Memphis Air Route Traffic Control Center
Memphis, Tennessee
PANEL BOARD REPLACEMENT POWER SERVICES BUILDING
SPECIFICATIONS

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SPECIFICATION FAA-ZME-805681

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SECTION 01010 SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Scope of Work - These specifications, together with the referenced specifications, standards, and drawings specified in the contract documents cover the requirements for all work associated electrical panel board replacement in the Power Service Building to include:

> Removing and replacing panel boards DPA, DPB, DPC, GLB, 3PDT (manual transfer switch) and transformer feeding GLB. The Feeders to DPA, DPB, DPC will remain. Remove unused junction- box and 2 CB panel on wall at GLB. Various branch circuits in all panel boards need replacing as some are older type conductors and some are not color coded for 480 volts.

The General Contractor (GC) shall be expected to work during day times, 0700 AM to 0430 PM. Extensive coordination between the GC and FAA personnel shall be required at all times in order to maintain an operational facility. **Prospective bidders are strongly recommended to perform a site visit to assess the actual conditions before submitting a bid. Site visits should be arranged thru the Contracting Officer's Office.**

B. FAA Holiday Moratorium - No work shall be scheduled or take place during the week of and the weekend preceding and following: The Thanksgiving, Christmas, and New Years Holidays. Only emergency work to restore critical services to the Facility will be considered and a moratorium waiver must be submitted and approved. The moratorium period will not be counted against the contract construction duration of the project.

C. Intent of Specifications - This specification identifies all material, labor, and equipment required to perform this work. All work performed and all materials and equipment used are subject to approval by the Contracting Officer (CO) and /or the Resident Engineer (RE). This shall include but is not limited to inspection, scheduling, reporting and submittals.

D. Title - Titles to division and sections of the specifications and notes and titles on drawings referring to subcontractors, division of work by trade, or type of work, are introduced merely for convenience in reading the specifications and drawings and do not imply any separate contractual arrangements of work assignments. Such separations into titled divisions and sections shall not operate to make the Government an arbiter to establish subcontract limits between the contractor and subcontractors, or between the subcontractors themselves.

E. Contract Documents - The drawings, as shown on the "List of Drawings" in Attachment 2 in each specification package, General, Architectural, Mechanical, Electrical, and Southern Standards, all form a part of the construction requirements for this project. The renovation of these systems shall be in accordance with the lines and grades shown on the drawings. The Contractor shall not use dimensions scaled from drawings. All dimensions shown on the drawings shall be field verified by the contractor prior to any modifications and fabrications. Any discrepancies between the drawings and specifications and the existing conditions shall be referred to the CO for adjustment before any work affected is performed.

F. Precedence of Contract Documents - In the event of a difference between the following contract provisions, the order of precedence to determine which provision shall govern is:

1. Contract Clauses and Provisions
2. Project Specifications
3. Project Drawings

Any discrepancies between the contract provisions, the specifications and the contract drawings shall be referred to the CO for a written determination in accordance with Contract Clause entitled Order of Precedence.

G. Contracting Officer -The term "Contracting Officer" (CO) as used herein denotes the person designated to act on behalf of the Government in the performance of this contract. Where reference is made to "Federal Aviation Administration" (FAA), "Resident Engineer" (RE), "Contracting Officer's Representative" (COR), or the like, this shall mean the Contracting Officer or his/her authorized representative.

H. Contractor Superintendence - In accordance with Contract Clause entitled SUPERINTENDENCE BY THE CONTRACTOR, the Contractor shall at all times during performance of this contract and until the work is completed and accepted, directly superintend the work or assign and have on site a competent superintendent with the authority to act for the Contractor.

The Contractor shall submit a Project Organizational Chart with the key personnel identified and their qualifications for the Government's review and approval.

1.2 SPECIAL REQUIREMENTS

A. Asbestos Containing Materials. - **No new materials supplied by the contractor for this construction shall contain asbestos or lead-based products.** The contractor shall verify that all materials, including those supplied by third parties, are asbestos free and/or lead-based free materials.

1. Contractor certification requirements. - The contractor shall provide to the Contracting Officer (CO) a signed and notarized document stating that to the best of his/her knowledge, no asbestos containing or lead-based materials were used during the construction, renovation, and/or modernization of this facility.

2. Material Data Safety Sheets. - The contractor shall submit Material Data Safety Sheets (MSDS) with all submittals for review and approval by the Contracting Officer. New materials found to contain asbestos and/or lead-based products will be automatically disapproved. Copies of all MSDS sheets shall be provided to the facility FAA personnel for the building records. The contractor shall comply with all health and safety provisions outlined in each MSDS and shall follow all OSHA guidelines regarding personnel protection.

3. Hazardous materials.- If the FAA RE suspects the presence of asbestos or lead-based products in the new materials, the FAA will sample the suspect material to verify that no asbestos containing material or lead-based material were used. If these materials are found to contain asbestos or lead-based products, the cost of the survey and all subsequent removal/replacement of any hazardous materials shall be at the contractors' expense.

B. Work plan and scheduling. – Prior to the Contracting Officer issuing the Notice To Proceed (NTP), the contractor shall submit for approval a plan and schedule of his work. This schedule shall include all of the requirements as defined in Section 01042 of this specification.

