

# ***CONSTRUCTION SPECIFICATIONS AND DRAWINGS***



***Installation of a  
Runway Visual Range  
to serve RWY 31  
at the  
McNary Field in Salem Oregon***

***July, 2009***

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## **SECTION 01010**

### **SUMMARY OF WORK**

#### **PART 1 GENERAL**

##### **1.1 SCOPE OF WORK**

The work covered under this specification includes replacing the TASKER 500 RVR with a Teledyne RVR for RW 13/31 at McNary Field in Salem, Oregon. Remove and demolish the existing Tasker, including all steel, concrete and wires. Demolition is elaborated in the following sections.

The contractor is required to furnish all labor, materials (except Government furnished), services, equipment, insurance, bonds, security notifications, licenses, permits, and fees in accordance with applicable federal, state and local regulatory requirements to complete the specified work. Any miscellaneous labor, equipment and/or materials not specifically detailed or specified, but required to complete the project, shall be provided as an integral part of the work.

The dimensions, measurements, and quantity of materials listed in this specification and on the construction drawings are estimated and are presented to give the contractor an idea of the total scope of work. The contractor is strongly encouraged to make a site visit to verify the existing conditions, quantities of materials, and amount of work required. The contractor is responsible for assuring that the bid reflects all work required to accomplish this project. Coordinate site visit with the FAA Project Engineer, Kelina Wong, (425) 591-8165.

The following items are a brief summary of the project and are provided solely for the purpose of revealing the general nature of the work involved. The Contractor is responsible for accomplishing all items of work in accordance with the applicable drawings, specifications and provisions of the contract. Any additional labor, materials, equipment, and/or appurtenances not specifically detailed or specified, but required to complete the project, shall be provided by the Contractor as an integral part of the scope of work specified.

##### **1.1.1 Installation and demolition of the RVR**

Contractor shall install the RVR as indicated on the construction drawings, and per manufacture instruction guidelines. RVR is to be located northeast of the existing GS antenna/GS building. Work includes: Construction of the RVR concrete foundation, GS/RVR power rack, associated grounding/bonding and installation of the RVR MG-20 mast, and comm. cable pull at the equipment base building, ATCT, and lighting building.

Contractor shall remove old existing wooden meter base and disconnect. Replace with new Power and Control Unit (PCU) that contains a new meter base and new GS disconnect, Double

Throw Switch, EG Disconnect Switch, SPD for GS Disconnect Switch, and a RVR Disconnect Switch. Contractor shall install the RVR VS power and control unit as indicated on the construction drawings. Unistrut rack shall be mounted on GRS and on frangible couplings (as per drawings). Grounding and bonding shall be constructed as per FAA-STD-19E. Contractor is to locate all utilities before construction.

Demolition of the old Tasker RVR to take place after the new Teledyne RVR is installed and in service. Contractor to coordinate with PGE as necessary to perform an "in service change out". If an outage is necessary, contractor shall coordinate with the Project Engineer/Resident Engineer and SSC. If an outage of the RVR is necessary, for more than 24 hours, a 30 day notice is required. For an outage of 8 hrs or less, a 24 hr notice is required. Demolition work includes removal of the old Tasker and associated power and control unit, including all structural steel members and hauled to the recycle bin at public works. Concrete to be removed and taken to the concrete recycle bin as directed. RVR DEB cable to be removed by contractor to the greatest extent possible, then cable can be cut; place a cable marker showing the direction of unused abandoned cables (as per airport manager). Holes and trenches from demolition need to be backfilled with suitable fill and compacted to 90% of maximum dry density AASHTO T-99. See section 3.4.4.1. Place 4" of top soil and compact before seeding with range grass.

#### **1.1.4 Installation of Power and Control for the RVR**

##### **1.0 General requirements**

1.1 1.1 Scope – The contractor shall furnish all labor, equipment and materials, except GFM/GFE, required to complete the project as shown on the Contract Drawings and described within this specification. The major work items for this project are as follows:

1. Remove and dispose existing 4"x4" support wooden pole for service KWH meter at GS power rack.
2. Remove and dispose existing 3.5"x3.5" wooden barrier post.
3. Remove and abandon existing underground GS feeder as shown on the electrical demolition plan.
4. Remove and abandon existing underground RVR branch circuit as shown on electrical demolition plan at the demolition phase.
5. Remove and dispose existing RVR tower at the demolition phase.
6. Provide new GS power rack including KHW cabinet, meter base, service power breaker, power steel rack, manual transfer switch, disconnect switches, surge protective devices, Engine-generator receptacle, conductors, conduits, J-box, and associated equipment and materials as shown on electrical one line diagram and electrical drawings.
7. Provide new RVR rack including power panel and circuit breakers, surge protective device, GFI outlet & waterproof cover box, obstruction lights, J-box, and associated

equipment and materials as shown on electrical one line diagram, electrical drawing, and electronics drawings. Note. Due to the RVR rack being located near the runway safety area; therefore, the RVR rack shall have frangible mounting anchor bolts with 4 feet width.

8. Provide new materials to install the RVR system (VS SIE) as shown on RVR electronic drawings.
9. Provide 4 wooden barrier poles (4"x4"x 5 feet H treated wood) to protect the new GS rack and RVR rack. These poles shall be paint with yellow color.
10. Provide 10 KW 120V/240V portable engine-generators (EG) unit to feed the existing GS and RVR facilities during the construction phase. Provide all temporary services required for construction, such as conductors, conduits, J-boxes, connectors, fuses, diesel fuel, and associated materials to provide continuous electrical power for the existing GS power panel at the GS shelter.
11. Coordinate with the commercial power company (Portland General Electric or PGE) for replacement of GS power rack, KWH meter cabinet, and power outage.
12. The contractor shall provide 10 KW 120v/240V portable generator including power cable, fuel and associated materials to feed facility during power outage phases. Estimate about 10 hours to 12 hours power outages during the installation.
13. The contractor shall coordinate with PEG (commercial power company) for power outage to replacement power rack & new KWH meter. The contractor shall pay PEG for all power service including power outage request.

Contractor shall install the power and control for the RVR as indicated on the construction drawings. Work includes: Installation of power & control conduits and conductors between the PCU, RVR and GS building. Installation of power & control conduits and conductors between VS rack and GS building. See drawings for trench detail. Utility locates are required around the GS site and hand digging is required because there are main transformer power runs through out this area. Contractor shall coordinate with PGE (Portland General Electric) to run a temporary generator while construction is in progress. Plan is to perform an in service change out. Please see electrical drawings for more details on wire sizes etc. Install 12"x12"x6" deep NEMA 3R J-box hinged cover on GS building interior wall with #2 AWG and connect to existing counterpoise and cad weld.

Work located at the Base building, ATCT, and Lighting Shelter to be constructed per drawings. Work includes replacing the J-Boxes in equipment base building and tower. Install minimum 12"x12"x6" deep NEMA 3R-J-box with screw cover at ATCT and replace existing 12"x12"x4" J-box with larger J- box min 12"x18"x6" deep NEMA 3R J-Box with screw cover at ATCT. Install new 25 PR #19 in existing 2" conduit from base building to 1<sup>st</sup> floor junction room in ATCT. Place new 12 PR #19 in existing 3" conduit from junction room in ATCT running west through existing manhole sweeping south to the Lighting Shelter. Contractor must identify unused abandoned cables at the ATCT 1<sup>st</sup> floor junction room. Conduits may need clearing/cleaning. See drawings for details on conduit usage. Install new 12"x12"x 6" deep NEMA 3R J-box with hinged Cover on Airport Lighting Shelter Wall with 1" EMT as per drawings (Approx. 30 LF) with #2 AWG and connect to existing counterpoise and cad weld. In

the Base building, replace existing 12"x12"x4" J-box with larger J-box minimum 12"x18"x 6" deep NEMA 3R J-box with screw cover.

### **1.1.5 General Site Work**

Contractor shall perform the general site work as indicated on construction drawings. Work includes: Installation of the fabric, road base and rock around the RVR, P/C station and RVR tilt down pole maintenance area.

## **1.2 REFERENCES**

Airport Ground Vehicle Operations Guide  
available from: [http://www.asy.faa.gov/safety\\_products/airportground/AGVO-guide.doc](http://www.asy.faa.gov/safety_products/airportground/AGVO-guide.doc)

## **1.3 DRAWINGS**

Callouts on the construction drawings indicate work to be done under this contract unless specifically noted "installed by others" or "existing". Callouts indicating work to be done do not always include the word "install".

### **1.3.1 Construction Drawings Provided**

Drawings applicable to this project are listed below. The written scale (e.g. 1"=100') is only valid for FAA "D - size" drawings (22"x34") and may be slightly off due to variations in printing. On reduced size drawings, the bar scales (where shown) and written dimensions remain valid.

### **1.3.2 As-Built Drawings**

The contractor shall provide three complete sets of As-Built drawings to the FAA Project Engineer at the end of the project. The following color codes shall be used:

Green -to indicated new or changed information

Red -to indicated deletions

Blue - to indicate notes to the draftsman

Any additional diagrams and/or schematics that would be helpful for the maintenance of the facility should also be included.

## **1.4 SUBMITTALS**

### **1.4.1 Material**

The contractor shall submit for approval; catalog data, cut-sheets, samples, and any other relevant information on the contractor furnished material to be used on this project. Two copies of the submittal package shall be given to the FAA Project Engineer for approval. Submittals on materials shall include, but is not limited to:

- Coated galvanized rigid steel conduit.
- Cement concrete material.
- Geotextile fabric.
- Aggregate material.
- Contractor furnished hardware.
- Contractor furnished electrical fittings and components.
- Contractor furnished cable and wire.
- Labels.
- Anti-rust product for threaded hardware
- Additional items deemed necessary by the Project Engineer.
- Pull Box's

**1.4.2 Schedule**

Prior to start, the contractor shall submit a schedule and work plan to the Project Engineer for approval. See section 3.1.2 for the maximum time allowed to complete this project. The schedule shall show start dates, duration, and finish dates for each work activity. Activities shall include, but are not limited to:

- Site layout.
- Installation of RVR/PCU foundations.
- Installation of power and control for the RVR.
- Installation of the incoming power service for the RVR.
- Site work.
- Gravel Walkway
- Inspection and cleanup.

The FAA reserves the right to modify the contractor's sequence of activities in the interest of facility operation and airport safety.

**1.4.3 Schedule of Values**

The contractor's proposal shall include a schedule of values, showing at a minimum, a breakdown of cost for each work activity listed in the work schedule / below. Cost for each item should include any profit and overhead.

- Site layout. \$ . \_\_\_\_\_ .
- Installation of RVR foundation. \$ . \_\_\_\_\_ .
- Installation of the RVR meter station foundation. \$ . \_\_\_\_\_ .
- Installation of power and control for the RVR. \$ . \_\_\_\_\_ .

- Installation of the incoming power service for the RVR. \$.\_\_\_\_\_.
  - Site work. \$.\_\_\_\_\_.
  - Inspection and cleanup. \$.\_\_\_\_\_.
- TOTAL PROJECT COST** \$.\_\_\_\_\_.

**1.4.4 Safety Plan**

The contractor shall submit a safety plan per paragraph 3.4.2.6 of this section.

**1.4.5 Work Plan**

The contractor shall submit a work plan per paragraph 3.4.5 of this section.

**1.4.6 Testing**

The contractor shall complete, at his own expense, all testing as required by these specifications. The results shall be submitted to the FAA Project Engineer. Required testing includes, but is not limited to, the following:

- Cable insulation resistance test (see FAA-C-1217f, 5.3.4)
- Earth resistance test (see FAA-C-1217f, 5.3.6)
- All Required Concrete Testing (performed by an independent testing company).
- Soil Compaction Testing (performed by an independent testing company).

**PART 2 PRODUCTS**

Reference herein or in the construction drawings to any specific commercial product, process, or service, any trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the Federal Aviation Administration. The contractor may submit a request for substitution of a product, process, or service specifically called out. Such request shall be through the submittal process.

**2.1 GOVERNMENT FURNISHED MATERIAL**

- (1ea) Runway Visual Range Touchdown Teledyne.

**2.1.1 Inventory and Inspection of GFM**

**This is not applicable for there are no GFM for this project:**

The contractor shall sign a copy of the Government furnished material (GFM) list acknowledging receipt of the furnished material, noting any discrepancies if necessary. When the contractor signs for custody, he acknowledges receipt in good condition and assumes responsibility for any

subsequent loss or damage. The contractor shall return all GFM that is not installed to the location where the material was picked up.

## **2.2 CONTRACTOR FURNISHED MATERIAL**

The contractor shall furnish all material that is required and not otherwise indicated to be Government furnished. Materials furnished by the contractor shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with the specification requirements.

The contractor is responsible for making their own arrangements for material delivery and receiving. The contractor shall not have any material delivered to any FAA offices. Delivery to the Airport address shall only be done with the prior approval of the airport management.

The list of contractor furnished material includes, but is not limited to:

- LIR pole MG-20 Jaquith
- Dual Obstruction Light L-810
- Concrete, re-bar, anchor bolts, cable markers, etc.
- Power, control, and grounding cable, as required.
- Ground rods, #1/0 bare copper guard wire, exothermic welds and misc. hardware for grounding system.
- 2" Frangible Couplings compression type.
- Geotextile fabric, as required.
- Aggregate material / Rotomill, as required.
- Coated galvanized rigid metal conduit, EMT, and PVC conduit as required.
- Electrical fittings and components, as required.
- Misc. hardware and Unistrut, as required.
- Labels for electrical components, cables, pull boxes, etc.
- Floor flanges, as required.
- 100 Amp Disconnect (fused at 30 amps) for service side

- 20amp breaker in the Airport Lighting Shelter
- Spare parts Enclosure box - for RVR
- Meter base, double throw switch, GS/EG/RVR disconnect switch, SPE for GS and EG recept .
- (4ea) J-box, 12"x12"x 6" deep NEMA 3R J box with hinged cover and screw cover
- (2ea) J-box, 12"x18"x 6" deep NEMA 3R J box with screw cover
- (4ea) 3"x3" Wooden posts (pressure treated) to protect the proposed PCU
- EG rental, temporary power, fuel etc. Contractor to coordinate with PGE.
- Guard posts

## **2.3 MATERIAL**

### **2.3.1 External Hardware**

All external hardware shall be hot dipped galvanized, stainless steel, or approved for long term outdoor use. All cut edges shall be filed smooth and treated with a cold galvanizing compound.

### **2.3.2 Galvanized Rigid Metal Conduit (GRMC)**

All galvanized rigid metal conduit (GRMC) installed below slab, on grade, or underground shall be coated. GRMC shall conform to Steel Structures Painting Council Standard, SSPC-PS 10.01), or be field wrapped with 0.01 inch thick pipe wrapping plastic tape applied with 50% overlap. Fittings used underground shall be protected by field wrapping as specified herein for conduit.

### **2.3.3 Anti-oxidant compound**

Use an anti-oxidant compound on all external threads, insertions, and connections.

### **2.3.4 Asbestos Free Material**

The Contractor shall not use any asbestos containing material (ACM) at any time during the construction. The Contractor shall verify that all material, including those supplied by third parties, are asbestos free materials. A written certification letter shall be provided by the Contractor to the FAA certifying that the finished work is asbestos free.

