be NEMA 4X stainless steel watertight, corrosion resistant.
 - 3. Exterior locations shall be NEMA 4X stainless steel watertight, corrosion resistant, including those noted on drawings to be NEMA 3, minimum.
- G. The enclosure shall be interlocked with the switch handle such that the enclosure door or cover cannot be opened with the switch in the "ON" position. The switch handle shall be capable of being padlocked in the "OFF" position but not in the "ON" position.
- H. Finish for NEMA 1 units shall be standard baked gray enamel finish over a rust inhibiting phosphate primer.

2.3 RATING

- A. The size, number of poles, and fusing for each switch shall be as noted on the drawings. As a minimum, no less than one pole for each ungrounded conductor shall be provided. Switches shall be rated 250 VAC or 600 VAC as required by the circuit to which it is connected.
- B. Switches serving motors with more than one set of windings shall have the number of poles necessary to disconnect all conductors to all windings in a single switch.

- C. Switches serving motor loads shall be horsepower rated to match motor and of sufficient size to handle the load regardless if rating noted on drawings is provided in ampere.

2.4 SERVICE ENTRANCE EQUIPMENT

- A. Switches used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

2.5 FUSES

A. General:

1. All fuses shall be of the same manufacture to retain selectability as designed. No fuse shall be installed until equipment is ready to be energized and after tightening of all electrical connections, inspection of all ground and grounding conductors and a megger test of adequate insulation to ground of all circuits.
2. All fuses shall be current limiting with 200,000 amperes interrupting capacity.
3. Fuses rated 601 amperes and larger shall be UL Class L and have a minimum time-delay of 45 seconds at 300% rating and have O-ring gas seals at the end bells.
4. Fuses rated 600 amperes or less, installed ahead of circuit breakers or circuit breaker panels, shall be UL Class K-1.
5. Fuses rated 600 amperes or less for all general power circuits shall be dual-element, UL Class RK-5 time-delay type. They shall be self protecting from extraneous heat.
6. Fuses installed in individual motor circuits shall be dual element time-delay type, UL Class RK-5. Provide fuse reducers when necessary.
7. Fuses called for to be rejection type are to have rejection fuse holders.
8. Fused disconnect switches for elevators and escalators shall have rejection fuse holders.

B. Fuse Requirements:

1. Dimensions and Performance: NEMA FU 1, Class as indicated.
2. Voltage: Rating suitable for circuit phase-to-phase voltage.
3. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay).
4. Power Load Feeder Switches: Class RK1 (time delay) or RK5 (based on load).
5. Motor Load Feeder Switches: Class RK5.
6. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay.
7. Lighting Load Feeder Switches: Class RK1 (time delay).
8. Other Feeder Switches Larger than 600 amperes: Class L time delay.
9. Other Feeder Switches: Class RK1 (time delay) or RK5 (based on load).
10. Power Branch Circuits: Class RK1 (time delay) or RK5 (based on load).
11. Motor Branch Circuits: Class RK5.
12. Lighting Branch Circuits: Class G.

C. Identification Label:

1. Provide a fuse identification label inside each fused switch, showing type and size of each fuse specified or as recommended by the manufacture of the equipment served.
2. Labeling for rejection type fused switches shall read "Warning-Use Only Current Limiting Fuses Class____, Type_____, MFR_".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all switches in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practice.
- B. All switches shall be firmly anchored to walls and supporting structures (where used). Switches shall be installed with the turning axis of their handles approximately 5'-0" above finished floor unless otherwise indicated. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation.
- C. Switches shall be mounted in accessible locations. Where a switch serves as the disconnecting means for a load, the switch shall be located as close as practical to the load with the switch handle within sight of the load.
- D. Provide lugs on disconnect switch as required to accept conductors called for on drawings.
- E. Disconnect switches shall not be mounted on equipment, unless specifically noted or required and meet all applicable codes. If switches are noted or required to be mounted on equipment they shall have vibrator clips on fuses and be connected to conduit system with liquid tight flexible conduit.
- F. Coordinate all requirements for controls between variable speed drive units and its respective motor with drive specification, manufacturer, provider and installer. Provide auxiliary contacts, relays, etc. as required.
- G. Install fuses in accordance with manufacturer's instructions, the NEC, and NEMA Standards.
- H. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- I. Label each fuse.

- J. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 28 16 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 28 16. The work described in Specification 26 28 16 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 28 16

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ENCLOSED SWITCHES AND
CIRCUIT BREAKERS
SECTION 26 28 16

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SECTION 26 41 13 - LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of a complete lightning protection system.

1.3 DESCRIPTION

- A. A Lightning Protection System (LPS) shall be provided and installed on the structure as noted, and shall be complete even though all items may not be completely shown on drawings. The LPS shall be installed by an experienced Lightning Protection Institute (LPI) - Certified Installer, and in compliance with the provisions of the prevailing and enforced code(s) for LPS as adopted by the National Fire Protection Association (NFPA) and the Underwriters Laboratories (UL). Confirm the prevailing LPS code(s) prior to preparation of the bid and again prior to commencement of the construction. The LPS drawings are provided as a minimum standard, but where a higher standard exists and will be enforced by the Authority Having Jurisdiction (AHJ), the contractor will use the higher standard if unable to confirm acceptance of the lesser standard prior by the Authority Having Jurisdiction to the bid. All of the LPS equipment required for a completely operable and certified LPS, whether shown or not, shall be included.
- B. Materials shall comply in weight, size and composition with the requirements of UL and the NFPA Code relating to this type of installation, and shall be UL Listed.
- C. Where the LPS products and materials being used are available from a single (1) manufacturer, the LPS contractor shall use those materials in lieu of products and materials from multiple manufacturers.
- D. System shall comply with the following:
 - 1. The Lightning Protection Institute (LPI-175) – confirm edition and amendments with AHJ.
 - 2. ANSI/NFPA 780; Class I or Class II as noted on the respective drawing set. The LPS contractor shall confirm the edition and amendments being enforced with AHJ prior to release of the bid.
 - 3. UL 96A; Master Label for:

- a) A new, single structure installation

1.4 REFERENCES

- A. ANSI/NFPA 780 – Standard for the Installation of Lightning Protection System.
- B. ANSI/UL 96 – Standard for Lightning Protection Components.
- C. LPI-175 and LPI-177 – Lightning Protection Institute.
- D. UL 96A - Installation Requirements for Lightning Protection Systems.
- E. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.5 SUBMITTALS

- A. The LPS design shown on these documents shall be used for the shop drawings and alternate means and methods will not be considered. The LPS contractor shall submit shop drawings showing the complete layout of all the LPS air terminals, all the LPS grounding electrodes, the respective in-ground box, the LPS bonding connections to the building metal structure(s) and the LPS connection to other metal objects located in the building and on the roof as shown. Provide a Symbol Legend to define the air terminals, the LPS grounding electrode, and the counterpoise ground loop size(s), the LPS down lead conductor size(s), and the LPS roof grid conductor size(s). Provide details, equal to those shown on these documents, which show the respective connection and termination types. Drawings shall include full layout of cabling and points, and connections.
- B. Submit product data showing dimensions and materials of each component being provided for the LPS. Provide documentation showing compliance with the specific requirements of ANSI/UL 96 and a listing label. Provide documentation showing that coordination between the LPS contractor and the General/Roof/Paint/Finish contractors exists. The LPS contractor shall confirm all LPS connection types and materials with the respective contractor to be sure that adhesives or welds will not compromise the integrity of the material on which it is being installed. The LPS contractor will not void the warranty of any other contractor by using dissimilar metals or adhesives which are not approved by the other contractor/manufacturer.
- C. Submit the LPS manufacturer's installation instructions for review and approval. Include submittal data for the adhesives to be used and welding types to be made.
- D. Submittal shall include manufacturer's installation instructions for the in-ground boxes as defined and shown on the LPS drawings.

1.6 PROJECT AS-BUILT DOCUMENTS

- A. Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors on red lined as-built documents. Maintain the red lined as-built documents and upon completion of the building prepare a REVIT model and drawings showing any changes to the bid documents.
- B. Photograph and maintain digital pictures of all welding and bonding which will not be visible after completion of the construction. The photos shall use the column line Alpha-Numerical system established by the architect and as shown on the architectural drawings. Provide copies of the digital photographs to the Engineer of Record (EOR) within two (2) days of taking the photos. Use the correct Alpha-Numerical indicator and a typed list of the photos being submitted and a brief explanation of each photo.

1.7 QUALIFICATIONS

- A. Manufacturer: A company which specializes in the manufacture of LPS equipment with a minimum of five (5) years documented experience. The company and their products shall be a certified member of the Lightning Protection Institute and the products shall bear the UL label as required.
- B. Installer: An LPS company licensed in the State of Florida and the City of Orlando to provide and install the LPS shown on the drawings. The contractor shall be certified and authorized to install the LPS of each manufacturer being used, they shall have a minimum of five (5) years documented experience, and they shall be a certified member of the Lightning Protection Institute.

1.8 PRE-INSTALLATION CONFERENCE

- A. Schedule and convene a pre-installation conference at least one (1) week prior to commencing any LPS work or excavation. Provide all attendees with at least a two (2) week notice prior to the meeting.

1.9 SEQUENCING AND SCHEDULING

- A. The LPS contractor shall coordinate the work for this section with the roofing, structural steel, exterior and interior finish, HVAC, plumbing, fire protection and electrical contractors prior to any installations. Maintain concurrence with these disciplines throughout the project to avoid any conflict between the materials, and to avoid conflict during installation by means and methods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Thompson Lightning Protection, Inc.: Premium Line.
- B. Independent Protection Company, Inc.: Premium Line.
- C. Heary Bros. Lightning Protection: Premium Lines.

2.2 MATERIALS

- A. Components: In accordance with ANSI/UL 96 and LPI.
- B. Air Terminals:
 - 1. Air Terminals shall be solid (aluminum), one-half inch (1/2") diameter for Class I installations, five-eighths inch (5/8") for Class II installations, as required to match roof conductors, and shall have proper base support for surface on which they are attached. Mount and securely anchored to the surface on which they are to be attached. Provide a blunt tip type air terminal.
 - 2. Terminal length: Twenty-four inches (24") or as otherwise noted on the drawings. Comply with the requirements of NFPA 780 for complete installation.
- C. Conductors:
 - 1. LPS Roof Conductor(s)- the LPS roof conductors shall consist of aluminum complying with the weight and construction requirements of the applicable NFPA 780 Code section or the LPI requirements, whichever is more stringent. The LPS roof conductor material shall match, and be compatible with, the roof and flashing materials. The LPS contractor shall use only gradual bends of eight inches (8") or more in radius when installing the conductor(s).
 - 2. LPS Down Conductor(s) - the LPS down conductors shall be copper, and shall be provided where shown and installed in a minimum one-inch (1") PVC, schedule 40 conduit as noted in the drawing details. Conceal the conduit within the structure and take a digital photograph of any welds or bonds connected to the LPS. Identify each photo with the location of the weld or bond. The LPS contractor shall use only gradual bends of eight inches (8") or more in radius when installing the conductor(s) and the conduit. The down conductor shall be sized in accordance with NFPA 780, Table 4.1.1.1.1 for Class I Installations, and in accordance with NFPA 780, Table 4.1.1.1.2 for Class II Installations.
 - 3. LPS Counterpoise – the LPS counterpoise (ground loop) conductor shall be a single (1) cable with thirty-two (32) strands of #17 AWG copper for Class I Installations, and a single (1) cable with twenty-eight (28) strands of #14 AWG copper for Class II Installations. The counterpoise shall be buried in a trench at a depth of two feet (2'-0") minimum. The LPS contractor shall maintain the integrity of the counterpoise conductor by keeping it out of contact with the piping, conduits or underground utility cables of other trades. Where the pipe,

conduit or another utility cable is within six inches (6") of the counterpoise conductor (above or below), the counterpoise conductor will be routed below the pipe, conduit or utility cable, and the LPS contractor shall maintain a minimum of twelve inches (12") of separation between the counterpoise conductor and any other utility pipe(s), cable(s) or conduit(s). Provide marking tape at six inches above the counterpoise conductor. Coordinate with all site trades to confirm their routing and depth prior to installation and connection of the counterpoise conductor. Do not connect the counterpoise conductor to the LPS ground rods until each rod has been tested and certified to be 5 Ohms or less in resistance. The LPS contractor shall only use gradual bends of eight inches (8") or more in radius when installing the counterpoise conductor. Plan and use "Sweep Type" radius when going under all other utility pipes, cables or conduits.

- D. Fastener: Exposed LPS conductor fasteners shall be of the same material as the conductor, and shall have ample strength to support conductor. Exposed fasteners shall be installed using only an approved method and only with approved adhesives.
- E. Couplings, Connectors and Splicers: The LPS ground rod couplings shall be threaded and self-tightening, DeMark type only. Provide Bronze or aluminum connectors as required to be compatible with conductor being connected.
- F. Ground Rods: The LPS grounding rods shall consist of multiple sections of copper clad driven rods, three-quarter inch (3/4") diameter, a minimum of ten feet (10'-0") long for each section. The installation shall comply with the instructions listed in the LPS construction documents and any additional requirements of Section 26 05 26 Grounding and Bonding, but this section shall prevail if there is a conflict. The tests shall comply with the instructions listed in the LPS construction documents and any additional requirements of Section 26 08 13 Tests and Performance Verification, but this section shall prevail if there is a conflict. Each LPS ground rod shall have a unique and distinct identification, and all reports provided to the EOR will use the same identification when reporting tests. The LPS ground rods shall be driven to a minimum depth of forty feet (40'-0") and tested. If required, additional rod section(s) will be added and the assembly will be driven further down until a maximum of 5 Ohms resistance is achieved when measured using a clamp on, digital recorder. The 5 Ohm requirement will be achieved at the rod before connection of the copper counterpoise ground loop conductor.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The LPS contractor shall verify that all surfaces are cleaned, prepared and ready to receive the work of this discipline.
- B. The LPS contractor shall verify that the actual field measurements are the same as those shown on the LPS shop drawings.

- C. The LPS contractor indicates acceptance of the existing conditions by beginning the work of the LPS construction.

3.2 PROTECTION OF SURROUNDING ELEMENTS

- A. The LPS contractor shall provide protection of all LPS equipment and installations during the project. Coordinate with the general contractor if temporary shoring, barriers or enclosures are required to protect the work of this section from damage or disfiguration.

3.3 INSTALLATION

- A. Install all LPS materials in accordance with manufacturer's written and published instructions.
- B. Install all LPS materials in accordance with requirements of UL 96A, ANSI/NFPA 780, and LPI. The LPS contractor shall verify with the AHJ prior to shop drawing submission.
- C. Install LPS ground rods as noted in the LPS Details and in accordance with Section 26 05 26 Grounding and Bonding. Where conflict exists between the requirements of Section 26 05 26 Grounding and Bonding and this section, the most stringent shall govern.
- D. The LPS materials shall be installed in an inconspicuous manner where possible. The LPS conductors shall be routed concealed where possible. Down conductors shall be concealed within structure, and shall be run in a one-inch (1") PVC, Schedule 40 conduit.
- E. Where the LPS fasteners are to be mounted in a masonry element, or in a structural element, the LPS contractor shall furnish the required fastener(s) to the Masonry or Structural contractor so they may be installed during construction of the project.
- F. Provide the proper connections to the LPS from all the grounded media in and around the protected structure. All connections shall be in accordance with the requirements of NFPA 780 for Surge Protection and Potential Equalization. The LPS contractor shall coordinate with the specific low-voltage contractor to determine the appropriate connection type(s) required and the specific locations.
- G. Provide the proper connections to the LPS from all grounding media in, on and around the structure to provide a common ground potential per NFPA 780 for Common Bonding of Grounded Systems, including the electrical service, the data, telephone and antenna system grounds, as well as underground metallic piping systems, underground metal conduits, etc.

- H. Counterpoise Ground Loop: The LPS contractor shall bond the counterpoise ground loop to the Electrical Ground System. Refer to Section 26 05 26 Grounding and Bonding for additional information. Items required to be bonded/connected as noted in 'F' and 'G' above shall be bonded/connected via Electrical Ground System where available and applicable.
- I. All exposed LPS conductors which are located within six feet (6'-0") or less above finished floor, or the finished grade, shall be protected and shielded properly as well as other exposed locations where a conductor is subject to mechanical damage.
- J. The LPS contractor shall coordinate with, and receive approval of, all penetrations of the roofing system and mounting to roofing system with LPS Designer and Roofing Contractor prior to submittal of shop drawings.
- K. The LPS contractor shall coordinate with, and receive approval from, the Structural Engineer of Record for all connections to structural steel, rebar, and other structural elements prior to submittal of shop drawings.
- L. Ground Terminals:
 - 1. The LPS ground connections shall be made in accordance with requirements of all applicable codes and Section 26 05 26 Grounding and Bonding (including but not limited to requirements for testing, ground rods, materials, wells, etc.).
 - 2. The LPS counterpoise ground rods shall be placed outside of the building at a minimum of two feet (2'-0") away from the building foundation. Refer to the specific LPS Details for additional information.
 - 3. The LPS counterpoise ground rod location shall consist of:
 - a) One (1) copper-clad steel (Copper-weld) driven ground rod which is three-quarter inch (3/4") in diameter and driven vertically to a minimum depth of forty feet (40'-0") into the ground. The rod will be tested, and if required, the contractor shall provide additional sections of rod to achieve a maximum of Five Ohms (5Ω) or less. The test of the ground rod shall only be performed a minimum of two (2) days after any substantial rain storm to avoid false readings.
 - b) Provide an in-ground box (ground well) enclosure at each ground rod location in accordance with LPS Details located on the LPS drawings.

3.4 FIELD QUALITY CONTROL

- A. The LPS contractor shall test all ground rods, using a digital Ground Testing and Recording Meter and provide a Grounding Matrix in the form of an Excel spreadsheet for review. Refer to IEEE Standard 81 for test methods and refer to the specific requirements of Section 26 08 13 Tests and Performance Verification for additional information. Each ground rod shall test positively for a maximum of Five Ohms (5Ω) resistance. The test on all ground rods shall only be performed a minimum of two (2) days after any rain to avoid false readings.

- B. The LPS contractor shall obtain the service of Underwriters Laboratories, Inc. to provide inspection and certification of the lightning protection system under provisions of UL 96A. Submit certification and submit in O & M Manual.
- C. The LPS contractor shall obtain, from the Underwriters Laboratories, Inc., a UL Master Label and attach it to the building at a location as directed by OAR. Submit copy of paperwork to EOR, OAR and submit in O & M Manual.
- D. The LPS contractor shall include the required test results for each counterpoise ground rod location including final length of each ground rod at each ground rod location.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 41 13 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 41 13. The work described in Specification 2641 13 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 41 13

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES (120VAC TO 480VAC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of surge suppression equipment for 120 volt AC to 480 volt AC circuits.

1.3 DESCRIPTION

- A. Provide all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building electrical and electronics systems from the effects of line induced transient voltage surge and lightning discharge as specified for systems with voltages between 120VAC and 480VAC.
- B. Provide surge suppression equipment for the following equipment:
 - 1. Each existing and new main electrical service switchboard as called for on drawings.
 - 2. Distribution and branch panels as called for on drawings.
 - 3. All electronic communications equipment installed per all Division 27 sections including but not limited to: monitoring/metering equipment.
 - 4. Point of use locations (receptacles, plug-in units) as required.
- C. All surge protection to be connected via a 30A 3 pole circuit breaker (whether shown on Plans/Schedules or not.)

1.4 SUBMITTALS

- A. Submit the following Product Data for each type of suppressor:
 - 1. Dimensions
 - 2. Means of mounting
 - 3. Compliance with UL Standards referenced
 - 4. Compliance with IEEE Standards referenced
 - 5. Design type (Hybrid, MOV)
 - 6. Internal fusing/Thermal Protection
 - 7. Recommended overcurrent protection
 - 8. Size of wire leads
 - 9. Visual failure indicator
 - 10. Warrantee

- 11. Performance data showing compliance with performance as specified herein
- 12. Non-Potted construction

1.5 PROJECT AS-BUILT DOCUMENTS

- A. Record locations of surge protection units; indicate actual units used on red lined as-built documents.

1.6 OPERATION AND MAINTENANCE DATA

- A. All approved shop drawings, product data, and cutsheets.
- B. Installation, connection, and maintenance information on each type of surge suppression.
- C. Procedure and time table for recommended periodic inspection of devices to determine usefulness and life expectancy.

1.7 QUALITY ASSURANCE

- A. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment.
- B. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor. Factory representatives are to approve installation prior to Substantial Completion.

1.8 REFERENCES AND REGULATORY REQUIREMENTS

- A. Equipment Certification: Surge protective devices equipment shall be UL listed and labeled for intended use.
- B. Surge protective devices shall be selected, installed and located in accordance with requirements of the following:
 - 1. ANSI/NFPA 780 - Lightning Protection Code, latest edition.
 - 2. ANSI/NFPA 70 - National Electrical Code, current adopted year.
 - 3. U.L. 1449 – 3rd Edition, Standard for Safety for Surge Protective Devices.
 - 4. 1363-1986 - Standard for Temporary Power Taps.
 - 5. ANSI/IEEE C62.41-1991 (IEEE 587) - Guide for Surge Voltages in Low-Voltage AC Power Circuits.
 - 6. ANSI/IEEE C62.33-1982 - Standard Test Specifications for Varistor Surge Protection Devices.
 - 7. ANSI/IEEE C62.45-1987 - IEEE Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

1.9 COORDINATION/PROJECT CONDITIONS

- A. Verify proper grounding is in place.
- B. Verify if space and proper clearance for the surge suppressor installation is available.
- C. Coordinate so that proper overcurrent device, as recommended by manufacturer, is installed to feed each surge suppression device.

1.10 WARRANTY

- A. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five (5) years.
- B. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced at no cost to the owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Suppressors shall be designed for the specific type and voltage of electrical service and shall provide clamping action for both normal (L-N) and common (L-N-G) mode protection.
- B. Suppressors shall be of a hybrid design, and include circuitry with tight, wave-tracking clamping characteristics.
- C. Suppressors shall be designed to withstand a maximum continuous operating voltage of not less than 115% of nominal RMS line voltage.
- D. Suppressors shall contain internal safety fusing to disconnect the suppressor from the electrical source if the suppressor fails, in order to prevent catastrophic failure modes.
- E. Suppressors shall be fail safe, shall allow no follow-thru current, shall have repeated surge capability, shall be solid state, shall be self-restoring, and shall be fully automatic.
- F. Suppressors shall be UL 1449 listed and shall be approved for the location in which they are installed.

2.2 SUPPRESSOR CRITERIA

- A. Main Electrical Service Entrance Suppressors (First Level of Protection) shall meet or exceed the following:
 - 1. General:

- a) Suppressors shall be tested as per IEEE C62.41-1991 to determine clamping voltage using Cat. C3 test criteria.
 - b) Suppressors shall be sequential surge tested as per IEEE C62.45-1987, and shall withstand 1000 test cycles at 10kA, Cat. C3 test criteria.
 - c) Internal fusing for each phase connected.
 - d) Fail-safe with no hold over current.
 - e) Enclosure:
 - 1) listed.
 - 2) Fire retardant.
 - 3) NEMA 1 as required for each location.
2. 400kA, remote monitoring.
- a) Remote Monitoring. Provide complete with normally open and normally closed dry contacts for remote annunciation of unit status for interfacing with Power Xpert Monitoring System.
 - b) Maximum Surge Capacity: 400,000 Amps. per phase.
 - c) Clamping voltage:
 - 1) Category B, UL 1449, Line to Neutral impulse (6KV - 1.2 x 50 μ s, 3kA - 8 x 20 μ s):
 - (a) 120/208V, 3 $\emptyset$, 4W: 600V
 - (b) 277/480V, 3 $\emptyset$, 4W: 920V
 - 2) Category C3, Line to Neutral impulse (20KV - 1.2 x 50 μ s, 10kA - 8 x 20 μ s):
 - (a) 120/208V, 3 $\emptyset$, 4W: 1160
 - (b) 277/480V, 3 $\emptyset$, 4W: 1660
 - d) The unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.
 - 1) Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.
 - 2) Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be located on the hinged front cover to redundantly indicate module or unit failure.
 - e) Basis of Design:
 - 1) Advanced Protection Technologies, Inc. #XTE/*XLHP/CL/DC Series for applied voltage in enclosure or integral to switchgear as noted on Drawings.
 - 2) Equal by Eaton, integral to equipment.

B. Branch Distribution and/or SubPanels (Second Level of Protection), suppressors shall

meet or exceed the following:

1. General.

- a) Suppressors shall be tested as per IEEE C62.41-1991 to determine clamping voltage using Cat. B3 test criteria.
- b) Suppressors shall be sequential surge tested as per IEEE C62.45-1987, and shall withstand 1000 test cycles at 3kA, Cat. B3 test criteria.
- c) Internal fusing for each phase connected.
- d) Fail-safe with no hold over current.
- e) Enclosure:
 - 1) listed.
 - 2) Fire retardant.
 - 3) NEMA 1.

2. 160kA, remote monitoring.

- a) Remote Monitoring. Provide complete with normally open and normally closed dry contacts for remote annunciation of unit status for interfacing with Power Xpert Monitoring System.
- b) Replaceable module design.
- c) Maximum Surge Capacity: 160,000 Amps. per phase.
- d) Clamping voltage:
 - 1) Category B, UL 1449, Line to Neutral impulse (6KV - 1.2 x 50µs, 3kA - 8 x 20µs):
 - (a) 120/208V, 3Ø, 4W: 530
 - (b) 277/480V, 3Ø, 4W: 920
- e) The panel mounted unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.
 - 1) Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.
 - 2) Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be located on the hinged front cover to redundantly indicate module or unit failure.
- f) Basis of Design:
 - 1) Advanced Protection Technologies #TE/*XT/160/DC Series for applied voltage in enclosure as required on drawings, as specified above, and/or as required by applicable codes.

3. 25kA Unit (Third Level of Protection)

- a) Maximum Surge Capacity: 25,000 Amps.

- b) Clamping Voltage at UL 1449, Line to Neutral Category B Impulse, (6kV – 1.2 x 50µs, 3kA, 8 x 20µs):

- 1) 120/208V, 3Ø, 4W: 500
- 2) 277/408V, 3Ø, 4W: 900

C. Point of Use Location (120 Volt), Hardwire.

1. 1449 Listed.
2. 20 Amp, 120V rated. All components must be 20 Amp rated.
3. Suppressors shall be tested per IEEE, C62.41-1991 for categories A and B.
4. Internal fusing.
5. Indicators for normal operation and failure indication.
6. Enclosure: Fire retardant high impact, phenolic or plastic housing or metal enclosure.
7. Clamping voltage UL 1449, Line to Neutral, Category B impulse at (3kA, 8 x 20 µs): 350V @ 120V.
8. Maximum Surge Capacity: 20,000 Amps.
9. Maximum continuous operating voltage: 115% of line voltage.
10. Provide hardwire connection or add 20 amp receptacle device to hardwired devices to match equipment being protected and maintain UL Listing.