C. Sequence of work. - The contractor shall be responsible for scheduling all aspects of the work and coordinating among the different trades involved in the project. The contractor shall follow the guidelines outlined in the sequence of work as described in the contract drawings. The Federal Aviation Administration has developed a list of milestones that the contractor shall be required to meet.

D. Construction Activities and Milestones. – Construction Activities and Milestones below shall be included in the submitted schedule. They are provided for guidance, but are not intended to direct how and when contract activities shall be ordered or take place in the submitted schedule.

1. SUBMITTAL APPROVAL
2. ORDER LONG LEAD ITEMS
   a. Panel boards
3. NOTICE TO PROCEED
   a. Scheduled by the FAA's CO
4. ESTABLISH PROTECTION OF PERSONNEL AND EQUIPMENT
5. REMOVE OLD AND INSTALL NEW PANELS
6. REMOVE PERSONNEL AND EQUIPMENT PROTECTION
7. EQUIPMENT WARRANTIE
8. CLOSE JOB

E. Driveway Closures - Contractor shall maintain access to the loading dock at all times.

END OF SECTION 01010

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SECTION 01030
SITE ACCESS, CONSTRUCTION LIMITS, USE OF FACILITIES AND WORK HOURS

PART 1 – GENERAL

1.1 SUMMARY

A. Existing facility operations. - Construction/demolition shall in no way interfere with Air Traffic Control Operations. The ARTCC is a 24-hour, seven day a week facility. Extreme care shall be exercised so as not to cause any interference or interruption of service from this facility. Controller functions are vital to the safety of the flying public. It is absolutely mandatory that the contractor protect FAA personnel and existing FAA communication, electrical and mechanical equipment both inside and outside buildings from damage caused by impact, water, debris, dust or odor. The contractor shall have the overall responsibility for the performance and enforcement of all forms of protection within the ARTCC premises against any damages due to work performed under this contract. Any damages incurred, as a result of construction activity during the performance of this contract will be repaired/replaced immediately by the contractor at no cost to the FAA.

Any work or activity that may impact the National Airspace System (NAS), such as work on critical equipment or circuits, will require coordination with the Contractor Office Representative (COR). The COR will prepare and submit a work or activity specific "Risk Assessment" for the facility's review and approval. This process may take one week to complete. Typically, this type of work or activity is performed from midnight to 05:00 am and/or on weekends.

B. Construction limits and access. -

1. Construction limits.- The contractor shall confine operations, activities, storage of materials and employee parking within the designated areas, as indicated on the construction staging plan, or as designated by the COR. Additional space the contractor deems necessary shall be obtained off site, at no additional cost to the Government.

2. Access. - Access route for the contractor, subcontractors, employees, deliveries, etc., shall through the main gate, or as designated by the COR. Access to all, parking areas, and loading dock shall be kept unobstructed. If temporary access obstruction is unavoidable, the contractor shall advise the COR immediately. Vehicles transporting materials shall not be loaded beyond the capacity prescribed by federal, state, or local laws. Obstruction of existing roadways, driveways, to the ARTCC is strictly prohibited.

3. Damage to site. - Damage to existing paving, lawns, curbs, sidewalks, and utilities caused by the contractor's activities shall be repaired immediately. Any damage to the building, interior or exterior, that are a result of the contractor's activities shall be repaired. The contractor shall pay all costs of repairs. After notice to proceed and prior to the commencement of construction, the contractor and COR shall conduct joint inspections of the existing areas affected by the construction. Existing damage or defects shall be noted and will be used as the basis for determination of damages caused by the contractor's operations.

4. The Contractors' employees shall not use the Cafeteria.

C. Inspection of site by contractor. - It is strongly urged that the contractor carefully examine the premises to determine the extent of work and the conditions under which it must be done.

D. Government use and access to premises. - The Government reserves the right to enter the construction area at any time for work inspection and for the operation of the facility.

E. Work hours. - All work hours, shifts, and overtime work shall be coordinated with the COR. Before commencing construction, furnish to the COR a statement of hours per day and days per week to normally be worked and approximate number of persons on the job for a normal work shift.

F. Security requirements.

1. Personnel List. - Contractor shall provide the COR with a list of contractor personnel who require access to the ARTCC. The list shall be submitted immediately after contract award. The list shall be kept current during the project and shall include the following:

   Full name, including middle initial
   Federal or State issued photo ID
   Date of Birth
   Place of Birth

2. Security Investigation and identification. - Contractor's personnel may be subject to security investigation by FAA. The contractor shall promptly complete all security forms provided by the CO. Contractor's personnel shall report to the FAA security guard at entrance to the facility and submit proper identification when signing in to obtain an FAA badge which will be worn on an outside garment, above the waist and below the neck, facing forwards, at all times while on the ARTCC premises. This badge shall be returned daily to the security guard when leaving the premises, unless otherwise noted.

3. Vehicle identification. - Vehicle identification tags will be issued for contractor and contractor's employees' vehicles that require access into the ARTCC site. The identification tags shall be displayed in the windshield of the vehicle at all times when the vehicle is on the site. The contractor shall be responsible for the collection and return of all vehicle tags that are no longer required.