## **PART 3 EXECUTION**

## **3.1 SCHEDULES**

### **3.1.1 Work schedule**

All work hours shall be coordinated with the Project Engineer. Project engineer is to coordinate with Airports to determine hours of work. No work shall be scheduled on Saturdays, Sundays or legal holidays without prior approval from the FAA Project Engineer.

If a GS outage is required, then work is to be conducted on a VFR day. An in service change out is required, therefore install the new Teledyne RVR before demolishing the existing Tasker RVR.

The contractor shall furnish the Resident Engineer with emergency (24 hour) contact phone numbers for the contractor's superintendent and an alternate individual. Such numbers will be used if the contractor needs to be contacted outside of normal working hours.

### **3.1.2 Construction Schedule**

All work shall be completed within 20 business days after the Notice to Proceed (NTP).

### **3.1.3 Weekly Look Ahead Work Schedule**

On a weekly basis, the contractor shall submit a schedule showing activities desired to be performed during the upcoming week. These work activities shall be approved by the FAA Project Engineer.

### **3.1.4 Deviation from Work Schedule**

The Airport Manager and the FAA Project Engineer reserve the right to suspend or stop construction as necessary for the safety of aircraft or airport property. In addition, the FAA may adjust the work hours to satisfy the facility operations.

### **3.1.5 Daily Construction Log**

The Contractor shall keep a Daily Construction Log. At a minimum, the daily log shall contain:

- Items accomplished for that day.
- Start and stop time of work.
- Name of workers (including sub-contractors), and hours they worked for that day.
- Weather (including sky, ground moisture conditions, and temperature).
- Material received.
- Documents and photographs showing the progress of work, and as required.

The Daily Construction Logs shall be turned over to the FAA Project Engineer on a weekly basis.

### **3.2 PRE-CONSTRUCTION MEETING**

Prior to the start of any work and the contractor's access to the work site, the contractor shall be required to attend a pre-construction meeting. Attendees at the meeting may include, but is not limited to, the FAA Project Engineer, Resident Engineer, FAA Contracting Officer, the Airport Manager, Airport Operations, FAA maintenance, and other interested parties as determined by the Project Engineer. Topics at the meeting will include: site access, airport security, work safety, work schedule, project expectations, work procedures, emergency plans, and other items relating to the execution of the project.

### **3.3 LAYOUT**

The contractor shall verify the field measurements and coordinates indicated on the drawings with the FAA Project Engineer before starting any layout. The contractor shall lay out his work from base lines and bench marks indicated on the drawings and shall be responsible for all measurements in connection therewith. The contractor shall furnish, at his own expense, all stakes, templates, platforms, equipment, tools, materials and labor as may be required in laying out any part of the work. All layout work shall be accomplished by a Professional Land Surveyor. The contractor is to properly maintain the specified layouts to assure proper alignment of the construction. Roads indicated to be installed under this contract shall be laid out and clearly marked at the beginning of the project and used as access roads during construction so as to minimize the disturbance to the surrounding areas.

### **3.4 SPECIAL REQUIREMENTS**

#### **3.4.1 Special Precautions**

The contractor shall conform to the rules and regulations of the airport and shall coordinate all work with the FAA Project Engineer.

Note: Unscheduled interruptions of the electrical service to FAA facilities may cause aircraft accidents and loss of life. Work requiring a temporary or permanent de-energization of equipment shall be scheduled in writing with the FAA Project Engineer and the onsite FAA maintenance personnel. Only onsite FAA maintenance personnel are authorized to energize/de-energize equipment, or to operate a circuit breaker, switch, or fuse in an FAA facility.

#### **3.4.2 Safety Requirements**

Aviation Safety is a primary consideration during airport construction. The Contractor is completely responsible for complying with the Airport's safety and operation procedures, as dictated by the Airport.

During the performance of this contract, the airport runways, taxiways, and aircraft parking aprons shall remain in use by aircraft to the maximum extent possible, **CONSISTENT WITH**

CONTINUAL SAFETY. The contractor shall not allow employees, subcontractors, suppliers, or any other unauthorized person to enter or remain in any airport area which would be hazardous to persons or to aircraft operations.

#### **3.4.2.1 Runway Safety and Object Free Areas**

The Runway Safety Area (RSA) width for runway 31 at the McNary Field in Salem, Oregon is 500'.

Prior to commencement of work, the contractor shall delineate the boundaries of the safety area with 3/8" x 1 1/2" x 4' long pointed lath (survey sticks) and bright orange flagging.

The contractor shall not be allowed into the Runway Safety Area without prior approval from the Air Traffic with ADO restrictions. In general, no workers or equipment shall be allowed inside the safety area when aircraft are using the runway. Work to be done inside the safety area shall be scheduled and closely coordinated by FAA Project Engineer with Air Traffic with ADO restrictions. Please refer to the RMP that was approved by the multidisciplinary team.

In addition to the restrictions of working in the Runway Safety area and Object Free Area, the Airport Manager and/or the FAA Project Engineer may impose more restrictive requirements as needed to maintain airport safety.

#### **3.4.2.2 Approach Surface**

No vehicles or equipment shall be permitted to penetrate an approach surface (extended along the runway centerline) of 20:1 for visual runways, 34:1 for runways with a non-precision approach, or 50:1 for runways with an operational ILS. The approach surface begins at the runway threshold centerline elevation and starts 200 ft downwind from the threshold (or from the location of the Displaced/Relocated threshold).

#### **3.4.2.3 Construction Vehicle Traffic**

The contractors' vehicles and equipment shall enter the work site and construction areas at approved locations, and by way of authorized routes. The use of runways, aprons, taxiways, ramps, will not be permitted unless specifically approved by the FAA Project Engineer and the Airport Manager. The contractor shall inform all personnel that aircraft have the right-of-way at all times. The contractor shall be responsible for maintaining control and security at each entry point, as approved.

As a minimum, all vehicles and motorized equipment that enter the Airport Operations Area (AOA) shall be marked per AC 150/5210-5B (or latest version). In general, all vehicles and motorized equipment inside the AOA shall be marked with a three foot by three foot flag with international orange and white 12 inch squares displayed in full view above the vehicles. At night, or during periods of low visibility, all vehicles and equipment operating in the AOA shall be identified with an approved yellow flashing beacon.

In addition, no personnel will be permitted to drive on the airside of the airport unless he/she has read, and certified that he/she has read, " A Guide to Ground Vehicle Operations on an Airport" (DOT/FAA/AS-90-3). Personnel shall comply with the airports regulations on access on the AOA and possibly obtaining a drivers permit.

THE AIRPORT AND/OR THE FAA MAY HAVE ADDITIONAL REQUIREMENTS FOR VEHICLES, EQUIPMENT, AND PERSONNEL OPERATING INSIDE THE AOA.

#### **3.4.2.4 Unauthorized Structures**

The contractor shall install no fences or other physical obstructions on or around the project work area without the approval of FAA Project Engineer and Airport Operations.

#### **3.4.2.5 Hazard Marking**

The contractor shall use barricades, flashers, flags, traffic cones, signs, etc., for the following:

- To prevent aircraft from taxiing onto a closed runway, taxiway or apron.
- To outline construction/maintenance areas.
- To identify isolated hazard areas such as open manholes, ditches, potholes, waste areas, etc.
- To identify FAA and Airport facilities, cables, power lines, ILS Critical areas, and other sensitive areas, in order to prevent damage, interference and facility shutdown.

All hazard markings shall be furnished and setup by the contractor. Barricades inside the runway safety area shall be lightweight and frangible. For daytime use, barricades should be supplemented by flags; for night time use, they shall have flashing yellow lights. Night time barricades shall not penetrate the approach surface. All markings shall be to the approval of the FAA Project Engineer.

#### **3.4.2.6 Safety Plan**

Prior to commencement of work, the contractor shall submit a safety plan for approval by the Project Engineer. An acceptable safety plan shall take into account areas discussed in Appendix 1 of AC 150/5370-2C and the Airport's rules for construction activity at the Airport.

#### **3.4.3 Radio Communications**

The contractor's superintendent (or someone appointed by the superintendent) shall be required to monitor a transceiver radio at all times when the contractor is operating inside the runway safety area. The transceiver shall be contractor furnished with a frequency range of 118-136 Mhz

and tuned to the local ATCT Tower or Ground Control (CTAF when tower is closed) frequency, UNICOM frequency, or as required. Such radios shall be used so that any unusual occurrence of approaching, departing, taxiing aircraft can be acknowledged by all concerned parties. The contractor's use of the transceiver radio is basically for listening purposes, transmitting should be in emergencies only.

#### **3.4.4 Work Limitations**

The contractor's activities shall be planned and scheduled to minimize disruption of normal aircraft activities. If the clearances and restrictions described in this section cannot be maintained while construction is underway (for example, when performing work that is required inside the runway safety area), action shall be taken to close runways (or taxiways, or aprons), displace/relocate the runway threshold temporarily (see 3.4.4.2), and/or to perform work at night or during periods of minimal aircraft activity, as approved.

##### **3.4.4.1 Trenches, Holes, and Excavations**

Trenches, holes, and any other type of excavation within the runway safety area are not allowed without either closing the runway or adequately displacing/relocating the runway threshold to accommodate the work. If a runway closure or displacement/relocation of the runway threshold becomes necessary, the contractor shall submit a detailed plan which must be approved by the Airport and the FAA.

If contractor plans to leave holes, trenches, or excavations open, contractor shall coordinate with the Resident Engineer and Airport Operations to comply with Airports regulations.

#### **3.4.5 Work Plan**

Prior to commencement of work, the contractor shall submit a work plan for approval by the Project Engineer (see 1.4). An acceptable work plan shall take into account all areas discussed in this section.

### **3.5 PROTECTION OF EXISTING UTILITIES AND CABLES**

The existing utility lines, utility structures and all underground cables, as may be shown on the drawings are approximate and incomplete. Where excavation occurs in the vicinity of existing utilities or cables, the contractor shall use whatever means necessary, including a private cable locator, to locate the existing utilities or cables prior to any excavation. The contractor shall stake all utility or cable crossings and such areas shall be hand excavated. The contractor shall immediately repair any damage done by the contractor or suppliers to utilities or cable within the work area. When an unexpected outage occurs, contact the POCC at 858-831-7522.

### **3.6 INSTALLATION AND WORKMANSHIP**

All work shall be performed according to the intent of the contract, and normal and accepted industry and Government standards.

All work shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulations, the workers shall be properly licensed. Electrical terminations and splices shall be done by a qualified electrician.

The contractor shall give constant attention to the work to facilitate the progress thereof, and shall cooperate with the Project/Resident Engineer in every way possible. The contractor shall have a competent superintendent on the work site at all times who is fully capable of reading and thoroughly understanding the plans and specifications and shall receive and fulfill instructions from the Project/Resident Engineer.

An initial inspection shall be conducted when a representative sample of work has been completed. This work shall be approved by the FAA Project Engineer or his representative, prior to the commencement of additional work.

All conduits shall be completely cleaned prior to installing cable. A flexible mandrel shall be used to clean out mud, dirt, and debris from the raceways.

Underground conduits shall be installed so that no water can be trapped in the raceway (water must be able to drain out of one end).

All foundations, manholes, vaults, pull boxes, equipment racks, buildings, roads, retaining walls and other above ground structures shall be installed square (perpendicular and parallel) to the runway centerline, prevailing structure or road as indicated on the drawings unless specifically indicated to be otherwise. Elevated conduits and structures (those extending above grade) shall be installed level and plumb. Unless otherwise indicated, maximum tolerance for vertical plumbness is  $1/8''$  horizontal for every four feet vertical. Exposed raceways shall be installed parallel to or at right angles with the lines of the finished structure, unless otherwise indicated.

Tops of foundations, cans, pull boxes, manholes, vaults, etc., shall be uniform with the tops of concrete at the surrounding structures, natural grade or as indicated on the drawings or as directed by the Project Engineer. Unless otherwise indicated, top of foundations, cans, pull boxes, manholes, etc. shall be level with a maximum tolerance of  $1/16''$  per foot.

Road curves shall be as indicated on the drawings or as indicated by the Project Engineer. Edges of roads, walkways and graveled areas shall be clean, sharp, and well defined. Installed surface material shall not be allowed to spill outside the defined edges.

Installed foundations, structures, walkways, and roads not meeting the above requirements shall be removed, disposed of, and re-installed correctly at the contractor's expense.

### **3.7 TEMPORARY FACILITIES**

The contractor shall provide and pay for all temporary services and facilities as specified below and as necessary for the proper and expeditious execution of the work. The contractor shall make, or have made, all connections to existing services and sources of supply as necessary and/or indicated and pay all charges for same. All work under this Section shall comply with applicable laws, rules, regulations, codes, ordinances, and orders of all Federal, State, and Local authorities having jurisdiction for the safety of persons, materials and property. The contractor shall remove all such temporary installations and connections when no longer necessary for the project work.

### **3.7.1 Temporary Water**

The contractor shall make arrangements to furnish a potable water supply for workers and project work, and pay for all water and services.

### **3.7.2 Temporary Toilets and Sanitation**

The contractor shall provide ample and suitable on site sanitary conveniences with proper enclosures for the use by the workers, FAA personnel, and FAA support personnel. Such conveniences shall be kept clean, properly ventilated and installed and maintained in conformity with requirements of all laws and ordinances governing such installations. Locations shall be subject to the FAA Project Engineer's approval. After completion of the work such conveniences shall be removed from the site.

## **3.8 SECURITY REQUIREMENTS**

The contractor shall comply with all security requirements established by the Airport. Only direct construction support personnel, vehicles and/or equipment will be allowed to the construction site.

During construction operations, the contractor shall use only the access gates and haul roads that are designated by the FAA Project Engineer. The contractor shall be required to keep access gates guarded and closed during construction hours. The gate may be opened only for authorized vehicle traffic flow. At such times as this gate is not guarded, it shall be closed and securely locked. The contractor shall be held duly responsible to uphold the above security stipulations at all times during the progress of the construction project. No deviations from these security measures shall be allowed at any time.

## **3.9 SAFETY**

All work shall be accomplished in accordance with OSHA Regulations (Standards – 29 CFR), Part 1926, Safety and Health Regulations for Construction.

Protective Equipment, including personal protective equipment for eyes, face, head, and protective clothing shall be used wherever it is necessary by reasons of hazards or environment [1926.95].

- Head protective equipment (helmets) shall be worn in areas where there is a possible danger of head injuries from impact, flying or falling objects, or electrical shock and burns [1926.100].
- Eye and face protection equipment shall be worn when machines or operations present potential eye or face injury [1926.102].

Specific work and operations requiring the mandatory use of personnel protective equipment shall be determined by the FAA Project Engineer.

### **3.10 SEDIMENTATION, EROSION, AND DUST CONTROL**

The Contractor shall submit a plan for sedimentation, erosion, and dust control. The plan shall show best management practices such as the use of silt fencing and/or hay bales to filter sediments from runoff and the application of water as needed to control dust.

### **3.11 DEBRIS CONTROL AND CLEAN-UP**

The work site shall be kept clean and orderly during the progress of work. Special attention shall be exercised to prevent the production of FOD (foreign object debris) which could cause damage to aircraft and/or airport equipment. Prior to the Contract Final Inspection, the contractor shall clean all areas of the construction site. This shall include but is not limited to the dress-up, sweep-up, and re-seeding of all areas disturbed during construction. **A NEAT FINAL APPEARANCE OF THE INSTALLED FACILITIES (INTERIOR AND EXTERNAL) SHALL BE EMPHASIZED!** All clean-up work shall be to the approval of the FAA Project Engineer.