D. Point of Use Location (120 Volt) Plug Strip

1. 20 amp, 120V rated.
2. Suppressors shall be tested per IEEE, C62.41-1991 for categories A and B.
3. Normal Mode (L - N), and common mode (L+N-G) protection.
4. Internal fusing.
5. 6 ft. line cord.
6. Protected outlets.
7. Indicators for normal operation and failure indication.
8. Re-settable circuit breaker.
9. On/off switch.
10. Extruded aluminum enclosure.
11. Clamping voltage UL 1449, line to neutral, Category B impulse at (3kA, 8 x 20 µs): 310V @ 120V.
12. Maximum Surge Capacity: 20,000 Amps.
13. Maximum continuous operating voltage: 135V.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide suppressor at first piece of electrical equipment (switchboard) that the electrical service encounters as it enters the facility.
- B. Provide suppressor at each branch panel as noted on drawings.
- C. Provide surge suppression at location where data, metering, or monitoring equipment

is connected to line voltage (120V). Provide cords and receptacles as required to connect surge protective devices equipment to equipment being protected and maintain UL listing.

3.2 INSTALLATION OF SUPPRESSORS

- A. Suppressors shall be installed as close as practical to the electric panel or electronic equipment to be protected, consistent with available space.
- B. Suppressors shall be close nipped to the device being protected in a position near the neutral bus which will minimize lead length between suppressor and the buses or control breaker to which the suppressor connects. Suppressor leads shall not extend beyond the suppressor manufacturer's recommended maximum lead length without specific approval of the Designer.
- C. Location shown on drawings is diagrammatic only.
- D. Suppressors shall be installed in a neat, workmanlike manner. Lead dress shall be as short and as straight as possible and be consistent with recommended industry practices for the system on which these devices are installed.
- E. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using #6 AWG core copper conductor and approved connections unless otherwise noted. Referenced to a common earth ground.
- F. Suppressors shall be installed in a manner that allows simple replacement within short periods of downtime.
- G. Suppressors other than point of use type shall be installed with a means of disconnecting the suppressor at the panel. At the main service entrance location, provide a dedicated 30 amp, 3P-CB, 100,000 AIC for the surge protective device. At the distribution secondary and subpanel locations, provide dedicated 20 amp or 30 amp, 3P-CB's, for the surge protective device. Label disconnect or CB "Surge Protector". Fused disconnects may be substituted for the CB, with the approval of the Designer. Change rating of CB's noted above as required to properly provide system as recommended by manufacturer.
- H. All suppressors are to be monitored by Power Xpert Monitoring System. Provide/install all electrical as required to comply with this.
- I. Suppressors at main switchgear are to be mounted integral to switchgear. Comply with all codes and UL labeling. Provide UL label for complete system. All status indicators are to be mounted to switchgear door, visible from exterior of switchgear without requiring operation of door, lid, etc.
- J. Suppressors at distribution panels to be mounted external to panel cabinet in NEMA 1 enclosure.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 26 43 00 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 26 43 00. The work described in Specification 26 43 00 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 26 43 00

SECTION 26 56 30 HIGH MAST AREA LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 BASIC DESIGN CRITERIA

- A. General. The lighting system shall conform to the requirements of the latest edition of the "Standard Specification for Structural Supports and Highway Signs, Luminaries and Traffic Signals" as published by the American Association of the State Highway and Transportation Officials (AASHTO) and FDOT Standard Specifications for Road and Bridge Construction.
- B. Design Calculations. The Contractor shall submit, for approval, calculations upon which design of lighting poles and anchor bolts are based.
- C. High mast lighting layout, feeders & branch circuits, photometrics are detailed in the contract documents. All contract documents shall be considered integral to this task.

1.2 QUALIFICATION

- A. The manufacturer listed below was utilized to develop the basis of design and photometric diagrams. High mast lighting system should match existing and shall be MUSCO Lighting or accepted equivalent.
- B. The listed manufacturers are represented by:
 - 1. MUSCO Lighting Brandon Albers (800) 825-6020
 brandon.albers@musco.com
- C. Approved Product: Musco's Light-Structure System™ with TLC for LED™ is the approved product. All manufacturers or substitutions shall provide a complete submittal package for approval as outlined in the contract documents. Special manufacturing or warranty requirements may be required to meet the standards of this specification.
- D. The Contractor's superintendent shall have 4-years of comparable experience in the installation of high mast lighting installations, including at least one such system with 100' nominal height poles.

1.3 SUBMITTALS

- A. Submit product data on all fixtures, poles, product warranty, accessories, tools and materials furnished by the Contractor for this Section including, concrete, rebar, lightning protection system, electrical materials, etc. Product data shall prove compliance with the Contract Documents.

- B. Included with the submittals shall be a point by point photometric layout with all necessary data, instruments and tools required to aim the fixtures. Point by point layout shall be a 30 foot by 30 foot or smaller grid. Point by point photometric submittal shall include both horizontal and vertical criteria demonstrating equivalent or superior quality of lighting as determined by the Engineer. Shadow studies and glare studies shall be provided to ensure adequate lighting on the apron and to ensure there is no objectionable glare effecting the air traffic controllers or pilots navigating the airport.
- C. Qualifications of an Underwriters Laboratories (UL) or Lightning Protection Institute (LPI) master labeled lightning protection installer, and lightning protection shop drawings.
- D. The Contractor shall submit the resume of the proposed high mast lighting electrical superintendent to the OAR and Engineer for approval prior to initiating work on the high mast pole assembly and erection.
- E. Structural calculations as required by Part 2.1.
- F. High Mast does not have to meet FDOT proprietary product approval limitations.
- G. The entire submittal package shall be accepted by the Engineer prior to starting any work for the high mast lighting system.

PART 2 - PRODUCTS

2.1 LIGHTING SYSTEM

- A. General. The High Mast Lighting Pole Assembly shall consist of a pole, concrete base, anchor bolts, lightning protection, grounding, lighting fixtures, internal wiring, SPDs, overcurrent protection, LED drivers and controls, disconnecting means and all appurtenances as required by the Contract Documents.
- B. Fixture shall be TLC-LED-600 and/or TLC-LED-400 to match existing and as manufactured by MUSCO Lighting or accepted equivalent.
- C. Design.

Design Specifications

1. AASHTO LRFD *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* (LRFDLTS-1)
2. FDOT Structures Manual Volume 3

Governing Standards and Construction Specifications

1. FDOT *Standard Specifications for Road and Bridge Construction* July 2022
2. FDOT Standard Plans FY 2022-2023

Design Wind Speed = 150 mph (Orange County)

FDOT Standard Specifications Section 715

The structural calculations and pole and anchorage drawings shall be signed and sealed by a registered professional engineer, licensed in Florida.

Structural calculations shall be submitted to the Engineer of Record for review of the design intent. The pole calculations shall be analyzed at the base of the pole, at every 5' interval up the pole, and at the points one (1) foot above and below each slip joint splice. At each of these intervals of the pole, the following information shall be given:

1. The pole's diameter, thickness, section modulus, moment of inertia, and cross-sectional area at each elevation.
2. The centroid, weight, projected area, drag coefficient, velocity pressure, and the wind force of each trapezoidal/round pole segment.
3. The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and the combined stress ratio (CSR) at each elevation.
4. The pole's angular and linear deflection at each elevation.

2.2 LIGHTING PERFORMANCE

- A. Illumination Levels and Design Factors: Lighting system design shall comply with IES RP-37, *Recommended Practice: Lighting Airport Outdoor Environments*, 2021. Operations and working areas shall be lit to an average target illumination level and uniformity as specified in the chart below.

Horizontal Criteria 2 fc 4:1 avg/min.

Vertical Criteria 2 fc 4:1 avg/min. @ 6.5 ft AFG at tail of aircraft in parked position

- B. Appropriate light loss factors shall be applied and submitted for the basis of design.

Dirt Depreciation factor 0.95

Lumen depreciation per LM-80-08 and TM-21-11.

- C. Color: The lighting system shall have a minimum color temperature of 4,000K and a CRI of 70.

# of Poles	Pole Designation	Pole Height
4	P10-P13	100 ft
3	P-14-P-15	70 ft

- D. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields. No symmetrical beam patterns are accepted.
- E. Glare Control: To minimize impact on ATCT personnel, pilots and apron personnel candela values shall be in accordance with RP-37.
- F. Spill Scans: Spill scans must be submitted indicating the amount of horizontal and vertical footcandles along the specified lines, Runway and Taxiway. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights.
- G. Shadow studies shall be performed to ensure consistent lighting levels, minimizing shadows.
- H. The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified independent testing laboratory with a minimum of five years experience or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

2.3 LIFE-CYCLE COSTS

- A. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for 10 years from the date of equipment shipment. Individual outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

2.4 LIGHTING SYSTEM CONSTRUCTION

- A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.
- B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.

C. System Description: Lighting system shall consist of the following:

1. Galvanized steel cross-arm assembly and mounting shall be designed as one system to work seamlessly with fixture application and aiming.
2. Anchor bolt foundation designed such that the steel pole and any exposed steel portion of the foundation is located a minimum of 24 inches minimum and as detailed in the plans, above final grade. The concrete for anchor bolt foundations shall be allowed to cure for a minimum of 28 days before the pole stress is applied unless shorter cure time approved by structural engineer of record.
3. Manufacturer will supply all drivers and supporting electrical equipment.
 - a. Remote drivers and supporting electrical equipment shall be mounted at the base of the pole in NEMA Rated aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing. Disconnect per circuit for each pole structure will be located in the enclosure.
4. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.

D. Safety: All system components shall be UL listed for the appropriate application.

2.5 POLE FOUNDATIONS

- A. The pole foundations shall be constructed of reinforced concrete at the locations and in accordance with the details indicated. The concrete, form, mixing, pouring, and reinforcing steel shall conform to the appropriate parts of the Contract Documents.

2.6 LIGHTNING PROTECTION

- A. Provide materials, equipment, labor, and supervision as necessary to install a complete high mast Lightning Protection System (NFPA 780 Class II System).
- B. The lightning protection design shown in the plans shall be considered the minimum acceptable design criteria. The lightning protection systems provided under this specification shall equal or exceed the minimum requirements shown in the plans and shall comply with this specification.

- C. Lightning Protection System shall be provided and installed on the high mast lighting pole(s) by experienced LPI Certified or UL Listed Installers in compliance with provisions of National Fire Protection Association (NFPA) 780, Standard for the Installation of Lightning Protection Systems and Underwriters' Laboratories (UL) UL 96 and UL 96A. All equipment to that result shall be included whether or not specifically called for herein with the additional requirement that the system shall meet all the requirements of the Lightning Protection Institute (LPI).
- D. Materials shall comply in weight, size and composition with the requirements of Underwriters' Laboratories UL 96 and NFPA 780 Class 2 relating to this type of installation, and shall be UL Labeled.
- E. System shall be inspected by an independent third party organization. As a result of the inspection the third party shall provide the following endorsement/accreditation.
 - 1. New Installation:
 - a) UL Master Label Service or
 - b) LPI Master Label Certificate.
 - 2. Reconditioned Installation:
 - a) UL Master Label Service or
 - b) LPI Reconditioned Master Label Certificate.
 - 3. Modified or partial installation:
 - a) UL Letter of Finding or
 - b) LPI Limited Scope Inspection.
- F. All prerequisite work and coordination necessary to obtain the independent third party inspection (including required coordination/work/shop drawings, etc. prior to the actual lightning protection system installation) is the responsibility of the Contractor.
- G. Bond pole base loop conductor to building lightning protection system.
- H. All materials used shall be that of Harger Lightning and Grounding, Grayslake, Illinois, 60030 or accepted equivalent.
- I. Shop drawings shall be submitted on the system layout and system components. These shop drawings shall be prepared by the lightning protection equipment manufacturer.

PART 3 - EXECUTION

3.1 ERECTING POLES

- A. The poles shall be installed at the locations and in accordance with the Contract Documents. The pole, together with the luminaire and hoist assembly, shall be assembled in accordance with the Manufacturer's recommendations.
- B. Within one week of notice to proceed the Contractor shall survey and stake the proposed location of all new poles, bollards and service and notify the OAR that the Contractor has completed this activity. The Contractor shall allow seven working days for the Owner, OAR, Engineer and tenants to review the proposed locations and make final adjustments to the proposed locations.

3.2 GROUNDING

- A. Grounding shall be in strict accordance with the NFPA 70, UL 96A and NFPA 780 and as indicated in the Contract Documents.

3.3 TESTS OF INSTALLATION

- A. Upon completion of the work, the installation shall be tested to assure that the design light distribution is met, that the installation is entirely free of ground faults, short circuits, and open circuits and that it is in satisfactory working condition.
- B. The Contractor shall furnish all labor, materials and apparatus (including a low-level reading lighting meter) necessary for making the required tests. The light meter shall have been calibrated within the last 12 months by a recognized laboratory and the Contractor shall furnish certification of such calibration. Any defective material or workmanship discovered as a result of these tests shall be removed and replaced by the Contractor at the Contractor's expense, and subsequent re-tests shall be made to the satisfaction of the Engineer. Field Measurements: Individual field measurements may vary from computer-calculated predictions and should be taken in accordance with IESNA RP-6-15.
- C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles and uniformity ratios are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy Owner
- D. Provide and turn over to the Owner's maintenance department a low level reading light meter, an inclinometer and all special tools necessary to adjust the fixture aiming or perform maintenance.

- E. In addition to the above requirements, up to four-night time trips shall be provided by the Contractor and manufacturer to adjust the aiming of the system and make the necessary allowances for light reflecting toward the Air Traffic Control Tower, runways or taxiways.

3.4 WARRANTY AND GUARANTEE

- A. 10-Year Warranty: The manufacturer shall supply a signed warranty covering the entire system for 10 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather conditions, events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or products made by other manufacturers.
- B. Maintenance: For 10 years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage of any area is materially impacted. Owner agrees to check fuses in the event of a luminaire outage

PART 4 – METHOD OF MEASUREMENT

- 4.1 The quantity of lighting units to be paid for under this item shall be the number of each type installed, complete and in place, ready for operation, and accepted by the OAR. Each lighting unit shall include the installation of an identification plate or tag as detailed in the plans.

PART 5 – BASIS OF PAYMENT

- 5.1 Payment will be made at the contract unit price for each item completed in accordance with the plans and specifications that is installed by the Contractor and accepted by the OAR. This item shall include all labor, materials, transportation, tools, equipment, supervision, and all incidentals necessary to furnish and install a high mast pole and fixtures - complete in accordance with the contract documents. This price shall include all components to provide electrical power to each high mast pole in accordance with the Contract Documents. This price shall include all conduit, L-867 bases, surge protection, grounding, feeders and branch circuits, LED drivers, support arm, pole, foundation, 4/0 AWG bare copper grounding cable and pole ground loop, ground rods, 4/0 bare copper bonding cable to building ground grid, exothermic welds, concrete, rebar, anchor bolts, internal wiring and components, lightning protection, markers, tags, sealants, adhesives, excavation, backfill, dewatering, wiring, terminations, aiming, testing and all incidentals and appurtenances necessary for the complete installation of the high mast lighting unit to the satisfaction of the OAR (RON A2 manholes are paid for under the RON pay item). Quantity of fixtures per pole varies with location. This price shall be full compensation for furnishing all materials and for all preparation, assembly and installation of these materials, and for all appurtenances necessary to furnish and install a fully operational high mast area lighting pole/fixture assembly to the satisfaction of the OAR and in accordance with the contract

documents. The cost of the light meter aiming devices, etc. shall be averaged into and included in the unit price for the pole bid item.

Item 26 56 30-5.1	High Mast Lighting Pole Assembly 100 ft tall – complete (LED fixture quantity as shown in Contract Documents)	– per Each (EA)
Item 26 56 30-5.2	High Mast Lighting Pole Assembly 70 ft tall – complete (LED fixture quantity as shown in Contract Documents)	– per Each (EA)

END OF SECTION 26 56 30

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ITEM 26 57 00 PRE-ENGINEERED PRECAST CONCRETE BUILDING – DESIGN/BUILD

PART 1 - GENERAL

1.1 Work Includes: Precast structural concrete building shell and components as shown on the SOUTH Remain Overnight (RON) DISTRIBUTION BUILDING drawings and needed for complete and proper installation, including:

- A. Design, Erection, and Production drawings.
- B. Factory Inspection and testing per PCI certification requirements.
- C. Fabrication of specified precast concrete components.
- D. Handling, storage and protection of precast concrete components.
- E. Transportation of precast concrete components to erection site.
- F. Erection of precast concrete components including all bearing pads, base plates, inserts, clamps, nuts, bolts, joint sealant, finishes, and other necessary appurtenances, and other hardware items for connections between cast-in-place concrete and precast components and tolerances for the placement of these components.
- G. Cast-in-Place foundations design and drawings including all steel reinforcement and embedded items in cast-in-place concrete.

1.2 REFERENCES

- A. Precast Concrete Institute
- B. PCI MNL 116-85 Manual for Quality Control For Plants and Production of Precast Prestressed Concrete Products
- C. PCI MNL 120-04 Design Handbook, 6th Edition
- D. American Concrete Institute
- E. ACI 318-05 Building Code Requirements for Reinforced Concrete
- F. American Society of Testing and Materials:
- G. ASTM A 185-94 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
- H. ASTM A 615-94 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

- I. ASTM A 706-92b Low Alloy Steel Deformed Bars for Concrete Reinforcement
- J. ASTM C 33-93 Concrete Aggregates
- K. ASTM C 94-94 Ready Mixed Concrete
- L. ASTM C 150-94 Portland Cement
- M. ASTM C 260-94 Air-Entraining Admixtures for Concrete
- N. ASTM C 330-93 Lightweight Aggregates for Structural Concrete
- O. ASTM C 494-92 Chemical Admixtures for Concrete
- P. ASTM C 618-94a Fly Ash and Raw or Calcified Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete
- Q. ASTM C 989-93 Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars
- R. ASTM C 1107-97 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- S. Other Standards:
 - 1. AWS D1.1 Structural Welding Code – Steel
 - 2. AASHTO Standard Specification for Highway Bridges

1.3 DESIGN REQUIREMENTS

- A. General:
 - 1. Precast Components: The manufacturer shall complete the design, including calculations and detailing, for all precast components specified on the Contract Drawings. Design shall be based on preliminary design criteria and conditions provided on the Drawings and in the Specifications. The manufacturer shall perform the complete design assuring that the manufacturing, transportation and erection process are compatible with the Contract Drawings and Specifications.
 - 2. Erection: The manufacturer's designer shall consider erection of the precast components including calculations and details for guying, staying, and shoring all precast components to assure structural stability during the construction stage and before all permanent structural connections are completed. Provide in the erection plan for removal, replacement, and relocation of guying, bracing, and shoring before all permanent precast structural connections are completed.

The manufacturer's registered professional engineer shall retain responsibility for the erection design.

3. Design of precast components and connections shall be prepared under the direct supervision of the manufacturer's State licensed professional engineer with approval by the Project Engineer.

B. Design Criteria:

1. Design loads:

- a. All dead and live loads specified on the Contract Drawings.
- b. All other loads specified for components, where applicable.
- c. Initial handling and erection stress limits.
- d. All precast components and connections to non-precast elements shall be designed in accordance with the PCI Design Handbook.
- e. All precast components shall have a minimum reinforcing in accordance with ACI 318. Analysis of prestressed components shall include a check of the shear reinforcing requirements at $0.1L$, $0.2L$, $0.25L$ and $0.3L$, where L is the component length.

C. Modifications:

1. All proposed modifications to the drawing and specifications shall be submitted to the Engineer and Engineer with complete design calculations and drawing.
2. The location of openings shall be shown on the shall be coordinated with the conduit and power plans provided in the Contract documents and shall be shown in the submittal drawings. Openings shall be located and field drilled (or cut) by the trade requiring them after precast components have been erected and grouted. Locations of all field cut openings shall be reviewed and approved by the manufacturer prior to drilling or cutting.

- D. Lifting devices shall be designed and cast into the components to ensure safe and efficient handling. Lifting devices shall be so arranged that they do not have to be removed; or, if they must be removed, they shall be arranged so that they are readily removed and any planned depressions in the concrete can be readily filled.

- E. Lift loops and erection inserts shall be located so they are not objectionable in the completed structure with a minimum concrete or grout cover as specified in ACI 318 and the PCI Design Handbook. Inserts located in areas exposed to view shall be recessed and patched with non-shrink, non-staining grout to match surrounding concrete, or cover and protect in an approved manner.

1.4 SUBMITTALS

- A. Design calculations and drawings specified in Section 1.03, Design Requirements.

- B. Concrete Mix Design: The manufacturer shall submit sources and proportions of all constituent materials, and mixture characteristics for all designs of Portland cement concrete. Submit manufacturer's laboratory or field data documenting required strength in accordance with ACI 318. Separate design is required for each strength and class of concrete. Data for each mix shall include the following:
1. Mix identification
 2. Specified strength
 3. Gradation of fine and coarse aggregates and combined gradation
 4. Sources of all constituent materials
 5. Proportions of all constituent materials
 6. Water/Cement Ratio
 7. Design slump (or flow) with tolerance
 8. Air content
 9. Unit weight
- C. Concrete Test Reports: Submit test reports of production of precast components. Reports will show 28-day compressive strength tests representing concrete placed in components.
- D. Erection Drawings: Shall be prepared showing:
1. Member piece marks.
 2. Plans and/or elevations locating and defining all precast components.
 3. Sections and details showing connections, embedded items and their relation to the structure.
 4. Joints and openings between members and between members and structure.
 5. Description of all loose, embedded and field hardware.
 6. Field installed anchor location drawings (if applicable).
 7. Shipping and handling requirements.
 8. All dead, live and other applicable loads provided by the Engineer of Record and used in the design of the precast components.
 9. Expansion joint details (if required).
- E. Production shop drawings: Submit, for record purposes only, drawings and calculations providing the following information: (Only representative/typical details of each element will be provided).
1. Plan and/or elevation view of each component
 2. Sections and details to indicate quantities and location of reinforcing steel, anchors, inserts and all embedded items. Catalogue and design data on all inserts, bearing plates, anchors, and embedded items
 3. Lifting and erection devices
 4. Dimension and finishes
 5. Prestress for strands and concrete strengths
 6. Methods for storage and transportation

- F. Shop drawing submittals shall demonstrate coordination with conduit entry points (size and quantity) and actual equipment sizes.
- G. Approvals: Erection shall not proceed without approval by the Engineer of Record of the appropriate drawing and design calculations.

1.5 QUALITY ASSURANCE

- A. Manufacturer qualifications
 - 1. The manufacturer shall have a minimum of 5 years proven experience in the design and manufacture of precast concrete and prestressed components, and having adequate finances, equipment, plant and skilled personnel to expeditiously design, detail, fabricate and install the work as required by the Drawings and Specifications.
 - 2. The Manufacturer shall be a producer/member of the P.C.I. Plant Certification Program.
- B. Engineering qualifications
 - 1. The manufacturer shall show evidence of an in-house engineering department managed by a registered professional engineer.
 - 2. The manufacturer's professional engineer shall hold current professional engineering registration in the state.
- C. Erector qualifications: Shall have been regularly engaged for a period not less than 5 years in the erection of precast components similar to those required for this project.
- D. Welder qualifications: Certified in accordance with AWS D1.1.

1.6 CONCRETE TESTING

- A. Unless otherwise directed by the Engineer, concrete testing shall be performed by the manufacturer in accordance with PCI MNL 116-85. If directed and paid for by the owner, testing shall be performed by an independent testing and inspection agency. If inspection discloses improper workmanship or inferior material, any subsequent inspection or test deemed necessary by the Engineer shall be at no cost to the Owner.
- B. All testing shall be performed by ACI Concrete Field Testing Technician Grade 1 in accordance with ACI CPI

1.7 ENGINEERS INSPECTION

The Engineer may elect to visit the manufacturer's plant to inspect and approve methods of control of the concrete mixes, component fabrication and curing methods, and approve first run production components no later than five days after the manufacturer's request. Access to the manufacturing facility shall be provided to the Engineer, Owner and the Owner's representative.

1.8 HANDLING, STORAGE, PROTECTION AND TRANSPORTATION

- A. Components shall not be shipped until the compressive strength of test specimens representing the component have developed a compressive strength of 80% of the specified compressive strength or until the component can safely support the superimposed dead load of other precast components, whichever is greater.
- B. Precast components shall be lifted and supported during manufacturing and yard handling only at the lifting and supporting points or both, as shown on the shop drawings and with appropriate lifting devices.
- C. Precast components shall be stored in a manner to minimize cracking, distortion, warping, staining, or other physical damage. Components shall be stored on properly cushioned supports to protect the edges.
- D. Units shall not be placed in contact with earth or other staining influences or to rest on corners.
- E. All holes and reglets shall be protected against water and ice in freezing weather.
- F. Precast components shall be delivered to the project site in such quantities and at such times to assure continuous operations. Components shall be transported with proper equipment, methods and with qualified personnel.

1.9 WARRANTY

- A. The Manufacturer shall provide the following warranty:
 - 1. "We (name of Manufacturer or Subcontractor) do, hereby, warrant that the precast units are in accordance with the contract documents and any authorized modification thereto, and will be free of spalls or show evidence of visible cracking beyond accepted industry standards, splitting, deformation, or loosening resulting from inferior materials or workmanship by this trade for a period of one (1) year effective from the date of the substantial completion of the precast erection. Precast units showing such defects will be repaired or replaced and made acceptable at no expense to the Owner."

1.10 BUILDING DIMENSIONS

- A. **The building unobstructed interior length shall be 26 feet 6 inches minimum. The building unobstructed interior width shall be 19 feet minimum. The building unobstructed interior height shall be 10 feet 6 inches minimum.**
- B. **The building dimensions are based upon the basis of design EATON electrical equipment. As a part of the submittal process the Contractor shall provide dimensioned shop drawings overlaying the building with the electrical equipment demonstrating compliance with the required NEC minimum working space about equipment.**
- C. **Should the Contractor elect to provide equipment other than EATON the Contractor will be responsible for any increased cost due to an increase in building size. In no case may the building be reduced in size. The free space on each side of the EATON equipment (7'6", 8'0") shall not be reduced. Seven feet shall be maintained between the fronts of the opposing switchgear units.**
- D. **Equipment layout shall comply with NFPA 70, National Electrical Code and all manufacturer's requirements and recommendation.**
- E. **Contractor shall carefully coordinate the necessary raceway installation to match the bottom conduit entry points within the switchgear assembly. There shall be no overhead raceways within the RON Distribution Building except for lighting and receptacles.**

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cementitious Materials
 - 1. Portland cement: ASTM C 150, Type I or III
 - 2. Fly Ash: ASTM C 618, Except the L.O.I. shall not exceed 3.0%
 - 3. Ground Granulated Blast Furnace Slag: ASTM C 989
 - 4. Architectural Cement: Cement meeting the requirements of ASTM C 150 or a blend of a cement meeting the requirements of ASTM C 150 and blended with fly ash, ground granulated blast furnace slag and/or silica fume to match the Owner's control sample
- B. Aggregates
 - 1. Normal Weight Aggregates: ASTM C33. Provide aggregates from a single source for architecturally finished concrete. Local aggregates not complying with ASTM C 33, but which have shown by special test or actual service to produce concrete of adequate strength and durability, may be used when acceptable to the Engineer
 - 2. Lightweight Aggregates: ASTM C 330

C. Admixtures:

1. Air-Entraining Admixture: ASTM C 260
2. Water reducing admixtures: ASTM C 494. Use in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low slump concrete, may be used subject to Engineer's acceptance. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of placing. Adjust quantities of admixtures as required to maintain quality control

D. Reinforcing Steel:

1. Billet steel: ASTM A 615, Grade 60K.
2. Low alloy steel reinforcing should conform to ASTM A 706 when welding reinforcement, Grade 60K, for welding.
3. Welded wire mesh shall conform to ASTM A 185, or ASTM A 497, Grade 60K, Plain.
4. Prestressing strand: Shall be uncoated seven (7) wire low relaxation strand ASTM A416, Grade 270K.