4. Escort requirement. - Contractor is responsible to provide an escort for his employees. This will required a security background investigation by the FAA. Contractor's personnel shall not violate any security regulations pertaining to the ARTCC facility. Violators may be removed from the premises with the right to reenter revocable. Contractor's day-to-day work schedules in the classified areas shall be so arranged to allow for minimum escort.

5. Right to search. - Current procedures at FAA facilities include the "right to search." If in the judgment of the FAA a cause to search a vehicle or the person of personnel exists, such search will be made.

6. Replacement of lost identification. - The FAA will provide personnel badges and vehicle identification tags as described above. It is the contractor's responsibility to return these badges and tags daily and upon completion of the project. The contractor shall be liable to pay for any FAA badge or tag not returned or replaced at the completion of the work. The payment for lost I.D. will be $10.00 for each and every tag or badge not returned or replaced, except for temporary badges.

7. Physical Security. - At the end of each workday, the contractor shall secure all construction areas by closing and locking all doors and gates. The contractor is responsible for the security of the staging area, and shall provide the required measures at no additional expense to the government.

END OF SECTION 01030

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SECTION 01040: COORDINATION, LOCAL PERMITS AND TESTING

PART 1 – GENERAL

1.1 SUMMARY

A. Project coordination. - It shall be the duty of the Contractor to prepare a detailed schedule of work and work layout to resolve conflicts and to assure coordination of the work by different trades.

B. Weekly Meeting. - Coordination between the COR and Contractor shall take place weekly at the site. Special meetings will be scheduled if requested by either the COR or Contractor. The subjects to be discussed at the progress meetings shall included, but are not limited to, the following:

-Safety concerns/Issues
-Progress of Work
-Previous meeting action items/issues
-Field problems
-Material and Equipment delivery status
-Submittal status/schedules
-Progress planned during the upcoming week(s)
-Review of changes, and potential effects on the schedule
-Construction schedule revisions
-Schedule Revisions
-Other current business

The following persons will be expected to attend meetings; FAA COR, Prime Contractor Superintendent, Project Manager and Project Manager/Superintendents for other major trades.

C. Facility Coordination Meeting. - Weekly coordination meeting shall take place between the facility managers, COR and the Contractor's Project Superintendent.

D. Work Affecting Operational Systems. - The contractor shall coordinate all work which has any or may have any impact on any operational system within the facility through the COR. The contractor shall immediately cease any work that is adversely impacting the operation of the ARTCC and shall immediately repair or restore any portion of the operational system that has been damaged or suffered diminished performance as a result of the contractor's activities.

E. Local permits and Coordination. - The Contractor will be responsible for obtaining and payment of all building fees, inspection fees, utility connection charges and any other fees or charges that may be incurred in the performance of this contract.

F. Applicable documents. - The contractor shall comply with all local city, county, and state construction codes.

1.2 TESTING

A. Contractor's responsibility.- Unless otherwise indicated as the responsibility of another identified entity, Contractor shall provide certified testing and inspection agencies, inspections, tests, and other quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction.

1. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Contractor's responsibility, the Contractor shall employ and pay a qualified independent testing agency to perform quality-control services.

2. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Government's responsibility, the Government will employ and pay a qualified independent testing agency to perform those services.

    a. Where the Government has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the Government, unless agreed to in writing by the Government.

B. Retesting - The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility.

    1. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements.

C. Selection and payment. - The contractor shall pay for all testing. The contractor shall select and use a certified and qualified testing laboratory to perform the requirements of this contract. The American Association of Laboratory Accreditation shall certify the testing laboratory.

D. Rejected materials or workmanship.- All materials or workmanship or both which have been rejected by the COR by reasons of failure to conform to the requirements of the Contract Documents shall be removed and replaced with new, acceptable materials by the contractor at the contractor's own expense. Contractor shall also pay for testing of new materials that have been installed in place of rejected materials.

    1. The testing laboratory will furnish three copies of each report directly to the COR covering all of its determinations and conclusions. Reports will show all data customarily listed by the laboratory in reporting on quantities, qualities, and types of materials, together with their correlation with the project and applicable Specification Section.

END OF SECTION 01040

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SECTION 01042 CONSTRUCTION SCHEDULES

PART 1 – GENERAL

1.1 SUMMARY

A. Description. - The work plan and schedule prepared by the contractor shall consist of a Gantt or Critical Path Method (CPM) chart(s) and logical narrative plan. The charts shall show all significant activities and shall include detailed activities when critical work is to be performed.

1.2 PRODUCTS

A. Diagrams -

1. Show the order of the activities.
2. Include construction activities, the submittal and approval of materials, samples and shop drawings, the procurement of critical materials and equipment, fabrication of special materials and equipment along with their installation and testing, and costs associated with each activity in the chart.

B. Progress Schedules. - Within 30 calendar days of contract award, the contractor shall submit the schedule and work plan. **A Notice to Proceed will not be issued until the schedule is approved.**

C. Software Files Schedules: Software file submissions may be accepted, if it can be read by software that the COR has already installed on their computer or if the contractor can provide a licensed copy of the scheduling software used to prepare the schedule file. The COR will get the software installed and will get it removed at the end of the project.