Upon completion of work, the contractor shall be required to obtain a letter from the Airport Manager indicating that the work area has been left in an acceptable condition. A copy of the letter shall be given to the FAA Project Engineer.

### **3.12 INSPECTION & ACCEPTANCE**

The Contractor shall maintain an adequate inspection system and perform such inspections to ensure that the work performed under the contract conforms to contract requirements. The Contractor shall maintain complete inspection records and make them available to the Government.

**THE PRESENCE OR ABSENCE OF A GOVERNMENT INSPECTOR DOES NOT RELIEVE THE CONTRACTOR FROM ANY CONTRACT REQUIREMENT.**

The Government inspections and tests are for the sole benefit of the Government and do not-

- Relieve the Contractor of responsibility for providing adequate quality control measures;

- Relieve the Contractor of responsibility for damage to or loss of the material before acceptance;
- Constitute or imply acceptance.

The Contractor shall, without charge, replace or correct work found by the Government not to conform to contract requirements. The Contractor shall promptly segregate and remove rejected material from the premises.

END OF SECTION



**SECTION 01060****ENVIRONMENTAL PROTECTION**

- 1.0 **SCOPE** - This section covers prevention of environmental pollution and damage as the result of construction under this contract. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, biological elements, or agents which adversely affect human health and welfare; unfavorably alter ecological balances of importance to human life; or affect other species of importance to man. The control of environmental pollution and damage requires consideration of air, water, and land, includes management of visual esthetics, noise, and solid waste, as well as other pollutants.
- 1.1 **Quality Control** - The Contractor shall establish and maintain quality control for environmental protection of all items set forth herein. The Contractor shall record any problems in complying with laws, regulations, ordinances, and corrective action taken.
- 1.2 **Subcontractors** - Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.
- 1.3 **Notification** - The Site Representative will notify the Contractor in writing of any observed noncompliance with Federal, state or local laws, regulations or permits. The Contractor shall, after receipt of such notice, inform the Site Representative of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Subcontract Administrator may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or costs or damages allowed to the Contractor for any such suspension.
- 1.4 **Protection of Environmental Resources** - The environmental resources within the project boundaries and those affected outside the limit of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas designed by the drawings and specifications. Environmental protection shall be as stated in the following subparagraphs.
- 1.4.1 **Protection of Land Resources** - The Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without special permission from the Site Representative.
- 1.4.1.1 **Disposal of Solid Wastes** - Solid wastes shall be placed in container which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. Waste materials shall be disposed of in accordance with local, county, state and Federal regulations.
- 1.4.1.2 **Disposal of Chemical of Hazardous Waste** - Chemical or hazardous waste shall be stored

in corrosion-resistant containers removed from the work area and disposed of in accordance with Federal, state and local regulations. The existing demolished E/G storage batteries shall be treated as hazardous waste.

- 1.4.1.3 Disposal of Discarded Materials - Discard materials, other than those which can be included in the solid waste category, shall be handled as directed.
- 1.4.2 Protection of Water Resources - The Contractor shall keep construction activities under surveillance, management and control to avoid pollution of surface and ground water.
- 1.5 Restoration of Landscape Damage - The Contractor shall restore the site to a general condition similar or equal to the existing conditions prior to construction. This work shall be accomplished at the Contractor's expense. The Site Representative shall have final approval for restoration.

\* \* \* END OF SECTION \* \* \*

**SECTION 02100**  
**SITE PREPARATION**

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**GENERAL**

1.1 GENERAL

**PRODUCTS**

Not Used

**EXECUTION**

3.1 SITE BOUNDARIES

3.2 GRUBBING

3.3 DISPOSAL OF CLEARED MATERIALS

## **SECTION 02100**

### **SITE PREPARATION**

#### **PART 1 GENERAL**

##### **1.1 GENERAL**

The contractor shall provide the labor, equipment and materials to clear and grub the site of all brush, trees, stumps, and other materials as specified herein.

#### **PART 2 PRODUCTS**

Not Used

#### **PART 3 EXECUTION**

##### **3.1 SITE BOUNDARIES**

The Contractor will locate all structures and access roads by establishing line and grade in the vicinity of each structure. The contractor shall verify established control points, perform any additional surveys and maintain control points as required to ensure the accuracy of the work.

##### **3.2 GRUBBING**

Grubbing shall consist of the removal and disposal of stumps, roots larger than 1-1/2 inches in diameter, matted roots, and subsurface piping, where indicated, from the designated grubbing areas. This material, together with logs and other organic or metallic debris not suitable for foundation purposes shall be excavated and removed to a depth of not less than 18 inches below the final ground elevation in areas indicated to be grubbed and in areas indicated as construction areas for access roads or walkways. Depressions made by grubbing shall be filled with suitable material and compacted such that the finished surface shall match the adjacent surface in composition, degree of compaction, and elevation.

##### **3.3 DISPOSAL OF CLEARED MATERIALS**

All brush, and other refuse from the clearing operations shall be removed from site and disposed of at the contractor's expense and at no extra cost to the Government. Disposal of material shall not be permitted on airport property.

END OF SECTION

## **SECTION 02200**

### **EARTHWORK**

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- 3.2 FILL AND BACKFILL
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  - 3.2.6 Backfilling of Conduit Trenches
  - 3.2.7 Fill and Embankment for Access Roads, Walkways, and Culverts
  - 3.2.8 Fill for Open Areas
  - 3.2.9 Placing of Crushed Rock and Topsoil
  - 3.2.10 Compaction Methods
  - 3.2.11 Determination of Density

## **SECTION 02200**

### **EARTHWORK**

#### **PART 1 GENERAL**

##### **1.1 GENERAL**

The contractor shall perform and complete all work as necessary for excavation, filling, backfilling, and grading required on the applicable drawings and specified herein.

##### **1.2 REFERENCES**

The latest edition in effect of the following publications form a part of this specification and are applicable to the extent specified herein.

###### **1.2.1 American Association of State Highway and Transportation Officials (AASHTO)**

AASHTO-T99	Moisture-Density Relations of Soils
AASHTO-T191	Field Determination of Density of Soil in Place, Sand Cone Method
AASHTO-T204	Field Determination of Density of Soil in Place, Dry Cylinder Method
AASHTO-T205	Field Determination of Density of Soil in Place, Rubber Balloon Method
AASHTO-T233	Field Determination of Density of Soil in Place, Block, Chunk or Core

###### **1.2.2 American Society for Testing and Materials (ASTM) Standard**

ASTM D-424	Test for Plastic Limit and Plastic Index of Soils
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## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

### **3.1 EXCAVATION**

#### **3.1.1 Classification**

All material excavated is unclassified and can be accomplished by trencher or backhoe and will not require ripping or blasting.

#### **3.1.2 Drainage**

Excavation shall be performed so that the area of the site and the area immediately surrounding the site and affecting operations at the site will be continually and effectively drained. Water shall not be permitted to accumulate in the excavation. The excavation shall be drained by pumping or other satisfactory methods to prevent softening of the foundation bottom, undercutting of footings, or other actions detrimental to proper construction procedures.

#### **3.1.3 Freezing**

When freezing weather is expected, excavations shall not be made to the full depth, unless the footing concrete can be placed immediately. If excavation is already at full depth, the excavation shall be protected from frost.

#### **3.1.4 Excavation for Slabs and Footings**

The excavations shall conform to the dimensions and elevations of the drawings applicable to footings and other foundation structures which are cast in place.

##### **3.1.4.1 Limits**

Excavations below indicated depths shall not be permitted except to remove material consisting of shale, sod, clods, stones larger than 4 inches, organic debris, trash or frozen material. Such unsatisfactory material shall be removed to a depth of 6 inches and replaced with satisfactory fill material. Unauthorized over excavation for footings shall be replaced at no additional cost to the Government to the indicated excavation grade with concrete. Excavation shall extend a sufficient distance from footings to allow for placing and removal of forms, installation of services, and for inspection, except where the concrete for walls and footings is authorized by the Resident Engineer to be deposited directly against excavated rock surfaces.

#### **3.1.5 Trench Excavation**

See drawings for trench details. Trenches for direct earth burial cables, conduits and other utilities shall conform to the dimensions and elevations shown on the applicable drawings. The banks need not be kept vertical but may be sloped or widened to such general limits as may be set by the Resident Engineer, provided there is no interference with other utilities. The trench bottom shall be a minimum of 6 inches wide or as required to provide separation between power and control cables or between power cables of different voltages. The trench depth shall be deep enough to allow cable placement plus an over excavation of at least three inches. The over excavation shall be filled with earth or sand containing no material aggregate particles that would be retained on a 1/4-inch sieve. The fill material shall be compacted to approximately the same density of the adjacent soil.

### **3.1.6 Excavation for Walkways and Access Roads**

The excavation shall conform to the dimensions and elevations of the drawings applicable to areas designed for vehicular and pedestrian traffic. Subgrade areas for access roads and walkways shall be plowed, disked and moistened or aerated as required obtain proper compaction. Muck, peat and other unsatisfactory material shall be removed to a minimum depth of 12 inches below excavation grade or as required to provide a satisfactory foundation. Low areas resulting from removal of such material shall be brought up to required grade with satisfactory fill material.

### **3.1.7 Excavation of Ditches, Swales and Culverts**

Ditches, swales and culverts shall be cut accurately to the cross sections and grades indicated. The sides and bottom of ditches and swales shall conform to the slope, grade, and shape of the section indicated. Care shall be taken not to excavate ditches and swales below the grades indicated. Excessive excavation shall be backfilled to the indicated excavation depth with approved material and compacted to 90 percent maximum density. All ditches, swales, and culverts excavated under this section shall be maintained until final acceptance of the work.

### **3.1.8 Safety and Protection of Work**

Sheeting and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel. The manner of bracing excavations shall comply with local regulations and OSHA construction regulations. Grading shall be performed in a manner to ensure proper drainage at all times.

### **3.1.9 Utilization of Excavated Materials**

Satisfactory excavated material shall be used in the work insofar as practicable. No excavated material shall be disposed of in such a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

### **3.1.10 Inspection of Excavated Area**

When excavations have reached the required elevations, the contractor shall not proceed with further construction of the excavated area until the area has been inspected by the Resident Engineer.

## **3.2 FILL AND BACKFILL**

### **3.2.1 Weather Conditions**

No fill or backfill operations shall be performed when weather conditions are determined by the Resident Engineer to be too wet or cold to permit such operations.

### **3.2.2 Satisfactory Material**

Material suitable for fill, backfill and embankment purposes shall be reasonably free of shale, sod, clods, and stones larger than 4 inches, organic debris, trash and frozen material. Only materials suitable for obtaining the degree of compaction specified herein shall be used.

### **3.2.3 Preparation of Surface for Fill and Embankment**

All surfaces designated to receive fill and embankment material shall be inspected prior to material placement. Soil surfaces on which compacted fill is to be placed shall be plowed, disked or otherwise broken up to a depth of 6 inches, pulverized, moistened or aerated as necessary, mixed and compacted to the same density as required for the fill or embankment material. Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be stepped or benched, as directed, in such manner that the fill material will bond with the existing surface. The finished surface shall be reasonable smooth, compacted and free from irregular surface changes. The degree of finish shall be that ordinarily obtained from blade-grader operations or, where more suitable, hand raking.

### **3.2.4 Source of Fill Material**

Fill material shall be selected for the particular fill area for which it is to be used. Fill material shall not be confused with surfacing aggregate. Necessary clearing, grubbing, and disposal of debris, shall be considered incidental operations to the borrow excavation and shall be performed by the contractor. All material stockpiled on site shall either be used as fill material or disposed of by the contractor. Fill shall be native material. After removing the existing RVR, fill the holes with native material, put 4" of topsoil and reseed all areas to match surrounding areas.

### **3.2.5 Fill for Slabs and Foundations**

Satisfactory material shall be placed in horizontal layers of 6 inches (loose measurement) and compacted to 95 percent maximum density. Unless directed by the Resident Engineer, no backfill shall be placed against footings prior to 7 days after footings and slabs are poured.

### **3.2.6 Backfilling of Conduit Trenches**

Trenches shall be backfilled as indicated on the drawings. Unless otherwise indicated, backfilling of the conduit trenches shall be done as follows:

- Place 4 inches of sand in the base of the trench.
- Place clean conduits on top of the sand base. Use conduit spacers (or other approved method) to maintain the required horizontal and vertical separation between conduits.
- Place sand to a level of 12 inches above the top of the conduits.
- TAMP sand.
- Place guard wire and warning tape.
- Place approximately 14" of select fill above sand (select fill shall contain no particles that would be retained on a 1 inch sieve).
- TAMP and COMPACT select fill to a minimum of 90% of maximum density in accordance with AASHTO-T-99. Compacted depth should be approximately 12" above sand.
- Place approximate 14" more of select fill.
- TAMP and COMPACT again to a minimum of 90% of maximum density.
- Place the remaining amount of select fill required and COMPACT and TAMP a third time. The finished level of the top of the trench shall not exceed 2 inches above the surrounding grade.

The disturbed area shall be cleaned, raked, and seeded. All trench backfilling shall be to the approval of the Airport Manager and the Project Engineer. **THE CONTRACTOR SHALL GUARANTEE THAT NO SETTLEMENT OCCURS WHICH LEAVES A DEPRESSION BELOW THE SURROUNDING GRADE FOR A PERIOD OF ONE YEAR AFTER PROJECT COMPLETION.**

### **3.2.7 Fill and Embankment for Access Roads, Walkways, and Culverts**

Fills and embankments shall be constructed at the locations and to lines and grades indicated on the drawings. The material shall be placed in successive horizontal layers of 8 inches, loose measure, for the full width of the cross section. Fills and embankments shall be compacted to 95 percent of maximum density. Final elevations after compaction shall not vary more than 0.05 feet from the established grade and approved cross section.

### **3.2.8 Fill for Open Areas**

All open areas to receive seed or sod shall be filled to within 6 inches of final grade with satisfactory material. Fill beneath this layer shall consist of material free of rocks larger than 6 inches and shall be placed in layers not greater than 8 inches, loose measure. All layers shall be compacted to 90 percent maximum density.

### **3.2.9 Placing of Crushed Rock and Topsoil**

On areas to receive crushed rock or topsoil material, the compacted fill or subgrade shall be scarified to a depth of 2 inches. Material to be placed shall then be evenly spread, graded and compacted to 90 percent of maximum density. Material required to be placed within two feet of footings or slabs shall be compacted by approved hand tampers. Compaction of topsoil to be grassed or sodded may be deferred until after seeding or sodding operations.

### **3.2.10 Compaction Methods**

Compaction shall be performed using the method and equipment suitable for the area as specified. Mechanical hand tampers shall be used only in areas adjacent to footings and slabs or in trenches or other areas where use of rollers is not practical. Compaction with pneumatic-tired rollers, three wheel power rollers, sheepsfoot rollers, etc., shall be used in all other areas as required to provide the specified compaction density.

### **3.2.11 Determination of Density**

Maximum density tests will be performed in accordance with AASHTO-T99 and field density tests will be performed in accordance with AASHTO-T191, T204, T205, or T233.