E. Anchors and inserts

1. Structural steel shall be of new material conforming to ASTM A 36.
2. Bolts: ASTM A 307.
3. Welded headed studs: AWS D1.1-Type B.
4. Deformed bar anchors: ASTM A496.
5. Mechanical splice for future expansion column and wall reinforcing anchorage: Splice Sleeve, Interlock.
6. Rod anchor bars: high strength coil rod, or approved equal.
7. Anchor finish:
 - a. Shop primer: Manufacturer's standards.
 - b. Hot dipped galvanized: ASTM A153.
 - c. Zinc Rich Coating: Self-curing, one component, standard brushing grade.
 - d. Cadmium plated: ASTM A165.

F. Forms

1. To be constructed of approved concrete, steel, wood or fiberglass reinforced plastic or high-density overlaid plywood to obtain the quality of the finish specified. Forms shall be designed to withstand vibration and anticipated lateral forces.
2. Forms shall be of such rigidity as to ensure sectional dimensions as outlined in MNL 116.
3. Parting Compound: Non-oil base.

G. Grout

1. Cement Grout: Portland cement, ASTM C150, Type I and clean, natural sand, ASTM C404. Mix at ratio of 1.0 part cement to 3 parts sand, by volume, with minimum water required for placement and hydration.
2. Non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating materials, water-reducing admixtures, complying with ASTM C 1107.

H. Bearing Pads

1. Tempered hardboard.
2. Plastic: Multi-monomer plastic strips shall be non-leaching and support construction loads with no visible overall expansion.
3. Chloroprene (Neoprene): Conform to Division II, Section 25 of AASHTO Standard Specification for Highway Bridges.
4. Laminated fabric-rubber pads: Preformed, unused synthetic fibers and new unvulcanized rubber. Surface hardness of 80 Shore A durometer plus or minus 10 percent.
5. Expansion bearing pads: Assemblies consisting of lower and upper components. The upper component shall consist of a stainless steel support plate and a sheet of stainless (14 gage minimum) with a minimum 2B mill finish. It shall be larger than the lower element by at least $\frac{1}{2}$ inch in each direction. The lower element shall consist of a bearing pad, a stainless support plate and a bonded contact layer of Teflon.

I. Concrete Mixes

1. General: Concrete mixes shall be proportioned to develop the required strength using either laboratory trial batch or field experience methods as specified in ACI 318, Chapter 5.
2. Freeze-thaw durability: Concrete exposed to freeze-thaw cycles shall be air entrained to produce a total air content in accordance with ACI 318, Chapter 4.
3. Compressive strength: The 28-day specified compressive strength of the concrete to be incorporated into each component shall be shown on the shop drawings. The minimum 28-day specified compressive strength for precast, prestressed components is 5,000 psi.

2.2 MANUFACTURER

A. General

1. Concrete for the precast components shall be batched in accordance with ASTM C 94.
2. Precast components shall be fabricated in accordance with PCI MNL 116 and ACI 318.

3. Forms shall be cleaned between castings. Parting compound shall be applied to forms to insure against discoloration and keep surface imperfections to a minimum.
4. Dimensional tolerances shall be in accordance with PCI MNL 116.
5. The minimum release compressive strength for prestressed components is 3,000 psi.
6. Components shall be cured after form removal in a moist condition and at a minimum temperature of 50 deg F until field molded specimens cured under similar conditions have developed a minimum compressive strength of 3,000 psi.
7. Lift loops and erection inserts shall be furnished cast as shown on the production drawings.
8. Components shall be identified with a number on back face or other exposed area that identifies the orientation of the component in its final position.
9. Coat exposed ends of prestressing strands in all prestressed components to protect against corrosion.

B. Welding

1. Welding shall be performed in accordance with AWS D12.1 and AWS D1.1.
2. Manufacturer shall furnish fit up plates or angles to compensate for deviations, alignment or location of inserts.
3. Welding shall not reduce cross-section of concrete reinforcement and cause tearing at end of the weld and progressive failure.

C. Finishes

1. Precast concrete exposed surface finishes shall match approved samples.
2. The vertical faces of spandrels and exterior wall panels shall be cast to provide a finish as designated by the Architectural drawings and the Owner's control sample.
3. Wall panels, spandrels, and columns to have the specified trowel, broom or float finish on the unformed surface.
4. Exterior precast components required to have a finish shall be [by contractor with owner approval].

2.3 DOORS AND HARDWARE

- A. Doors shall be aluma-clad steel 7 feet tall by 3 feet 6 inches wide **single and double leaf as noted in plans**. Hardware, panic bars, auto door closers, and locksets shall be furnished by the Contractor and shall match GOAA standard system.

2.4 FIRE EXTINGUISHERS

- A. Provide and install two 30 pound CLASS A, B, C fire extinguishers.

2.4 **SPACE CONDITIONING**

A. Basis of Design is BARD Climate Control Solutions 5-ton PTAC Unit with 9 kw electric heat. PTAC Unit shall be 5-ton unit model W60A or accepted equivalent. Each unit shall be furnished with the following:

- **Factory sleeve through wall,**
- **Factory 9 kW electric heat,**
- **Digital remote thermostat and fan speed controller,**
- **Provide six spare filters. Install new filter at beneficial occupancy,**
- **Provide heavy duty thin line architectural louver with hurricane impact approval,**
- **Provide condensate drain kit. Pipe condensate to L-868C base can adjacent to concrete building pad,**
- **Provide low ambient controller and enthalpy economized for secondary PTAC.**
- **Provide and install all electrical and temperature control systems.**

PART 3 - EXECUTION

3.1 ERECTION

A. Erection Equipment and Safety

1. The erection contractor shall be responsible for safe erection and comply with applicable local and state safety regulations. Components shall be lifted by means of suitable lifting devices at points provided by the manufacturer.
2. The erection contractor shall be responsible for becoming familiar with the Contract drawings, specifications and erection drawings.
3. Each component shall be safely and adequately secured in position by positive mechanical connections.
4. Temporary bracing shall be sufficient to brace work adequately.
5. Connections are to be completed as erection progresses.
6. Erection equipment shall not be bent, twisted, warped or damaged in any way.
7. All wire ropes for cranes or lifting bars shall be of full sections -- not bent, twisted, kinked, torn or stretched. The lifting capacity of all lifting beams, platforms and trusses shall be posted.

- B. Erection shall not commence until a pre-erection inspection has been performed to demonstrate that all raceways entering the structure from below grade are installed and completed to support the building erection.**

3.2 SITE ACCESS

- A. General Contractor shall be responsible for providing suitable access to the building, proper drainage and firm, level bearing for the hauling and erection equipment to operate under its own power.**

- B. General Contractor shall make provisions as required for placement and accurate alignment of anchor bolts, plates or dowels in column footings, grade beams and other field placed supporting members.

3.3 INSTALLATION

- A. The manufacturer shall perform a field pre-erection survey prior to erection of precast members. Any discrepancies shall be reported to the contractor as soon as they are discovered for correction prior to start of precast erection.
- B. Work shall be executed by workmen skilled in this trade, set work plumb, true and square with joints parallel and uniform, all in accordance with the approved erection drawings. Shims and bearing plates shall be accurately placed.
- C. Components shall be anchored in final position by bolting and/or welding as shown on drawings. All field welding must be done by certified welders in accordance with AWS D12.1. Complete grouting and dry packing as shown on the drawings.
- D. Clean up: At the completion of the work, and at other such times directed by the Engineer, all rejected and surplus materials, rubbish and apparatus shall be removed from the project site.

3.4 ALIGNMENT

- A. Components shall be properly aligned and leveled as required by the shop drawings. Variations between adjacent components shall be reasonably leveled out by jacking, loading or any other feasible method as recommended by the manufacturer and acceptable to the Engineer.
- B. Components shall be erected as shown on the contract and shop drawings in conformance with PCI Committee Report "Tolerances for Precast and Prestressed Concrete", PCI Journal, Vol. 30, #1, January-February, 1985.

3.5 FIELD WELDING

- A. Field welding shall be performed by certified welders using equipment and materials compatible with the base materials.

3.6 CLEAN UP

- A. As work progresses, all excess or foreign materials which would become difficult to remove from finished surfaces, or which would harden on finished surfaces shall be removed.

- B. On completion of the work, all surplus materials, tools, equipment and debris, leaving the building in a clean condition shall be removed to the satisfaction of the Owner.
- C. Final cleaning of all material is the responsibility of the general contractor/construction manager of the project.

3.7 INSPECTION AND ACCEPTANCE OF WORK

- A. Final acceptance and acceptance of erected precast components shall be made by the Owner Authorized Representative to verify conformance with plans and specifications.
- B. Components incorporating concrete that has failed to meet strength requirements of plans and specifications when evaluated in accordance with ACI 318 shall be cored as directed by the Engineer. Unit may be rejected and replaced at the Engineer's discretion after the core test. The costs of these tests shall be borne by the Contractor.

PART 4 – METHOD OF MEASUREMENT

- 4.1 The quantity of units to be paid for under this item shall be the number of each type installed, complete and in place, ready for operation, and accepted by the OAR. Each unit shall include the installation of all incidentals and appurtenances as detailed in the Contract Documents.

PART 5 – BASIS OF PAYMENT

- 5.1 Pay item 26 57 00-5.1, South RON Distribution Building is a lump sum pay item to furnish and install a precast structural concrete building shell and components as shown on the Contract Documents and needed for complete and proper installation including doors and hardware. Item includes all engineering, transportation, coordination, materials, labor, supervision, and all incidentals required to furnish and install the complete structure as shown in the Contract Documents. Division and coordination of work between electrical contractor and precast building contractor shall be the responsibility of the Contractor. All work as shown in the Contract Documents shall be completed to the satisfaction of the OAR.

Item 26 57 00-5.1 South RON Distribution Building – Complete - Lump Sum (LS)

END OF ITEM 26 57 00

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SECTION 26 57 01 – SOUTH REMAIN OVERNIGHT (RON) ELECTRICAL DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and other Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for the South Remain Overnight (RON) Electrical Distribution System.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material and accessories, and mounting hardware for a complete and operating system as described within the Division 26 Specification Sections.
- B. Furnish, perform, or provide all labor including planning, purchasing, transporting, storing, installing, testing, cutting and patching, trenching, excavating, backfilling, coordination, field verification, equipment (installation and safety), supplies, and materials necessary for the installation of complete electrical systems (as described or implied by these specifications and the applicable drawings) in strict accordance with applicable codes, which may not be repeated in these specifications, but are expected to be common knowledge of qualified Bidders.
- C. All work shall comply with all applicable codes as a minimum and with the additional requirements called for in these Contract Documents.
- D. Only trained and licensed personnel shall perform work. No Work shall be performed which violates applicable Codes, even if called for in the Contract Documents.
- E. Coordinate requirements with Utility Company and all applicable GOAA Testing, Certification and repair contractors prior to bid. Bid to include all work required.
- F. Make connections of all items in the Work using electric power including wire, conduit, circuit protection, disconnects and accessories. Securing of rough-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment.

- G. The Contractor shall provide and install panic hardware on all RON electrical distribution structures doors. All electrical room doors shall open in the direction of egress and shall include applicable life safety signage, exit lighting and emergency lighting.

1.4 QUALITY ASSURANCE

- A. Install Work in locations shown or described in the Contract Documents, unless prevented by Project conditions.
- B. Install all equipment so that all Code and Manufacturer recommended working and servicing clearances are maintained. Properly arrange and install all equipment within designated spaces. If a departure from the Contract Documents is necessary, submit to the OAR for approval detailed drawings of the proposed changes with written reasons for the changes. No change shall be implemented without the issuance of a change order or other directive permitted by the General Conditions.
- C. The Contractor shall verify finish dimensions at the project site in preference to using dimensions noted on Contract Documents.

1.5 INVESTIGATION OF SITE

- A. Investigate the site and existing conditions thoroughly before bidding. Advise OAR of discrepancies or questions noted.
- B. During the course of the site visit, electrical bidder shall become familiar with all aspects of the proposed work and existing field conditions of the work. No compensation or reimbursement for additional expenses for failure to investigate the existing facilities will be authorized. This shall include rerouting around existing obstructions.
- C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.
- D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions can be anticipated and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Notify OAR if deviations are found.
- E. All existing electrical is not shown. The Contractor shall become familiar with all existing conditions prior to bidding, and include in his bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is abandoned due to renovation.
- F. Protect all existing electrical raceways within concrete slabs, below concrete slabs, overhead raceways, equipment, etc. from damage due to renovation. Repair or replacement of utilities or other property damaged by operations in conjunction with the work will be at no cost to the Owner.

- G. Occupied existing buildings must remain in operation while work is being performed. Schedule work for a minimum outage to Owner. Notify the OAR appropriately for any shutdown of existing systems.
- H. The 26 XX XX series of specification are applicable to the South RON Electrical Distribution System.

1.6 CONTRACT DOCUMENTS

- A. The drawings are diagrammatic and are not intended to include every detail of construction, materials, methods, and equipment. They indicate the result to be achieved by an assemblage of various systems. Coordinate equipment locations with Architectural and Structural drawings. Layout equipment before installation so that all trades may install equipment in spaces available. Coordinate installation in a neat and workmanlike manner..
- B. Contractor shall provide 1/4" scale coordination drawings for all electrical, mechanical and communications rooms during the shop drawing submittal phase, utilizing detailed dimensions from equipment actually submitted (all disciplines) and field-measured/verified existing conditions. These drawings are also required for any room where conduits equal to or greater than 1-1/4" in size, equipment (panels, HVAC, disconnects, comm. racks) or other large objects are being installed. Drawings shall show all electrical, mechanical, plumbing, fire protection, structural, etc. coordinated so that problems are discovered/prevented prior to installation. Claims during construction for additional funding in rooms where properly coordinated drawings were not submitted will not be considered.
- C. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. All such items incidental to a complete and operating system shall be provided.
- D. Submit specific shop drawings which indicate the fabrication, assembly, installation, and erection of particular systems' components. Drawings that are part of the Contract Documents shall not be considered a substitute for required shop drawings, field installation drawings, code requirements, or applicable standards.
- E. Locations indicated for outlets, switches, and equipment are approximate and shall be coordinated with the Contract Documents. Where instructions or notes are insufficient to locate the item, notify the OAR.

1.7 MATERIALS AND EQUIPMENT

- A. Unless otherwise noted, all material shall be new and UL listed or labeled. In lieu of UL listing or labeling, a statement or data demonstrating compliance with contract documents from a nationally recognized testing agency shall be submitted to the OAR.

- B. Where multiple items of the same equipment or materials are required, they shall be the product of the same Manufacturer.
- C. Prior to placing equipment orders, verify the physical size of specified equipment to fit spaces allotted on the drawings and with NEC working clearances. Internal access for proposed equipment substitutions shall be provided. The required 1/4" scale drawings shall show that this coordination has taken place.
- D. Electrical equipment shall be protected from the weather, during shipment, storage, and construction per manufacturer's recommendations. Should any apparatus be subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the Contractor, to ascertain the suitability of the apparatus, or it shall be replaced without additional cost to the Owner.
- E. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair and test damaged equipment in compliance with industry standards at no additional cost to the Owner. Equipment required for the test shall be provided by the Contractor.
- F. Material and equipment shall be provided complete and shall function up to the specified capacity/function. Should any material or equipment as a part or as a whole fail to meet performance requirements, replacements shall be made to bring performance up to specified requirements. Damages to finish by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Owner.
- G. Where tamperproof screws are specified or required, Phillips head or Allen head devices shall not be accepted. For each type used, provide OAR with three tools. OAR will designate the specific hardware design to correspond with existing devices elsewhere in the building to limit special tool requirements.
- H. Communications backboards shall be 3/4" A/B grade, Class A, flame spread, painted with light gray fire retardant paint. Neatly mask off a minimum of one (1) plywood manufacturer's pre-printed certified fire rating stamp per section of board prior to application of paint. Remove masking after paint has cured. Plywood shall comply with the requirements of Low Emitting Materials for composite wood.

1.8 COORDINATION

- A. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner:
- B. The electrical subcontractor shall be provided with a set of Contract Documents for all areas of Electrical Work.

- C. Installation studies shall be made to coordinate the electrical work with other trades. Work shall be preplanned. Unresolved conflicts shall be referred to the OAR prior to installation of the equipment.
- D. Coordination drawings shall be prepared prior to the start of work. Drawings shall show the actual physical dimension required for the installation to assure proper integration of equipment with building systems and NEC required clearances. Location of conduit racking, etc., shall be provided. Coordination drawings shall be provided for all areas. Comply with the requirements of Division 01.
- E. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in the Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed. Adjustments to contract value will not be considered due to lack of coordination.
- F. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.
- G. Coordinate the exact location of stub-ups, etc. with OAR and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.
- H. The Contract Documents describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, conduit, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.

1.9 PROVISION FOR OPENINGS

- A. Locate openings required for work. Provide sleeves, guards or other approved methods to allow passage of items installed.
- B. Coordinate with roofing Contractor on installation of electrical items which penetrate the roof. Roof penetrations shall be installed so as to not void roof warranty.
- C. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types with Contractor.

1.10 CONCRETE PADS

- A. Furnish and install reinforced concrete pads for transformers, switchgear, generators, motor control centers, and other free-standing equipment. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by three (3) inches each side, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment. Pads shall be reinforced with W1.4 x 1.4 6 x 6 welded wire mesh. Chamfer top edges 1/2". Trowel all surfaces smooth. Provide 3000 psi concrete.

1.11 SURFACE MOUNTED EQUIPMENT

- A. Surface mounted fixtures, outlets, cabinets, conduit, panels, etc. shall have finish or shall be painted as directed by designer. Paint shall be in accordance with applicable sections and/or divisions of these specifications.
- B. Maintain 1/4" air space between equipment and wall.

1.12 CUTTING AND PATCHING

- A. Reference Division 01 - General Requirements.
- B. New Construction:
 - 1. Cutting of work in place shall be cut, drilled, patched and refinished by trade responsible for initial installation.
 - 2. Backfill new grades to match adjacent undisturbed surface.

1.13 INSTALLATION

- A. Erect equipment to minimize interference and delays with the execution of the Work.
- B. Take care in erection and installation of equipment and materials to avoid marring finishes or surfaces. Any damage shall be repaired or replaced as determined by the designer/OAR at no additional cost to the Owner.
- C. Equipment requiring electrical service shall not be energized or placed in service until OAR is notified and is present or have waived their right to be present. Where equipment to be placed in service involves service or connection from another Contractor or the OAR, notify the OAR in writing as appropriate when the equipment will be ready.
- D. Equipment supports shall be secured and supported from structural members unless written approval is granted by OAR.

- E. Plywood material shall not be used as a backboard for mounting panel boards, disconnects, motor starters, and dry type transformers. Provide "cast in place" type inserts or install expansion type anchor bolts. Electrical equipment shall not be mounted directly to dry wall for support without additional channels as anchors. Channels shall be anchored to the floor and structure above. Panelboards and terminal cabinets shall be provided with structural framing located within drywall partitions.
- F. Inserts, pipe sleeves, supports, and anchorage of electrical equipment shall be provided. Where items are to be set or embedded in concrete or masonry, the items shall be furnished and layout made for setting or embedment thereof so as to cause no delay.
- G. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the OAR.

1.14 AS-BUILT DOCUMENTS

- A. As-Built Documents: As-built Documents include Drawings, Shop Drawings, Specifications, Addenda, Change Orders, and other modifications permitted by the General Conditions.
- B. Comply with all requirements of Division 01
- C. Verify aspects of redlined as-builts for accuracy. As-Built Documents shall show all components including but not limited to:
 - 1. All raceways 1-1/4" and above, cable tray systems, and grouped raceway racking as installed, including dimensions from fixed building lines such as column lines.
 - 2. All site underground raceways and duct banks indicating burial depths and distances from fixed building lines or global tracking coordinates.
 - 3. Underground pull boxes and manholes including elevations. Detail manhole and pull boxes, conduit terminations (butterfly layout) including conduit sizes, designated systems and cabling description.
 - 4. General conduit routing from receptacle to receptacle, fixture to fixture, device to device. (Exact routing is not required for raceways 1" and smaller.)
 - 5. Junction box splices shall be shown in exact location and clearly noted referring to the written authorization by the OAR.
 - 6. Any combining of circuits (which is only allowed by specific permission).
 - 7. Any circuit number changes.
 - 8. All conductors and cables, conductors and cable sizes, raceway sizes, etc. not shown on contract documents and any changes from the documents.
 - 9. Any switchboard, panelboard, motor control center, relay panel, or dimming control panel schedule changes, including load changes.
 - 10. Exact quantity of conductors and cables shall be shown for all raceway systems.
 - 11. Exact location of all driven grounding electrodes including burial depths and

- dimensions from fixed building lines. Location of all grounding system busbars.
 - 12. Riser diagrams exactly as installed.
 - 13. Motor control devices, terminal cabinets, equipment racks, disconnects and switches and surge protection devices.
 - 14. Changes to the equipment schedules (i.e., symbol legends, light fixture schedule, etc.) to agree with items actually furnished.
 - 15. Changes to plan notes to agree with items actually furnished, actual installation methods, etc. respectfully.
 - 16. Cross-out all items, circuitry, devices, etc. not applicable.
- D. As-Built red line information shall not compromise the clarity of the Contract Documents and Shop Drawings. Major components such as grouped raceway assemblies, cable tray systems, larger conduits, duct banks, racking, elevations, dimensions, etc. shall be shown on a clean architectural base plan(s) separate from the Contract Electrical Documents, as required to clearly delineate work. Obtain electronic base plan file from OAR.

1.15 "OBSERVATION OF WORK" REPORT

- A. Reference the General Conditions.
- B. Items noted by designer/OAR during construction and before final acceptance which do not comply with the Contract Documents will be listed in an "Observation of Work" report which will be sent to the Contractor for action. Correct all deficiencies in a prompt concise manner. After completion of the outstanding items, provide a written confirmation report for each item. The report shall indicate each item noted, and method of correction. Enter the date on which the item was corrected, and return the signed reports so items can be rechecked. Failure to correct the deficiencies in a prompt concise manner or failure to return the signed reports shall be cause for disallowing the requests for payment.
- C. The electrical project superintendent shall be present at all required observation of work reviews as project progresses. Provide the OAR with equipment for access and review of all Work in place, as well as personnel fully familiar with all aspects of the work. Provide access to all electrical components such as junction boxes, panelboards, switchboards, devices and fixtures for review by the designer/OAR.
- D. Prior to start of Substantial Completion inspection, provide access to and prepare all electrical equipment and related components complete and ready for review by designer/OAR including compliance with Division 1.
- E. Items noted after acceptance during one-year guarantee period shall be checked by the Contractor in the same manner as above. The signed reports are to be returned by him when the items have been corrected.

1.16 SYSTEMS WARRANTY

- A. Reference the General Conditions.
- B. Warranty shall be by the Contractor to the Owner and shall cover a period of one year from the date of the Substantial Completion. Warranty shall not include light bulbs/lamps in service beyond one month from date of substantial completion of the System.
 - 1. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the OAR upon project completion.
- C. Where items of equipment or materials carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material.
- D. Where extended Guarantees are called for herein, furnish three copies to be inserted in Operation and Maintenance Manuals.
- E. All preventative maintenance and normal service will be performed by the Owner's maintenance personnel after final acceptance of the work which shall not alter the Contractor's warranty.

1.17 WASTE MATERIALS DISPOSAL

- A. Include in base bid the transport and disposal or recycling of all waste materials generated by this project in accordance with all rules, regulations and applicable guidelines. Comply fully with Florida Statute 403.7186 regarding mercury containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at time of disposal. Provide OAR with written certification of approved disposal.

1.18 PROHIBITION OF ASBESTOS AND PCB

- A. Prior to the Final Review field visit the Contractor shall certify in writing that the equipment and materials installed in this Project under this Division 26 contain no asbestos or PCB. Additionally, all manufacturers shall provide a statement with their submittal that indicates that their product contains no asbestos or PCB. This statement shall be signed by a duly authorized agent of the manufacturer.

PART 2 – PRODUCTS

- A. Products are described in the 26 XX XX series specifications and as detailed in the plans.

PART 3 – EXECUTION

- A. Furnish and install all components necessary for a complete South Ron Electrical distribution system as shown in the contract documents. Major items of system are listed below:
1. Two 2,500 ampere, 480 volt, three phase 4 wire electrical services and distribution systems at the South RON Distribution Building.
 2. Extension of these circuits, to include all cable, raceway, counterpoise, concrete and all incidentals to the South RON Island 1 and South RON Island 2.
 3. Fabrication of eight power pedestals, four on each island.
 4. #2 AWG bare solid copper counterpoise over all RON power ducts.
 5. All grounding and bonding, ground rods, ground loops etc.
 6. Furnish and install miscellaneous feeders and branch circuits.
- B. All electrical, mechanical and other associated work shown on the RON contract documents is included in this scope of work with the following exceptions:
1. 2W4" communication duct bank is paid for as a linear foot under the L-110 pay item.
 2. #2 AWG bare solid copper counterpoise over the L-110 2W4" communication duct bank is paid for as a linear foot under the L-108 pay item.
 3. A1 and A2 manholes are paid for as each under the L-115 pay item.
 4. High mast poles are paid for as each under the 26 56 30.
- C. Install all items in accordance with NFPA requirements and all manufacturer's recommendations and instructions.

PART 4 - METHOD OF MEASUREMENT

- A. Except for the pay items listed above, this item shall be paid for as lump sum; in place, ready for operation, and accepted by the OAR. The RON complex item shall include the installation of all incidentals and appurtenances as detailed in the Contract Documents.