1.3 EXECUTION

A. Review and Evaluation. - The Contractor shall participate in a review and evaluation of the proposed schedule with the Contracting Officer. Any revisions necessary as a result of the review shall be re-submitted for approval of the Contracting Officer within 14 days after the conference. The contractor for planning, organizing, and directing work, reporting progress, and requesting payment for work accomplished shall then use the approved schedule. If the contractor, thereafter, desires to make changes in the schedule, the Contracting Officer shall be notified in writing, stating the reasons for the change. If the Contracting Officer considers the change to be of a major nature, the contractor may be required to revise the schedule and submit it for approval, without additional cost to the government.

B. Weekly Update. - The contractor shall meet with the COR at monthly intervals to discuss the construction progress. If the project is behind schedule and requires a change in the schedule, the contractor shall submit a revised schedule with a description of the delaying factors and their impact, and an explanation of corrective actions taken or proposed.

C. Payment. - The monthly update shall show the activities or portions of activities completed during the reporting period, and their total value will be the basis for the contractor's periodic request for payment. Payment will be based on the total value of such activities completed or partially completed after verification by the Contracting Officer.

D. Submission Requirements. - Schedule charts shall be on (minimum) 11" x 17" size paper. Update charts shall show the date of the latest revision. Schedule charts with revisions and monthly updates shall be submitted in three copies.

E. Requirements for Schedule Chart. –

1. Activities.- The significant activities to be included in the schedule chart shall include, but not be limited to:
   a) The milestones listed in 01010 1.2. D.
   b) Contractor shall provide a cost loaded schedule with a minimum of 30 activities
   c) Any system shutdowns or cut-overs
   d) Any other significant activities that the contractor or FAA believes is necessary.
   e) Will show work in each related to each panel board to be worked on
   f) Shall consist of network analysis system, or Gantt chart (bar chart)
   g) Contractor shall provide a cost loaded schedule with a minimum of 30 activities the schedule shall indicate which panel boards are being worked on
   h) The diagram shall show a continuous activity flow from left to right. The diagram shall show the sequence in which the work is to be accomplished as planned by the Contractor
   i) Dates shall be shown on the diagram for start of the project, any milestones required by the contract, and contract completion
   j) The critical path shall be clearly identified
   k) Network activities shown shall include submittal and review of shop drawings and samples and procurement of materials and construction activities
   l) Government activities that affect progress shall be shown. These include but are not limited to: Notice-to-Proceed, approvals, and inspections

F. Shutdown and Cut Over.

1. Electrical Systems. - New construction shall have no impact on the critical or essential electrical service at this facility. However, all electrical connections within live power panels will be scheduled with the COR at least 14 days in advance. All electrical connections to existing panels shall be coordinated with FAA personnel. Equipment shutdown and lock-out shall be accomplished by FAA personnel.

2. Startup - The contractor will complete initial startup testing and training.

G. Acceptance and Warranties

1. The Contractor shall warranty material and equipment furnished by the various manufacturers in writing for period of two (2) years (or not less than the industry standard for the material specified, nor the manufacturer's standard warranty period, whichever is greater) on building systems finishes or equipment from the date of final project acceptance by the FAA. Mechanical equipment in particular (HVAC equipment,) shall be warranted in writing for period of three (3) years (or not less than the manufacturer's standard warranty period whichever is greater), from date of final project acceptance by the FAA. The cost of any extended warranties will be included in the contract sum.

H. New utility work.

Interface all existing utility work with new work as indicated in the plans and specifications.

END OF SECTION 01042

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SECTION 01300 SUBMITTALS

PART 1 – GENERAL

Applicable provisions of this Section and other provisions and requirements of the Contract Documents apply to all sections, except as modified in Sections of Divisions 2 through 16.

1.1 SUMMARY

Submit Shop Drawings, product data, samples, warranties, certificates, test reports and third party disposal letters as required by the contract documents.

1.2 RELATED REQUIREMENTS

A. Section 01040: Coordination and Testing

B. Section 01651: Materials and Equipment

C. Section 01800: Closeout Procedures

1.3 SUBMITTALS

Submittals required include, but are not necessarily limited to, the following:

A. Submittal schedule

B. Construction progress schedule

C. Submittal log

1.4 SUBMISSION REQUIREMENTS

A. Number of Copies - Submit in ample time for approval before installation. Unless otherwise noted, submit a minimum of four (4) copies of documents to the Resident Engineer (RE). The RE will retain Three (3) copies. If additional copies are required, provide the quantity and submit additional copies to meet this requirement.

B. Time for Approval - Receive submittal approvals prior to starting the work. Time necessary for government approval or disapproval of samples, certificates, test reports, and shop drawings will not be more than 30 calendar days after receipt of a submittal. All materials installed in the work shall match the approved submittals. After a submittal has been approved, the RE will permit no substitutions without written approval. No extension of Contract Time will be authorized because of failure to transmit to the RE sufficiently in advance of the Work to permit processing.