END OF SECTION



**SECTION 02930  
SEEDING**

**PART 1 GENERAL**

**1.1 GENERAL**

All seeded areas disturbed by the contractor shall be restored to its original condition. The work covered by this section consists of furnishing all labor, materials, tools, equipment, plant and services necessary to complete the portion of site work including topsoil placement, sodding and planting specified herein and as shown on the applicable drawings.

**PART 2 PRODUCTS**

**2.1 FERTILIZER**

A commercial fertilizer, uniform in composition, free flowing and suitable for spreading with approved equipment shall be used. Fertilizer shall be not less than 40 pounds nitrogen and 40 pounds phosphorus per acre.

**2.2 SEED**

New seed shall be applied so that the resulting growth results in a turf that matches the undisturbed surrounding areas. Range grass of some kind may be appropriate for seeding on the 4" of topsoil. **The exact seeding mixture shall be obtained from and approved by the Airport. Contact Tom Franklin (Airport Manager) at 503.589.2058 to determine reseeding procedures.**

**PART 3 EXECUTION**

**3.1 PREPARATION OF GROUND & SEEDING**

Areas to be seeded shall be raked or otherwise cleared of stones larger than 3" in diameter, sticks, and other debris which might interfere with sowing of seed and growth of grasses. Following preparation, fertilizer shall be uniformly spread over the entire area to be seeded. Immediately after fertilizing the seed shall be sown at the specified rate and the seed shall be raked in 1/2 to 3/4 inch.

**3.2 MAINTENANCE AND REPAIR**

The contractor shall maintain seeded and sodded areas until the Contractor Acceptance Inspection. Maintenance shall consist of watering and mowing operations and protecting such areas from traffic. Repair shall consist of reestablishing seed or sod areas damaged by traffic, erosion, drought, fire, or water. Such areas shall be re-sodded or re-seeded in accordance with this specification or as directed by the Resident Engineer until a satisfactory growth is obtained.

END OF SECTION

**SECTION 02930**

**SEEDING**

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2.2 CYLINDRICAL CONCRETE PIERS  
2.3 FORM TIES  
2.4 FORM OIL

**EXECUTION**

3.1 FORM WORK PLACEMENT  
3.2 FORM CURING  
3.3 FORM REMOVAL

## **SECTION 03100**

### **CONCRETE FORMWORK**

#### **PART 1 GENERAL**

##### **1.1 GENERAL**

The contractor shall provide all labor, equipment and materials as required to locate and place concrete forms specified herein or on applicable drawings.

#### **PART 2 PRODUCTS**

##### **2.1 FORMS**

Forms shall be wood, plywood, metal or other approved material. The contractor may use prefabricated forms for cylindrical foundations if indicated on the applicable drawings. All form materials shall be of the grade or type suitable to obtain the kind of finish specified.

##### **2.2 CYLINDRICAL CONCRETE PIERS**

All cylindrical concrete piers, if required, shall be formed to a depth of two feet minimum. Use approved cylindrical forms.

##### **2.3 FORM TIES**

Form ties shall be either fixed band type or threaded internal disconnecting type with a working load suitable to prevent deformation of forms. They shall be of the type as to leave no metal closer to the surface than 1/2 inches for steel ties and 1 inch for stainless steel ties. Twisted wire ties shall not be permitted.

##### **2.4 FORM OIL**

Form oil shall be nonstaining and shall not cause softening of the concrete or impede the wetting of surfaces to be cured with water or curing compounds.

#### **PART 3 EXECUTION**

##### **3.1 FORMWORK PLACEMENT**

Formwork shall not be placed prior to inspection, testing or approval of the excavated area and imbedded items by the Resident Engineer. Forms shall result in a final structure which does not exceed +1/2 inch variation in any dimension shown on the applicable drawings. Form joints shall

be sufficiently tight to prevent leakage of mortar. Form oils shall be placed on forms or form ties and shall be removed from reinforcing steel or conduits if accidentally applied to such.

### **3.2 FORM CURING**

In hot, dry climates, wood forms remaining in place shall not be considered adequate curing, but shall be loosened so that the concrete surfaces may be cured in accordance with 3-3.6.

### **3.3 FORM REMOVAL**

Forms shall not be removed until concrete has attained at least 30 percent of the specified 28-day compressive strength.

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**SECTION 03200**

**CONCRETE REINFORCEMENT**

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- 3.4 PLACING REINFORCEMENT
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**SECTION 03200**  
**CONCRETE REINFORCEMENT**

**PART 1 GENERAL**

**1.1 GENERAL**

The contractor shall provide the necessary labor, materials and equipment for the placement of steel reinforcement as specified herein and shown on the applicable drawings.

**1.2 REFERENCES**

The following specifications and standards of the issues currently in force, form a part of this section and are applicable as specified herein.

**1.2.1 American Society for Testing and Materials (ASTM)**

ASTM A 615 - Deformed Billets Steel Bars for Conc. Reinforcement

ASTM A 185 - Welded Wire Fabric for Concrete Reinforcement

**1.2.2 American Concrete Institute (ACI) Standards**

ACI 315 - Manual of Engineering and Placing Drawings for Reinforced Concrete Structures

## **PART 2 PRODUCTS**

### **2.1 REINFORCING STEEL**

Reinforcing steel shall be new, clean, undamaged, and unless otherwise indicated, conforming to ASTM A-615, grade 60.

### **2.2 TIE WIRE, CHAIRS, AND SPACERS**

All devices necessary to properly space, support and fasten steel reinforcement in place during concrete placement shall conform to ACI 315. Tie wire shall be 16 gauge or larger annealed iron wire.

## **PART 3 EXECUTION**

### **3.1 REINFORCEMENT SURFACES**

Steel reinforcement shall be free of mud, oil or other nonmetallic coatings which may affect bonding quality. Mill scale or rust remaining after hand brushing with a wire brush is permissible.

### **3.2 BENDING**

All bends in bars and ties shall be cold bent. No bends shall be made in bars or ties partially embedded in concrete.

### **3.3 HOOKS**

Hooks indicated shall be 180 degree hooks. The bend diameter as measured on the inside of the bar shall be not less than 6 bar diameters for bars and not less than 1-1/2 inches for #3 ties.

### **3.4 PLACING REINFORCEMENT**

Steel reinforcement shall be accurately placed at the spacing and in the sizes indicated on the applicable drawings and secured against displacement during the pour operations. Reinforcement shall be placed within +1/2 inch of the indicated dimensions.

### **3.5 QUALITY ASSURANCE**

Two copies of mill certificates of steel compliance with ASTM A 615 shall be submitted to the Resident Engineer at the time of site delivery. The certificate shall be signed by an authorized officer of the contractor, and shall include the project name and location, and the quantity and delivery date to which the certificate applies.

END OF SECTION



## **SECTION 03300**

### **CAST-IN-PLACE CONCRETE**

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## **SECTION 03300**

### **CAST-IN-PLACE CONCRETE**

#### **PART 1 GENERAL**

##### **1.1 GENERAL**

The contractor shall provide the necessary materials, labor and equipment for the placement of concrete as specified herein and shown on applicable drawings.

##### **1.2 REFERENCES**

The following specifications and standards of the issues currently in force, form a part of this section and are applicable as specified herein.

###### **1.2.1 American Society for Testing and Materials (ASTM) Specifications**

ASTM C 33 Specifications for Concrete Aggregates  
ASTM C 94 Specifications for Ready-Mixed Concrete  
ASTM C 143 Slump of Portland Cement Concrete  
ASTM C 150 Specification for Portland Cement  
ASTM C 231 Air Content of Freshly Mixed Concrete by the Pressure Method  
ASTM C 260 Specification for Air-Entraining Admixtures for Concrete  
ASTM C 494 Specification for Chemical Admixtures for Concrete

###### **1.2.2 American Concrete Institute (ACI) Specification**

ACI 211.1 - Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete

##### **1.3 SUBMITTALS**

Provide certification signed by material producer and contractor that all materials and mix compositions comply with the specified requirements.

#### **PART 2 PRODUCTS**

##### **2.1 CEMENT**

All cement shall conform to ASTM C 150, Type I or Type III as indicated on the drawings.

##### **2.2 AGGREGATES**

Aggregate shall conform to ASTM C 33 except that maximum aggregate size shall be 3/4-inch.

### **2.3 WATER**

Water used in mixing and curing operations shall be clean, and free from oils, acids, organic matter and chemical suspensions which may adversely affect cure times, strength requirements or service life of the concrete.

### **2.4 ADMIXTURES**

Air entraining admixtures shall conform to ASTM C 260. Admixtures used for water-reducing and retarding shall conform to ASTM C 494, Type A or Type D.

### **2.5 QUALITY**

#### **2.5.1 Slump**

The concrete shall have a slump of 3 to 4 inches.

#### **2.5.2 Strength**

Unless otherwise indicated on the construction drawings, Type I concrete shall have a 28 day compressive strength of 3,000 psi and Type III shall have a 7 day compressive strength of 3,000 psi.

#### **2.5.3 Air Content**

Air entraining for all concrete shall be 4 to 8 percent.

#### **2.5.4 Proportions**

Concrete materials shall be proportioned in accordance with ACI 211.1 for site mixed concrete and ASTM C 94 for ready mixed concrete.

### **2.6 EXPANSION JOINT FILLER**

Use flexible foam expansion joint filler for example, Ceramar by W.R. Meadows, Inc. Product shall meet the requirements of ASTM D 1752, Sections 5.1 through 5.4 with the compression requirement modified to 10 psi minimum and 25 psi maximum and shall be compatible with hot-pour joint sealers.

### **2.7 EXPANSION JOINT SEALANT**

Use one-part self-leveling polyurethane sealant such as Sonolastic SL1 by Sonneborn (or approved equal). Product shall comply with Federal Specification TT-S-00230C, Type 1 Class A; ASTM C 920, Type S, Grade P, Class 25, Use T, M.

## **PART 3 EXECUTION**

### **3.1 MIXING AND PLACING CONCRETE**

#### **3.1.1 Site Preparation**

Prior to placing concrete all areas to receive concrete shall be inspected and approved by the Resident Engineer. Concrete shall not be deposited on muddy or frozen material. All surfaces to be in contact with the concrete shall be wetted.

#### **3.1.2 Mixing**

All mixers used for ready mix or site mix operations shall be cleaned prior to material recharge. The area of operation of the mixers shall be such as to not endanger existing structures or excavations. All concrete shall be mixed until there is a uniform distribution of materials. Concrete having attained initial set or having contained water for more than 90 minutes shall not be used in the work.

#### **3.1.3 Conveying**

Concrete shall be conveyed from the mixer to the deposit site by equipment which will prevent separation or loss of material and which will ensure a nearly continuous flow of material at the deposit site.

#### **3.1.4 Depositing**

Concrete shall be placed in such a manner as to prevent displacement of forms or reinforcement. Placing shall be stopped if contamination due to sloughing occurs until the contaminant can be removed. In the case of form or reinforcement displacement, placing may be continued only if the displacement is corrected within specified tolerances. The placing of concrete shall be a continuous operation at each deposit site and shall be completed within 1-1/2 hours after the addition of water. Concrete shall be deposited in 12 to 18 inch layers as level as possible prior to consolidation operations. Under no circumstances shall fresh concrete be placed over concrete that is no longer plastic. Time between placements at each deposit site shall not exceed one hour for regular mixes and two hours for retarded mixes.

#### **3.1.5 Cylindrical Concrete Piers**

Tops of piers shall be furnished flat within the confines of the Sonotube forms. Unless otherwise approved, the edges shall have a 1/2" or 3/4" radius. No spillage (mushrooming) over the tops of forms will be allowed.

### **3.1.6 Consolidation**

Consolidation of concrete during and after placing shall be performed using an internal vibrator with a vibration frequency not less than 150 hertz. Each layer shall be consolidated so that concrete is thoroughly worked around reinforcement, embedded items and forms. Vibrators shall penetrate about 6 inches into underlying layers to ensure proper union of the layers. Movement of the vibrator over the layer shall be such as to ensure uniform plasticity without pooling of cement.

### **3.1.7 Finish**

After the concrete has been placed and consolidated, the surface shall be screed with straight edges, floated, and troweled to the required finish level. All concrete surfaces shall have a smooth finish except for exposed top surfaces which shall have a broom finish. Broom lines shall be straight and parallel to the form edges and well defined. Unless otherwise indicated on the drawings, the foundation surface shall be level +/- 1/8" and all exposed edges shall be chamfered 1 inch (1/2" or 3/4" radius on circular tops). **A NEAT, CLEAN, PROFESSIONAL CONCRETE FINISH IS REQUIRED!** Concrete not meeting this requirement shall be completely removed and replaced at the contractor's expense.

Apply a Concrete Curing Compound (SealMaster or as approved) as directed by the manufacturer and as approved. Concrete Curing Compound should generally be applied once the concrete is firm enough to walk on with no surface water present (about one hour after final trowelling or when application will not mar surface).

## **3.2 CURING**

Concrete shall be maintained above 50 degrees F and less than 120 degrees F and in a moist condition during the cure period. The cure period shall be 7 days when Type I Portland cement is used and 3 days when Type III Portland cement is used. Exposed surfaces shall be covered with burlap, cotton, or other approved fabric or sand. If air temperatures are expected to exceed 75 degrees F, water curing shall be continuous and forms shall be loosened as soon as the concrete has set sufficiently to prevent damage. In conditions where air temperature may be expected to fall below 40 degrees F, equipment and covering to maintain a 50 degree concrete temperature shall be provided. Salt or other chemicals to prevent freezing shall not be permitted.

## **3.3 ANCHOR BOLTS, PLATES, AND COUPLINGS**

### **3.3.1 Anchor Bolts and Plates**

Anchor bolts shall be installed in concrete prior to the concrete setting and at a time and manner to assure that there is no voids around the bolts. Anchor bolts and plates shall be set level and plumb, and within a tolerance necessary for their proper alignment and to the structure support. Flanges and anchors shall be set level and plumb, and within a tolerance necessary for their

proper alignment and to the frangible structure they support. All bolts and other hardware shall be hot-dipped galvanized and shall be contractor furnished (unless otherwise indicated to be government furnished).

### **3.3.2 Embedded Couplings**

Couplings embedded in concrete shall be installed so that the top of the coupling is flush with the top of concrete and conduits to be extended from the coupling are level and plumb. Foundations with embedded couplings that do not meet this requirement shall be removed and re-installed at the contractors expense.

## **3.4 QUALITY ASSURANCE**

### **3.4.1 Testing**

Testing for the concrete shall be arranged by the contractor and performed by an independent testing company (in the presence of the Resident Engineer) at the expense of the contractor. If these tests show concrete strength less than specified, the contractor shall correct the situation and be responsible for all associated cost.

### **3.4.2 Certification**

The contractor shall furnish a certificate that all materials, compositions, densities and mixtures to be used meet local or state requirements. The contractor shall provide the Resident Engineer with a delivery ticket (batch ticket) for ready mix concrete from the concrete supplier at the time of each delivery which certifies compliance with material and quality requirements specified herein. The tickets shall indicate the delivery date, time dispatched, name and location of project, name of contractor, name of concrete producer, truck number, quantity, air content, admixtures and design strength of the concrete delivered.

## **3.5 REPAIR OR REPLACEMENT**

The contractor shall restore concrete damaged by work under this contract to its original condition as directed by the Resident Engineer. The Resident Engineer shall reject any fresh concrete not meeting slump or air entrainment requirements. Any concrete not meeting strength requirements shall be removed and replaced by the contractor. Any repair or replacement costs shall be paid by the contractor.