PART 5 - BASIS OF PAYMENT

- A. Pay item 26 57 01-5.1, South RON Electrical Distribution System is a lump sum pay item to furnish and install all electrical service equipment, distribution equipment, feeders, branch circuits, power outlets, overcurrent protection, raceway, cables, grounding, bonding and components as shown on the Contract Documents and needed for complete and proper installation of the South RON facility. Item includes all transportation, coordination, materials, labor, supervision, bollards, 30' x 30' x 1' & 30' x 60' x 1' concrete pads, reinforcing and all incidentals required to furnish and install all the complete system as shown in the Contract Documents. All work as shown in the Contract Documents shall be completed to the satisfaction of the OAR.

This price shall include all concrete, rebar, markers, tags, sealants, adhesives, gravel, sodding, excavation, backfill, dewatering, incidentals and appurtenances, etc., necessary for the complete installation of the item to the satisfaction of the OAR and OUC. This price shall be full compensation for furnishing all materials and for all preparation, assembly and installation of these materials, and for all appurtenances necessary to complete these items. Any incidental work items not specifically identified and not provided by others shall be part of the Contractor's work effort and included as part of the pay item with no separate identification and payment.

Item 26 27 01-5.1 South RON Electrical Distribution System - Lump Sum (LS)

END OF SECTION 26 57 01

ORLANDO INTERNATIONAL AIRPORT
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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

SOUTH RON ELECTRICAL
DISTRIBUTION SYSTEM
SECTION 26 57 01

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SECTION 28 43 20 - EMERGENCY FUEL SHUT OFF SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.
- B. Related Specification Sections:
 - 1. SECTIONS 26 01 01 General Provisions and Requirements for Electrical Work, 26 05 10 Electrical Symbols, 26 05 19 Building Wire and Cable, 26 05 26 Grounding and Bonding, 26 05 29 Hangers and Supports, 26 05 33 Conduit, 26 05 35 Pull and Junction Boxes, 26 05 53 Identification for Electrical Systems, 26 08 00 Commissioning of Electrical Systems, 26 41 13 Lightning Protection System and 26 43 00 Surge Protection Devices.
 - 2. SECTIONS SP-100 General Provisions and Requirements for Electrical Work, SP-104 General Electrical Safety Requirements and Temporary Airfield Lighting, L-108 Underground Power Cable for Airports, L-110 Airport Underground Electrical Duct Banks and Conduits and L-115 Electrical Manholes and Junction Structures.

1.2 SUMMARY

- A. Refer to the above Specifications in addition to the following.
- B. This section provides requirements for the expansion and configuration of the emergency fuel shut off (EFSO) system located in the APM/ ITF South Terminal Complex (STC)

1.3 SCOPE OF WORK

- A. Refer to the above Specifications in addition to the following.
- B. Contractor shall expand the EFSO system for the STC. The EFSO system shall is a standalone system and shall not be integrated with or connected to the fire alarm system in any manner.
- C. The work in this section includes the 2W2 and 4W2 duct banks and the EFSO system electrical pull boxes.
- D. Where listed on the drawing responsibility matrix, the following components shall be defined as follows.

1. Headend and Software: Contractor shall furnish, install, and program all required headend equipment and software including, but not limited to licensing, system expansion, redundancy, workstation licenses, operating software license or any other software required to support all new elements under this contract. Contractor shall be required to coordinate requirements as well as scheduling license installation. Headend and software include any panels, cabinets, management/administrative software, software licenses, programming, and components which serve the purpose of performing system-wide coordination, monitoring, data processing, control and other global functions.
2. Integration with the Existing Tank Farm Monitoring System: Energizing and connecting of new components to the existing tank farm monitoring system shall be performed by the current tank farm monitoring system maintenance Contractor. The tank farm monitoring system maintenance Contractor shall perform all necessary testing to certify the system modification and perform the necessary programming changes required for a complete operating system. The work performed by the tank farm monitoring system maintenance contractor is part of the contract and shall be included in the bid price and fully coordinated by the contractor.
3. Interfaces: Contractor shall provide all system interfaces. Interfaces include all hardware, software, wiring, cabling, programming, interface devices and appurtenances as required for communication between systems, or between a given system and an operator, to provide the specified functionality.
4. Horizontal Cable: Contractor shall provide dedicated EFSO signal cabling as described in this section.
5. Field Devices: Contractor shall provide all field devices including, but not limited to power supplies, initiating devices, notification appliances, indicators, speakers, auxiliary devices, and similar equipment or appliances.

1.4 DESCRIPTION

- A. Provide all labor, materials, equipment, and services necessary and required to provide, install and test a complete EFSO system to comply with these specifications and all regulatory requirements.
- B. Provide a complete EFSO system. The system shall include but not be limited to all control panel components, power supplies, batteries, signal initiating devices, notification devices, wire, fittings, accessories, programming, software licenses, and interfaces to other systems required to provide a complete operating system.
- C. The contractor shall coordinate with all other systems required to provide a complete and operational system.

1.5 SOUTH TERMINAL COMPLEX

- A. All initiating devices shall be addressable. Control shall be microprocessor based and field-programmable node. All electronics shall be solid state.

- B. System to be a zoned, non-coded, closed circuit supervised fire alarm system. The entire EFSO system shall be continuously electrically supervised against interruption or failure of the initiation and notification circuits including switches and electrical contacts. Detect opens, shorts, and grounds in the system.
- C. Coordinate with other Work to assure completeness of system including but not limited to: conduit, raceways, outlet boxes, wire, cable, supports, surge suppression, junction boxes, pull boxes, identification, enclosures, cabinets, and grounding.
- D. Provide all required control and interlock wiring between EFSO system and fuel system equipment. Controls are required to/for/from: control valve solenoids, leak detection pressure switches, water level detection switches, push buttons, alarm modules, light flashers, etc. (as applicable to Work).
- E. The Contractor shall provide and install the EFSO system (including all equipment, wiring, etc.) in accordance with the manufacturer's recommendations.
 - 1. Installation of devices shall be in accordance with the manufacturer's requirements as well as the requirements of the contract Documents. Recommendations by the manufacturer for the proper installation of the EFSO system and its equipment shall not preclude the requirements for the Contractor to comply with the requirements of the contract Documents.
 - 2. Termination of EFSO circuits shall be in accordance with the manufacturer's recommendations, applicable requirements of the National Electric Code (NFPA 70), ADA, other applicable Codes and the Contract Documents.
 - 3. The EFSO installer shall be responsible for ensuring that prior to bidding the project the Electrical Contractor understands the raceway requirements for the project. Claims by the Contractor after award of the project in regard to additional raceway required either by the EFSO System Manufacturer's recommendations for proper installation of the system and its associated equipment, or for compliance with the requirements of the Contract Documents, shall not be allowed.
- F. The Contractor is advised that circuit routing for this system is not necessarily shown on the project drawings. The Contractor shall provide and install all raceways, wiring and cabling required for a complete and fully functional system as intended by these specifications. All wiring and/or cabling shall be in conduit. Contractor shall provide and install a properly sized, flush mounted outlet box for every device. Contractor shall size and route raceways to accommodate the proper installation of the system cabling. T-Tapped cabling shall not be acceptable. In locations where raceway and/or conduit is not accessible after completion of the project, conduit shall be routed from device to device or fire rated access panels shall be installed to provide access to junction and pull boxes. Routing of raceway from device to device shall only be acceptable where the wiring scheme of the system, as recommended by the manufacturer, requires cable to pass from device to device. Contractor shall properly terminate each device according to the manufacturer's recommendations. Provide and install firestopping where penetrations are made through rated walls and floors.
- G. All EFSO cabling shall be in raceway.

- H. The EFSO System shall be tested, by the Contractor, in the presence of the Fuel system operator, upon permanent installation of the equipment in the fuel tank farm control building and prior to acceptance by the Owner. This testing shall be in addition to any other testing required by these project documents. The Contractor shall be responsible for including all costs for this testing within his bid. The testing procedure shall include in-depth testing of all portions of the system that have been moved, modified or worked in as part of this project. In addition, this testing shall, as a minimum, involve random testing of devices at the discretion of the fuel system operator.
- I. The EFSO system shall not share a raceway, junction box, enclosure, manhole or device with any other system.
- J. Provide and install all relays as required for a complete and operational EFSO system, complying with all applicable codes and all requirements, and coordinated with all divisions of these specifications.
- K. Zoning
 - 1. Activation Zones.
 - a. Activation zones are based on the pipe layout for the fuel system. Four control valves in CV-10 supply two different portions (Zones) of the hydrant piping. Any activation of a pushbutton in the zone shall cause both control valves for that zone to be closed.
 - 1) Zone C: Gates 250, 251, 252, 253 and 254.
 - 2. CV-10 Downstream Cross-Connect Valve.
 - a. If the CV-10 Downstream Cross-Connect Valve position indicator shows the valve in any position other than closed, Zones C and D shall be considered one zone and all four control valves in CV-10 shall be closed upon activation of any EFSO push button.
 - 3. Gate 245 exception.
 - a. Gate 245 is the physical location of CV-10 and therefore could have leak indications that could come from both zones. Therefore, any activation of a pushbutton at gate 245 shall shutdown Zones C and D.

1.6 SYSTEM OPERATION

- A. System operation shall meet the operation requirements of all codes and regulatory requirements.
- B. Upon activation of the EFSO System by a EFSO Station push button the following shall take place:
 - 1. Energize the blue light installed the EFSO Station and at the EFSO Panel Alarm Station.
 - 2. Sound audible alarm installed above the push button and at the EFSO Panel Alarm Station.
 - 3. Cause alarm to be displayed on the control panel and the graphical display at the tank farm.
 - 4. Close all control valves in CV-10 by zone.

- C. Leak Detection: Upon activation of the low-pressure component of the leak detection pressure switch, the system shall provide a supervisory fault condition. Upon activation of the high-pressure component of the leak detection pressure switch, the following shall take place:
 - 1. Energize the blue light at the EFSO Panel Alarm Station.
 - 2. Sound audible alarm at the EFSO Panel Alarm Station.
 - 3. Cause alarm to be displayed on the control panel and the graphical display at the tank farm.
- D. Liquid Level Detection: Upon activation of the low or high liquid level alarm, the system shall provide a supervisory fault condition.
- E. System supervisory faults, such as shorts, opens, and grounds in conductors, operating power failure, or faults within supervised devices, shall place the system in the trouble mode, which causes the following system operations:
 - 1. Visual and audible trouble signal indicated by zone at the EFSO control panel.
 - 2. Visual and audible trouble signal indicated at the tank farm.
- F. Manual acknowledgement function at the EFSO control panel shall silence audible signal at the control panel and the EFSO Panel Alarm Station; visual signal shall be displayed until initiating failure or circuit trouble is cleared.
- G. Alarm Reset: The system shall remain in the alarm mode until manually reset with a key accessible reset function. The system shall reset only if the initiating circuits are cleared.
- H. EFSO Station Reset: The system shall remain in the alarm mode until the push button is reset. The button is reset by pulling out on the button. Once the button is reset, the audible signal at the EFSO Station shall stop and the flashing blue light shall continue until the alarm reset is used at the EFSO control panel.
- I. Lamp Test: manual lamp test function causes alarm indication at each lamp on the fire alarm control panel and the remote annunciator.

1.7 SUBMITTALS

- A. Submit in accordance with SECTION 26 05 00 Common Work Results for Electrical.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit in accordance with SECTION 26 05 00 Common Work Results for Electrical and SECTION 26 01 00 Operation and Maintenance Manuals.

1.9 O & M MANUALS

- A. Submit in accordance with SECTION 26 05 00 Common Work Results for Electrical and SECTION 26 01 00 Operation and Maintenance Manuals.

1.10 QUALITY ASSURANCE

- A. Refer to Specification SECTION 26 05 00 in addition to the following.

- B. Manufacturer: Company specializing in manufacturing the products specified with minimum ten (10) years' experience and with service facilities within 50 miles of Project.
- C. Installer:
 - 1. Company specializing in installing the products specified with minimum ten (10) years' experience and certified by the State of Florida as fire alarm installer.
 - 2. The installing Contractor shall be a direct sales division of, or the authorized and designated distributor for, the fire alarm system manufacturer.
 - 3. Installing Contractor shall maintain a local staff of specialists, including a Fire Alarm Planning Superintendent, for planning, installation, and service.
 - 4. The installing Contractor shall be capable to provide emergency service 7-days-a-week, 24 hours a day. The installing Contractor shall have been actively engaged in the business of selling, installing and servicing fire alarm systems for at least five consecutive years from date of bid opening.

1.11 OWNER'S INSTRUCTION:

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Provide instruction to the Owner's designated personnel upon completion of the system installation. Instruction shall include a functional training session on the EFSO control panel operation and on peripheral device operation, including what are normal indications and alarm indications of each type of device.
 - 1. Videotape all training sessions and deliver (4) copies of tapes to Owner's Authorized Representative (for use in future training).

1.12 EQUIPMENT WARRANTY

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Warrant all equipment to be new and free from defects in material and workmanship, and will, within one year from date of acceptance by GOAA, repair or replace any equipment found to be defective.
 - 1. No charges shall be made by the installer for any labor, equipment or transportation during this period to maintain functions.
 - 2. Respond to service call within twenty-four (24) hours after receipt of such a call.

1.13 REFERENCES AND REGULATORY REQUIREMENTS

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. The equipment and installation shall comply with, but not be limited to the current or applicable provisions of the following:
 - 1. National Electric Code, Article 760.
 - 2. National Fire Protection Association Standards:
 - a. NFPA 70 - National Electrical Code.
 - b. NFPA 72 - Application, performance, installation and maintenance of fire alarm systems and their components.

3. Underwriters Laboratories Inc. The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:
 - a. UL 864/UOJZ: APOU Control Units for Fire Protective Signaling Systems.
 - b. UL 1481: Power Supplies for Fire Protective Signaling Systems.
 4. Florida Building Code: Latest adopted edition.
 5. Florida Administrative Code.
 6. General: The system shall comply with all applicable Codes, Ordinances and Standards as interpreted and enforced by the local authority having jurisdiction.
 7. State of Florida: Division of State Fire Marshal.
- C. Each item of the EFSO system shall be listed and classified by UL and FM as suitable for purpose specified and indicated.
- D. All Control Equipment shall be listed under UL category UOJZ.
- E. The system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.
- F. IEEE: The EFSO system includes solid state electronic components. Therefore, the equipment manufacturer shall provide certification that all such equipment is internally protected from, or can withstand, power line surge voltages and currents as specified in Table 1, Location Category a High Exposure of ANSI/IEEE Standard C62.41-1980 (formerly IEEE Standard 587).

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide all equipment necessary for the complete EFSO system expansion.
- B. All equipment shall be new and UL listed for intended fire alarm purposes.
- C. Provide all equipment to perform all functions and features even though not specifically noted or specified herein.
- D. See drawings for description of devices.
- E. All devices shall be addressable type.
- F. Provide back box as recommended by system manufacturer for all devices.
- G. System manufacturers:
 1. Edwards Systems Technology
 2. Siemens
 3. Notifier
 4. Approved equal

2.2 INITIATING DEVICES

- A. EFSO Station: Push button operator, Square D Class 9001, Type 4X with extended guard #SKR2RH13. Enclosure similar to #KY1. Or equal.
 - 1. Mounting: Flush plate, stainless steel, Square D Class 9001, Type SK, similar to #K25 but shall be watertight. Or equal.

2.3 NOTIFICATION APPLIANCES

- A. General:
 - 1. All notification devices shall be white in color
 - 2. All notification devices shall be rated for exterior use.
- B. Visual Alarm Devices:
 - 1. EFSO Station Light: Incandescent lighting fixture with 100 watt incandescent equivalent LED bulb and guard. Crouse Hinds #VGR116 and blue globe #VN73 gasket. Or equal.
 - 2. EFSO Panel Alarm Station: Strobe warning light, 120V, with blue color dome. Unit shall be weatherproof. Federal Signal Corp. Model #LP3P or equal.
- C. Horns: Vibrating horn, 120v, with 4" square outlet box and grill for flush mounting. Federal Signal Corp. Model #350 +FG+FB or equal.

2.4 AUXILIARY DEVICES

- A. Power supplies, controllers, modules, relays, housings, etc. as required by system manufacturer to support all devices required for a complete and operational system.
- B. Isolation Modules:
 - 1. The Isolator Module (IM) is an addressable device that protects a signaling line circuit (SLC) from a wire-to-wire short.
 - 2. The module monitors line voltages and opens the data line when a short is detected, isolating the short between the two modules located electrically closest to the short.
 - 3. The loop controller assigns an address to the module.
 - 4. The module uses one detector address on the SLC.
- C. Addressable control Modules:
 - 1. Provide Input / Output / relays as required and as shown on details
 - 2. Where installed in motherboards provide appropriate version.
- D. Addressable Circuit Interface Modules:
 - 1. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that cannot otherwise be equipped for multiplexing communication. Modules transmit identification and status to the EFCP using a communication transmitter and receiver with unique identification and capability for status reporting to the EFCP. Modules shall be used for monitoring of non-addressable devices such as valve position.

2. Addressable Circuit Interface Modules shall be capable of mounting in a standard electric outlet box.
- E. Control Relays: UL listed SPDT or DPDT 10 amp rated contacts, status LED. Provide metal enclosure w/LED Viewing Port
 1. A single relay may be energized from a voltage source of 24 Vdc, 24 Vac, 115 Vac or 230 Vac by wiring to appropriate input terminals.
 2. Each relay position contains a red light emitting diode (LED) which indicates the relay coil is energized.
 3. Provide dust proof metal enclosure with LED viewing hole for all modules.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. All of the work specified in this section shall be included within the scope of the contract. The contractor shall retain the current tank farm monitoring system maintenance Contractor to perform, at a minimum, the following tasks:
 1. Provide any programming required for the tank farm monitoring system.
 2. Update the system as-built drawings, CAD files and bitmaps.
- C. Locate, install, and EFSO system in accordance with the equipment manufacturer's written instructions, and the latest editions of the NFPA, the National Electrical Contractors Association publication "Standard of Installation" and all applicable codes referenced in this specification.
- D. Provide all work required for a complete system including complete system testing and checkout. All components shall be properly mounted and wired. The installation of this system shall comply with the directions and recommendations of authorized factory representatives.
- E. Provide wiring, cabling, raceways, and electrical boxes in accordance with manufacturer's written instructions.
- F. Components shall be electrically "burned-in" by operating the component at full power for a period as recommended by the manufacturer.
- G. Installation shall be done in a neat workmanlike fashion by a firm regularly engaged in Fire Alarm Installation and Service.
- H. The installation and inspection of all EFSO devices and systems shall be performed by, or under the direct on-site supervision of, a licensed fire alarm technician or a fire alarm planning superintendent who shall certify the work upon completion of the activity. The certifying licensee shall be present for the final test prior to certification.
- I. Installation plans and wiring diagrams shall bear the signature and license number of the licensed Fire Alarm Planning Superintendent, the date of installation and the name, address, and certificate-of-registration number of the registered firm.

- J. All components shall be completely wired. System shall be fully operable when main power service has failed and the Emergency Standby Generator has assumed emergency system loads. This shall require that any devices which required 120 volt power shall receive supply from an emergency 120 volt source.
- K. Power supplies are to be loaded to a maximum of 75% of their capacity. Provide additional power supplies where required to comply with this maximum loading requirement.

3.2 RACEWAYS AND BOXES

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Provide dedicated raceway with applicable boxes for all EFSO wiring in accordance with applicable sections of these specifications.
- C. All initiating, indicating and auxiliary control devices shall be mounted on UL listed outlet boxes.
- D. Provide supporting devices per SECTION 26 05 29 Hangers and Supports.
- E. Identify raceways and boxes per SECTION 26 05 53 Identification for Electrical Systems.

3.3 WIRE/CABLE

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Conductor: 98% conductivity, solid copper or stranded copper with maximum of 7 strands. If stranded conductors are used, then a compression lug shall be installed at every end. Wrapping twisted strands at terminal block screw is not acceptable. As an acceptable equivalent, stranded conductors without crimp-on lugs may be terminated into terminal strips of box-lug connectors.
- C. Insulation: A type approved by NEC for the application. All cable shall be UL listed for fire-protective signaling application. Communication, Class 3 or Multi-Purpose cables shall not be substituted for FP cable types.
- D. Color Coded:
 - 1. Wiring shall be color coded as required to match existing fire alarm system.
 - 2. Permanent wire materials shall be used to identify all splices and terminations for each circuit at all junction boxes, outlet boxes, and terminations.:
- E. UL:
 - 1. General: Fire-protective signaling cable shall be UL listed as non-power limited or power limited as needed to match the output of the fire alarm equipment.

2. Non-Power Limited: Fire protective signaling circuits classified as non-power limited shall use cable listed under UL Electrical Construction Materials Directory. Category HNHT, "NON-POWER LIMITED FIRE-PROTECTIVE SIGNALING CABLE". All such cable shall have fire resistance, listing and markings as described in NEC 760-17. Minimum cable marking shall be NPLF.
 3. Power Limited: Fire protective signaling circuits classified as power limited shall use cable listed under UL Category HNIR, "POWER LIMITED FIRE-PROTECTIVE SIGNALING CABLE". All such circuits shall be durably marked where plainly visible at terminations to indicate that it is a power-limited fire protective signaling circuit. Refer to paragraph titled "Fire Resistance of Cables" for additional requirements.
 4. Fire Resistance of Cables: Power-limited fire-protective signaling circuit cables shall be UL listed as described in NEC 760-49. All such cable shall bear a cable marking that includes a Type designation as given in NEC Table 760-50. Provide Type FPL.
- F. Connections of Installation Wiring:
1. Connections to Equipment: In accordance with NFPA for monitoring integrity and with the equipment manufacturer's instructions.
 2. Connections of installation wiring to alarm initiating device and alarm indicating appliances shall be monitored for integrity.
 3. Interconnecting means shall be arranged so that a single break or single ground fault will not cause an alarm signal.
 4. Apply a compression lug, similar to T&B Sta-Kon Terminal, to all stranded conductors at terminations or use box-lug terminal strips.
 5. There shall be no wire splices. All wiring shall be continuous, uncut between devices and terminal blocks.

3.4 EFSO STATION

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Install push button at 54 inches AFF to top of device.
- C. Install horn at 66 inches AFF to top of device.
- D. Install blue light at 78 inches AFF to top of device.
- E. Install sign at 84 inches AFF to bottom of sign.
- F. All stations shall be in unobstructed locations.

3.5 END-OF-LINE DEVICE

- A. Mount end-of-line device box with last device or separate box adjacent to last device in circuit. Provide and install nameplate on plate with point number and "EOL."

3.6 AUXILIARY CONTROL RELAYS

- A. The installation wiring between the system panel and the auxiliary relay shall be monitored for integrity.

3.7 EQUIPMENT LABELING

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Engraved laminate labels shall be screw installed on terminal cabinets, EFCP, etc. equipment.

3.8 EQUIPMENT MOUNTING

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. All equipment and associated wiring shall be installed in a neat manner and firmly secured with appropriate hardware in the equipment enclosure or to ceiling/wall.

3.9 CABLE/DEVICE IDENTIFICATION

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Provide and install permanent machine-printed cable markers/device labels on all cables/wire lines, telephone lines, modules, etc., at terminal strips, terminal cabinets and at main equipment. Numbers and markings shall also correspond to point-to-point diagrams. (See SECTION 26 05 53 Identification for Electrical Systems and SECTION 27 10 00 Premise Distribution System for additional requirements.)

3.10 FIELD QUALITY CONTROL

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. Testing:
 - 1. General: A final inspection of the system shall be rendered by the authorized factory representatives. Final inspection shall include a comprehensive verification audit with inspection and test of 100% of all EFSO system equipment. Audit performers shall have license or certification acceptable to the authority with jurisdiction.
 - 2. Each EFSO station shall be functionally tested for alarm operation.
 - 3. Each EFSO station shall be functionally tested for proper wiring supervision.
 - a. **Initiating Devices - Automatic:**
 - 1) Each automatic initiating device shall be activated in accordance with manufacturer's instructions to ensure proper operation.
 - 2) Each automatic initiating device shall be functionally tested for proper wiring supervision.
 - 3) Each automatic initiating device shall be inspected to ensure proper placement and mounting.
- C. An acceptance test run shall be performed by the authorized factory representative in the presence of the Owner, OAR, Designer, and Authority Having Jurisdiction. The AHJ shall be consulted for any requirements for the condition of the system during acceptance testing.

- D. Coordination: Coordinate all requirements of the Work of other trades surrounding installation of the EFSO system. Ensure installation and interface to all peripheral items required to interact with the EFSO system.
- E. Fill out all programming sheets required by manufacturer. Submit sheets with O & M manuals.

3.11 DEMONSTRATION

- A. Refer to Specification SECTION 26 05 00 in addition to the following.
- B. When system is complete it shall be demonstrated to OAR representative who shall be given complete instructions, parts, manuals and maintenance information.
- C. Demonstrate normal and abnormal modes of operation, and required responses to each.

3.12 AUTHORITY HAVING JURISDICTION

- A. Refer to Specification SECTION 26 05 00 in addition to the following.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The emergency fuel shutoff system modifications and expansion will be paid on a lump sum basis. This lump sum shall include all components required in this specification, shown on the drawings and as required to make the system operational.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. Payment will be made on a single lump sum basis for the EFSO system modifications and expansion.

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EFSO System Modifications and Expansion

END OF SECTION 28 43 20

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SECTION 33 05 19 – PRESSURE PIPING TIED JOINT RESTRAINT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. This section describes the requirements and procedures for pressure piping tied joint systems.

1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. ANSI B1.1 - Unified Inch Screw Threads.
- B. ASTM International (ASTM):
 - 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM A143 - Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - 4. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 6. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 7. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - 8. ASTM A588 - Specification for High Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick.
 - 9. ASTM B633 - Specification for Electrodeposited Coating of Zinc on Iron and Steel.
 - 10. ASTM F436 - Specification for Hardened Steel Washers.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate restrained joint details and materials being utilized. Submit layout drawings showing piece numbers and locations. Also, indicate restrained joint locations.
- B. Product Data: Submit catalog data for restrained joint details and installation instructions.
- C. Design Data: Submit design calculations showing determination of restrained lengths and submit joint restraint details. Use joint restraint devices specifically designed for applications described in manufacturer's data.
- D. Manufacturer's Installation Instructions: Submit installation instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Project Record Documents: Record actual locations of joint restraints.

PART 2 - PRODUCTS

2.1 PIPE RESTRAINT

- A. All plugs, caps, tees and bends, unless otherwise specified, shall be restrained by mechanically restrained joints. Fittings shall be restrained with Meg-A-Lug or equal pipe restraint with collars, tie rods and retainer glands shall be only if specifically approved by the Wastewater Division. Where concrete is to be placed around bolted joints, a sheet of 3 mil (minimum) polyethylene shall be placed between the fitting and the concrete. Tie rods, clamps or other metal components shall be stainless steel 316. Backfilling over pipe restraints shall not proceed until inspected by the designated inspector.
- B. Manufacturers
 - 1. ROMAC Industries "GripRing"
 - 2. EBAA Iron "MEGALUG"
 - 3. Or approved substitution.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify pipe and fittings are ready to receive work.
- B. Field measure and verify conditions.
- C. Clean surfaces of pipe and fittings to receive tied joint restraint system.