C. Submittal Approval - The checking, marking or approval of the submittal by the FAA shall not be construed as a complete check, but will indicate only that the product or method of construction and detailing is satisfactory. Approval will not relieve the contractor of the responsibility for compliance with the specifications or for any error that may exist. The Contractor shall be responsible for the dimensions and design of adequate connections, details, and satisfactory construction of all work. Possible approval actions taken by the FAA include:

1. Approved as submitted - If the RE marks a submittal "approved as submitted" each copy of the submittal will be identified as having received such approval by being stamped and dated. After submittal has been approved, the RE will permit no substitutions without written approval.
2. Approved as noted - If the RE marks "approved as noted", the submittal is satisfactory contingent upon Contractor acceptance of corrections, notations, or both, and if accepted, does not require resubmittal.
3. Not approved - If the RE marks "not approved", the submittal data does not meet job requirements and the Contractor must resubmit. If the submittal is disapproved, the Contractor shall resubmit the corrected material in the same quantity as specified for the original submittal with in fourteen (14) calendar days of notification. Correct disapproved submittals and resubmit for approval by the RE. Approval of resubmittals requires an additional fourteen (14) calendar days.
4. Submittal Schedule - Identify within the Contractor's Construction Schedule a schedule of submittals for shop drawings, material approval, etc., showing the dates when submittals will be submitted for the project.
   a) Contents - On the schedule indicate the following information:
      1) Schedule date for submittal
      2) Related Section number
      3) Submittal category (Shop Drawings, Product Data, or Samples)
      4) Name of the subcontractor (if applicable)
      5) Description of the part of the Work covered.
5. Distribution - Following response to the initial submittal, print and distribute copies to the RE, Government, subcontractors, and other parties required to comply with submittal dates indicated. When revisions are made, distribute to the same parties. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.
6. Schedule Updates - Revise the schedule after each meeting or activity where revisions have been recognized or made.

D. Construction Progress Schedule – The progress chart to be prepared by the Contractor pursuant to the Contract Clause entitled "SCHEDULES FOR CONSTRUCTION CONTRACTS" shall consist of network analysis system, or pertchart (barchart). The contractor shall be required to complete the work within the contract time limits after receipt of Notice to Proceed excluding the FAA holiday moratorium as specified in section 01010.

1. Contractor shall provide a cost loaded schedule with a minimum of 15 activities The schedule shall indicate which roof areas are being worked on..

2. The diagram shall show a continuous activity flow from left to right. The diagram shall show the sequence in which the work is to be accomplished as planned by the Contractor.

3. Dates shall be shown on the diagram for start of the project, any milestones required by the contract, and contract completion.

4. The critical path shall be clearly identified.

5. Network activities shown shall include submittal and review of shop drawings and samples and procurement of materials and construction activities.

6. Government activities that affect progress shall be shown. These include but are not limited to: Notice-to-Proceed, approvals, and inspections.

NO PHYSICAL CONSTRUCTION WORK AT THE SITE MAY TAKE PLACE UNTIL THE CONTRACTOR SUBMITS AND THE GOVERNMENT APPROVES THE SCHEDULE. Government review of schedule submittal(s) will not exceed 30 calendar days. Resubmittal, if necessary shall not exceed fourteen (14) calendar days.

E. Schedule updates will be provided weekly. Changes for the current week may be hand written. Actual work completed that is more that one week old shall be updated and printed out. Changes to the early and late start times and early and late finish times for scheduled activites will be updated weekly.

F. Submittals - Submit shop drawings, material and equipment lists, and all other data required under various headings of these specifications necessary to permit commencement of work. RE will return the submittals within 30 calendar days after receipt, indicating approval or disapproval.

G. Submittal Preparation - Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Transmittals - transmittal letters identifying the contents of the submittal shall accompany all submittals. It shall be clearly indicated on the transmittal letter with a statement and signature of the Contractor that the submittal item was verified for compliance with the contract requirements and approved by the Contractor. Transmittal letters shall consist of one original.

2. Contents - Submittals shall be complete and detailed and assembled into sets. Lack of completeness or clarity or inadequate description will be justification for disapproval. Submittals shall bear the following information:

   a) Name of project or facility and contract number;
   b) Date of submission;
   c) Contract drawing number and latest revision;
   d) Specification page and paragraph number;
   e) Name of contractor and subcontractor or supplier/manufacturer;
   f) Clearly identified contents and location of work;
   g) Any proposed variances to specification requirements;
   h) Contractor's approval certifying he checked and coordinated the work of other trades.

1.5 SHOP DRAWINGS

A. Applicable Documents -

B. Presentation: Present drawings in a clear and thorough manner. Identify details by reference to sheet and detail, building wing and section shown on contract drawings.

1. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
2. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings.

C. Contents - Provide the following information on each submittal:

1. Submittal number (paragraph 2.1 of this Section) and identify as "Part A" or "Part B" item
2. Date of submission
3. Name of project and facility (full name)
4. Name of Contractor or Subcontractor
5. Reference to drawing number (with revision, if applicable) and/orspecification section
6. Clearly identify contents and location of work.
7. Contractor's approval certifying he checked and coordinated the work of other trades.
8. Dimensions.
9. Identification of products and materials included by sheet and detail number
10. Compliance with specified standards
11. Notation of coordination requirements
12. Notation of dimensions established by field measurement
13. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 36 by 48 inches.

D. Submittal - Submit blue- or black-line prints for the RE's review. Submit five copies, of which the RE will retain three.

1. One of the prints returned shall be marked up and maintained as a "Record Document."
2. Do not use Shop Drawings without an appropriate final stamp indicating action taken.