END OF SECTION

**SECTION 16050****BASIC ELECTRICAL MATERIALS AND METHODS****1.0 General requirements**

1.1 1.1 **Scope** – The contractor shall furnish all labor, equipment and materials, except GFM/GFE, required to complete the project as shown on the Contract Drawings and described within this specification. The major work items for this project are as follows:

1. Remove and dispose existing 4"x4" support wooden pole for service KWH meter at GS power rack.
2. Remove and dispose existing 3.5"x3.5" wooden barrier post.
3. Remove and abandon existing underground GS feeder as shown on the electrical demolition plan.
4. Remove and abandon existing underground RVR branch circuit as shown on electrical demolition plan at the demolition phase.
5. Remove and dispose existing RVR tower at the demolition phase.
6. Provide new GS power rack including KHW cabinet, meter base, service power breaker, power steel rack, manual transfer switch, disconnect switches, surge protective devices, Engine-generator receptacle, conductors, conduits, J-box, and associated equipment and materials as shown on electrical one line diagram and electrical drawings.
7. Provide new RVR rack including power panel and circuit breakers, surge protective device, GFI outlet & waterproof cover box, obstruction lights, J-box, and associated equipment and materials as shown on electrical one line diagram, electrical drawing, and electronics drawings. Note. Due to the RVR rack is located near the runway safety area; therefore, the RVR rack shall have frangible mounting anchor bolts with 4 feet width.
8. Provide new materials to install the RVR system (VS SIE) as shown on RVR electronic drawings.
9. Provide 4 wooden barrier poles (4"x4"x 5 feet H treated wood) to protect the new GS rack. These poles shall be paint with yellow color.
10. Provide 10 KW 120V/240V portable engine-generators (EG) unit to feed the existing GS and RVR facilities during the construction phase. Provide all temporary services required for construction, such as conductors, conduits, J-boxes, connectors, fuses, diesel fuel, and associated materials to provide continuous electrical power for the existing GS power panel at the GS shelter.
11. Coordinate with the commercial power company (Portland General Electric or PGE) for replacement of GS power rack, KWH meter cabinet, and power outage. Pay PGE for any service during the construction.
12. The contractor shall provide 10 KW 120v/240V portable generator including power cable, fuel and associated materials to feed facility during power outage phases. Estimate about 10 hours to 12 hours power outages during the installation.

13. The contractor shall coordinate with PGE (commercial power company) for power outage to replacement power rack & new KWH meter. The contractor shall pay PEG for all power service including power outage request.

- 1.1.1 Service Characteristics - The building service included 120/240V, 1-phase, 3-wire system.
- 1.1.2 Utility Service and Interruption of Service - Contact on site FAA personnel to coordinate outages for power and equipment connections. The FAA Operations at this facility are providing aircraft flight control and assistance information which is required for safety of the aircraft and the public, therefore, any power loss to facility equipment is very serious and must be carefully coordinated with facility personnel. Unscheduled interruptions of electrical service to FAA facilities or equipment may cause aircraft accidents and loss of life. Work requiring a temporary or permanent de-energization of equipment shall be scheduled in writing with the onsite FAA maintenance personnel through the Contracting Officers Representative. Only onsite FAA maintenance personnel are authorized to energize, de-energize equipment or to operate a circuit breaker, switch or fuse in a FAA facility. Determine all interface requirements and provide material and labor needed to complete any connections to be scheduled during an outage. Work procedures shall include lock-out/tag-out procedures in accordance with FAA order 3900.49.
- 1.1.3 Interpretation of Contract Drawings - In general, the drawings utilize accepted diagrammatic symbolism to indicate electrical construction work. The symbol does not have any dimensional significance. The layout of wiring, circuits, outlets, and equipment is developed as an engineering aid and should not be interpreted as a release from responsibility for installing the work without space conflict; however, all work shall be installed in accordance with the diagrammatic intent of the drawings. The contract drawings indicate the extent and approximate location and arrangement of equipment, conduit, and wiring. The Contractor shall determine exact location from field measurements, so that the outlets and equipment will be properly located and accessible. If any conflicts occur necessitating departures from the contract drawings, details of departures and reason shall be submitted as soon as possible for written approval from the Site Representative. **In the event of a discrepancy between the specifications and the drawings, the specifications shall prevail.**
- 1.1.4 Local Utility Companies - The rules and regulations of the local utility companies providing service.
- 1.1.5 Minor Departures - Minor departures from exact dimensions shown in electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The Contractor shall promptly obtain approval from the Subcontract Administrator, via the Site Representative prior to undertaking any such proposed departure
- 1.1.6 Submittals - See Division 1, Section 01300 of these specifications.

- 1.2 Workmanship - All electrical installation work shall be performed by experienced electricians regularly engaged in this type of work and properly licensed when required. All materials and equipment shall be installed in conformance with the contract documents, and in accordance with recommendations of the manufacturer as verified by the Site Representative.
- 1.3 Applicable Documents & Codes – The installation shall conform to this specification and to the applicable rules of FAA standards, NFPA 70 or local code, whichever requires the highest quality of material and workmanship. The current issues of the following documents in effect on the date of the invitation for bids form a part of this specification and are applicable to the extent specified herein.
- 1.3.1 Federal Specifications
- |               |   |
|---------------|---|
| A-A-59544     | Cable and Wire, Electrical (Power, fixed Installation)  |
| W-C-375c      | Circuit Breakers, Molded Case; Branch Circuit and Service   |
| A-A-59551     | Wire, Electrical, (Uninsulated)   |
| HH-I-510 B    | Insulation Tape, Electrical, Friction   |
| HH-I-553      | Insulation Tape, Electrical (Rubber, Natural and Synthetic)                                       |
| HH-I-595 A    | Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic, or Low-Temperature Application |
| W-B-30        | Ballast, Fluorescent Lamp   |
| W-C-586       | Conduit Outlet Boxes, Bodies and Entrance Caps  |
| W-C-1094      | Conduit and Conduit Fittings; Plastic, Rigid  |
| W-F_406 B     | Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible                                |
| W-F-408 B     | Fittings for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall [EMT] Type)                          |
| W-F-414       | Fixture, Lighting (Fluorescent, Alternation Current, Recessed and Surface Ceiling)                |
| W-J-800 C (1) | Junction Box; Extension, Junction Box; Cover, Junction Box (Steel, Cadmium, or Zinc-Coated)       |
| W-P-115       | Panel, Power Distribution   |
| W-S-610 B(1)  | Splice, Conductor   |
| W-S-865       | Switch, Box (Enclosed), Surface - Mounted   |
| WW-C-563      | Conduit, Metal, Rigid, and Bend and Elbow, Electrical Conduit: Thin wall Type (EMT)               |
| WW-C-566      | Conduit, Metal, Flexible  |
| WW-C-581 D(3) | Conduit, Metal Rigid; and Coupling, Elbow, and Nipple, Electrical Conduit, Zinc-Coated            |
| WW-C-582      | Surface Metal Raceways  |
- 1.3.2 National Fire Protection Association (NFPA) Publications
- |         |   |
|---------|---|
| No. 70  | National Electrical Code (Latest Edition)                           |
| No. 780 | Standard for the Installation of Lightning Protection System (2004) |

- 1.3.3 National Electrical Manufacturers Association (NEMA)
- |       |  |
|-------|--|
| TC2   | Electric Plastic Tubing (EPT), Conduit (EPC-40 and EPC-80) and Fittings                            |
| TC6   | PVC Plastic Utilities for Underground Installation   |
| WC 70 | Thermoplastic Insulated Wires and Cable for the Transmission and Distribution of Electrical Energy |
| WD1   | General color requirements for Wiring Devices  |
- 1.3.4 Insulated Cable Engineers Association (ICEA) Publications
- |          |  |
|----------|--|
| S-19-81  | Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy                                   |
| S-66-524 | Cross-Linked Thermosetting-Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. |
| S-68-516 | Ethylene-Propylene-Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy                    |
- 1.3.5 Underwriter's Laboratories, Inc., UL Standards
- |         |   |
|---------|---|
| UL 6    | Ridgid Metal Conduit.   |
| UL 50   | Building Materials List Cabinets and Boxes                        |
| UL 96   | Lightning Protection Components                                   |
| UL 96A  | Installation Requirements for Lightning Protection Systems        |
| UL 486c | Splicing Wire Connectors  |
| UL 514b | Fittings for Conduit & outlet Boxes                               |
| UL 542  | Lamp holders, Starters, and Starter Holders for Fluorescent Lamps |
| UL 651  | Schedule 40 and 80 Rigid PVC Conduit                              |
| UL 797  | Electrical Metallic Tubing  |
| UL 870  | Wireways, Auxiliary Gutters and Associated Fittings               |
- 1.3.6 FAA Standard (included in this specification)
- |               |  |
|---------------|--|
| FAA-C-1217f   | Electrical Work, Interior  |
| FAA-STD-019e  | Lightning protection, Grounding, Bonding and Shielding for Facilities                |
| FAA-STD-020b  | Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment    |
| FAA-C-1391b   | Installation and Splicing of Underground Cables.                                     |
| FAA-E-2072b   | Cable, Telephone, Exterior.  |
| Order 6950.27 | Short Circuit Analysis and Protective Device Coordination Study Hand Book Reference. |
- Distribution of Electrical Energy
- |          |  |
|----------|--|
| S-66-524 | Cross-Linked Thermosetting-Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. |
| S-68-516 | Ethylene-Propylene-Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy                    |

### 1.2.1 Underwriter's Laboratories, Inc., UL Standards –

UL 96A	Master Labeled Lightning Protection Systems
UL 651	Schedule 40 and 80 Rigid PVC Conduit
UL 50	Building Materials List Cabinets and Boxes
UL 542	Lamp holders, Starters, and Starter Holders for Fluorescent Lamps
UL 870	Wireways, Auxiliary Gutters and Associated Fittings.

### 1.2.2 National Electrical Manufacturers Association (NEMA) –

TC2	Electric Plastic Tubing (EPT), Conduit (EPC-40 and EPC-80) and Fittings
TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
WC 5	Thermoplastic Insulated Wires and Cable for the Transmission and Distribution of Electrical Energy
WD1	General Purpose Wiring Devices

## 2.0 MATERIALS

2.1 General – The contractor shall furnish all materials not specifically shown as GFM or GFE to complete the work. Materials required installing the GFE, including lugs, terminations, mounting hardware, anchoring, etc. shall be provided by the contractor at no additional cost. Materials and equipment must comply with all contract requirements. Materials to be furnished by the contractor under this specification shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs. All materials for installation in wet locations shall be listed and labeled by Underwriters Laboratory (UL) as suitable for wet locations. All other materials provided by the contractor shall bear the label of UL if the materials are normally evaluated and labeled by UL. All materials and practices shall be in strict compliance with FAA-C-1217f. and FAA-STD-19e.

2.1.1 Short Circuit Analysis and Protective Device Coordination – All fuses and circuit breakers included within this electrical power distribution system have been analyzed with the design short circuit and protective device coordination studies. Any changes or other manufacturer components that are different than those specified in these specifications could compromise the design analysis for this modification. All protective devices obtained by the Contractor for installation as per this specification shall be, as specified, or a coordination study must be performed by a Professional Engineer at the Contractor's expense, and is subject to submittal and approval by the Site Representative. Submit time vs. current curves and all manufacturers' specifications for these devices for approval. These documents shall be submitted to the Site Representative per section 1300 of these specifications.

### 2.2 Conductors -

- 2.2.1 Uninsulated Conductors shall be copper and shall only be used where specifically identified within the contract drawings. Uninsulated conductors shall comply with Federal Specifications A-A-59551. Conductors No 6 AWG and smaller shall be solid and conductor No 4 AWG and larger shall be stranded.
- 2.2.2 Insulated Conductors shall be copper in accordance with Federal Specifications A-A-59551.
- 2.2.3 Control cables shall be insulated copper conductors, shielded and jacketed.
- 2.2.4 Size and Type Conductors - Unless indicated otherwise on the contract drawings, all conductors shall be soft drawn copper with thermoplastic or thermosetting insulation type THW, THWN, and XHHW for general use, or type THHN for use in dry locations only. Control wire shall be stranded. The minimum size wire, except for control wiring, shall be No. 12 AWG. Control wire shall be no smaller than No. 14 AWG. Power conductors #10 AWG and smaller shall be solid, #8 and larger shall be stranded. All temperature limitations for conductors shall be met per NEC 110-14C and table 310-16.
- 2.2.5 Wire Delivery - Wire and cable shall be delivered to the project site in original boxes and factory reels. Insulation shall have repetitive markings stating the manufacturer, size, type of insulation, etc.
- 2.3 Conductor Splices, Terminations, and Connectors - Federal Specification WA-A-59213: Splices in stranded wire, and wire No. 8 and larger, shall be made with compression connectors. Splices in Wire No. 10 and smaller (solid) shall be made with wire nuts. Insulated wire nuts must be taped for mechanical integrity. In either case, the splice shall be made both mechanically and electrically secure and comply with paragraph 110-14 (a) of the National Electrical Code. If the connector is not insulated, the splice shall be half wrapped with electrical plastic tape until the thickness is twice the thickness of the original insulation. All splices shall be made at accessible junction and outlet boxes except where direct burial splices are indicated. All splices, including those made with insulated wire nuts, shall be insulated with electrical tape or shrink tubing to an insulation value level equal to or greater than that of the factory insulated conductors. In cases where more than one cable must terminate at the same connection point, recommend use two wire Polaris type connectors if there is room for this configuration, or a special terminal shall be used with multiple barrels provided for multiple cable termination. Two or more cables are not allowed to terminate with one single lug designed for only one single termination. Splices made in pole bases, handholes, manholes, or direct buried shall be made using a cast resin splice kit designed for direct burial manufactured by Raychem, 3M, or an approved equal and shall be UL listed for wet locations.
- 2.4 Tape - Electrical tap shall be 3M or approved equal and be suitable for application.  
Plastic Tape - Federal Specification HH-I-595.

Rubber Tape - Federal Specification HH-I-553.

- 2.5 Fittings, Cable and Conduit - Federal Specification W-F-406 and W-F-408.
- 2.6 Outlet Boxes - Sheet Steel - Boxes shall be either the cast metal hub type (for receptacles) conforming to Federal Specification W-C-596 or shall be one piece galvanized steel (NEMA-1 and 2 for dry and interior locations and NEMA 3 and 4 for wet and exterior locations) type conforming to Federal Specification W-J-800. Where not sized on the drawings, boxes shall be sized in accordance with the NEC. Boxes shall be provided in the wiring or raceway system for pulling wires, making connections, and mounting devices. Each box shall have the volume required by the National Electrical Code for the number of conductors in the box. Each outlet and switch box shall include a grounding pigtail. Boxes installed for concealed wiring shall be provided with extension rings or plaster covers. Boxes shall not be supported from sheet metal roof decks. Boxes and supports shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported. All exterior above ground receptacles and junction boxes shall be weatherproof.
- 2.7 Raceways -
- 2.7.1 Galvanized Rigid Steel Conduit (GRS) - Federal Specification WW-C-581, hot-dip galvanized. All fittings shall be threaded. All connectors shall include insulated bushings.
- 2.7.2 Tubing, Electrical, Zinc-Coated Metallic Steel (EMT) - Federal Specification WW-C-563. EMT shall be mild steel, electrically welded, electro-galvanized and labeled with Underwriter Laboratory seal of approval. All EMT fittings shall be compression and steel type. Indentor type, set-screw type fitting will not be accepted. EMT connectors shall include insulated bushings.
- 2.7.3 Flexible Metal Conduit - Federal Specification WW-C-566. Flexible metal conduit shall be galvanized steel conforming in all respects to Underwriter's Laboratories Standards. Flexible metal conduit and fittings shall be UL Listed as grounding type.
- 2.7.4 Plastic Conduit - Polyvinyl Chloride (PVC) conduit shall be schedule 40, heavy wall rigid plastic with fittings and accessories designed for direct earth burial. Exposed PVC conduit shall be sunlight resistant. Manufactured to NEMA TC-2 and Federal Specification W-C-1094; UL listed.
- 2.7.5 Flexible Electric Non-Metallic Tubing - Flexible electric non-metallic tubing shall not be used.
- 2.8 Fuses - A complete set of fuses shall be installed and one set of spares shall be furnished for each fusible device. Fuses shall have a voltage rating not less than the circuit voltage. Fuse types shall be as indicated in the construction drawings.