3.2 INSTALLATION

- A. Install joint restraint system in strict accordance with manufacturer's instructions, requirements, and recommendations. Ensure that joints are mechanically locked together to prevent joint separation.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 33 05 19 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 33 05 19. The work described in Specification 33 05 19 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 33 05 19

SECTION 33 11 00 – WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. The work covered by this Section consists in furnishing all labor, equipment and materials, and in performing all operations in connection with construction of water utility distribution piping and appurtenances, complete and ready for use in accordance with the latest Specifications of the American Water Works Association and the applicable plans, and subject to the terms and conditions of the contract.

1.3 MAINTAINING WATER SERVICE AND SHUTDOWNS

- A. The Contractor's attention is called to the fact that the existing system must be kept in operation at all times.
- B. No valve or other control device on the existing system shall be operated by the Contractor without first obtaining approval from the existing system's owner.

1.4 REFERENCES

- A. Orlando Utilities Commission (OUC) Water Business Unit Construction Standards, General Policy and Procedures (latest revision).
- B. OUC Water Material Specifications Manual (latest revision).

1.5 SUBMITTALS

- A. Shop Drawings: Indicate piping layout, including piping specialties.
- B. Product Data: Submit data on pipe materials, pipe fittings, valves, hydrants, and accessories.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- E. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with FDOT Standard Specifications except as modified herein.
- B. Perform work in accordance with OUC standards.
- C. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials and construction pertaining to construction of water distribution systems shall be in accordance with American Water Works Association (AWWA) Standards.
- B. All piping materials and appurtenances installed, as a part of the Orlando Utilities Commission water distribution system shall be in accordance with the OUC Water Materials Specifications Manual and the latest revisions thereto. Such materials shall, in no event, be less than that necessary to conform to the requirements of any applicable law, ordinances, or codes.
- C. All piping materials and appurtenances shall be new, unused, and designed for the use intended. The materials shall be of standard first grade quality, produced by expert workers, and intended for the use for which they are offered. Materials, which are inferior or are lower in grade than indicated, specified, or required shall not be accepted. The Owner, Engineer of Record, and/or Orlando Utilities Commission reserve the right to make such judgments.
- D. All pipe diameter of 12" and less shall have a minimum burial depth of 36" and not to exceed 48" deep unless approved by the Owner, Engineer of Record, and/or OUC.
- E. All pipe with a diameter of 12" or greater shall have a minimum burial depth of 48" and not to exceed 60" depth unless approved by the Owner, Engineer of Record, and/or OUC.
- F. Materials and construction pertaining to restoration and construction of roads and structures shall be in accordance with the latest edition of FDOT Standard Specifications for Road and Bridge Construction or as called for on the Plans.
- G. No glued joints shall be allowed. Mechanical restrainers are the only acceptable method of restraint.
- H. All interior coatings and equipment in contact with potable water shall be approved per NSF 61.

2.2 DUCTILE IRON PIPE (DIP)

- A. All 4" through 24" ductile iron pipe used in the water distribution system shall be Pressure Class 350 compression/slip joint pipe conforming to ANSI/AWWA C150/A21.91 and

ANSI/AWWA C151/A21.91 and the latest revisions thereto unless otherwise specified. All ductile iron pipes shall be lined with cement mortar in conformance with ANSI/AWWA C104/A21.90 and the latest revisions thereto. Self-restraining gaskets installed with ductile iron pipe shall be proprietary gaskets made by the same manufacturer as that of the pipe. Joints between pipe and fitting shall be mechanical joint.

- B. Acceptable manufacturers of DIP are currently shown in the OUC Water Material Specification Manual at www.ouc.com.

2.3 POLYVINYL CHLORIDE PIPE

- A. C900 PVC Pipe (4")

All 4" PVC pipe used in the water distribution system shall be SDR 18 compression joint PVC pipe conforming to AWWA C900 and the latest revisions thereto. The outside dimension (OD) shall be 4" cast iron O.D. with wall thickness DR 18. The color shall be Water Blue, or the pipe shall have continuous blue markings to conform to the AWWA adopted color code. Compression joint PVC shall have an elastometric-gasket bell on one end and connections shall be made using an gasket-gasket conforming to ASTM D3139. Coupling end pipe shall not be used. Fittings used with C900 PVC pipe shall be Class 350 ductile iron Compact fittings conforming to ANSI/AWWA C153/A21/53 and the latest revision thereto.

- B. Class 200 PVC Pipe (2" or smaller)

All 2" or smaller PVC pipe used in the OUC water distribution system shall be Class 200 compression joint pipe. The outside dimension (OD) shall be the same as 2" galvanized Schedule 40 pipe. The color shall be blue, or the pipe shall have continuous blue markings to conform to the AWWA adopted color code. Compression joint PVC shall have an gasket-gasket bell on one end and connections shall be made using and elastomeric-gasket conforming to ASTM D3139. Coupling end pipe shall not be used.

- C. Restrained Joint Pipe (PVC)

All approved sizes of C900/RJ must be Class 150 (DR18) rated.

- D. Acceptable manufacturers of PVC pipe are currently shown in the OUC Water Material Specifications Manual (latest revision).

2.4 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. HDPE shall have a ductile iron pipe outside diameters and be in accordance with AWWA C 906. The dimension ratio shall be verified by the Contractor based on the anticipated pullback force and external loads required for the directional drilling and at a minimum the pipe shall be DR11. The minimum working pressure rating of the pipe supplied shall be minimum 200 psi.
- B. Materials used for the manufacturing of polyethylene pipe shall be PE 4710 High Density Polyethylene (HDPE) meeting the ASTM D3350 cell classification of 345464E (for color stripes). The material shall have a minimum Hydrostatic Design Basis (HDB) of 1600 psi

at 73°F when tested in accordance with Plastics Pipe Institute (PPI) TR-3 and shall be listed in the name of the pipe and fitting manufacturer in PPI TR-4.

- C. Pipes shall be marked in accordance with AWWA requirements.
- D. Contractor shall use HDPE MJ adaptors for making connection to different pipe material such as DIP or PVC. Mega-Lug restraints with stainless steel inserts will not be allowed for connection; however electro fusion couplings are acceptable.

2.5 PIPE IDENTIFICATION

- A. Ductile iron potable water mains require special identification. See OUC standard detail sheet.
- B. PVC water mains shall either be solid blue on color or white with blue lettering. Lettering shall appear on three sides of the pipe and shall run the entire length of the pipe. The lettering shall be a permanent part of the pipe.
- C. Three solid blue lines permanently manufactured into the piping material shall identify polyethylene water mains. The lines shall appear on three (3) sides of the pipe, run the entire length of the pipe, and be no less than 3/16" wide.
- D. All nonmetallic water mains shall be installed with a continuous, blue, insulated, 10 gauge or larger copper wire installed directly on top of the pipe for future location purposes. The wire shall be installed in such a fashion so as to sustain continuity. The contractor must perform a successful continuity test with an OUC representative present. Location markers, if used, shall be installed at no less than 40 foot intervals and at the manufacturer recommended depth.

2.6 FITTINGS

- A. Ductile iron pipe fittings, including bends, tees, crosses, reducers, sleeves, caps, plugs, and offsets, shall all be mechanical joint in conformance with ANSI/AWWA C111.A21.11 and the latest revision thereto. Ductile iron pipe fittings shall have standard bituminous pipe coating outside, and cement lining and seal coat inside in conformance with ANSI/AWWA C104/A21.40 or protective fusion bonded epoxy coating for interior and exterior conforming to C116/A21.16.98 and the latest revisions thereto.
- B. All four (4) inch through twelve (12) inch ductile iron fittings, except offsets, shall be Class 350 "compact" fittings conforming to ANSI/AWWA C153/A21.53 and the latest revisions thereto.
- C. All 16" through 24" ductile iron pipe fittings and six (6) inch through twelve (12) inch offsets shall be Class 350 "compact" fittings conforming to ANSI/AWWA C153/A21.53 and the latest revisions thereto. Thirty (30) inch ductile iron pipe fittings shall be Class 250 "Compact" fittings conforming to ANSI/AWWA C153/A21.53 and the latest revisions thereto.
- D. Acceptable manufacturers are listed on the OUC Water Material Specifications Manual (latest revision).

2.7 FITTINGS – SPECIAL CONSIDERATIONS

- A. Certain construction requirements necessitate the use of, or adaptation to, pipe, fittings, or joints not usually installed in the Orlando Utilities Commission water distribution system. All special pipe, fittings, or joints shall be designed for the use intended and whenever possible, meet the appropriate AWWA standard.

1. Flanged Fittings

All flanged fittings shall be gray iron or ductile iron conforming to ANSI/AWWA C153/A21.53, C110/A21.10 and the latest revisions thereto, and shall be flange by flange, Class 250, pressure rating 250 psi. All flanges shall be faced and drilled in accordance with ANSI B16.1 Class 125.

2. Sleeves

In addition to meeting specifications for mechanical joint pipe fittings, sleeves shall generally be the short pattern.

3. Reducers

All reducers shall be MJ x MJ.

4. Caps and Plugs

All ductile iron caps and plugs shall conform to the pipe fitting specifications and they shall be tapped two (2) inch FIPT with a two (2) inch brass plug inserted.

5. Couplings

Couplings (transition) designed to join pipe of differing materials and diameters shall be bolted, sleeve-type couplings for plain end pipe conforming to ANSI/AWWA C219 and the latest revisions thereto. All transition couplings shall be used only for the type and diameter of pipe for which they were designed.

2.8 GATE VALVES

- A. Distribution system gate valves, four (4) inch through sixteen (16) inch, shall be resilient seat or wedge gate valves conforming to AWWA C116/A21.16 and the latest revisions thereto. The valves shall have mechanical joint ends with a working pressure of 200 psi, operate in the vertical position, open left or counter clockwise with a non-rising stem and a two (2) inch square operating nut. The interior of the cast iron or ductile iron valve shall be lined with a thermosetting epoxy protective coating. All internal ferrous surfaces shall have a 4 mil factory applied thermosetting epoxy coating.
- B. Acceptable manufacturers are listed on the OUC Water Material Specifications Manual (latest revision).

2.9 BUTTERFLY VALVES

- A. Distribution system butterfly valves, twelve (12) inch through 24", shall be Class 150B for buried installation with mechanical joint connections and they shall conform to ANSI/AWWA C116/A21.16 and the latest revisions thereto. The operator shall open left or counter clockwise with a two (2) inch square-operating nut. All internal ferrous surfaces shall have a 4 mil factory applied thermosetting epoxy coating.
- B. Acceptable manufacturers are listed on the OUC Water Material Specifications Manual (latest revision).

2.10 TAPPING VALVES

- A. Four (4) inch through sixteen (16) inch tapping valves shall be Class 250 resilient seat or wedge valves conforming to AWWA C116/A21.16 and the latest revisions thereto. The valves shall have a mechanical joint end and a tapping valve end. They must operate in the vertical position, open left or counter clockwise with a non-rising stem and a two (2) inch square operating nut. The exterior and interior of the cast iron valve shall be lined with a thermosetting epoxy protective coating. All internal ferrous surfaces shall have a 4-mil factory applied thermosetting epoxy coating.
- B. Acceptable manufacturers are listed on the OUC Water Material Specifications Manual (latest revision).

2.11 FIRE HYDRANTS

- A. Materials for fire hydrant shall be as required by the OUC and/or the Authority Having Jurisdiction (AHJ).

2.12 SERVICE CONNECTIONS

- A. Materials for service connections shall be as required by the OUC.

2.13 BACKFLOW PREVENTION DEVICES

- A. Reduced Pressure Principle Backflow Preventer (RPZ)

RPZ devices shall be approved by OUC or meet ANSI/AWWA C511 and the latest revisions thereto or ASSE Standard #1013 (rev. 1993 or newest revision) or USC CCC&HR or Florida Building Code. Acceptable devices include, but not limited to, the table below.

<u>MAKE</u>	<u>SIZES</u>	<u>REQUIREMENT MET</u>
AMES	¾ thru 10"	ASSE
HERSEY	¾ thru 10"	USE
CLAVAL	¾ thru 1¼", 2" thru 10"	USC
FEBCO	¾ thru 10"	USC
BUCKNER	¾ thru 2"	ASSE
CONBRACO	¾ thru 2"	ASSE

<u>MAKE</u>	<u>SIZES</u>	<u>REQUIREMENT MET</u>
NEPTUNE	¾ thru 3"	USC
RAINBIRD	¾ thru 10"	USC
WATTS	¾ thru 10"	USC
WILKINS	¾ thru 10"	USC, ASSE

PART 3 - EXECUTION

3.1 HANDLING

- A. All pipe, fittings, and appurtenances shall be handled in such a manner during transport, loading, unloading, and installation so as to protect the materials from any damage. Particular care shall be taken not to injure pipe coating, both interior and exterior. Broken, cracked, misshapen, imperfectly coated, or otherwise damaged or unsatisfactory material shall not be installed.
- B. When not being handled, the pipe shall be supported on timber cradles to provide uniform support along the full length of the pipe. The pipe shall be supported in a manner, which shall not permit distortion or damage to the lining or coating when being transported.
- C. Under no circumstances shall valves be dropped, skidded, rolled, or placed against pipe or other fittings in such a manner that damage could result. Slings, tongs, or hooks used for lifting shall be properly padded in such a manner as to prevent damage. Particular care shall be taken not to injure valve coatings, both interior and exterior. If any part of the valve's coating and lining is damaged, the valve replacement shall be made before installation.
- D. Valves shall be stored at all times in a safe manner to prevent damage and kept free of dirt, mud, or other foreign matter.
- E. Gaskets shall be stored in a clean, dark, dry location and out of contact with petroleum products until immediately before use. All gaskets shall be used on a first-in, first-out basis.
- F. Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations. When pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or some other acceptable means to ensure absolute cleanliness inside the pipe.

3.2 PLACEMENT AND BEDDING – DUCTILE IRON PIPE

- A. Ductile Iron pipe shall be installed in accordance with the manufacturer's specifications and instructions for the type of pipe use and the applicable manuals and AWWA Standards (the DIPRA *Handbook of Ductile Iron Pipe* and AWWA C600 for ductile iron pipe), unless otherwise stated in these standards.
- B. Proper tools, implements, equipment, and facilities shall be used for the safe installation of all materials. Pipe, fittings, valves, and other appurtenances shall be carefully lowered

into the trench piece by piece. Under no circumstances shall piping materials be dropped, dumped, or slid into the trench.

- C. Lumps, blisters, and excess coating shall be removed from the bell and spigot ends of each pipe. The outside of the spigot and the inside of the bell shall be wire brushed and wiped clean, dry and free from oil and grease before the pipe is laid. Pipe joints shall be made up in accordance with the manufacturer's recommendations. Every effort shall be employed to ensure that sand or other debris does not enter the pipe.
- D. The interior of the pipe shall be thoroughly cleaned of all debris, tools, clothing, and other foreign matter, before being gently lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. Any residue considered difficult to remove by scouring flush shall be removed by appropriate means and swabbed or sprayed with a liquid sodium hypochlorite solution (NaOCl), hereafter called 10% liquid chlorine.
- E. When new main extensions are connected to existing mains, the new valve and/or fitting to be connected to the existing main shall be cleaned and shall receive a generous coating of 10% liquid chlorine. Any lateral dead end stubs (for future fire hydrants or water main extensions) shall be swabbed or sprayed with 10% liquid chlorine if they are not equipped with valves for adequate flushing and disinfect ion. The inside of tapping tees and the outside of the main to be sleeved shall be cleaned and swabbed or sprayed with 10% liquid chlorine to kill any trapped bacteria.
- F. Bell sections and spigot ends are to be cleaned of all foreign matter with a firm bristle brush. The lubricant used on the sealing gaskets shall be suitable for use in potable water and shall not support any bacteria growth. The lubricant shall be in closed container and kept clean at all times.
- G. Before laying any pipe, an adequate survey shall be accomplished to show horizontal and vertical alignment, and to prevent conflicts with other utilities.
- H. When laying pipe, the trench water shall be pumped out and kept at a minimum. During suspension of work for any reason for any time, including the end of the workday, a watertight plug shall be placed in the end of the pipe last laid to prevent mud or other foreign material from entering the pipe.
- I. Pipe shall be laid with bell ends facing in the direction of laying (upstream). The work shall at all times progress with caution so as to prevent damages to underground obstruction, both known and unknown. Every effort shall be made to lay the pipe in a straight line, using only the fittings designated on the plans.
- J. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe.
- K. Push-on joint pipe shall generally be used in the distribution system. All compact fittings shall be mechanical joint. The joints of all pipelines and fittings shall be made absolutely tight. The gasket material for the joint shall be properly positioned before the pipe is lowered into the trench. The joining of all pipe and fittings shall proceed in accordance with

the manufacturer's instructions and requirements. Once the joint has been seated and tightened, all bolts and nuts shall be checked and retightened one more time.

- L. The push-on joint shall be made up by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it seats completely as per the manufacturer's recommendations. Backhoe buckets or excavation equipment are not to be applied directly to the pipe.
- M. Plugs shall be inserted in the bells of all dead ends of the pipe, tees, and crosses, and plain ends shall be capped.

3.3 BACKFILLING AND COMPACTION – DUCTILE IRON PIPE

- A. After the pipe and fittings have been laid, inspected, and found to be satisfactory, the trench shall be backfilled in accordance with DIPRA Laying Condition 2.
- B. Backfill material shall be free from cinders, ashes, refuse, organic matter, boulders, rocks, stones, or other material that is unsuitable. The spoils of the trench may be used if it is suitable. All trenches shall be backfilled by hand, from the bottom of the trench to the centerline of the pipe in layers of 6 inches. Backfill material shall be deposited in the trench for the full width on each side of the pipe.
- C. Compaction shall be performed by tamping. The pipe shall be backfilled by hand or by approved mechanical methods from the centerline of the pipe to the specified grade. Compaction shall be done in accordance with the requirements of the agency having jurisdiction.
- D. In the absence of specific standards, all compaction shall conform to the following: The space between the pipe and the trench sides shall be packed full by hand shoveled earth, free from lumps, carefully deposited in layers, not exceeding 6 inches in depth. Such material shall be placed equally on each side of the pipe, and at the same time suitably tamped until enough fill has been so placed and compacted to provide a minimum cover of twelve (12) inches above the pipe. All backfill placed to this elevation shall be compacted to a minimum density of 98% of the modified proctor density. From this point, the backfill shall be compacted in uniform layers not exceeding twelve (12) inches in depth to a minimum of 98% of the modified proctor density where it is to support paving, sidewalks, etc. All other backfill shall be compacted to 90% of the modified proctor density.

3.4 PLACEMENT AND BEDDING – POLYVINYL CHLORIDE PIPE

- A. Polyvinyl Chloride pipe shall be installed in accordance with the manufacturer's specifications and instructions for the type of pipe use and the applicable manuals and AWWA Standards, the Unibell Handbook of PVC Pipe Design and Construction, and AWWA M23 PVC Pipe Design and Installation for PVC pipe unless otherwise stated in these standards.
- B. Although recommended installation procedures for PVC pipe do not vary substantially from procedures used with other pipe products, there are differences that are significantly more important.
- C. Trench width at the ground surface may vary depending on depth, type of soil, and position of surface structures. The minimum clear width of the trench, sheeted or unsheeted,

measured at the springline of the pipe should be one foot greater than the outside diameter of the pipe. The maximum recommended clear width of the trench at the top of the pipe is equal to the pipe outside diameter plus two feet.

- D. When laying PVC pipe, the trench water shall be pumped out and kept at a minimum until the pipe has been installed and backfill has been placed to a sufficient height to prevent flotation of the pipe. The trench bottom shall be constructed to provide a firm, stable, and uniform support for the full length of the pipe. Bell holes shall be provided at each joint to permit proper assembly and pipe support. When an unsuitable subgrade condition is encountered that could provide inadequate pipe support, additional trench depth shall be excavated and refilled with suitable foundation material. Rock, boulders, and large stones shall be removed to provide a four (4) inch soil cushion on all sides of the pipe and accessories.
- E. As with ductile iron pipe, PVC pipe shall be laid with bell ends facing the direction of laying (upstream). The work shall at all times progress with caution so as to prevent damage to underground obstruction, both known and unknown. Every effort shall be made to lay the pipe in a straight line, using only the fittings designated on the plans.
- F. To prevent damage, proper implements, tools, and equipment shall be used for the placement of pipe in the trench. Under no circumstances shall the pipe or accessories be dropped in to the trench.
- G. All foreign matter or dirt shall be removed from the pipe interior. Pipe joints shall be assembled with care, in accordance with the manufacturer's recommendations. The outside of the spigot, the interior of the bell, and the gasket shall be cleaned using a rag, brush, or paper towel to remove any dirt or foreign material before the assembling. The gasket, pipe spigot bevel, gasket groove, and sealing surfaces shall be inspected for damage or deformation. Any residue considered difficult to remove by scouring flush shall be removed by appropriate means and swabbed or sprayed with a liquid sodium hypochlorite solution (NaOCl), hereafter called 10% liquid chlorine. Only lubricant as specified by the pipe manufacturer shall be applied to the joint and gasket. The lubricant shall be suitable for use in potable water and it shall not support any bacteria growth.
- H. Push-on joint PVC pipe with factory-installed gaskets shall generally be used in the distribution system. All fittings shall be mechanical joint. The joints of all pipelines and fittings shall be made absolutely tight. The joining of all pipe and fittings shall proceed in accordance with the manufacturer's instructions and requirements. Once the joint has been seated and tightened, all bolts and nuts shall be checked and retightened one more time.
- I. After the spigot is correctly aligned to the bell of the pipe, the spigot shall be inserted in the bell until it contacts the gasket uniformly. The pipe shall then be pushed in the bell either by hand or with the use of a bar and block to the manufacturer's reference mark that indicated the correct depth of spigot penetration into the pipe's gasket joint. If undue resistance to insertion of the pipe end is encountered, or if the reference mark does not position properly, the joint shall be disassembled and the gasket position and other joint components shall be checked. The assembly steps shall be repeated.
- J. A square cut is essential for proper assembly of field-cut pipe. The pipe shall be marked around its entire circumference to assure such a cut. The factory-finished beveled end

shall be used as a guide for field beveling, either with a pipe beveling tool or a wood rasp that will cut the correct taper. Sharp edges on the leading edge of the bevel shall be rounded off with a pocketknife or a file.

- K. The weight of fire hydrants, valves, or Ductile Iron fittings shall not be carried by PVC pipe. When pipe laying is not in progress, open ends of installed pipe shall be closed to prevent entrance of trench water, dirt, foreign matter, or small animals into the line. 6" and larger pipe shall be carried by Ductile Iron pipe only.

3.5 BACKFILLING AND COMPACTION – POLYVINLYL CHLORIDE PIPE

- A. After the pipe and fittings have been laid, inspected, and found to be satisfactory, the trench shall be backfilled in accordance with the applicable manuals and AWWA Standards, the Unibell Handbook of PVC Pipe Design and Construction, and AWWA M23 PVC Pipe and Design and Installation for PVC pipe.
- B. PVC pipe shall be installed with proper bedding providing uniform longitudinal support under the pipe. Backfill material shall be worked under the sides of the pipe to provide satisfactory support. Initial backfill material shall be placed to a minimum depth of six (6) inches over the top of the pipe. All pipe embedment material shall be selected and placed carefully, avoiding stones greater than 1 ½" in diameter and debris. Sharp stones and crushed rock larger than ¾" which could cause significant scratching or abrasion of the pipe, and shall be excluded from the embedment material. Proper compaction procedures shall be exercised to provide soil densities as required.
- C. After placement and compaction of pipe embedment materials, the balance of the backfill materials may be machine placed. All backfill material shall be free from cinders, ashes, refuse, organic matter, boulders, rocks, stones, or other material that is unstable. Proper compaction procedures shall be exercised to provide required densities to meet the same density requirements stated for ductile iron pipe.

3.6 JOINT DEFLECTION – DUCTILE IRON PIPE

- A. Whenever it is necessary to deflect ductile iron pipe from a straight line, either in a vertical or horizontal plane without the use of fittings, the amount of deflection allowed shall not exceed that allowed under AWWA C600 and in accordance with the manufacturer's recommendations. No deflection shall be sought until the pipe has been properly homed or seated.
- B. For restrained joint ductile iron pipe the deflection shall not exceed 80 percent of the manufacturer recommended deflection. The maximum allowable deflection for unrestrained ductile iron pipe shall not exceed that shown in the tables below.

Ductile Iron Pipe Deflection – 18 Foot Joint						
Nominal Pipe Size (inches)	Mechanical Joint			Push On Type Joint		
	Deflection (inches)	Radius of Curve (feet)	Deflection Angle (degrees)	Deflection (inches)	Radius Curve (feet)	Deflec- tion An- gle (de-
6	27.0	145	7	19.0	205	5
8	20.0	195	5	19.0	205	5
10	20.0	195	5	19.0	205	5
12	20.0	195	5	19.0	205	5
16	13.5	285	3	11.0	340	3*

* Maximum deflection angle may be larger than shown. Consult manufacturer

Ductile Iron Pipe Deflection – 20 Foot Joint						
Nominal Pipe Size (inches)	Mechanical Joint			Push On Type Joint		
	Deflection (inches)	Radius of Curve (feet)	Deflection Angle (degrees)	Deflection (inches)	Radius Curve (feet)	Deflec- tion An- gle (de-
6	30.0	160	7	21.0	230	5
8	22.0	220	5	21.0	230	5
10	22.0	220	5	21.0	230	5
12	22.0	220	5	21.0	230	5
16	15.0	320	3	12.0	380	3*

* Maximum deflection angle may be larger than shown. Consult manufacturer

3.7 JOINT DEFLECTION – POLYVINYLE CHLORIDE PIPE

- A. Deflection and longitudinal bending of PVC pipe shall be strictly in accordance with AWWA M23 *PVC Pipe-Design and Installation* and the Unibell *Handbook of PVC Pipe Design and Construction*.
- B. For restrained joint ductile iron pipe the deflection shall not exceed 80 percent of the manufacturer recommended deflection.

3.8 TRENCHLESS PIPE INSTALLATION

- A. Trenchless pipe installation shall be per FDOT Specifications.

3.9 FITTING INSTALLATION

- A. All fittings and related materials shall be handled in such a manner during transport, loading, unloading, and installation so as to protect the materials from any damage. Particular care shall be taken not to injure fitting coatings, both interior and exterior. Broken, cracked, misshapen, imperfectly coated, or otherwise damaged or unsatisfactory material shall not be installed.