1.6 PRODUCT DATA

A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, Material Safety Data Sheets (MSDS), standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves, for all materials brought on site.

B. Preparation

1. Clearly mark or highlight each copy to identify pertinent site specific products or models the Contractor intends to use
2. Highlight/clearly indicate all performance characteristics and capacities
3. Highlight/clearly indicate all dimensions and clearances required

Note: If the submittal is not clearly marked, regarding the above pertinent data, the submittal will be returned marked "DISAPPROVED".

1.7 WARRANTIES/GUARANTIES

A. Assemble two (2) copies with original signatures of warranties executed by each of the respective manufacturers, suppliers, and subcontractors into a warranty book and prepare a Table of Contents.

B. Additional Data - Provide complete information for each item, include the following:

1. Product or work team
2. Firm, with name of principal, address, and telephone
3. Scope
4. Effective dates of warranty based on Final Acceptance of the item.
5. Information for owner's personnel on proper procedures to evoke the warranty in case of failure and instances which might affect the validity of warranty

C. Warranties - Effective after project completion and acceptance by the FAA.

1.8 CERTIFICATES

Assemble certificates executed by each of the respective manufacturers, suppliers, and subcontractors.

A. Additional Data - Provide complete information for each item to certify compliance with contract documents.

1. Product or work item
2. Firm, with name of principal
3. Scope of compliance
4. Signature by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

PART 2 – MATERIAL

NOT USED

PART 3 – EXECUTION

3.1 GENERAL

Submittals are required for, but not limited to, the items listed in the specifications or on the drawings. The following is a partial list of submittals required: Schedules, Manufacturer's Literature, Shop Drawings, Samples, Test Reports, Warranties, Certificates, Design Calculations, MSDS, and Installation Instructions. This list should not be construed as a complete list of all submittals required. Submittal dates shall comply with this specification unless a more stringent date is specified. Substitutions and all requested changes will require a submittal.

3.2 SCHEDULE FOR CRITICAL SUBMITTALS

Process after the construction contract has been awarded and prior to NTP:

All Critical Submittals are due 30 calendar days after the contract has been awarded. See below for a list of critical submittals. The construction Notice to Proceed (NTP) will not be issued until all critical submittals are approved. All other submittals shall be submitted and approved prior to installation or construction. Critical submittals include the following:

1. Section 01300 - Construction Schedule
2. Section 16460 Transformers
3. Section 16470 Panelboards
4. Section 16476 Disconnect switches.

No later than two weeks after the contract has been awarded, the Contractor shall be available to participate in a meeting/telecom with the Contracting Officer, Resident Engineer and Office Project Engineer to discuss and coordinate the following:

1) Contractor's FAA point of contact for submitting the Critical Submittals.
2) Discuss the submittal process and forms.
3) Discuss process and forms for request of FAA security badges.
4) Discuss the proposed date for Notice to Proceed (NTP)

PART 4 – QUALITY ASSURANCE

NOT USED

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

SECTION 01651 MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1-1 SUMMARY

A. General. - Material and equipment incorporated into the work shall conform to applicable specifications and standards and comply with size, make, type and quality specified, or as specifically approved in writing by the COR. Manufactured and fabricated products shall be designed, fabricated and assembled in accordance with the best engineering and shop practices. Like parts of duplicate units shall be manufactured to standard sizes and gages and shall be interchangeable. Two or more items of the same kind shall be identical and manufactured by the same manufacturer. Products shall be suitable for service conditions. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing. Do not use material or equipment for any purpose other than for which it is designed or specified. Furnish and install products specified, under options and conditions for substitution stated in this section.

1. Manufacturer's instructions.- When contract documents require that installation of work shall comply with manufacturer's printed instructions, copies of such instructions shall be distributed to parties involved in the installation, including two copies to the COR. Maintain one set of complete instructions at the job site during installation and until completion. Products shall be handled, installed, connected, cleaned and conditioned in strict accordance with such instructions and in conformity with specified requirements. If job conditions or specified requirements conflict with manufacturer's instructions, the contractor shall consult with the COR for further instructions. All work shall be performed in accordance with manufacturer's instructions. No preparatory step or installation procedure shall be omitted unless specifically modified or exempted by contract documents.

2. Transportation and handling. - Products shall be delivered in undamaged condition, in manufacturer's original containers or packing, with identifying labels intact and legible. Shipments shall be inspected to ensure compliance with requirements of contract documents and approved submittals, and products are properly protected and undamaged immediately on delivery. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packing.

3. Storage. - Unless specified, products shall be stored in accordance with manufacturer's instructions, with seals and labels intact and legible. Products subject to damage by the elements shall be stored in weather tight enclosures.

4. Temperature. - Temperature and humidity shall be maintained within the ranges required by the manufactures instructions. Fabricated products shall be stored above the ground, on blocking or skids to prevent soiling or staining. Products that are subject to deterioration shall be covered with impervious sheet coverings and adequate ventilation shall be provided to avoid condensation.