- 2.9 Junction and Pull Box – Indoor junction and pull boxes for electrical work shall be code gauge sheet steel and provided with a flat screw cover. Exterior junction boxes shall be NEMA 4 type. Power and Control wiring shall not occupy the same junction box.
- 2.10 Wireways - Square duct type wireways shall conform to UL Standard 870. Wireways shall be sized as shown on the construction drawings and shall be hinged cover type. Wiring gutters shall be electrically bonded together.
- 2.11 Lighting and Power Panelboards - Panelboards shall be of the size and type indicated on the construction drawings. Panel shall be dead front type, shall conform to Federal Specification W-P-115, Type I, Class 1, and shall be UL listed unless specified otherwise. Manufactures shall be as indicated or an approved substitution. Busses shall be copper with tin coating. Front covers shall be “door-in-door” construction allowing access to circuit breaker termination by opening a hinged cover. Doors shall be lockable and be supplied with locks. Doors over 48 inches high shall have auxiliary fasteners on top and bottom. All panelboard doors, which include locks, shall have flush type cylinder locks and catches, keyed alike, with two keys furnished with each lock. Ground and neutral busses shall be provided by the manufacturer as part of the panel assembly. The panelboard shall be constructed of code gage galvanized sheet metal and shall be finished with a rust inhibiting prime coat and two coats of light gray enamel.
- 2.11.1 Circuit Breakers - All circuit breakers shall be the quick-made, quick-break, bolt on, thermal magnetic type, shall conform to Federal Specification W-C-375, and shall be U.L. listed. Circuit breakers shall be rated for the voltage of the circuit on which they are used, and shall have a minimum interrupting rating of 10,000 amperes, symmetrical for branch breakers, and 22,000 amperes, symmetrical for main breakers unless indicated otherwise. All circuit breakers shall have a trip indicating feature. Single pole breakers shall be a full size module, and two and three pole breakers shall be sized in even multiples of a single pole breaker. A submittal is required from the Contractor for characteristic curves for main and branch circuit breakers. Breakers shall be sized so that two single pole breakers shall not be capable of fitting in a single housing. Multi-pole circuit breakers shall have an internal common trip mechanism. All circuit breakers and the panelboards in which the breakers are installed shall be made by the same manufacturer and shall be UL listed for the panelboard. Self-enclosed circuit breakers shall be mounted in NEMA OS-1, Type 1 enclosures with trip rating, voltage rating, and number of poles as indicated on drawings.
- 2.11.2 Bus Bars - All buses (phase, neutral, & ground) shall be copper. Bus capacity shall be as indicated on the drawings. Circuit breaker current carrying connections to bus shall be of the bolted type, and factory assembled. Stab in types are not acceptable. Bus bar connections to branch circuit breakers shall be of the sequence phase type. The neutral bus shall be insulated from panelboards. All panelboards shall have an uninsulated ground bus bolted to the cabinet, with provision for individual branch circuit ground conductor

connections, adequate in size to accommodate present and future equipment grounding conductors. Isolate ground bus from the neutral bus. The ground bus bar shall be structurally integral to the panelboard or attached to the panelboard with a bolt, nut and lock washer. If the ground bus bar is mounted to the enclosures with screw threads only, a separate, bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar.

- 2.11.3 Directories - Directories shall be typed to indicate the load served by each circuit and shall be mounted in a holder with protective covering. The directory shall be arranged so that the typed entries simulate the circuit breaker positions in the panelboard. Circuits shall be connected as indicated on drawing. Any changes shall be "As-Built" on the drawings and a new directory shall be typed to reflect the change.
- 2.11.4 Existing Breaker Panelboards - When adding circuits to an existing panelboard, the new breakers shall be made by the same manufacturer as the panelboard.
- 2.11.5 Fusible Panelboards - Not Used
- 2.12 Safety Switches - Safety switches shall be heavy-duty "HD" types. Switches installed outdoors, or in damp or wet locations, shall be mounted in NEMA 3R enclosures. Switch shall be of the voltage and current ratings indicated on the drawings, and each shall be capable of interrupting ten (10) times the full rated load current. The switches shall be of the quick-make, quick-break type, and all parts shall be mounted on insulating bases to permit replacement of any part from front of the switch. All current carrying parts shall be high-conductivity copper, designed to carry a rated load without excessive heating. Switch contacts shall be silver-tungsten type or plated to prevent corrosion, pitting and oxidation, and to assure suitable conductivity. Switches shall have rejection fuse blocks to prevent replacement by lower rated fuses and shall be capable of being locked in the on and off position. The Contractor shall install switches meet the applicable requirements of the National Electrical Code (NEC). The service entrance disconnect shall be UL rated for service equipment.
- 2.13 Surge Suppression Equipment
- 2.13.1 Service Entrance Surge Arrester - A fused secondary surge arrester provided with disconnect capability shall be installed on the load side of the service disconnect as close as possible to the service terminals. Separate terminating lugs shall be provided within the service disconnect for the surge arrester. The arrester input shall be internally fused for short circuit protection and shall include disconnect capability. The enclosure door shall include indicating lights to demonstrate that each suppression device is functional. Each suppression device within the arrester shall be replaceable as a unit. Outdoor arresters shall come with a NEMA 4 enclosure and enclosure penetrations shall be watertight. Indoor arresters shall come with a NEMA 12 enclosure. Arresters shall be tested in accordance with ANSI/IEEE C62.11. In addition the arrester shall meet the following FAA-STD-019E requirements:

1. Modes of protection: L-N, L-L, L-G
2. Peak Surge Current: 3kA with 8/20uSec current impulse
3. Clamping Voltage: 400V L-N, L-G, 700V L-L for 120/208V system.
4. Clamping Voltage: 700V L-L & L-G for 277/480V system.

2.13.2 Branch and Feeder panel Surge Protective Device -Each individual branch and feeder panel shall have a Surge Protection Device (SPD) installed. The SPD shall be installed on a dedicate circuit. The SPD shall be located as close as possible to the panel board with the wires being as short and straight as possible. Kinks and sharp bends shall be avoided. The enclosure door shall include indicating lights to demonstrate that each suppression device is functional. Each suppression device within the arrester shall be replaceable as a unit. Outdoor SPD shall come with NEMA 4 enclosure and enclosure penetrations shall be watertight. Indoor SPD shall come with NEMA 12 enclosure Arrester shall be tested in accordance with ANSI/IEEE C62.11. In addition the arrester shall meet the following FAA-STD-019E requirements:

1. Mode of protection: L-N, L-L, L-G
2. Peak Surge Current: 3kA with 8/20uSec current impulse
3. Clamping Voltage: 475V L-N & L-G, 775V L-L for 120/208V system.
4. Clamping Voltage: 775V L-N & L-G, 1275V L-L for 277/480V system.

2.14 Emergency Lighting Fixtures - Each fixture shall have twin sealed beam lamp, 25 watt, 6 volt, Nickel-cadmium back-up battery rated for one hour. Emergency lights shall conform to Federal Specification W-L-305, type I, class I, style D, or E, with the number of heads as indicated on the drawings. Emergency light sets shall be connected to the wiring system by a cord no more than 3 feet in length to a single receptacle. Aim lights toward critical pathways. The Site Representative shall approve exact location and aiming.

### 3.0 EXECUTION

3.1 General - The rules, regulations and specifications referenced herein shall be considered as minimum requirements for this work. This specification shall govern when conflicts occur between reference documents and this specification. All materials and equipment shall be installed in accordance with the contact drawings and the recommendations of the manufacturer as approved by the RE. The installation shall be accomplished by skilled workmen regularly engaged in this type of work. Electricians shall be properly licensed for the type of work being performed. All installation practices and materials shall conform to NFPA 70, FAA-C-1217f, FAA-STD-19e, and FAA-C-1391b.

3.2 Working Clearances - All electrical equipment installed under this project shall be in compliance with NEC Article 110-26. In no case shall the working clearances of existing equipment be infringed upon by new equipment installed under this contract.

- 3.3 Contract Drawing – Where the electrical drawings indicate (diagrammatically or otherwise) the work to be completed and intended function, the contractor shall furnish all equipment, material, and labor to complete these installations, and accomplish these indicated functions. Further, the contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with all other project work. Minor departures from exact dimensions shown in electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The contractor shall promptly obtain approval from the RE prior to undertaking any such proposed departure.
- 3.4 Cable and conduit Cover Requirement – Cables and conduits for underground installation shall be placed at the depths shown on applicable drawings. If depths are not indicated on the drawings, minimum depth shall be as required by NFPA 70, however, in no case shall the cover be less than 24”.
- 3.5 Warning Tape – A 4 inches wide plastic warning tape, 6 mil minimum thickness, shall be continuously imprinted with the appropriate legend and shall be located 6-8 inches below finish grade and directly above the cable runs.
- 3.6 Separation – Power and control conductors shall not occupy the same raceway. Power conduits shall be separated from control conduits by a minimum of 3 inches. Where separation is not possible, control cables shall be fire wrapped with Fire-Stop adhesive tape over the cables entire exposed length in each junction box, handhole, and pull box.
- 3.7 Raceway Installations -
- 3.7.1 General - Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceways for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductor will be allowed to traverse these enclosures. Minimum conduit or tubing size shall be ¾-inch, but may be ½-inch for control wiring. Each run shall be complete before conductors are pulled into the conduit and shall be swabbed before conductors are installed. All conduit terminations shall include insulated bushings. Ends of conduit systems not terminated in boxes or cabinets shall be capped. Crushed or deformed raceways shall not be installed. All metallic conduit enclosing AC service lines shall be terminated using conductive fittings to panelboard, the power meter, and to the service. All buried metallic conduit enclosing signal, control, status and other power lines shall be terminated using conductive fittings to facility junction boxes, equipment cabinets, enclosures, or other grounded metal structure.
- 3.7.2 Conduit Installations - The wiring method shall consist of insulated copper conductors pulled into rigid metallic conduit, electrical metallic tubing (EMT), or flexible metallic conduit. Conduit system shall be installed complete before conductors are pulled into the conduit. Each run shall be cleaned and swabbed before conductors are installed. The minimum size conduit shall be ¾", and may be ½" minimum for control wiring. All conduit terminations shall include insulated bushings. Unless otherwise noted on the

drawings, conduit installations shall run parallel or perpendicular to the building lines in a neat and workmanlike manner. Location of exposed conduit runs will be subject to approval of the Site Representative. Conduit shall be supported as per NEC requirements. All unused conduits shall have a pull string/wire installed with a minimum tensile strength of 200lbs. Ten inches minimum slack shall be left at each end of the conduit.

- 3.7.3 Field Bends - Field bends shall be avoided where possible and where necessary shall be made with standard, approved hickey and conduit bending devices.
- 3.7.4 Field cutting and Threading - All field cut conduits shall be square cut and the ends carefully reamed to remove all burrs. Conduit threads shall be tapered such that they provide continuity and solidly grounded connections. The use of running threads will not be permitted.
- 3.7.5 Holes and Sleeves - The contractor shall provide all holes and sleeves necessary to install conduit and equipment. All required flashing, escutcheon, and sleeves shall be contractor furnished.
- 3.7.6 Galvanized Rigid Steel (GRS) - Rigid steel conduit may be used in all locations. For installation below slab or underground, the conduit shall be factory coated with either .008 inch of epoxy resin per Spec. MIL-R-21931, .020 inch of polyvinyl chloride, or .063 inch of coal tar enamel per Spec. MIL-P-15147, or shall be field wrapped with .01 inch thick pipe wrapping plastic tape designed for this purpose applied with 50% overlap. Method used requires prior approval by the Site Representative. All fittings for use with rigid steel conduit shall be of threaded type of the same material as the conduit. Where conduits enter NEMA type 1 boxes or cabinets without threaded hubs, grounding type double locknuts plus a phenolic insulated bushing or a metallic grounding bushing shall be used on the open end. For all other types of boxes and cabinets, use grounding hubs.
- 3.7.7 Electrical Metallic Tubing (EMT) - EMT may be used only in dry interior locations, and where not subject to physical damage. Fittings to be used with EMT shall be standard fittings designed for use with this type of conduit. All EMT fittings shall be the compression type. Indenter or set-screw type fittings will not be acceptable. EMT connectors shall include insulated bushings. Where conduits enter enclosures without threaded hubs, an appropriate threaded connector with cast or machined threads (not sheet metal) and locknut shall be used to securely bond the conduit to the enclosure. In addition, connectors shall have an insulated throat, smooth bell shaped end, or a metallic insulated bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation. Insulated bushings shall be provided to bond ground conductor to raceway. EMT shall not be used on circuits above 600 volts, nor in sizes greater than 3 inches in diameter.
- 3.7.8 Flexible Steel Conduit, and Liquidtight Flexible Metal Conduit - Flexible steel conduit shall be in 6-foot or less nominal lengths for terminal connections to motors or motor driven equipment, and may be used in short lengths for other applications as permitted by

the NEC. Liquidtight flexible conduit shall be used outdoors or in wet locations. A separate ground conductor shall be provided across all flexible connections, in addition to the green equipment ground, and terminated to flexible metal conduit connectors designed for this purpose. This separate ground conductor shall be installed on the outside of the flexible connection for inspection purposes and shall be strapped to the conduit between connectors. This conductor shall be at least the same size as the required equipment-grounding conductor per NEC table 250-122. If Liquidtight flexible conduit is required to be longer than six (6) feet in length, the contractor shall obtain approval from the Site Representative.