- B. Gaskets shall be stored in a clean, dark, dry location until immediately before use. Dirt or other foreign material shall be prevented from entering the fitting during handling or laying operations.
- C. Proper tools, implements, equipment, and facilities shall be used for the safe installation of all materials. Fittings and other appurtenances shall be carefully lowered into the trench piece by piece. Under no circumstances shall materials be dropped, dumped, or slid into the trench.
- D. Lumps, blisters, and excess coating shall be removed from the bells of each pipe. The inside of the bell shall be wire brushed and wiped clean, dry and free from oil and grease before the fitting is installed. Joints shall be made up in accordance with the manufacturer's recommendations.
- E. Every effort shall be employed to ensure that sand or other debris does not enter the fitting. Any residue considered difficult to remove by scouring flush shall be removed by appropriate means and swabbed or sprayed with a liquid sodium hypochlorite solution (NaOCl), hereafter called 10% liquid chlorine.
- F. The lubricant used on the sealing gaskets shall be suitable for use in potable water and shall not support any bacterial growth. The lubricant shall be in closed containers and kept clean at all times.
- G. All fittings shall be mechanical joint. The joints of all pipelines and fittings shall be made absolutely tight. The joining of all pipe and fittings shall proceed in accordance with the manufacturer's instructions and requirements. The mechanical joints shall be centered in the bells and shall be assembled in accordance with the most current edition of AWWA standards.
- H. The joints shall be tightened on opposite sides of the fittings in such a manner that the gland shall be brought up evenly to the joint. If effective sealing is not obtained, the joint shall be disassembled and reassembled after thorough cleaning. The bolts shall be tightened to the torque recommended by the manufacturer. If the joint is defective, the fitting shall be removed and replaced.
- I. The following table indicates the typical number and sizes of bolts and nuts necessary for each facing or bell of the various sizes of compact (C153) ductile iron fittings.

Compact Ductile Iron Fittings

Size	Number of Nuts & Bolts	Bolt Diameter	Bolt Length
4"	4	$\frac{3}{4}$ "	3 $\frac{1}{2}$ "
6"	6	$\frac{3}{4}$ "	3 $\frac{1}{2}$ "
8"	6	$\frac{3}{4}$ "	3 $\frac{1}{2}$ "
10"	8	$\frac{3}{4}$ "	3 $\frac{1}{2}$ "
12"	8	$\frac{3}{4}$ "	3 $\frac{1}{2}$ "
16"	12	$\frac{3}{4}$ "	4"

- J. Plugs shall be inserted into the bells of all tees and crosses, and plain ends shall be capped.

3.10 VALVE INSTALLATION

- A. Proper tools, implements, equipment, and facilities shall be used for the safe installation of all valves. Valves shall be carefully lowered into the trench piece by piece. Under no circumstances shall valves be dropped, dumped, or slid into the trench.
- B. Lumps, blisters, and excess coating shall be removed from the bells of each valve. The inside of the bell shall be wire brushed and wiped clean, dry and free from oil and grease before it is installed. Joints shall be made up in accordance with the manufacturer's recommendations.
- C. Every effort shall be employed to ensure that sand or other debris does not enter the valve. Any residue considered difficult to remove by scouring flush shall be removed by appropriate means and swabbed or strayed with a 10% liquid sodium hypochlorite solution (NaOCl), hereafter called 10% liquid chlorine.
- D. The lubricant used on the sealing gaskets shall be suitable for use in potable water and shall not support any bacterial growth. The lubricant shall be in closed containers and kept clean at all times.
- E. The joints of all pipelines and valves shall be made absolutely tight. The joining of all pipe and valves shall proceed in accordance with the manufacturer's instructions and requirements.
- F. The mechanical joints shall be centered in the bells and shall be assembled in accordance with the most current AWWA standards.
- G. If effective sealing is not obtained, the joint shall be disassembled and reassembled after thorough cleaning. The bolts shall be tightened to the specified torques with a torque wrench.
- H. If the joint is defective, the fitting shall be removed and replaced. Valves shall be installed so that the operating nut is plumb.
- I. Cast iron valve boxes, with cast iron tops and bottoms, shall be installed over the valve, firmly supported and maintained centered over the valve and plumb over the operating nut of the valve with the box cover flush with the surface of the finished pavement or at such other levels as may be directed. The valve and valve box shall be installed so as to allow a valve key to move easily through the valve box and completely open and close the valve.
- J. Blow-off valves shall be installed at the ends of all dead-end water mains when practical. The blow-off shall be installed in such a fashion so as to direct the discharge water where it can be disposed of safely and easily. Fire hydrants installed at or near the dead-end may be used as blow-offs. All blow-off valves shall be restrained in accordance with the Specifications.

3.11 FIRE HYDRANT INSTALLATION

- A. Fire hydrant installation shall be as required by the OUC and/or AHJ.

3.12 JOINT RESTRAINT

- A. Joint restraint shall be in accordance with Section 330519.

3.13 SERVICE INSTALLATION

- A. Service connection installation shall be as required by the OUC.

3.14 BACKFLOW PREVENTION DEVICE INSTALLATION

- A. Pipe lines shall be thoroughly flushed to remove foreign material and debris before installing the device.
- B. If not already provided with the assembly, shut off valves shall be installed at each end of the device for testing and servicing purposes
- C. The device shall be placed in the horizontal position unless otherwise specified by the manufacturer's instructions.
- D. The device shall always be installed in an accessible location to facilitate testing and servicing.
- E. The centerline of the device shall always be installed a minimum of 12 inches plus the nominal size of the device above ground or the maximum flood level, whichever is highest, in order to prevent any part of the device from becoming submerged. The relief valve shall never be plugged or solidly piped into a drainage ditch, sewer, or pump. The relief valve discharge pipe shall be terminated a minimum of 12 inches above ground or maximum flood level and located so that it is clearly visible and accessible.
- F. The device shall be adequately supported to prevent the assembly from sagging.

3.15 LEAKAGE TEST FOR DUCTILE IRON AND PVC PIPE

- A. Where newly laid pipe or valved section thereof has been laid and backfilled between the joints, it shall be subjected to a hydrostatic gauge pressure of 150 psi for a minimum of 2 hours. During the hydrostatic test, the water main shall also be checked for leakage, which, if detected, shall be stopped by an OUC approved method.
- B. All testing shall be in accordance with AWWA Standard C600 and the latest revision thereto and shall be conducted in the presence of OUC and the Engineer of Record.
- C. Each valved section of the pipe shall be slowly filled with water. The test pressure, based on the elevation of the lowest point of the water line or section under test, and corrected

to the elevation of the test gauge, shall be applied by means of test pump connected to the pipe in a satisfactory manner.

- D. Before applying the specified test pressure, all air shall be expelled from the pipe. If fire hydrants, sample points, taps, or blow-offs are not available at high elevations taps at points of high elevation shall be made before the test is made. Plugs shall be inserted in place of the tops after the test has been completed.
- E. Any cracked or defective pipes, fittings, or fire hydrants discovered as a consequence of the pressure test shall be removed and replace with new material and the test shall be repeated until satisfactory results are received.
- F. The leakage test shall be conducted at the above-mentioned pressure of 150 psi. Leakage is defined as the quantity of water, in gallons per 2-hour, to be supplied into the newly laid pipe or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
- G. No pipeline installation shall be approved when leakage is greater than that determined by the following formula:

$$L = (SDP^{1/2})/148,000$$

L = allowable, in gallons per hour

S = length of pipe tested, in inches

D = nominal diameter of pipe, in inches

P = average test pressure during leakage test, in pounds per square inch (gauge)

- H. Any installation of 300 feet or less shall not exceed zero water loss.

3.16 DISINFECTION OF POTABLE WATER PIPING SYSTEM

- A. Disinfection and flushing of the potable water piping system shall be in accordance with Section 331300.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The length of pipe shall be measured in linear feet of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The pipes shall be measured separately. All fittings and valves shall be included in the footage as typical pipe sections in the pipe being measured. All necessary excavation, shoring, backfill, de-watering, pipe cradles, thrust blocks, pipe bedding and other works required to install the pipe shall be considered incidental to the placement of the pipe.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. These prices shall fully compensate the Contractor for furnishing all materials and for all preparation and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 33 11 00-5.1	2-Inch PVC SDR17 Pipe - per linear foot
Item 33 11 00-5.2	1-Inch Type K Copper Pipe - per linear foot

END OF SECTION 331100

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SECTION 33 13 00 – DISINFECTION OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. This section provides written description and direction of required practices in the process of disinfecting potable water main and appurtenances prior to their placement for service.
- B. Chlorination shall not take place until:
 - 1. The main is constructed in accordance with the Contract Documents as modified by the Engineer during construction and all construction permit requirements are met.
 - 2. All blow offs, injection and sample points are constructed and ready for use.
 - 3. The main has been thoroughly flushed with scouring velocities as needed.
 - 4. The main has been successfully pressure and leakage tested.
 - 5. Chlorine neutralization chemicals, and methods for application and disposal of chlorinated water, have been established by the Contractor. The Contractor shall dispose of the water without causing a nuisance, property damage and in compliance with the National Pollution Discharge Elimination System (NPDES) and all applicable jurisdictions.
- C. The basic disinfection procedure, per ANSI/AWWA C651, consists of:
 - 1. Preventing contaminating materials from entering the water main during storage, construction, or repair.
 - 2. Removing, by flushing or other means, those materials that may have entered the water main.
 - 3. Chlorinating any residual contamination that may remain and flushing the chlorinated water from the main.
 - 4. Protecting the existing distribution system from contaminants due to hydrostatic pressure test and chlorination procedures.
 - 5. Determining the bacteriological quality by laboratory test after chlorination.
 - 6. Final connections of the approved new water main to the existing distribution system.
- D. All materials in contact with potable water will be NSF 61 certified and all chemicals used in disinfection will be NSF 60 certified.

1.3 APPLICABILITY

- A. All new water mains shall be flushed and disinfected in accordance with ANSI/AWWA C651 (or current revision thereto) and bacteriological samples shall be collected and analyzed on two consecutive days.
- B. All newly disinfected water mains shall maintain, after samples have been collected, a minimum pressure of 20 psi until a Letter of Clearance has been obtained from the FDEP.

1.4 REFERENCES

- A. Orlando Utilities Commission (OUC) Water Business Unit Construction Standards, General Policy and Procedures (latest revision).
- B. OUC Water Material Specifications Manual (latest revision).

1.5 SUBMITTALS

- A. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Certificate: Certify cleanliness of water distribution system meets or exceeds specified requirements.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with ANSI/AWWA C651; maintain one copy of document on site.

PART 2 - PRODUCTS

2.1 CHLORINATION CHEMICALS

- A. 10% Liquid Chlorine (per ANSI/AWWA C651)

2.2 DECHLORINATION CHEMICALS

- A. As listed in Appendix C of ANSI/AWWA C651

PART 3 - EXECUTION

3.1 PREVENTIVE AND CORRECTIVE MEASURES DURING CONSTRUCTION

- A. It should be noted that any connection of a new water main to the existing distribution system prior to receipt of satisfactory bacteriological samples might constitute a cross-section. Therefore, the new main must be isolated until bacteriological tests described in Section 7 of AWWA Standard C651 are satisfactorily completed. OUC maintains a procedure to protect the existing distribution system from backflow contamination during testing of a new water main.
 - 1. OUC relies on the feed valve to be in a closed position to protect the existing distribution system during testing phase. The feed valve is to be operated only for flushing and chlorination procedures. To help ensure protection, any operation of this valve must be authorized by O.U.C.
 - 2. OUC does not allow a customer service connection to the new water main until final clearance is received from the DEP. However, to maintain pressure and

insure water quality, the feed valve is put in the open position when bacteriological testing has been determined to be satisfactory by a state approved laboratory.

- B. Precautions shall be taken to protect pipe, fittings, and valves against bacteria contamination. It is realized that pipe and appurtenances cannot always be kept clean when stored on a construction site prior to laying, or in a storage yard awaiting installation. Immediately prior to laying the pipe, sections are to be inspected for debris and all debris shall be removed.
- C. When new main extensions are to be connected to existing mains, the new valve and/or fitting to be connected to the existing line is to be cleaned and shall receive a generous swabbing of 10% liquid chlorine. This process is done because the point of injection of the disinfection solution is generally downstream from these fittings.
- D. Any lateral dead-end stubs (for future fire hydrants and main extensions) must be swabbed or sprayed with 10% liquid chlorine if they are not equipped with valves for adequate flushing and chlorination operation. The inside of tapping tees and the outside of the main to be sleeved are to be cleaned and swabbed or sprayed with 10% liquid chlorine.
- E. Blow-offs, referred to as "orifice size" or "flush opening of pipelines", are to be installed so that flushing water will not cause erosion of soil or sod or pollution to existing streams or lakes. The blow-off valve shall be a throttling valve large enough to permit an adequate flush as described below. Blow-offs will be installed size for size on the newly installed main up to 12". All newly installed mains larger than 12" shall have at least 12" blow-offs. Larger blow-offs may be needed to achieve the required flushing velocity. Blow-offs shall be left in place until the new water main is placed into service.

3.2 FLUSHING

- A. Proper flushing and scouring of the newly installed water mains removes air and debris. A clean system is essential to the pressure test and chlorination process. Flushing, however, is not a substitute for preventive measures taken before and during pipe laying.
- B. The duration of flushing will vary with the length of line and to some extent, with pipe size. The objective of the flushing is to "change the water" in the new water line a minimum of six (6) times at a velocity of 5 fps minimum flushing velocity in order to scour out all loose debris. The duration of the flushing in seconds can be determined by multiplying 6 (change of water) times the length of pipe in feet divided by 5 (desired velocity of the water).
- C. Before flushing begins, the new water line must be filled with no air pockets. When filling new water lines 16" and larger, they must be filled with a 3/4" tap and all sample points open to assure discharge of air. After filling, the flushing is to be controlled from the blow-off valve to prevent entrapping air. Sample points are to be flushed during the flushing process.
- D. The flushing period shall be continuous once it is started. In other words, two separate five-minute flushes will not constitute a ten-minute flush. The minimum length of flushing time is six minutes for any size or any length of pipe.

3.3 DISINFECTING AND SAMPLING

- A. The disinfecting agent (chlorine) shall be liquid sodium hypochlorite (NaOCl) referred to previously as 10% liquid chlorine.

- B. The 10% liquid chlorine is introduced into the new line through a tapped inlet and a portable chlorinator to a measured residual of 25 mg/L (250 ppm) minimum. Care should be taken to prevent the backup of chlorine solution in the old water main by:
 - 1. Closing the upstream valve and disconnecting the chlorinator.
 - 2. Simultaneously closing the blow-off valve and stopping the portable chlorinator.
- C. Flow during chlorination is controlled from the downstream or blow-off end of the line.
- D. Sampling spigots are to be opened and flushed with the chlorine solution prior to placement on the sampling point. After installation of the sampling spigots, they are to be capped, bagged, or foil wrapped to prevent contamination by windblown debris and locked to prevent unauthorized handling. Warning tags in good condition are to be attached to each sample point.
- E. The disinfecting or chlorinating procedure is generally a five (5) day process that normally starts on a Monday.
 - 1. Monday: Chlorine is introduced into the main and left there overnight.
 - 2. Tuesday: The chlorine is completely flushed, filled with system water, and secured for 24 hrs.
 - 3. Wednesday: Samples are taken from each sample point and delivered to the OUC laboratory for analysis.
 - 4. Thursday: Repeat Wednesday samples.
 - 5. Friday: If both samples pass the lab test, the main may be placed into full service after FDEP clearance.
- F. OUC uses the continuous feed method of chlorination. The continuous feed method consists of placing 10% liquid chlorine in the main during construction, completely filling the main to remove all air pockets, flushing the completed main to remove particulates, and filling the main with potable water. Chlorine gas may be used as an alternative only when accomplished by a certified contractor.
- G. Procedure for chlorinating the main.
 - 1. At a point not more than 10ft (3m) downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 25mg/L (250ppm) free chlorine. To ensure that this concentration is provided, measure the chlorine concentration at regular intervals in accordance with the procedures described in the current edition of *Standard Methods for the Examination of Water and Wastewater* or AWWA Manual M12, or using appropriate chlorine test kits. The table, from AWWA C651, below gives the amount of chlorine required for each 100 ft (30.5m) of pipe of various diameters. Solutions of 10% liquid chlorine required may be prepared with sodium hypochlorite or calcium hypochlorite.

Pipe Diameter In (mm)		10 percent Chlorine Solution gal (L)	
4	(100)	0.016	(0.06)
6	(150)	0.036	(0.14)
8	(200)	0.065	(0.25)
10	(250)	0.102	(0.39)
12	(300)	0.144	(0.54)
16	(400)	0.260	(0.98)
20	(500)	0.400	(1.50)
24	(600)	0.580	(2.20)

2. The chlorinated water shall be retained in the main for at least 24 hours. At the end of this 24 hr period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine.
3. Direct feed chlorinators, which operate solely from gas pressure in the chlorine cylinder, shall be used for the application of liquid chlorine. The danger of using direct feed chlorinators is that water pressure in the main can exceed gas pressure in the chlorine cylinder. This allows a backflow of water into the cylinder, resulting in severe cylinder corrosion and escape of chlorine gas. Hypochlorite solutions may be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. Feed lines shall be of such material and strength as to safely withstand the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the solution is applied to the main. The pump must have a screen filter through which the chlorine solution must pass before injection into the main.

3.4 FINAL FLUSHING

- A. The final flushing consists of the following steps:

1. Clearing the main of heavily chlorinated water: After the applicable retention period, heavily chlorinated water should not remain in contact with pipe for longer than 24-hrs. In order to prevent damage to the pipe lining or corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or is acceptable for domestic use.
2. Disposing of heavily chlorinated water must meet appropriate governing agency regulations and is the responsibility of the developer/contractor.

3.5 BACTERIOLOGICAL TESTS

- A. Standard Conditions. After final flushing and before the new water main is connected to the distribution system, two consecutive set of acceptable samples, taken at least 24 hr apart, will be collected from the new main. Sampling points should be spaced 500 feet (152m) apart on distribution mains with turns and bends. On straight run mains, the spacing can be increased to 1000 feet (305m) apart. In addition, samples will be collected from each end of the line and from each branch. The sample points should be left no lower

than three (3) feet above the finished parkway grade and no higher than five (5) feet All samples shall be tested for bacteriological quality in accordance with *Standard Methods for the Examination of Water and Wastewater* and shall show the absence of coliform organisms.

- B. Sampling Procedure. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by *Standard Methods for the Examination of Water and Wastewater*. No hose or fire hydrant shall be used in the collection of samples. A corporation cock will be installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

3.6 EMERGENCY OR MAINTENANCE CHLORINATION

- A. In the event a water main should rupture and repairs need to be made all repairs will be made by an OUC approved method.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. The items described in Specification 33 13 00 are incidental to other pay items and shall not be measured for payment.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

- A. No direct payment shall be made for the work described in Specification 33 13 00. The work described in Specification 33 13 00 is incidental to other items and shall be paid for in the respective bid item of which it is a component part

END OF SECTION 331300

SECTION 33 52 43 - AVIATION FUELING SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. Furnish all labor, equipment and material for the complete installation of the aircraft fueling system as indicated and specified.
- B. All Work related to the aircraft fueling system specified in DIVISION 33 and shown on the Plans shall be performed by an experienced Aircraft Hydrant Fuel System Contractor or Subcontractor meeting the following qualifications:
 - 1. The Contractor or Subcontractor shall be a Florida Licensed Mechanical Contractor and a Florida Licensed Pollutant Storage System Specialty Contractor experienced in the construction of underground aircraft hydrant fuel systems within active Aircraft Operations Areas (AOA). The Contractor or Subcontractor shall have a minimum of ten years' experience constructing underground aircraft hydrant fuel systems equal to or greater than the scope of work in this contract.
 - 2. Within the last seven years the Contractor or Subcontractor shall have constructed at least three underground aircraft hydrant fuel systems with a value greater than or equal to \$1,250,000.00 each and including at least 2,000 linear feet of 12 inch or larger fuel pipe, 20 or more hydrant fuel pits, one or more isolation valve pits, and one or more control valve vaults. One of the three above projects shall include the installation of 12 inch or larger double wall fuel pipe according to Florida Regulations.
 - 3. The Project Manager and Superintendent for the Contractor or Subcontractor shall have each completed a minimum of three underground aircraft hydrant fuel systems of a size equal to or greater than the work in this contract.
 - 4. The Contractor or Subcontractor shall submit letters of reference from airlines or airport administrations attesting to their abilities and past performance to perform hydrant fuel system construction of a size equal to or greater than the scope of work in this contract.
 - 5. The Owner's shall determine the acceptability of all submitted information and approve or disapprove the submitted Aircraft Hydrant Fuel System Contractor or Subcontractor.

1.3 ACTION SUBMITTALS:

- A. Submittals shall constitute a representation to Owner and Owner's Authorized Representative that Contractor has either determined or verified all quantities,

dimensions, field construction criteria, materials, catalog numbers and similar data or he assumes full responsibility for doing so, and that he has coordinated each Submittal with the requirements of the Work and the Contract Documents. Contractor certifies that the Material and Equipment shown and marked on the Submittals are in compliance with the Contract Documents and can be installed, operated, and maintained in the allocated space.

- B. Submit as specified in the individual Specifications sections, Plans and other Contract Documents.
- C. Submittals shall constitute a representation to the Owner and the Owner's Authorized Representative that the Contractor has either determined or verified all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data or that the Contractor assumes full responsibility for doing so, and that the Contractor has coordinated each Submittal with the requirements of the Work and the Contract Documents. Contractor certifies that the equipment and materials shown and marked on the Submittals are in compliance with the Contract Documents and can be installed, operated, and maintained in the allocated space.
- D. Include, but not limited to, the following:
 - 1. Piping fabrication drawings:
 - a. Include in-plan view of all systems piping 2-1/2 inches and larger. Provide isometrics for piping systems or tubing 2 inches in diameter and smaller.
 - b. Show the actual equipment furnished, equipment location by dimension, and connections.
 - c. Dimension pipelines in plan view and locate in elevation. Indicate support locations.
 - d. Submit before beginning fabrication.
 - e. All drawings shall be provided in AutoCAD.
 - 2. Supports:
 - a. Detailed drawings of support assemblies indicating the following:
 - i. Plan and elevation of piping.
 - ii. Plan and elevation of support components.
 - iii. Complete Bill of Materials.
 - iv. Tag designation.
 - v. Erection requirements including field weld sizes and weld rod requirements.
 - vi. Concrete pad, grout, and foundation details.
 - 3. Manual Operated Valves.
 - 4. Control Valves.
 - 5. Pressure gauges
 - 6. Coating Materials.

7. Fiberglass Pit Assemblies.
8. Prefabricated Valve Pits and Covers.
9. Pipe, Fittings and Accessories.
10. Pipe Supports.
11. Control System.
12. Leak Detection System.
13. Welding qualification and procedures.
14. Welder certificates signed by the Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
15. Installation and erection instruction books and maintenance manuals including, but not limited to, the following:
 - a. Manual Operated Valves.
 - b. Gauges
 - c. Leak Detection System.
 - d. Control System.
 - e. Fittings and Special Materials.
 - f. Prefabricated Pit Assemblies.
16. Bind all instruction books and manuals complete in three-ring binders with hard durable covers clearly and permanently identified with Contract name and number.
17. Each manual shall include the equipment purchase order.

1.4 QUALITY ASSURANCE:

- A. Acceptable Manufacturers: Specified in each Section of DIVISION 33.
- B. All Equipment and Materials shall be the latest design, new, and the first quality standard product of manufacturers regularly engaged in the production of such Equipment and Materials for a minimum of 5 years.
- C. When two or more units of the same class of Equipment are required, they shall be products of a single manufacturer.
- D. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, unload, check, and store in suitable facilities all Equipment and Materials.
- B. Examine all Equipment and Materials for concealed damage and report any damage to Owner.
- C. Be responsible for the safety and protection from loss or damage of all Equipment and Materials received until the Work is complete.
- D. Pay all demurrage charges and claims for damage to vehicles resulting from the unloading operation.
- E. Protect all Equipment and Materials during storage and prior to start-up which shall include the coverings of all openings, protection against rust and other damage, and other similar measures. Equipment may be stored outdoors only when approved.
- F. Furnish all labor, Materials, and Equipment necessary to make a complete installation as indicated and specified.
- G. Provide all necessary supports, brackets, or foundations for properly installing all Equipment or temporary piping.
- H. Coordinate with the other trades before installation of Materials. Extra charges shall not be approved for interferences due to lack of coordination.
- I. All Equipment shall be properly adjusted and lubricated before final acceptance.
- J. Spot paint all Equipment where the shop paint has been damaged or flaked off.
- K. Furnish all bolts, studs, nuts, and gaskets for makeup of all connections to the Equipment and replace all gaskets damaged during storage, inspection, cleaning, or placing into service.
- L. Retighten all threaded and bolted connections after installation.
- M. Contractor shall be responsible for all added expenses due to his choice of Equipment.
- N. All Materials shall be installed at times necessary to avoid delays in construction.
- O. Provide vents and drains at high and low points where indicated and as required elsewhere for satisfactory draining and venting of fuel systems.
- P. All connections to valves 3 inches and larger shall be made with flanges unless indicated otherwise; all connections to Equipment shall be made with unions or flanges.
- Q. Piping shown on the Drawings is partially diagrammatic and not necessarily the exact routing. Provide all necessary bends that may be required to avoid conflict and interferences. Bends required in addition to those indicated shall be submitted for approval prior to fabrication.
- R. Provide sleeves and flashings for all piping penetrating walls and slabs. Provide all required openings in walls and slabs.
- S. Installation shall equal or exceed the minimum requirements of the applicable codes and these Specifications; however, where local codes and ordinances are more

stringent, they shall govern.

- T. Verify all measurements and location of existing facilities and piping before commencing work.
- U. Certain permanent and temporary piping and equipment systems shall be installed, inspected, tested, flushed, and placed into operation prior to complete installation of the Work.
- V. Contractor shall provide all gaskets, companion flanges, bolting, weld caps, temporary blank-off plates, temporary piping systems, labor, materials, and accessories required to place these systems into operation.

3.2 WELDING QUALIFICATION AND APPROVAL:

- A. Procedure: The Welding Procedure Specification (WPS) that is intended to be used on the job shall be submitted to Owner's Authorized Representative.
- B. Submit certified copies of the Procedure Qualification Records (PQR) as evidence that the intended procedures have been qualified in accordance with the latest revisions of the following codes:
 - 1. ASME B31.3 - Process Piping.
 - 2. ASME Boiler and Pressure Vessel Code, Section I and Section IX.
- C. Design for the conditions of this Contract. Be complete and specific, and where necessary, differentiate between shop and field welding.
- D. Welder Performance Qualification (WPQ) Test Certificates:
 - 1. Furnish welder performance qualification test certificates, made in strict compliance with the above codes.
 - 2. Submit current qualification test records for each welder on the Project and keep record files current. Welder shall have been qualified to the WPS within the last six months.
 - 3. Welder Performance Qualification test certificates shall be submitted to Owner's Authorized Representative before the welder shall be permitted to work on the Project.
 - 4. Welders shall be certified for the type of pipe material welded.
 - 5. Submit copies of the Welder Performance Qualification (WPQ) test certificates to Owner's Authorized Representative for review as specified for Submittals.
 - 6. Welders and welding operators shall be qualified without the use of backing rings for all welding.
- E. Submit WPS, PQR and WPQ on the forms contained within Appendix A of the ASME Boiler and Pressure Vessel Code, Section IX.
- F. Stamp all welds with the welders or welding operators' identification number or symbol.