5. Substitutions. - A separate request for each substitution shall be submitted. Each request shall be supported with complete data substantiating compliance of proposed substitution with the requirements stated in the contract documents. Each request shall include product identification, manufacturer's literature including address, product description, reference standards and performance and test data. Samples shall be submitted as applicable. An itemized comparison of the proposed substitution with the product specified shall be included. The following information shall also be included: data relating to changes in the construction schedule; list of changes required in other work or products; and accurate cost data. Substitute products shall not be ordered or installed without written acceptance. In making a formal request for substitution, the contractor represents that he has investigated the proposed products and has determined that it is equal to or superior in all respects to that specified. The contractor ascertains that he will provide same warranties or bonds for substitutions as for product specified. That he will coordinate installation of accepted substitution into work to be complete in all respects; that he waives claims for additional costs caused by substitution which may subsequently become apparent; and that cost data is complete and includes related costs under his contract. Primarily, an "or equal" product will not be considered a substitution. If an actual substitution is accepted, it shall be done only by formal contract modification and not by a submittal approval.

6. New equipment and materials – All contractor supplied materials and equipment that will remain in the government's custody after contract completion, shall be new. Refurbished and or used equipment and materials are disallowed for construction purposes under this contract.

END OF SECTION 01651

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SECTION 01652 PROTECTION OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements Included. - It shall be the Contractor's responsibility to provide protection of work from weather, physical damage, improper use, and other adverse natural conditions. It shall be the responsibility of the Contractor to replace any damaged work including finishes, material, and equipment.

1.2 RELATED REQUIREMENTS. - The Respective Section of the Specification covering items of work.

Section 01651: Materials and Equipment
Section 01710: Cleaning

A. Protection during Installation.

1. Sleeves. - Provide watertight closures for sleeve openings below grade.

2. Building Openings. - Provide protection of temporary openings in the building to completely protect the contents and enable work to progress, during winter and all weather conditions. The method and means shall be subject to approval by the COR.

3. Base Materials. - Provide protection of base materials to receive finishes from physical damage.

4. Protection after Installation. - Provide protection of installed products and finished surfaces to prevent damage from subsequent operations. Remove when no longer needed, prior to completion of work.

5. Floors and Stairs.- Protect finished floors and stairs from dirt and damage:

(a) In areas subject to foot traffic, secure heavy sheathing in place.
(b) For movement of heavy products, lay planking or similar materials in place.
(c) For storage of products, lay tight wood sheathing in place.

6. When some activity must take place in order to carry out the contract, obtain and abide by recommendations of installer for protection of surface. Remove upon completion of the activity.

END OF SECTION 01652

* * * *

SECTION 01710 CLEANING

PART 1 - GENERAL

1-1 SUMMARY

The scope of this project will be performed in a partially occupied special use environment. Daily cleaning and protection shall be a requirement. All prospective bidders are encouraged to visit the project site to ascertain the criticality of maintaining a clean litter free environment.

A. Requirements Included.

1. Execute cleaning during the progress of work. This includes but not limited to the following:
   a) Remove waste packaging and waste construction material.
   b) Remove temporary protective covers and barriers at the end of each shift.
2. Execute cleaning for final inspection.
3. Execute cleaning at completion of the work.

1-2 RELATED REQUIREMENTS

Section 01651: Materials and Equipment
Section 01800: Contract Closeout.

1-3 PRODUCTS

A. Materials. - Use only those cleaning materials recommended by the manufacturers of the surface being cleaned so as not to create hazards to health or property.

1-4 EXECUTION

A. Disposal Requirements. - Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

B. Final Cleaning.
1. Employ skilled workmen for final cleaning.
2. Remove grease, mastic, adhesive, dust, dirt, stains, fingerprints, labels, and other foreign materials from visible interior and exterior surfaces.
3. Ventilating system:
4. Clean permanent filters and replace disposable filters if units were operated during construction. Do not operate blowers and coils without filters during construction.
5. Broom clean exterior paved surfaces, repair damaged sod areas with sod and rake. Clean other surfaces of the grounds.
6. Prior to final completion. Contractor shall conduct an inspection of interior and exterior surfaces, and all work areas to verify that the entire work is clean.

C. During Construction. - Maintain all areas under Contractor's control free of extraneous debris. Conduct a specific maintenance program to prevent accumulation of debris at the construction site, storage and parking areas, and along access roads and haul routes.

D. ARTCC Operational Areas. - Clean up after each work shift.

E. Debris Collection. - Provide containers for debris deposit and schedule periodic collections and disposal of debris. Provide additional collections whenever the periodic schedule is inadequate to prevent accumulation.

END OF SECTION 01710

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SECTION 01720 OPERATIONS AND MAINTENANCE MANUALS

PART 1 – GENERAL

1.1 SUMMARY

A. The Construction Contractor shall furnish five original copies of the manufacturers' Operations and Maintenance (O&M) manual for equipment as specified. One complete O&M data manual shall be furnished prior to the time that equipment acceptance tests are performed. The remaining O&M data shall be furnished before the contract is completed. O&M data may be prepared by the equipment manufacturer and shall be submitted by the Contractor to the Contracting Officer's Representative (COR) as specified.

O&M instructions shall be legible and easy to read, with large drawings (when used), folded into the manual. Specific O&M data to be submitted shall, but not limited to, all approved project submittals and vendor data.