- 3.7.9 Polyvinyl Chloride (PVC or Rigid Nonmetallic) Conduit – PVC shall be heavy wall conforming to UL 651. PVC may only be used underground, in concrete, or as a 6” maximum vertical riser above grade or floor surface to connect to metal conduit. Make joints in PVC conduit in compliance with manufacturer's instructions. Make all bends by means of an electrical heating unit approved by the conduit manufacturer where standard elbows and fittings cannot be used. Rigid nonmetallic conduit may be used for lightning protection system conductors and indoors to protect signal-grounding conductors.
- 3.7.10 Surface Metal Raceways - Surface metal raceways shall conform to Federal Specification W-C-582. Surface metal raceways shall be installed only in exposed, dry locations where not subject to physical damage.
- 3.7.11 Wireways - Square duct shall only be installed in accessible locations. Covers shall be hinged and shall also have screw fasteners. Wireways installed in wet or damp locations shall be rated for these locations.
- 3.7.12 Underground Conduit and Cable Depth Requirements - Unless otherwise specified, all underground cables, ducts and conduits shall be installed a minimum of 24” deep to top of conduit.
- 3.4 Junction, Outlet and Pull Boxes -
- 3.4.1 Special Construction - Furnish pull boxes as shown on the drawings for cable to be installed by others.
- 3.4.2 Junction, Pull and Outlet Boxes - A junction or outlet box shall be provided at each location indicated in the plans and specification, or where necessary for compliance with the National Electrical Code, or for a neat, workmanlike installation. All boxes shall be of sufficient size and shape to meet code requirements.
- 3.5 Supports and Fasteners - Supporting methods for all electrical equipment and branch circuitry shall conform to the best practice, utilize only approved materials, and satisfy all requirements of the National Electrical Code. Raceways shall be securely supported and fastened in place at intervals of not more than 10 feet with pipe straps, wall brackets, hangers, or ceiling trapeze. Raceways shall also be supported within 3 feet (maximum)

of termination. Fastening shall be by toggle bolts on hollow masonry units; by expansion-bolts on concrete or brick; by machine screws, welded threaded studs, or spring tension clamps on steel work. Male type nylon anchors or threaded studs driven in by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Raceways shall not be supported from sheet metal roof decks. Do not support conduit or electrical equipment with wire. All metallic electrical support structures shall be electrically continuous and shall be bonded to the multipoint ground system or the Earth Electrode System either directly or indirectly.

- 3.6 Cable Installation in Conduit - The Contractor shall take all necessary precautions to insure against damaging the insulation and conductor during installation in conduit. A non-petroleum based lubricant approved by Underwriters' Laboratories shall be used if necessary to reduce tension during pulling. The cable may be pulled by power winch or by hand. Cable ends shall be sealed with cable end sealing caps or a waterproof tape. Where more than one cable is installed in a conduit, all shall be pulled at the same time. Splices shall not be pulled into a conduit. Control cable shall not be installed in the same conduit as power cable.
- 3.6.1 Dedicated Neutral and Grounding Conductor - Shared/common neutrals shall not be permitted. Neutral conductor sizes shall not be less than the respective feeder or phase conductor. For each 120 Volt circuit installed under this contract, the Contractor shall install a dedicated neutral and equipment grounding conductor throughout the entire circuit. The phase conductor, the neutral and the equipment grounding conductor shall be properly identified as a set at the source panel, in every J-box where a termination takes place and at each electrical device where the circuit terminates. Each utilized single pole overcurrent protective device shall have a dedicated neutral conductor.
- 3.7 Cable Termination - Cable terminations shall conform to NEC Article 110-14. Splices shall be made only at outlets, junction boxes, or in accessible raceways. Terminations of all control, 600V power, and coaxial cables shall be as specified. Care shall be taken not to damage conductors when removing insulation. Compression lugs, properly insulated, should be used whenever possible. Compression splices shall be taped with electrical insulating tape in a manner which makes their insulation equal to the insulation on the conductors. Wire nuts may be used to splice conductors sized #10 AWG and smaller. Wire nuts shall be taped for mechanical security. Compression connectors shall be used to splice conductors #8 AWG and larger. Multiple cables shall not be terminated in lugs listed for only one conductor. Splicing in panelboards is not permitted.
- 3.8 Identification -
- 3.8.1 Equipment Identification - Each of the following types of equipment shall be identified with a nameplate which shows: the functional name of the unit, voltage utilized, single or three phases as applicable, the panel and circuit number powering the equipment, and any other pertinent information. Nameplates shall be non-ferrous metal or rigid plastic,

stamped, embossed, or engraved with 3/8-inch minimum height lettering and numerals. Name plate background and lettering shall be in black. The plates shall be secured to the equipment with a minimum of two screws. Switches for local lighting do not need to be identified.

Panel boards

Disconnect Switches

Manual Transfer Switch

Junction Boxes

RVR electronic panels

Additional equipment shall be identified as required in the construction documents.

3.8.2 Conductor identification - In addition to color coding, all feeder, line, phase, branch, and neutral conductors shall be identified by shrink embossed labels, markers, or equivalent means as approved by the Site Representative. Panel and circuit numbers shall be identified. Conductor identification shall be provided at all terminations, and in all junction boxes through which these conductors pass.

3.8.3 Special Identification - All panelboards and disconnects which are added or modified in this project shall have the following yellow background type label with black lettering engraved and attached according to section 3.7.1. The first line shall be 1/2-inch lettering.

**CAUTION – SELECTIVELY COORDINATED  
THIS EQUIPMENT MUST BE REPLACED WITH  
IDENTICAL PROTECTIVE DEVICE TO  
MAINTAIN SELECTIVE COORDINATION**

3.9 Color Coding of Power Conductors - All wiring, including feeders, shall be color coded as specified herein. The color-coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable. All feeder and branch circuits, including neutral conductors, shall be identified at both ends of the conductor with panel and circuit number indicated. Neutral conductors shall be continuous. For conductors No. 4 AWG and larger, where color-coding is not available, color-coded tape, half lapped for a minimum length of 3 inches shall be used. In no case, however, shall green insulated conductors be re-identified for purposes other than grounding, nor shall white or neutral gray conductors be re-identified as other than grounded (neutral) conductors. Where conductors are color coded in this manner, they shall be color coded in all junction boxes and pullboxes, accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors shall be color coded as follows:

Phase Conductors - Phase conductors shall be color coded as follows:

	240/120V 1-PH 3-W	(240) 208Y/120V 3-PH 3or4-W	480Y/277V 3-PH 4-W
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Phase A	Black	Black	Yellow
Phase B	Red	Red	Brown
Phase C		Blue	Orange
Neutral	White	White	Grey/White

Color coding for conductors in control cables shall be in accordance with NEMA Standard WC-5. DC power conductors shall be color coded as follows: Positive conductor, red with brown tracer. Negative conductor, brown with red tracer.

- 3.9.1 **Application** - Where color coding is not available, color coded tape, half lapped for a minimum length of 3 inches shall be used. Where conductors are color coded in this manner, they shall be color coded in all junction boxes and pullboxes, accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors in open raceways and junction boxes shall be color coded at a maximum of 3'-0" intervals.
- 3.10 **Grounding and Bonding** - Grounding shall be in accordance with NFPA 70, FAA-C-1217 f (Section 4.4), and FAA-STD-019E. The grounding system for the facility shall be as indicated on the contract drawings and as specified. An equipment grounding system to properly safeguard equipment and personnel shall supplement the grounded neutral of the secondary distribution system. Each overcurrent device shall have its own equipment-grounding conductor. A green insulated ground wire shall be installed in each conduit used for power conductors to light fixtures, receptacles, and all electrical equipment. All metallic non-current carrying parts of electrical equipment shall be grounded with an equipment grounding conductor whether or not shown on the drawings. When surface metal raceways, wireways, or cable rack systems are installed, a separate copper conductor shall be installed on the raceway and shall be properly bonded to each section. The size of this wire shall be #6, unless otherwise indicated.
- 3.10.1 **Equipment Grounding Conductors** - See Table 250-122 of the National Electrical Code for minimum size of this conductor. Bare conductors shall not be permitted except for exterior use. Where insulation is required it shall be green for equipment grounding conductors number 6 AWG and smaller. Equipment grounding conductors larger than number 6 AWG and equipment grounding conductors in multiconductor cables (any size) shall be identified by marking all exposed insulation with green tape.
- 3.11 **The Grounding Electrode Conductor** for the electrical service shall be as sized on the drawings and shall be connected to the earth electrode system with an exothermic weld in an access well. This conductor shall be connected to a neutral bus inside the main service disconnect. This ground bus shall be connected to the neutral bus only at this location.
- 3.12 **Painting and Finishing** - Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection as directed by the Site Representative.

- 3.13 Repair of Existing Work - Electrical work shall be carefully laid out in advance. Where cutting, channeling, chasing, or drilling of floors, wall partitions, ceilings, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, it shall be carefully done. Damage to the building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost.
- 3.14 Surge Arrester - Arrester shall be compatible with the service voltage, and shall be wired to avoid loops, sharp bends and kinks, and to minimize the length of the conductor and number of bends. Arrester enclosure shall be mounted within 4" or less of the service disconnect enclosure and shall be close nipple directly to the service disconnect. Conductor length shall not exceed 12" unless approved by the Site Representative. There shall be no interconnection between neutral and ground within the arrester.
- 3.15 Demolition Repair - Wall sections exposed by demolition of equipment under this Contract shall be repaired/refinished to match existing. All penetrations and mounting holes shall be sealed weather-tight and refinished to match surrounding surface. All repairs shall be made to the satisfaction of the Site Representative.
- 3.15 Mechanical Equipment - Contractor shall provide all conduits, J-boxes, cable, lugs, terminations, disconnects, protective devices, etc. as required to complete power and control service to all mechanical equipment installed/affected by this Contract. The Contractor shall coordinate all work between mechanical and electrical Sub-Contractors to complete fuel and ventilation systems even if not specifically identified within the drawings. Installation not specifically covered in the construction documents shall be performed per the manufacturer recommendations. Mechanical systems shall be tested and meet requirements outlined in mechanical drawings and specifications.
- 4.0 QUALITY ASSURANCE
- 4.1 General - The Contractor shall keep records of all tests performed and shall submit, per specification section 01300, a letter type test report to the Site Representative prior to final FAA inspection of the Contractor's work. The report shall list the tests performed and results obtained.
- 4.1.1 Tests - The Contractor shall furnish the instruments, materials and labor necessary to perform the following tests. All tests shall be performed in the presence of the Site Representative or his/her designated representative.
- 4.1.2 Continuity Tests - Before connection of material, the Contractor shall perform continuity testing on all conductors installed under this job. Submit 6 copies of test reports to the Site Representative for approval prior to equipment connections. Test reports shall include circuit #, phase time and date of test, equipment served, test results, and signature of the person conducting the test.

- 4.1.3 Insulation Resistance Tests - Feeders and branch circuits shall have their insulation tested after installation, but before connection to fixtures or appliances. Motors shall be tested for grounds or short circuits after installation but before start-up. All conductors shall test free from short circuits and grounds, and a minimum insulation resistance phase-to-phase and phase-to-ground shall be 30 mega ohms measured with a 500-volt DC insulation resistance tester (As per FAA-C-1217 f section 5.3.4.). Apply the test voltage for at least one minute after the meter reading has stabilized. Submit test results to the Site Representative for approval prior to equipment connections. Test reports shall include circuit #, phase, time and date of test, equipment served, test results, and signature of the person conducting the test.
- 4.1.4 Operating Test - After the interior wiring system installation is completed, and at such time as the Site Representative may direct, the contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of the manufacturer and this specification. The test shall be performed in the presence of the Site Representative or an authorized representative. The contractor shall furnish all instruments and personnel required for the tests.
- 4.1.5 Load Balancing - Before energizing any new electrical 3-phase equipment, which has been installed under this contract, the contractor shall make certain that the phase rotation is positive. Load balancing requires that no single phase load shall exceed a 20% difference between readings in any two phases. The contractor shall take phase angle and load measurements on the service disconnect and each distribution panel and report the results to the Site Representative in writing. These readings shall be taken with all loads energized. The Contractor shall redistribute single-phase loads where there is greater than a 20% difference between readings in any two phases at the approval of the Site Representative and the FAA. The Contractor shall be required to document current readings taken before and after installation, and any phase loaded above 80% of the rating of its overcurrent protective device.

\*\*\* END OF SECTION \*\*\*

**SECTION 16136****RACEWAYS AND BOXES****PART 1 GENERAL.**

- 1.1 **Scope** - This specification provides equipment and installation requirements for raceways, including conduit, wireways and cable rack systems. It also provides equipment and installation requirements for boxes, including electrical component junction boxes and communication cable junction boxes.
- 1.2 **Specific Items of Work:**
- A. See Section 16100
- 1.3 **Applicable Publications:** The following specifications and standards form a part of this section and are applicable as they apply to this specification. The latest issue of the publications shall be used.

**Federal Specifications**

WW-C-566	Conduit, Metal Flexible
WW-C-581	Galvanized Steel Conduit
WW-C-582	Surface Metal Raceways

**National Fire Protection Association (NFPA) Publication**

NFPA 70	National Electric Code
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**FAA Specifications & Standards**

FAA-C-1217f	Electrical work Interior
FAA-STD-019e	Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities

**U.S. Army Corps Of Engineers (USACE)**

TI 809-04	Seismic Design for Buildings
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**Under Writers Laboratories (UL)**

UL 5	Surface Metal Raceways and Fittings
UL 6	Rigid Metal Conduit
UL 50	Enclosures for Electrical Equipment
UL 514A	Metal Outlet Boxes

UL 514B	Fittings for Conduit and Outlet Boxes
UL 797	Electrical Metallic Tubing
UL 870	Wireways, Auxiliary Gutters and Associated Fittings

National Electrical Manufacturers Association (NEMA)

NEMA 250-2003	Enclosures for Electrical Equipment
NEMA OS-1	Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA VE 1	Cable Tray Systems

1.4 Submittals: See section 1.3 in division 16100.

**PART 2 MATERIALS:**

- 2.1 Contractor Supplied Materials: The Contractor shall supply all the necessary materials and hardware required to install raceways and junction boxes described in this specification. Items not specifically mentioned in this specification, but necessary to complete the installation, shall be furnished without additional fee. These items include Unistrut supports, nuts and bolts, and other miscellaneous hardware. Unistrut supports used outside the equipment shelter shall be galvanized or stainless steel as well as the nuts, bolts and other hardware.
- 2.2 Junction Boxes - Boxes shall be either cast metal hub type conforming to UL514A and UL514B or shall be one piece galvanized steel type conforming to UL514B and UL514B. Where not sized on the Project Drawings, boxes shall be sized in accordance with the NEC.
- 2.3 Conduit: Conduit shall be of the types shown on the Project Drawings. Minimum conduit shall be ¾" unless otherwise specified.
- A. Rigid Steel Conduit - Rigid steel conduit shall conform to the requirements of Federal Specification WW-C-581. Rigid steel conduit shall be provided with insulated throat, grounding bushings at all connections to junction boxes and handholes.
- B. Rigid Nonmetallic Conduit - Rigid nonmetallic conduit shall conform to UL 651 and/or NEMA TC2 or TC6 (Type DB). Rigid nonmetallic conduit shall be provided with an end bell at all handhole connections.
- C. Electrical Metallic Tubing (EMT) - EMT shall conform to UL 797. EMT may be used only in dry interior locations, and where not subject to physical damage. EMT shall not be used on circuits above 600 volts nor in sizes greater than 3 inch diameter. The ends of EMT shall be fitted with insulating throat connectors.
- D. Flexible Metal Conduit - Flexible metal conduit shall conform to Federal Specification, WW-C-566. Flexible metal conduit shall be galvanized steel

conforming in all respects to Underwriter's laboratories Standard. Flexible metal conduit and fittings shall be UL Listed as grounding type. Flexible metal conduit shall not be used in lengths exceeding 6 feet. Liquid-tight flexible metal conduit shall be used outdoors and in wet locations.