3.3 FIELD TESTS:

A. Testing:

1. Perform all tests as specified and required by the codes. Additional tests deemed necessary by Owner shall be performed to ensure proper operation and function of the Equipment furnished, and to certify that the furnished Equipment meets the performance specified.
2. Perform tests before Work is concealed and only after notifying Owner that items are ready. All tests shall be witnessed by Owner or Owner's Representative.
3. Conduct tests in a safe and orderly manner with qualified trained personnel in accordance with safety codes and local ordinances.
4. Obtain all necessary approvals, acceptances, and permits.
5. Correct all deficiencies resulting from tests.
6. Tests and Checks of Piping Systems for Acceptance:
 - a. Inspection, Testing, and Flushing shall be as specified in SECTION 33 52 53.

- B. Removed fuel from existing or new fuel pipe, that is returned to the Owner, shall be tested by a third party for contamination before returning to Owner. If it is determined that the fuel is contaminated, the Contractor shall take the fuel to an Oil/Fuel Recycling Facility to be disposed of. As the fuel is offloaded, it shall be metered, and a record of the fuel amount shall be given to the Contractor. Records shall be provided to the Owner.

PART 4 METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

No separate measurement for payment for work in this section shall be made. Work in this section shall be included in other unit price Bid Items.

PART 5 BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

No separate payment shall be made for work in this section shall be made. Payment for work in this section shall be included in other unit price bid items.

END OF SECTION 33 52 43

SECTION 33 52 44 - IDENTIFICATION OF FUEL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. This Section includes the identification of piping and equipment. All exposed piping within pits and vaults should be labeled.

1.3 ACTION SUBMITTALS

- A. Submit as specified in SECTION 33 52 43.
- B. Include, but not limited to, the following:
 - 1. Catalog cuts.
 - 2. Sample(s) representative of labels specified.

1.4 REFERENCE STANDARDS

- A. American Petroleum Institute:
 - 1. Recommended Practice 1637 - Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Service Stations and Distribution Terminals.
- B. American Society of Mechanical Engineers (ASME):
 - 1. A13.1 - Scheme for the Identification of Piping Systems.
- C. Energy Institute:
 - 1. EI 1542 - Identification Markings for Dedicated Aviation Fuel Manufacturing and Distribution Facilities, Airport Storage and Mobile Fueling Equipment.
- D. Federal Aviation Administration:
 - 1. Advisory Circular 150/5230-4B - Aircraft Fuel Storage, Handling and Dispensing on Airports.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Comply with listed Codes and Standards for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the following:
 - 1. W. H. Brady Company.
 - 2. Seton Name Plate Corporation.
 - 3. Gammon Technical Products.
- B. Paint products shall be as specified in SECTION 33 52 46.

2.2 IDENTIFICATION OF PIPING

- A. Materials: Pressure-sensitive type labels or paint/stencil as specified herein.
- B. Sizing of Pipe Markers, Arrows:
 - 1. Conform to ASME A13.1 as a minimum for legend letter size and length of color field based upon outside diameter of pipe or covering if applicable.
 - 2. Size of arrows shall be coordinated with pipe marker and letter size and also be based upon outside diameter of pipe, or covering if applicable.
- C. Color Coding:
 - 1. Jet A piping:
 - a. Label in accordance with EI 1542 and FAA Advisory circular 150/5230-4B. Label or stencil flow direction on piping.
 - b. Provide pressure sensitive type labels, Gammon Technical Products GTP-2135-5 (JET-A) or equal.

2.3 IDENTIFICATION OF FUEL EQUIPMENT

- A. Materials: Protective Coatings as specified in SECTION 33 52 46.
- B. All fuel system valves shall be painted black.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean area of surface to receive label or other pressure-sensitive item free of oil, grease, dust, dirt, or other substances which would affect adhesion.
- B. On painted surface, install label only after coating system is complete and dry.

3.2 LOCATIONS

- A. Piping Labels:
 - 1. Use proper label type suitable for exterior location as applicable.
 - 2. Locate labels on piping near connections to equipment, adjacent to valves or fittings, and at intervals not to exceed 25 feet.
 - 3. For piping with arrows, indicate direction of flow. Place arrows adjacent to or

below labels, depending upon visibility. For dual-flow piping, indicate both directions.

4. Locate legends to be visible from normal line of vision above floor finish or grade level.
5. Replace labels which do not adhere properly.
6. Location of identification/labels shall be approved by Owner.

PART 4 - METHOD OF MEASUREMENTMETHOD OF MEASUREMENT

No separate measurement for payment for work in this section shall be made. Work in this section shall be included in other unit price Bid Items.

PART 5 - BASIS OF PAYMENTBASIS OF PAYMENT

No separate payment for work in this section shall be made. Payment for work in this section shall be included in other unit price Bid Items.

END OF SECTION 33 52 44

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SECTION 33 52 45 - FUEL SYSTEM PIPE, CONNECTIONS, AND INSTALLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. This Section covers aircraft fueling system piping, fittings, welded and screwed connections, qualification procedures, welding procedures, materials, radiographing (and other nondestructive testing) requirements, and existing pipe abandonment and construction requirements.
- B. Buried piping shall be of double wall construction with pipe and fittings as specified herein for "CARRIER PIPE" and "CONTAINMENT PIPE". Piping in vaults, pits and tie-ins to existing shall be as specified for "CARRIER PIPE"
- C. All materials, items, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig from 0 to 100°F and a specific gravity of 0.81 ± 0.05 .
- D. All end connections on piping and fittings to be welded shall be prepared for butt welding, without backing ring. Butt welding end preparation shall conform to ASME B16.25.

1.3 REFERENCE STANDARDS

- A. American Petroleum Institute (API):
 - 1. Spec 5L - Line Pipe.
- B. American Society of Mechanical Engineers (ASME):
 - 1. B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
 - 2. B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
 - 3. B16.20 - Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed.
 - 4. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
 - 5. B16.25 - Buttwelding Ends.
 - 6. B16.47 - Large Diameter Steel Flanges.
 - 7. B16.5 - Pipe Flanges and Flanged Fittings.
 - 8. B31.3 - Process Piping.
- C. American Society for Testing and Materials (ASTM):
 - 1. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - 2. A105 - Carbon Steel Forgings for Piping Applications.

3. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
4. A139 - Electric-Fusion (Arc) - Welded Steel Pipe (NPS 4 and Over).
5. A193 - Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service.
6. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
7. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
8. A269 - Seamless and Welded Austenitic Stainless-Steel Tubing for General Service.
9. D229 - Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation.

1.4 ACTION SUBMITTALS

- A. Product Data:
 1. Pipe, Fittings, and Accessories.
 2. Gaskets.
 3. Flange Insulation Assemblies.
 4. Pipe Supports.
 5. Pipe Seals.

1.5 QUALITY ASSURANCE

- A. All pipe and piping materials shall be produced by a manufacturer acceptable to the Owner's Authorized Representative.
- B. The double-wall piping system including all fittings shall be a factory prefabricated system. The manufacturer shall have a minimum of 5 years of experience in the design and manufacturing of containment piping systems.
- C. A complete stress analysis of the double-wall piping system shall be conducted by the manufacturer. Allowable stresses shall be defined by ASME B31.3. Analysis shall assume fluid temperature of 65°F to 95°F. Provide written report of analysis and results to the Owner's Authorized Representative.
- D. The containment piping system manufacturer shall provide on-site field supervision during critical periods of installation which includes, but is not limited to, the following:
 1. Inspection upon unloading.
 2. Inspection of initial trenching operations.
 3. Closure of containment piping.
 4. Testing.
 5. Initial backfilling operations.

- E. Upon completion of installation, the manufacturer shall provide a written certification that the containment piping system was installed in accordance with the manufacturer's specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the listed manufacturers.
1. Double-Wall Pipe:
 - a. Rovanco.
 - b. Permapipe.
 - c. Thermacor.
 2. Flange Gaskets:
 - a. Flexitallic.
 - b. Garlock.
 - c. Lamons.
 - d. Klinger.
 3. Flange Insulation Assembly:
 - a. EnPro Industries, Inc. (GPT)
 - b. Advance Products & Systems, Inc.
 - c. Approved equal.
 4. Pipe Supports:
 - a. Anvil.
 - b. Cooper B-Line.
 - c. Piping Technology & Products.
 5. Pipe Sleeve Seal:
 - a. EnPro Industries, Inc. (GPT)
 - b. Approved equal.
 6. Pipe Sleeve Insulators:
 - a. Advance Products & Systems, Inc.
 - b. EnPro Industries, Inc. (GPT)

2.2 FUEL CARRIER PIPING MATERIALS

- A. Pipe shall be ASTM A53 Grade B, ASTM A106, Grade B or API 5L Grade B, seamless or electric resistance welded double random lengths to reduce the number of joints. Stamp all pipe and stencil/label coated pipe with specification and grade.

Submerged arc welded pipe is not acceptable. Material certificates and mill test reports shall be provided for all piping.

- B. Pipe 2 inches and smaller shall be seamless Schedule 80, pipe 2-1/2 inches through 10 inches shall be Schedule 40, and 12 inches or larger shall be 3/8- inch (0.375-inch) wall thickness.
- C. All buried carrier piping shall have full penetration welded connections, except where indicated otherwise for connection to existing piping. Socket-weld connections shall be used for 2 inches and smaller pipe in pits and aboveground piping except for connections to threaded valves, unions, and other equipment. Threaded and flanged connections shall be prohibited on all buried piping.
- D. Pipe or fittings in the fuel piping systems shall not be galvanized.
- E. Mill Cleaning and Coating of Pipe
 - 1. All carrier pipe 2-1/2 inches and larger and fittings 6 inches and larger shall be internally epoxy lined at the mill as specified in SECTION 33 52 46.
 - 2. All single-wall carrier pipe and fittings and containment pipe and fittings shall be externally coated as specified in SECTION 33 52 46.
 - 3. Clean inside and outside of pipe and fittings by sand or grit blasting or pickling to remove all mill scale.
 - 4. Apply in the mill an approved rust preventive coating to the interior and exterior of pipe and fittings immediately after cleaning. Rust preventive shall be approved by Owner and applied as recommended by the manufacturer. Rust preventive coating may be deleted from the pipe interior if pipe is internally epoxy lined immediately after cleaning. Rust preventive coating may be deleted from the pipe exterior if the pipe is externally epoxy coated immediately after cleaning.
 - 5. The ends of the pipe shall be capped at the factory using suitable galvanized metal or plastic caps, secured with a double wrap of 2-inch-wide pressure sensitive tape.

2.3 FITTINGS FOR WELDED CARRIER PIPE

- A. Butt welding type carbon steel, ASTM A234 Grade WPB, ANSI B16.9 for sizes 2-1/2 inches and larger. Wall thicknesses shall match pipe.

Socket welding 3,000-pound forged steel, ASTM A105, conforming to ASME B16.9 and B16.11, for sizes 2 inches and smaller. Butt weld fittings in lieu of socket weld are acceptable.
- B. Elbows shall be long radius unless noted and indicated otherwise.
- C. Changes in direction of pipe of other than 45 degrees or 90 degrees shall be made as follows:
 - 1. With long radius weld ells cut to the proper angle and shop beveled.
 - 2. Or, at the option of Contractor, with long radius pipe bends. Pipe roundness shall be maintained to factory tolerance for straight pipe lengths. Submit Shop Drawings of all bends and bending procedures for approval by Owner's Authorized Representative.

3. Bends of 2 degrees or less may be miter joints.
- D. Welded Branch Connections:
 1. Welded branch connections shall be butt welding tees except as described herein and with Owner's Authorized Representative's approval.
 2. Fabricated tees shall be insert-type weldolets, elbolets, or vessolets. Standard weldolets shall not be used for below ground application, unless the existing below ground piping is to be abandoned-in-place, demolished, or permanently closed. Fittings and connections shall provide a smooth and accessible surface suitable for 100% nondestructive examination of all welds.
 3. Fabricated branch connections for aboveground piping or piping exposed in pits 2 inches and smaller shall be sockolets. Field-fabricated half couplings shall not be used.

2.4 JET FUEL CONTAINMENT PIPE

- A. Containment pipe shall be ASTM A139, 0.25-inch wall thickness spiral welded steel.
- B. Containment piping, including connections, shall be of full welded construction and shall be liquid tight. Piping shall be rated for 50 psig.
- C. Containment pipe shall be externally coated as specified in 33 5246. No interior lining is required.
- D. Containment piping shall be sized to contain the fuel carrier pipe with sufficient clearance for field assembly and thermal expansion/contraction.
- E. Fuel carrier pipe shall be supported within the containment piping. Pipe supports / centering devices shall be fixed to prevent movement during transportation, installation, and operation. Pipe supports shall be constructed of a material that is compatible with the fuel carrier pipe. Pipe supports shall allow liquid to drain to the containment low point drain.
- F. Centering devices are to be designed by the double-wall piping manufacturer and provided as part of the prefabricated piping system. Centering devices are to be constructed to allow drainage and venting of the containment piping system.
- G. Containment pipe connectors for field welding shall be of split-sleeve or overlap weld design. Connectors shall be designed to withstand all mechanical forces. Wall thickness shall be equal or greater than pipe material.
- H. End seals consisting of steel plate shall be provided as indicated on the contract drawings. End seals shall be design to accommodate forces imposed by expansion of the carrier pipe.
- I. At each end seal termination point in a vault or pit, provide a 3/4-inch NPT connection for venting and a 1-inch NPT connection for draining the annular space. Provide plugs for connections not used.

2.5 FITTINGS FOR CONTAINMENT PIPE

- A. Fittings for containment pipe shall be factory fabricated from ASTM A234 Grade B steel pipe fittings, A53 steel pipe bends mitered to required angle or manufacturer's

standard containment pipe fabricated fittings design. Allow clearance for the fuel pipe inside as shown on the drawings. Provide spacers as required to support pipe in fitting.

- B. Wall thickness shall match pipe.
- C. Containment fittings shall be all welded construction.
- D. External coating for fittings shall be as specified in Section 33 52 46 for field applied external coating.

2.6 FITTINGS FOR THREADED FUEL PIPE

- A. 3,000-pound forged steel conforming to ASME B16.11.
- B. Threads of threaded jointed piping shall be full, clean, sharp, and true.
- C. Bushings shall not be used except as noted and indicated on the Drawings.
- D. Threaded fittings shall not be used except where noted.

2.7 FLANGES AND GASKETS

- A. Flanges shall be standard weldneck type 150-pound forged steel, ASTM A105, and conforming to ASME B16.5, except where 300-pound, 600-pound, or ASME B16.47 Series B flanges are required to correspond to the equipment to which the piping is joined. ASME B16.47 Series A flanges are acceptable for companion pipe flanges above 24-inch size. Inside diameter of flanges shall be bored to match the inside diameter of the mating piping. Slip-on flanges conforming to the above standards shall be provided where noted and indicated on the Drawings.
- B. Flange facings shall correspond to the equipment to which the piping is joined, and unless otherwise required, shall be standard 1/16-inch raised face flanges.
- C. Flange gaskets shall be "Flexitallic Type CG" using 304 stainless-steel windings with flexible graphite "fire rated" filler, or approved equal, conforming to ASME B16.20.
- D. Gaskets shall be resistant to the effects of aviation hydro-carbon fuels and manufactured of fire-resistant materials.
- E. Full face gaskets shall be used for flat face steel flanged joints. Full face gaskets shall conform to ASME B16.21, 1/8-inch thickness and be of fire-resistant composite material.
- F. Ring gaskets shall be used for steel flanged joints with raised face flanges.
- G. Gaskets shall be 1/8 inch in thickness and exceed the temperature and pressure rating of the flanges associate with the gaskets.

2.8 FLANGE BOLTS AND NUTS

- A. Machine bolts shall be heavy hexagonal alloy carbon steel conforming to ASTM A193 Grade B7.
- B. Nuts shall be heavy hexagon alloy carbon steel conforming to ASTM A194, Grade 2H.

- C. Stud bolts may be used as required for corresponding equipment.

2.9 FLANGED INSULATING JOINTS AND FLANGE PROTECTORS

- A. For insulating flange joint and flange protector specifications, refer to SECTION 13 47 13 CATHODIC PROTECTION SYSTEM.

2.10 PIPE SUPPORTS

- A. Support design and location shall be as indicated. Refer to SECTION 33 52 43.
- B. Provide complete assemblies adequately rated for the applied loads.
- C. Install all required inserts and anchors prior to concrete placement.
- D. Refer to Drawing for anchor bolt requirements.
- E. Spacing and arrangements shall conform to ANSI B31.3.
- F. Support locations are indicated on the Drawings for pipe sizes 2-1/2 inches and larger only, based on the pipe routing shown. Contractor shall locate and provide supports for piping smaller than 2-1/2 inches in accordance with specified Codes and Standards.
- G. Contractors shall provide additional supports as required due to changes in the pipe routing or equipment supplied.
- H. Reduce spacing one quarter where changes in direction occur.
- I. Pipes run parallel in the same plane may be supported on gang supports.
- J. Install to prevent sag or vibration and to adequately support the piping without interfering with inherent flexibility.
- K. Make adjustments after systems are placed in operation.
- L. Explosion or powder driven fasteners shall not be used.

2.11 WELDING FILLER MATERIALS

- A. Welding filler material shall be provided in accordance with the applicable welding procedure specification.
- B. Filler materials shall be compatible with the base metal and shall be specified and purchased by ASME BPVC Section IX or AWS classification and chemical composition.
- C. Welding electrodes and filler materials shall be properly stored in suitable regulated temperature enclosures in accordance with manufacturer's recommendations. The use of wet or moist electrodes will not be permitted.

2.12 THREADED PIPE JOINT SEALING

- A. Either of the two materials specified below may be used for sealing of threaded pipe joints unless otherwise specified. All threaded joints shall be sealed.
- B. Screwed Pipe Joint Tape: TFE tape applied to male threads. Tape width, number of

wraps, and use of additional paste sealant shall be in accordance with tape manufacturer's recommendations.

- C. Screwed Pipe Joint Compound: Use compound which is resistant to the effects of aviation hydrocarbon fuels and Underwriters' Laboratories approved for the application intended.

2.13 PIPE SLEEVES

- A. Provide sleeves for all pipes passing through equipment pads, slabs, valve vault walls, and other concrete or masonry structures.
- B. Sleeve sizes through 10 inches shall be Schedule 40 steel pipe or standard wall thickness. Sleeve sizes 12 inches and larger shall have 0.375-inch wall thickness or standard wall thickness.
- C. Provide an anchor collar/water stop of the same type of steel as the sleeve. The collar shall be welded all around on both sides to the sleeve at the point on the sleeve that positions at the midpoint of the structural wall or pad when the sleeve is in place.
- D. Sleeves shall be 2-inch nominal pipe size larger for pipes less than 4-inch nominal diameter and two pipe sizes larger for pipes 4-inch nominal diameter and larger. Coordinate sleeve dimension with sleeve seal specified herein.
- E. Sleeves through walls shall be cast in place. Sleeves through pads shall be cast in place. Piping shall be installed centered in sleeve.
- F. Sleeves shall be hot-dip galvanized. Where split sleeves are installed around existing pipes, sleeves shall be joined with full penetration welds. See structural design documents for required repair of galvanization removed to complete welding of split sleeves.

2.14 PIPE SLEEVE SEAL (SEGMENTED SEALING ELEMENTS)

- A. EnPro Industries, Inc. (GPT) "Link-Seal" 400 Series, Model "O", nitrile (Buna-N) sealing elements.
- B. Use one seal at each end of the sleeve through walls and pads to keep the pipe in proper alignment.

2.15 PIPE SLEEVE INSULATORS

- A. Insulator shall be a segmented collar molded of high-density polyethylene with runners.
- B. Shoe height of runners shall be as required to center the pipeline in the sleeve.
- C. Insulator shall be bolted around the fuel pipe without damaging the pipe coating.
- D. Sleeve insulator shall provide dielectric insulation between carrier and casing pipes.

2.16 PIPE BEDDING MATERIAL

- A. Pipe bedding material shall consist of clean, dry, washed sand conforming to ASTM C144 or ASTM C33 with not more than 5% by weight passing the No. 200 sieve.

Pipe bedding material shall have a neutral pH.

B. Sieve Analysis:

Sieve	ASTM C33 Percent Passing	ASTM C144 Percent Passing
3/8-in.	100	---
No. 4	95 to 100	100
No. 8	80 to 100	95 to 100
No. 16	50 to 85	70 to 100
No. 30	25 to 60	40 to 75
No. 50	10 to 30	10 to 35
No. 100	2 to 10	2 to 15
No. 200	---	0 to 5

PART 3 - EXECUTION

3.1 HAULING AND STRINGING PIPE

- A. Perform the hauling and stringing of pipe and other materials in such a manner as to prevent damage to pipe and material. If damage is sustained, Contractor shall be responsible for repair or replacement cost.
- B. Galvanized metal or plastic caps covering the ends of the pipe shall remain in place until the welding of the pipe. If any caps are not in place, resecure to the pipe ends to prevent dirt, water, and other foreign material from entering.
- C. String pipe on right-of-way in such a manner as to cause the least interference with the normal use of the land crossed. Leave gaps at intervals to permit use of land and passage of equipment.
- D. Contractor shall promptly repair, at his own expense, all roads, fences, building, or other property damaged by him in the progress of the Work.

3.2 LAYING UNDERGROUND PIPE

- A. Pipe Trench excavation, backfill, and compaction shall conform to P-152 (Excavation and Embankment) of the Specifications.
- B. Lay, embed, and maintain all underground pipelines to the flow-line elevation and grades shown on the Drawings.
- C. The full length of each section of pipe shall rest solidly upon the pipe bed of compacted sand with depth as indicated. Sand bags or blocking shall be removed prior to final pipe bedding backfill.

- D. Any pipe that has the grade or joint disturbed after being laid shall be taken up and relaid.
- E. Do not lay pipe in water or when trench conditions are unsuitable except by written permission of Owner.
- F. Anchor pipe during installation to prevent flotation prior to placement in service.
- G. When Work is not in progress, securely close open ends (watertight) of pipe or fittings so that no trench water, earth, or other substance will enter the pipe or fittings.
- H. Contractor shall be responsible for maintaining the cleanliness of the piping interior. Water, dirt, or foreign material shall be removed from the piping interior at no additional cost to the Owner.
- I. Install pipe so as to be clear of contacts with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures.
- J. Where coated fuel pipes cross other pipes, conduits or metallic structures with a separation of less than 6 inches, install an insulating separator.
- K. For utilities without cathodic protection, insulating separators shall be 12-inch by 12-inch by 1/2-inch thick UHMW polyethylene sheets. For utilities with cathodic protection, insulating separators shall be 36-inch by 36-inch by 1/2-inch thick UHMW polyethylene sheets.

3.3 INSTALLATION OF PIPE IN VAULT OR PITS.

- A. Install complete with valves, fittings, and accessories and make all necessary connections.
- B. Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements.
- C. All fabrication and installation shall conform to ASME B31.3.
- D. Verify all measurements, and location of existing facilities and underground piping, before commencing Work. Submit discrepancies for clarification before proceeding with the installations.
- E. Arrange all piping with proper slopes, true to line, without sags, traps, or pockets, and pitched to drain at the lowest points so that entire systems can be emptied.
- F. Provide high point vents, pump outs, and low point drains as required or indicated on the Drawings.
- G. Provide threaded unions where indicated and as required elsewhere to permit satisfactory disassembly of small-bore piping for threaded valve and equipment maintenance.

3.4 HANDLING COATED PIPE

- A. Storage Racks
 - 1. Storage rack material shall be 4 to 6 inches in bearing width and placed not less than 10 feet apart.
 - 2. Do not rack pipe 10 inches in diameter and larger more than two sections in

height; and pipe 8 inches and under not more than 4 sections in height.

3. Protect all racked pipe by use of suitable padded material between sections.
4. All coated pipe shall be protected from ultraviolet deterioration.

B. Handling Operation

1. All trucks handling coated pipe shall have properly padded bolsters, chains, and binders so as to not damage the coating.
2. Pipe shall not be rolled off the truck but shall be carefully lowered onto the skids by mechanical equipment.
3. Coated and wrapped sections of pipe must be lifted with slings of approved width and are not to be dragged or pulled into position.

3.5 PIPE CLEANING

- A. Clean each joint before welding into the system, to remove all loose debris.
- B. Remove materials such as welding rods, dirt, and similar materials, left inside after completion of the lines. Expense incurred by Owner for removal of such objects shall be reimbursed by Contractor.

3.6 GAS FREE CONDITIONS

- A. All operations in the construction area that involve open flames, or the possibility of arcing or sparking shall be conducted in a "Gas Free" condition.
- B. These operations shall include but not be limited to the following:
 1. Use of internal combustion engines not equipped with Underwriters' approved spark and flame eliminators.
 2. Use of electric motors or electric devices with arcing brushes or sliding contacts that could produce arcing or sparking.
 3. Use of tools which may produce impact sparks.
 4. Electric or gas welding.
 5. Use of cutting or other torches or other open flame equipment.
 6. Holiday testing.
 7. Use of equipment with hot surfaces or glowing elements.
 8. Use of any other equipment or procedure that could create a fire hazard.
- C. Contractor shall monitor the use and suitability of the equipment and procedures on the job and maintain a safe "Gas Free" condition when necessary during construction.
- D. Prior to commencing any phase of the Work requiring a gas free condition, Contractor shall make the following provisions:
 1. Empty pipes containing fuel and purge of all vapors.
 2. Isolate, blank off, and adequately ventilate open piping sections so that no part

of the pipe containing fuel or vapors is exposed.

3. Make certain that there are no open pools or reservoirs of fuel exposed in the vicinity of the Work.
 4. Perform all other safety precautions necessary to ensure that these operations are conducted in a safe manner in accordance with all applicable codes.
- E. Use a combustible gas analyzer to make certain no combustible gas concentrations exist in the construction area when performing these operations.

3.7 CONNECTION TO EXISTING PIPE

- A. The Contractor shall connect to the existing fuel pipes at the location shown on the drawings. Existing jet fuel lines are pressurized with jet fuel. Take necessary precautions before performing work on existing pipelines.
- B. Connections shall include modifying portions of the fuel pipes to allow the new fuel pipe adequate clearance to cross the existing fuel pipes.
- C. Exercise extreme caution on active jet fuel pipes. This work shall include draining, purging, cutting, lowering, welding, testing, flushing, coating repairs, restoration and all incidental work to connect to the fuel pipe. Cleaning, testing, and flushing of pipe shall be in accordance with SECTION 33 52 53. Provide gas free conditions.
- D. Each pipe shall be taken out-of-services only as directed by the Owner's Authorized Representative. Only one pipe may be out-of-service at a time. An out-of-service pipe must be returned to service before work on the next pipe can begin. Provisions shall be made to provide fuel with the remaining pipes in service.
- E. All work on existing fuel pipes must be coordinated with GOAA and the fuel facility operator.
- F. Contractor shall provide complete construction procedure and shop drawings of this work to Owner's Authorized Representative for approval.
- G. Connection to existing pipe includes draining and refilling pipe to be placed back in service.

3.8 DRAINING AND REMOVING FUEL FOR CONNECTION TO EXISTING PIPING

- A. The Contractor shall submit in writing a request at least 25 days prior to scheduling his work and shall have the approval of the Owner's Authorized Representative as to the time and date for isolating any fuel line to be drained. Work shall be completed within the time frame specified. Arrangements shall be made for the appropriate fire protection measures to be present during any of the fuel handling procedure. Any requirements to work hours other than what might be considered normal working hours (0800-1700) shall be done without any increase to contract cost.
- B. The Contractor shall have at hand a clean, uncontaminated tank truck for collecting the fuel and shall arrange with the fuel facility operator the return of fuel to storage at the tank farm. The Contractor shall also provide fuel quality testing of fuel to be returned to storage. The Contractor will dispose of fuel not meeting test criteria.
- C. The Contractor shall locate and identify the proper isolation valves associated with the fuel line to be drained.

- D. If the pipe section to be drained does not have a low point drain, the Contractor shall provide for the installation of a temporary drain connection, to be removed upon completion of the work.
- E. The Contractor shall be responsible for preventing fuel spills, and damage to the piping system and shall make good, at his expense, cleanup of any spill or repair to the fuel system.
- F. All systems that have been out-of-service shall be flushed in accordance with SECTION 33 52 53 prior to returning to service.

3.9 WELDED JOINTS

- A. Process: Welding shall be accomplished by the use of the shielded metallic arc (SMAW) process or gas tungsten arc welding (GTAW) or combination of both processes and shall be in strict accordance with ASME B31.3.
- B. The minimum space between pipe welds shall be not less than 3 inches.
- C. Procedure: Upon award of the Contract, submit for review current certified copies of the welding procedure specification (WPS), the procedure test record (WTR) and the welder qualifications test record (WQTR) that are intended to be used on the job in accordance with SECTION 33 52 43.
 - 1. Welding procedure shall be designed for the conditions of this Contract and shall be complete and specific, and shall differentiate between shop, field welding, manual and automatic welding.
 - 2. The Contractor shall provide the services of a testing laboratory, approved by the Owner's Authorized Representative, to certify each manual welder and welding machine operator for this Contract. Welds shall be made and tested as required by ASME B31.3 and Section IX of the ASME Boiler Code. The following conditions shall apply for qualification testing of each welder.
 - a. All welds shall be made in the flat, horizontal, vertical-downhill or overhead position.
 - b. All pipe groove weld test assemblies shall be welded in 6G test position. If welding is going to be done outside or in an enclosed shop then the welder performance test shall also be done outside in an enclosed shop. Wind screens or welding tents, if used, can be added for outside welding to minimize the effect of wind on arc shielding. No backing rings shall be used.
 - c. All test welds shall be given a radiographic examination prior to the performance of bend test. Orientation shall be clearly marked on the image so that top dead center and bottom dead center is known when reading the film.
 - d. All test welds shall be given the required guided bend tests as well as the radiographic examination
 - e. Welders failing to qualify after (2) unsuccessful attempts shall not be retested and shall not be permitted to perform any welds on this project.
 - f. All test results shall be submitted to the Owner's Authorized Representative for approval.

- D. Costs: Costs incident to these procedures and the welder's qualification tests shall be assumed by Contractor.
- E. Inspectors: Shop welding and fabrication shall be subject to the right of Owner to maintain one or more inspectors in the shop or to visit the shop at any time this Work is in progress.
- F. Identification:
 - 1. Each welder shall identify his weld with specific code marking signifying his name and assigned number.
 - 2. Contractor shall maintain a code listing assigned to each welder.
 - 3. Stamp on the pipe using "low stress" steel stamp, or other approved method, not closer than 4 inches to a weld.
- G. Butt Welding End Preparation on all Pipe:
 - 1. Conform to ASME B16.25 and B31.3.
 - 2. Shop and field bevels shall be machine cut; manual flame cutting without machine guide shall not be permitted.
 - 3. Remove internal masking applied at pipe ends for internal coating.
- H. All underground carrier pipe welds shall have complete joint penetration and fusion and shall conform to ASME B31.3, except as specified in ARTICLES 3.10 and 3.11. Root pass and second pass shall be performed using GTAW process.
- I. Backing rings shall not be used.
- J. Align pipe joints with pipe clamps prior to welding as specified in WPS. Clamps or other alignment devices shall not reduce the internal pipe diameter. Misalignment shall be held within the limits stated in the WPS. Correcting for misalignment shall be done as shown in Figure 328.4.3 (a) or (b) of ASME B 31.3.
- K. Defective welds shall be repaired in accordance with ASME B31.3 at Contractor's expense.
- L. Repairs to defective welds shall not be made prior to authorization. Owner will determine on the basis of the testing laboratory report if repairs may be made or if the entire joint must be cut out and welded again.
- M. No weld metal shall project within the piping at completion of the welding.

3.10 RADIOGRAPHIC EXAMINATION

- A. Contractor shall coordinate and arrange for radiography by an approved testing laboratory of all welds on 100% of the underground carrier pipe or inaccessible fuel lines, and also a minimum of 10% of selected aboveground or exposed welded joints. This shall include all circumferential butt welds and all fabricated branch connections.
- B. Testing laboratory shall be selected by and employed by Contractor subject to Owner's approval.
- C. The radiographing shall be coordinated by Contractor and conducted at the Project Site such that Owner and the testing laboratory are provided with adequate notice

that welds are available for radiographing and all the work required of Contractor in connection with the radiographing is properly completed at no additional cost to Owner. Factory welds of the final carrier pipe shall be radiographed by an approved testing laboratory. Radiography of factory welds may be conducted at the factory site.

- D. Reports for both factory and field welds shall be submitted throughout the progress of the Work as described below.
- E. All radiographing and subsequent reports shall be in accordance with the requirements of ASME B31.3.
- F. Each weld shall be assigned a number. Contractor shall maintain a marked up copy of piping drawings identifying the location and number of each radiographed weld. Upon completion of the Work, these drawings shall be submitted with as constructed drawings.
- G. Radiograph exposure records shall be kept by the testing laboratory which show date, location, area, film number, serial number, film combination, time, source-film distance, angulation, weld number and other pertinent information for each weld radiographed.
- H. A summary of this record and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Owner's Authorized Representative, and Contractor.
- I. All joints shall be left exposed until radiographing and other testing is completed.
- J. Welds which do not meet the standards of acceptability as outlined in the above mentioned ASME B31.3, will be judged unacceptable and shall be repaired or cut out and rewelded by Contractor as directed by the testing laboratory, all at no additional cost to Owner. Repaired and rewelded joints will then be reradiographed.
- K. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.
- L. All the costs of the radiographing at each weld and the accompanying reports and interpretation shall be paid by Contractor and shall be included in the Contract Price. Contractor shall be responsible for coordination and scheduling of the Work.

3.11 MAGNETIC PARTICLE AND DYE PENETRANT TESTING

- A. Contractor shall coordinate and arrange for dye penetrant or magnetic particle testing of all containment pipe welds by an approved testing laboratory of all new buried welds on Plidco fittings.
- B. The dye penetrant or magnetic particle tests shall be conducted on the entire 360-degree circumference of each Plidco connection to existing system piping.
- C. Testing laboratory shall be selected by and employed by Contractor subject to Owner's Authorized Representative's approval.
- D. The dye penetrant or magnetic particle testing of containment pipe welds at shop and field connections shall be coordinated by Contractor and conducted at the Project Site such that the Owner and the testing laboratory are provided with adequate notice that welds are available for testing and all the Work required of

Contractor in connection with the testing is properly completed at no additional cost to Owner.

- E. Reports for field welds shall be submitted throughout the progress of the Work as described below.
- F. All dye penetrant or magnetic particle testing and subsequent reports will be in accordance with the requirements of ASME B31.3 and Section V of the ASME Boiler and Pressure Vessel Code.
- G. Each weld shall be assigned a number. Contractor shall maintain a marked-up copy of piping drawings identifying the location and number of each weld. Upon completion of the Work, these drawings shall be submitted with as built drawings.
- H. Dye penetrant or magnetic particle testing records shall be kept by the testing laboratory which show date, location, area, weld number, and other pertinent information for each weld tested.
- I. A summary of this record, and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Owner's Authorized Representative, and Contractor.
- J. All fittings shall be left exposed until testing is completed.
- K. Welds which do not meet the standards of acceptability as outlined in the above mentioned ASME B31.3 will be judged unacceptable and shall be repaired or cut out and re-welded by Contractor as directed by the testing laboratory, all at no additional cost to Owner. Repaired and re-welded joints will then be retested.
- L. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.
- M. All the costs of the testing at each weld and the accompanying reports and interpretation shall be paid by Contractor and shall be included in the Contract Price. Contractor shall be responsible for coordination and scheduling of the testing work.

3.12 EXISTING PIPE ABANDONMENT

- A. Leave in place existing pipe indicated to be abandoned.
- B. Drain fuel from pipe and return to the fuel system operator
- C. Clean pipe and remove all fuel residue from carrier pipe and containment pipe.
- D. Fill containment pipe and carrier pipe with pumped flowable cement grout.
- E. Pipe abandonment shall be incidental work and the costs included the bid items in this section.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

Method of Measurement for 14"/16", 12"/16" Double Wall pipe and 6"/10" Double Wall pipe shall be measured in linear feet of pipe in place, completed, and accepted. Measurement shall be made from end to end or from end to pipe stub out at vault or pit. All fittings, welds,

radiography, magnetic particle or dye penetrant testing, coating and lining, nitrogen charging, laying pipe, pipe embedment, backfill and compaction, connections, supports, draining existing pipe and refilling existing pipe shall be included in the contract unit price.

Method of Measurement for 6"/10" Double Wall Pipe Connections to Existing 12"/16" Double Wall Pipe shall be measure for each in place, completed and accepted. All fittings, welds, radiography, mag particle or dye penetrant testing, coating and lining, nitrogen charging, laying, embedment, backfill and compaction, connections, supports, draining existing pipe and refilling existing pipe shall be included in the contract unit price.

PART 5 - BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

These contract prices shall fully compensate the Contractor for furnishing all material and for all preparation, excavation, and installation of these items, and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment for the 14"/18", 12"/16" Double Wall pipe and 6"/12" Double Wall pipe shall be made per linear foot for procurement, installation, testing and commissioning at the contract unit price for the bid item.

Payment for the 6"/10" Double Wall Pipe Connections to Existing 12"/16" Double Wall Pipe shall be made per each, for procurement, installation, testing and commissioning at the contract unit price for the bid item.

Bid Item 33 52 45 -5.1 Foot	14"/18" Double Wall Pipe	per	Linear
Bid Item 33 52 45 -5.2 Foot	12"/16" Double Wall Pipe	per	Linear
Bid Item 33 52 45 -5.3 Foot	6"/10" Double Wall Pipe	per	Linear
Bid Item 33 52 45 -5.4	6"/10" Double Wall Pipe Connections to Existing 12"/16" Double Wall Pipe	per	Each

END OF SECTION 33 52 45

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AIRFIELD CIVIL, APRON & TAXIWAY PAVING

FUEL SYSTEM PIPE, CONNECTIONS, AND
INSTALLATION
SECTION 33 52 45

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SECTION 33 52 46 - LIQUID FUELS PIPELINE COATING SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections including sustainability requirements, apply to this Section.

1.2 SUMMARY

- A. This Section covers the field and shop-applied corrosion protection coatings of exterior and interior surfaces for fuel system piping, pipe supports, valves, fittings, equipment, structural steel, and all materials to be located underground.
- B. Coating includes surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat and finish coats to be shop applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.
 - 1. Where surface preparation and first (prime) coat are specified in other sections to be shop applied such as for structural steel, or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat.
 - 2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
 - 3. Where equipment or materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
 - 4. Refer to applicable sections to determine whether surface preparation and first coat, or complete coating system, is to be shop applied.
- C. See Specification SECTION 33 52 45 for special safety requirements for a "gas-free" condition during certain operations in the construction area.
- D. Colors:
 - 1. Colors shall be selected after submittal of approved manufacturer's color Samples.
 - 2. Color of finish coatings shall match accepted color Samples.
 - 3. When second and finish coats are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat.

1.3 REFERENCE STANDARDS

- A. The work shall be performed in accordance with the latest requirements of laws and codes governing this work, including but not limited to:
 - 1. Society for Protective Coatings (SSPC):

- a. SP 1 - Solvent Cleaning. Removes oil, grease, soil, and other substances. Used with other methods to remove rust, paint, and mill scale.
- b. SP 3 - Power Tool Cleaning. Removes loose material. Not intended to remove all scale or rust.
- c. SP 5 - White Metal Blast Cleaning. Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
- d. SP 6 - Commercial Blast Cleaning. Two-thirds of every 9 square inches free of all visible residues; remainder only light discoloration.
- e. SP 7 - Brush-Off Blast Cleaning. Removes only loose material, remaining surface tight and abraded to give anchor pattern.
- f. SP 10 - Near-White Blast Cleaning. At least 95% of every 9 square inches shall be free of all visible residues.
- g. SP 11 - Power Tool Cleaning to Bare Metal.

1.4 ACTION SUBMITTALS

A. Product Data:

- 1. Schedule of products to be used. Schedule shall include the following information:
 - a. Surfaces for system to be applied.
 - b. Surface preparation method and degree of cleanliness.
 - c. Product manufacturer, name, and number.
 - d. Method of application.
 - e. Dry film mil thickness per coat of coating to be applied.
 - f. Color charts for selection and acceptance.

B. Technical and material safety data sheets.

1.5 QUALITY ASSURANCE:

A. Include on label of container:

- 1. Manufacturer's name, product name, and number.
- 2. Type of paint and generic name.
- 3. Color name and number.
- 4. Storage and temperature limits.
- 5. Mixing and application instructions, including requirements for precautions which must be taken.
- 6. Drying or curing time.

B. Factory-Applied Pipe Coatings:

- 1. Coating applicator shall have a minimum of 5 years of certifiable experience

in the type of coating work required.

2. Certification of quality control procedures during application of internal and external coatings shall be submitted to Owner's Authorized Representative for review. Certification to include: Surface preparation, film thickness per coat, curing procedures, and holiday testing.
- C. Pre-Painting Conference:
1. Within 90 days after Contract award and before Project field painting starts, representatives for Owner, Contractor, coating contractor, and coating manufacturer's technical representative shall meet with Owner's Authorized Representative.
 2. Agenda for the meeting will include details of coating specifications to ensure understanding and agreement by all parties for compliance.
- D. Coating contractor shall certify in writing to Owner's Authorized Representative that he has previously applied all the systems in this Specification and has the ability to prepare the surfaces correctly as specified.
1. A coating report shall be completed daily at each phase of the coating system starting with surface preparation. These will be submitted on the form attached at end of this Section.
- E. In the event a problem occurs with coating system, surface preparation, or application, coating contractor and coating manufacturer's technical representative shall promptly investigate the problem and submit results to Owner's Authorized Representative.
- F. Stated VOC shall be unthinned maximum VOC certified by manufacturer. Maximum VOC allowable in this area shall be verified and complied with by coating contractor.

1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Delivery of Materials:
1. Deliver in sealed containers with labels and information legible and intact.
 2. Allow sufficient time for testing if required.
- B. Storage of Materials:
1. Store only acceptable materials on Project Site.
 2. Provide separate area and suitable containers for storage of coatings and related equipment.
 3. Dispose of used or leftover containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Proprietary names and product numbers are specified in most protective coating system data sheets for material identification.
- B. Subject to compliance with specified requirements, provide products from the listed manufacturers.
 - 1. Carboline Company, Inc.
 - 2. Sherwin-Williams.
 - 3. International.
 - 4. Tnemec Company, Inc.
 - 5. Valspar.
 - 6. Devoe - AkzoNobel.
 - 7. Polyken Pipeline Coatings.
 - 8. Tapecoat Company.
 - 9. Denso North America.
 - 10. 3M Electrical Specialties Division.
 - 11. PPG.

2.2 GENERAL

- A. Materials furnished for each protective coating system shall be compatible to the substrate.
- B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
- C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Owner's Authorized Representative of any unsuitable substrate or coating conditions or product.
- D. Internal pipe coating shall be certified by the manufacturer to be suitable for exposure to Jet A fuel.

2.3 SURFACES AND MATERIALS TO BE COATED

- A. Shop-applied internal epoxy lining for carrier pipe and fittings
 - 1. Surfaces to be coated: Internal epoxy coating of fuel piping and fittings 2-1/2 inches and larger.
 - 2. Surface Preparation: SSPC-SP10 with nominal profile depth of 1.5 to 2.5 mils (38 to 63 microns).
 - 3. First Coat: High solids, high build, amine-cured epoxy, 55% solids by volume, off- white or similar color. Apply at 5 to 6 mils (125 to 150) dry film thickness. 2" (50 mm) cutback at pipe ends.
 - 4. Second Coat: Same as first coat, except white color. 2" (50 mm) cutback at pipe ends.
 - 5. System Total: Minimum 10 mils (250 microns) dry film thickness.

6. Volatile Organic Content: Per local regulatory requirements.
 7. Inspection: Check for voids with suitable electric holiday detector operating at proper voltage.
 8. Approved Products:
 - a. Amercoat 240
 - b. Devran 744
 - c. Interline 850
 - d. Tneme-Liner Series 61
- B. Shop-applied external protective pipe coating for containment pipe and fittings and any buried carrier pipe and fittings.
1. Surfaces to be coated: Exterior of secondary containment pipes and fittings and buried carrier pipe and fittings to be coated with Fusion Bonded Epoxy (FBE).
 2. Surface Preparation: Grit blast to SSPC-SP10, with minimum profile depth of 2.5 mils (0.064 mm). Surface shall be clean and dry.
 3. Field: Grit blast uncoated or damaged coated area to SSPC-SP6. Surface shall be clean and dry.
 4. First Coat: Shop applied, fusion bonded epoxy powder. Apply at 20 mils (0.508 mm) minimum dry film thickness. 2" (50 mm) cutback, or wipeback at pipe ends.
 5. Second Coat: Field applied, two component catalyzed epoxy specifically for use with specified first coat and of same color.
 6. System Total: 20 mils (0.508 mm) dry film thickness.
 7. Inspection: Check for voids with suitable electric holiday detector operating at proper voltage. Touch up as recommended by manufacturer.
 8. Approved Products:
 - a. Valspar PipeClad
 - b. 3M Scotchkote 206N
 - c. NapGuard 7-2500
- C. Field-applied external protective coatings
1. Surfaces to be coated: Underground fittings, field welds, and other large repairs of exterior of buried piping systems.
 2. Surface Preparation: Clean free of dirt, mil lacquer, wax, oil, grease, rust, mill scale, or other foreign material, in accordance with SSPC-SP2 or SSPC-SP3.
 3. First Coat: Field applied high-solids, fast-drying, surface tolerant epoxy coating. Minimum 87% solids by volume. Apply at 10 mils dry film thickness.
 4. Second Coat: Same as first coat.
 5. System Total: 20 mils (0.508 mm) dry film thickness.
 6. Field Inspection/Repair: Check for voids with suitable electric holiday detector operating at proper voltage.
 7. Approved Products:

- a. TC 7100 Wet Bond Epoxy
 - b. Protal ST Epoxy Mastic
- D. Field-applied external coatings where interfacing with existing coating systems
- 1. Apply pipe wrapping system to bare pipe and wrap interface between new and existing coating system. Overlap new tape wrap over existing and new coatings a minimum of 6 inches each.
 - 2. Surface Preparation: Clean free of dirt, mil lacquer, wax, oil, grease, rust, mill scale, or other foreign material.
 - 3. First Coat: Apply primer in a uniform thin film, free of runs, sags, and drips.
 - 4. Second Coat: Apply 35 mil polyethylene tape of proper width for pipe size. Clean same as above, apply primer, and polyethylene joint wrap tape in a spiral fashion with 50% overlap. End joint wrap with final edge directed downward. Tape temperature shall be minimum of 40° F. Overlap end splices 6".
 - 5. Field Inspection/Repair: Check for voids with suitable electric holiday detector operating at proper voltage.
 - 6. Approved Products:
 - a. Polyken Primer & Polken No 930-35 Wrap
 - b. TC-MA 2000 Primer & TC-P-35 Joint Wrap
- E. Coatings for pipes in underground pits and vaults.
- 1. Surfaces to be coated: Exterior of pipe, fittings, and valves in underground vaults or pits.
 - 2. Surface Preparation: Shop: SSPC-SP6 and profile depth 1.5 to 2.5 mils (38 to 63 microns). Field: SSPC-SP6 or 11 and profile depth 1.0 mil (25 microns) minimum.
 - 3. First Coat: High solids polyamine or polyamide epoxy coating with minimum 67% solids by volume. Apply at 5 to 8 mils (125 to 200 mm) dry film thickness.
 - 4. Second Coat: Same as first coat - white color.
 - 5. System Total: Minimum 10.0 mils (250 microns) dry film thickness.
 - 6. Volatile Organic Content: Per local regulatory requirements.
 - 7. Inspection: Check for voids with suitable electric holiday detector operating at proper voltage.
 - 8. Approved Products
 - a. Amerlock 2/400
 - b. Carbolite 890
 - c. Interseal 670 HS
 - d. Sherwin Williams Macropoxy 646 FC
 - e. Epoxoline II Series N69
- F. Coatings for aboveground piping
- 1. Surfaces to be coated: Aboveground exposed piping, valves, and other fuel equipment with corrodible surfaces (exterior). All fuel system valves shall be painted black.

2. Surface Preparation: Field First Coat: SSPC-SP6 1.5 to 2.5 mil profile (38 to 63 microns).
 3. First Coat: High build, high solids polyamide, polyamine, or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 to 6.0 mils (100 to 150 microns) dry film thickness.
 4. Second Coat: High build, high solids polyurethane low sheen enamel with minimum 60% solids by volume. Apply at 4.0 to 5.0 mils (75 to 125 microns) dry film thickness.
 5. System Total: Minimum 8.0 mils (0.229 mm) dry film thickness.
 6. Volatile Organic Content: Maximum per local regulatory requirements.
- G. Coating for Casing to be installed by Micro Tunneling
1. Surfaces to be coated: Buried Micro Tunneling Casing, extended to minimum 6 inches inside vaults.
 2. Surface Preparation: SSPC-SP5/NACE 1/ISO Sa 3 White Metal Blast Cleaning with a minimum angular anchor profile of 3.0 mils (76.2 microns). All surfaces must be clean, dry and free of oil, grease and other contaminants.
 3. First Coat: High build, high solids polyamidoamine epoxy with minimum 67% solids by volume. Apply at to 6.0 mils (150 microns) dry film thickness.
 4. Second Coat: Series 431 must be applied to Series N69 or N140 within 7 days. Scarify the surface with fine abrasive before topcoating if exceeding this maximum recoat window.
 5. System Total: Minimum 36 mils (914 microns) dry film thickness.
 6. Volatile Organic Content: Maximum per local regulatory requirements.
 7. Approved Products
 - a. Tnemec Hi-Build Epoxoline II, Series N69 or Pota-Pox Plus Series N140 for First Coat.
 - b. Tnemec Perma-Shield PL Series 431 for Second Coat.
 - c. Approved equal.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparations specifications listed.
1. If grease or oils are present, SSPC-SP 1 shall precede any other method specified.
 2. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.
 3. Prepare surfaces of field welds, sears, or other damage, and touch up with coating as specified or recommended by manufacturer.
- B. Depth of profile will be as specified for each system, but in no instance shall it exceed

one-third of the coating dry film thickness per coat.

- C. Prepare only those areas which will receive the first coat of the system on the same day.

3.2 APPLICATION

- A. Apply coatings in accordance with coating manufacturer's recommendations. Use properly designed brushes and spray equipment for all applications.
- B. Coating for the casing pipe installed by means of microtunneling shall have a letter from the coating manufacturer certifying that the product is suitable for the intended application.
- C. Any damage to protective coating shall be repaired per the manufacturer's recommendations and proper cure times shall be adhered to prior to installing carrier pipes and casing pipes.
- D. Dry film thickness of each system shall meet the minimum specified but not exceed it more than 20% or coating manufacturer's requirements if less.
- E. On unprimed surfaces apply first coat of the system the same day as surface preparation.
- F. Shop painting shall remain 3 inches away from unprepared surface of any substrate such as areas to be welded or bolted.
- G. Environmental Conditions:
 - 1. Atmospheric temperature must be 50°F or higher during application, unless approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating curing time requirements.
 - 2. Wind velocities for exterior applications shall be at a minimum and not greater than coating manufacturer's limits.
 - 3. Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least 5°F above the dew point.
 - 4. Provide adequate ventilation equipment in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
- H. Protection:
 - 1. Cover or otherwise protect surfaces not being painted, areas not to be painted, and the work of other trades. Remove protective materials when appropriate.
 - 2. Provide signs to indicate fresh paint areas.
 - 3. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
 - 4. Provide cover to prevent paints from entering orifices in electrical or mechanical equipment.
 - 5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, thinners, and related materials. Dispose of leftover

containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.

6. Do not remove or paint over equipment data plates, code stamps on piping, or UL fire- rating labels.

3.3 CLEANING

- A. Touch up and restore damaged finishes to original condition as required.
- B. Remove spilled, dripped, or splattered paint from all surfaces.

3.4 COATING REPAIRS

- A. Repair all damages to pipe coating systems before the piping is holiday tested.
- B. This includes all cuts, breaks, voids, bruised or scarred spots, or other damage caused prior to delivery, or resulting from handling or installation of the pipe, or from any cause whatsoever.
- C. Included also are damaged coatings where new connections are made to existing coated pipes or where existing coated pipes are uncovered or exposed for any reason.
- D. Also repair the coating where welds are made and where damaged or broken by the installation of instrumentation or other accessories or appurtenances.
- E. Repair all holidays detected during inspection of coatings.
- F. Repair coating where field welds are made or where otherwise damaged.
 1. Complete all weld radiography for fuel piping joints prior to application of coatings.
- G. Inspection:
 1. Use wet film gauges to check each application about every 15 minutes in order to correct low or heavy film build immediately.
 2. Use dry film gauge to check each coat when dry, and the total system when completed.
 3. Use holiday or pinhole detector on metal systems to detect and correct voids when indicated on system sheet.
 4. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
 5. Check temperature of the substrate at regular intervals to be certain surface is 5°F or more above the dew point.
 6. Complete coating reports daily using form approved by the Owner's Authorized Representative.

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

No separate measurement for payment for work in this section shall be made. Work in this section shall be included in other unit price Bid Items.

PART 5 – BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

No separate payment for work in this section shall be made. Payment for work in this section shall be included in other unit price Bid Items.

END OF SECTION 33 52 46