- 2.4 Wireways: Wireways shall conform to UL 870. Wireways shall only be installed in accessible locations. Wireways installed in wet or outdoor locations shall be galvanized or stainless steel and rated for outdoor installation.
- 2.5 Cable Tray Systems: NA
- 2.6 Square duct: NA.
- 2.7 Seismic Bracing: The Contractor shall provide bracing in accordance with TI 809-04.

### **PART 3 EXECUTION:**

- 3.1 General: The rules, regulations and reference specifications enumerated in section shall be considered as minimum requirements. FAA requirements often exceed those of other Standards organizations such as NEC. Adherence to other standards shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship when so required by this specification.
- 3.2 Workmanship: All materials and equipment shall be installed in accordance with the contract drawings. Conduit, boxes and raceways shall be installed so that vertical surfaces are plumb and horizontal surfaces are level. The installation shall be accomplished by qualified workers regularly engaged in this type of work. Where required by local regulations, the workers shall be properly licensed.
- 3.3 Galvanized rigid Steel (GRS): All GRS conduit shall comply with the following installation requirements:
  - A. Terminate with a grounding type insulated bushing and double locknut at each underground or cabinet box termination.
  - B. GRS conduit shall be used for conduit risers from trenches and outside above ground installations.
  - C. All connections shall be made with threaded connectors. Field cut threads shall match factory threads perfectly.
  - D. All field threads and any damaged galvanized surfaces shall be treated with three coats of a zinc rich paint.
  - E. GRS shall be shop bent to meet installation requirements.

- F. Underground installations shall be field wrapped with 0.010 inch pipe wrapping plastic tape applied in the following thickness:
- |                                       |            |
|---------------------------------------|------------|
| Low density or medium density plastic | 0.020 inch |
| Epoxy resin                           | 0.008 inch |
| Coal tar enamel                       | 0.063 inch |
- 3.4 Installation of Electric Metallic Tubing (EMT): EMT shall be installed in manner that creates the least interference with existing wall and ceiling mounted conduit and boxes. Conduit shall be neatly routed with lines kept horizontal, vertical and parallel to shelter walls. Installation shall meet the following requirements:
- A. EMT shall not be used on circuits above 600 volts.
  - B. Only standard compression type fittings shall be used with EMT.
  - C. Connectors shall be insulated throat type.
  - D. EMT is for interior use only.
- 3.5 Cable Rack Support Systems: Cable rack system shall be supported and installed as shown on the electrical drawing and meet the following conditions:
- A. Spacing of supports shall not exceed 6 feet
  - B. Supported from structural members only (do not drill into structural members)
  - C. Fasteners shall be designed for use with the supporting surface and be capable of supporting 1-1/2 times the actual load
- 3.6 Supports: Electrical boxes, conduits and raceways shall be securely fastened to wood with wood screws, carriage bolts and lag screws. Bolts and expansion shields shall be used on masonry and brick and machine screws or welded studs on steel work. Support systems shall be capable of carrying at least 1-1/2 times the weight of the supported system. Conduit shall be supported with straps designed to support conduit at intervals not exceeding 3 feet.
- 3.7 Outdoor Conduit and Wall Penetrations: Conduit exposed on the outside wall of the shelter shall be rigid steel galvanized. The following are installation requirements:
- A. Conduit must be secured to the building at 3 foot intervals with conduit straps.
  - B. Threaded couplers at the junction box shall be watertight, fitted with neoprene washers.

- C. LB conduit body shall be installed at the wall penetration.
  - D. The shelter wall must be penetrated at an elevation approximately 3 inches above cable trays inside the shelter. The area around the wall penetration shall be encapsulated with plastic sheathing during drilling operations to prevent dust from getting into the electronic equipment inside the shelter.
  - E. The hole through the shelter wall shall closely match the outside diameter of a rigid steel galvanized nipple.
  - F. The area around the nipple shall be sealed with Sikaflex acrylic caulk. The inside of the conduit nipple shall be sealed with duct seal.
- 3.8 Raceway Grounding: Surface metal raceways, wireways, or cable rack systems shall be installed in a manner that assures electrical continuity. Insulated copper bonding jumpers shall be installed between adjacent raceway sections to assure proper bonding.

**\*\*\*END OF SECTION\*\*\***



## SECTION 16670

### LIGHTNING PROTECTION, BONDING & GROUNDING

#### PART 1 GENERAL

- 1.1 General: The contractor shall provide all labor, equipment and materials as necessary to install lightning protection and grounding systems as specified on the drawings and in this specification. The contractor's work shall comply with all applicable sections of FAA-STD-019e, Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities. The major work items for this project are as follows:
1. Provide air terminal at the GS power rack.
  2. Provide two down conductors at each GS rack.
  3. Expose by hand digging existing earth electrode system (EES) for exothermic weld to new down conductors.
  4. Provide exothermic weld to bond each end of RSC conduit to the down conductor.
  5. Provide exothermic weld to bond bottom support poles at the each rack.
- 1.2 Applicable Documents: The following specifications and standards of the issues currently in force, form a part of this section, and are applicable as specified herein.
- 1.2.1 National Fire Protection Association (NFPA) Publications-
- No. 70 National Electric Code  
No.780 Standard for the Installation of Lightning Protection Systems
- 1.2.2 Underwriters' Laboratories
- UL 96A Installation requirements for Lightning Protection Systems  
UL 96 Standard for safety for lightning Protection Components
- 1.2.3 Federal Aviation Administration
- FAA STD 019e Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities  
FAA-STD-020b Transient Protection, Grounding, Bonding and Shielding Requirements for Electronic Equipment  
FAA-C-1217f Electrical Work, Interior
- 1.3 Submittals:
- 1.3.1 Air Terminals – product data sheet
- 1.3.2 Fasteners – product data sheet

## PART 2 MATERIALS

- 2.0 **Materials:** All lightning protection component and conductor material shall be copper class II. Copper materials shall not be used on aluminum surfaces. All materials shall be new, the standards products of manufacturer's regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with those shown on the drawings and as specified herein. All lightning protection conductors and hardware shall carry the Underwriters' Laboratories, Inc. label or have factory certificates that the material complies with the Underwriters' Laboratories, Inc. No aluminum or other dissimilar materials shall be used. All materials used in this installation shall be in strict accordance with NFPA 780 and FAA-STD-19e.
- 2.1 **Air Terminals:** Air terminals shall be solid copper. Copper air terminals may be nickel plated. Air terminals shall be a minimum of 24 inches (305 mm) in height, at least 5/8 inches (12.7 mm) in diameter, and shall have a "bullet" or tip point. Also see FAA-STD-19e (section 4.2.3.5.1).
- 2.2 **Lightning Protection system conductors:** All conductors used in a lightning protection system (down conductors) shall be class 2 main sized conductors as defined by NFPA 780 or larger. See FAA-STD-19e (section 4.2.3.2.1).
- 2.3 **Fasteners:** Fasteners shall be copper or bronze. Galvanized or plated materials shall not be used.
- 2.4 **Fittings:** Bonding devices, cable splicers, and miscellaneous connectors shall be suitable for use with the installed conductor and shall be copper or bronze with bolt pressure connections to the cable. Cast or stamped crimp type fittings shall not be used.
- 2.5 **Ground Rods:** Ground rods shall be copper or copper clad steel, 3/4-inch diameter and a minimum length of 10 feet. Copper cladding shall be 1/64 inch minimum thick. Also see FAA-STD-19e (section 4.2.4.3.8).
- 2.6 **Facility Counterpoise (Earth Electrode System):** #4/0 AWG bare copper ground consisting of 28 strands and with a cross sectional area of 211,500 CM.
- 2.7 **Grounding Conductors:** The grounding electrode conductor shall have green colored insulation or be bare copper and sized as shown on the contract drawings. Where not shown, the conductor shall be sized in accordance with Table 250-95 of the National Electrical Code except that it shall not be sized smaller than No. 6 AWG for bare conductors or No. 12 AWG for insulated conductors. The grounding conductor for the bulkhead plates shall be a No. 4/0 AWG insulated copper cable.
- 2.8 **Bonding Jumpers:** Bonding jumpers used in interior locations to bond sections of metal objects shall be insulated copper and sized in accordance with Table 250-95 of the NEC.
- 2.9 **Adhesive:** Mastic shall be of the type suitable for bonding to fiberglass surface of the RU shelter.

- 2.10 **Other Hardware:** Fasteners shall be of the same materials as the conductor base material or copper in most cases. Fasteners shall not be made of aluminum, galvanized steel or plated materials. Bonding devices, cable splicers and connectors shall be suitable for use with the installed conductor and be copper or bronze with bolt pressure connections.

### **PART 3 EXECUTION**

- 3.0 **Installation:** The grounding system for the facility shall be as indicated on the contract drawings, as specified in FAA STD 19e, as required by the applicable documents and as specified herein. In the event of conflicting requirements, the most stringent shall apply.
- 3.1 **Air Terminal Assembly:** Install assembly and air terminal as shown on the drawings. Top of air terminal shall be as shown on the drawings and in no case less than 10-inches above the support mast. Anchor antenna down conductor to mast every 3 feet with U-bolt pipe clamps, Thompson No. 803, or equal. The down conductor shall be extended to and clamped to the halo ring.
- 3.2 **Down Conductors:** Install down conductors away from power and signal cables. Down conductors shall maintain a horizontal or downward course and be supported with fasteners every 3 feet. Bend radius shall not be less than 8. Bends less than 90 degrees will not be allowed. Down conductors shall be exothermically welded to a 4/0 AWG copper conductor prior to entering the ground at not than 18 inches above ground level. The 4/0 AWG copper conductor shall enter the ground and be welded to ground rod that is exothermically welded to the EES. See FAA-STD-19e (section 4.2.3.4.2).
- 3.3 **Structural Steel :** Ground structural steel to the earth electrode system with a #4/0 bare copper cable. Connect #4/0 cable with a clamp at the base of member and with an exothermic weld at the counterpoise.
- 3.4 **Ground Rods:** Ground rods shall be driven full length into the earth so that the top is a minimum of 12 inches below finished grade. Where ground rods cannot be driven because of soil conditions, a ground plate must be installed, and will be substituted at the rate of one ground plate per ground rod.
- 3.5 **Metal Conduits:** Conduits shall be terminated with an insulated, grounding bushing at all junction boxes, handholes and building entries. Conduits in enclosures shall be interconnected with a single, grounding conductor. At junction boxes, conduits shall be grounded to the enclosure. At handholes, the conduits shall be grounded to a ground rod. At building entries, metal conduits shall be grounded to the multi-point ground plate.
- 3.6 **Metal Bodies:** Metal bodies (downspouts, gutters, vents, ladders, etc.) within 6 feet of an exposed lightning protection system shall be bonded to the lightning protection system **with Class II** secondary conductors and approved UL fittings and splicers.
- 3.7 **Ductbanks:**

The contractor shall install a #1/0 AWG bare copper conductor a minimum of 10 inches above the cables and exothermically weld it to the earth electrode system or a ground rod at each end.

- 3.8 Grounding Connections: All equipment, armored cable, GRS conduit and all other exposed, non-current carrying metal parts of electrical equipment shall be grounded by an equipment grounding conductor sized as designated in the drawings and specifications, but in no case smaller than that required by Table 250-95 of the NEC. Bare conductors shall not be permitted except for where shown on the drawings. All connections to the equipment to be grounded shall be made with a ground connector specifically intended for that purpose. Connecting screws or mounting bolts are not suitable for use as grounding connections. Connections to ground electrodes and all other underground connections shall be exothermic welded except at access wells. Connections at access wells shall be made using pressure connectors or clamps.
- 3.9 Other Hardware: Install hardware in a neat manner, parallel or perpendicular or plumb where fastened to surfaces. Prior to bonding to surfaces, all connection points shall be cleaned of paint, insulation and other non-conducting materials over an area that extends at least ¼ inch beyond the bonding surface of the larger member.
- 3.10 Underground Connections: No part of the underground cable or connections shall be concealed until the Contracting Officer's Representative has inspected, tested and approved the ground rods or plates, conductors and connections in that part of the system. Any faulty connections or items shall be corrected or replaced as directed by the Contracting Officer's Representative.
- 3.11 Grounding Electrode Test: Contractor shall measure the earth electrode grounding resistance of the installed counterpoise. Test shall be a 3-point earth resistance test. The maximum resistance acceptable shall be 10 ohms. If the measured resistance to ground is not ten ohms or less, additional grounding electrodes shall be installed. The contractor shall provide two sets of the grounding electrode test to the FAA.

**\*\*\* END OF SECTION \*\*\***

## SECTION 16950

**ELECTRICAL TESTING**1.0 GENERAL REQUIREMENTS

1.1 Scope – The contractor shall provide the instruments, materials and labor necessary to perform electrical tests as specified herein.

## 2.0 ELECTRICAL TESTS

2.1 . General - This Section specifies the requirements and procedures for the electrical system testing requirements include measurement and establishment of the quantities of the electrical system as required to meet design specifications, and the recording and reporting of the results. All instruments shall have been calibrated within a period of two years preceding testing. All testing shall be accomplished before connection is made to any existing or new equipment. All tests shall be performed in the presence of the RE. The results of these below tests shall be submitted to the RE for review and approval.

2.2 . Test the following

1. Insulation resistance test
2. Continuity test.
3. Neutral Isolation test
4. Earth resistance test
5. Load balancing test
6. Operating test

2.2.1. Report forms - Test data sheets arranged for collecting test data in logical order for submission and review. This data should also form the permanent record to be used as the basis for any future testing. Prior to final inspection, the contractor shall submit a test report including the circuit being tested, the test results, the person performing the test, the date of the test, and the model test equipment.

2.2.2. Insulation Resistance test – All Government furnished conductors, existing conductors to be reused, and the contractor furnished conductors shall be tested prior to installation. All feeders and branch circuits shall have the insulation tested after installation and before any splices or terminations are made to equipment. All conductors shall test free from short circuits and grounds, and have a minimum phase to phase and phase to ground insulation resistance of 30 Mega-Ohms when measured with a 500 VDC insulation tester for at least one minute after the meter reading has stabilized. Motors and transformers shall be tested for grounds or short circuits after installation but before start-up.

2.2.3. Continuity test – All power cables and control cables, including individual conductors of a multi-conductor cable, shall be continuity tested prior to connection.

- 2.2.4. Neutral Isolation Test – For All new installation, the neutral in the service entrance switch shall be tested for isolation from ground with an Ohm meter capable of reading greater than 20,000 Ohms.
- 2.2.5. Failure of Conductor Under Test – Conductor, including splices, which fail test requirements shall be repaired or replaced, and re-tested. Conductor or cable shall not be energized until it has passed all test requirements
- 2.2.6. Earth Resistance Test  
Using the fall of potential method, the contractor shall measure the resistance to earth of each individual ground rod or ground plate prior to interconnection with the 4/0 AWG cable loop. The results of these tests shall be submitted to the RE for review. After approval by the RE, the ground rods shall be interconnected and the resistance to earth of the new ground system shall be tested with the results submitted immediately to the RE for approval. The FAA requires the resistance to earth of the EES shall be as low as practicable and not over 10 Ohms. Note. Tests shall not be conducted within 48 hours of a rainfall or in frozen soil.
- 2.2.7. Operating Test – After the wiring system installation is completed, the contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of these specifications. The test shall be performed in the presence of the RE.

1.3 SUBMITTALS:

- A. Test Data:  
1. Submit the data collected during testing.
- B. Completed Test Reports:  
1. Submit the completed test reports

END OF SECTION 16950