PART 2 - PRODUCTS

2.1 CONTENTS

A. The equipment manufacturers' operations and maintenance data shall contain, as a minimum, the following information as applicable:

(a) Front matter
(b) Introduction
(c) Preparation for use of equipment
(d) Principles of operation
(e) Operating instructions
(f) Maintenance and servicing instructions
(g) Parts list
(h) Repair and overhaul instructions
(i) Warranty documents

2.2 FRONT MATTER

The front matter consists of a cover or title page, table of contents, and safety precautions.

A. COVER. - The cover shall include the following identification: "OPERATIONS AND MAINTENANCE MANUAL", and include the name of the equipment, system, or facility component, the name of the Contractor, contract number, and date the manual was prepared.

B. TITLE PAGE. - The title page shall contain the same information as the cover, and the following additional information: Names, addresses, phone numbers, and principal contact for each contractor and subcontractor installing the equipment, and the equipment manufacturer's local representative for each item of equipment.

C. TABLE OF CONTENTS. - The manual shall contain a table of contents. The table shall list all parts, chapters, sections, and paragraph numbers in the order of presentation used in the text. It shall include a list of illustrations and a list of tables, whenever they are included in the manual.

D. SAFETY PRECAUTIONS. - The manual shall contain safety precautions where hazards may be present during installation, operation, or maintenance of the equipment. Hazards may include, but are not limited to; presence of high voltage, electrostatic discharge, radio frequency radiation, radioactive materials, the presence of poisonous fumes or explosive gases, and the depletion of oxygen in a closed environment. During preparation of the narrative for equipment installation, operation, or maintenance; a hazard warning or caution statement shall precede the point in the narrative where the hazard may be encountered.

2.3 INTRODUCTION

The manual shall contain an introduction containing the following:

(a) Purpose and functions of equipment.
(b) Capabilities.
(c) Performance characteristics.
(d) Description; including model number, dimensions, weight, volume, and center of gravity, when applicable.
(e) Power and utility requirements.
(f) Environmental limitations.
(g) List of items furnished with equipment.
(h) List of additional items required for operation and maintenance, but not supplied with equipment.
(i) Handling precautions and special storage requirements.
(j) Warranty information.

2.4 INSTALLATIONS AND PREPARATION FOR USE INSTRUCTIONS

(NOT USED)

2.5 PRINCIPLES OF OPERATION

(NOT USED)

2.6 OPERATING INSTRUCTIONS

(NOT USED)

2.7 MAINTENANCE AND SERVICING INSTRUCTIONS

Maintenance and servicing instructions shall be provided for both preventive and corrective maintenance. Instructions shall include a list of test equipment, special tools, and materials needed for maintenance and service. This list shall include nomenclature, part/model number, application, range, and accuracy. Instructions should include illustrations to show how test connections are made. Actions and normal indications shall be shown for each test.

A. Cleaning and inspection. - Periodic cleaning and lubrication information including types of cleaning agents and lubrication, and the frequency of lubrication and inspection intervals shall be included. Cleaning required during repair and shall be included in those appropriate sections.

B. Performance verification. - (NOT USED)

C. Inspection. - Instructions for inspection of equipment and frequency of inspection for damage and wear shall be provided with emphasis on allowable service limits such as wear, backlash, end play, balance, voltage, resistance, pressure, and/or length and depth of scoring.

D. Troubleshooting. - Equipment malfunctions that may occur during operation shall be identified. Equipment troubleshooting data and fault isolation techniques shall include:

(a) An indication or symptom of trouble.
(b) The instructions necessary, including test setups, to determine the cause of the problem.
(c) The action required restoring the roof.

The troubleshooting information shall be in a chart, logic tree, or tabular format with appropriate headings, or as a logic, block, or schematic diagram. Troubleshooting data shall include instructions suitable for identifying the lowest replaceable unit (LRU) that when removed and replaced will restore the equipment to operation.

E. Disassembly, repair, replacement, and reassembly. – (NOT USED)

F. Reprogramming. - (NOT USED)

G. Preparation for shipment. -(NOT USED)

2.8 PARTS LIST

The manual shall include a parts list containing positive identification of parts in the equipment item.

A. Illustrated parts list. - Clear and legible illustrations shall identify component parts and parts relationship.

B. Parts listing. - Part names and part numbers shall be shown on illustrations or tables. When the illustrations do not contain both part numbers and part names, the illustrations and the separate listing shall show either index reference, or key-numbers that cross-reference from the illustrated parts to a parts list. The parts list shall identify the actual manufacturer/vendor and the part number or generic description. Parts in the listing shall be grouped by assemblies, subassemblies, and modules with the parts identified to the assembly from which they are components.

C. Common commercial parts.- Common commercial hardware and items that are not of special design such as bolts, washers, nuts, screws, fittings, keys, hinges, wire, cable, gasket material, tubing, and hose that are available from a wide range of sources shall be identified by part number or the notation "Commercial" instead of a part number. The part name including nomenclature or description shall be complete enough to facilitate substitution of equivalent items as shown below:

Examples:

Figure No.	Part No.	Part Name (Nomenclature or Description)
2-4	Commercial	Nut, hex head, plain steel, 1/4"-20 UNC-3BS
2-5	Commercial	Wire, electrical, copper tin plated, No. 14 AWG. 19 strands of No. 27 AWG, 0.250 in. dia.

D. Recommended spare parts. - The equipment manufacturer or supplier shall provide a list of recommended spare parts that are required to support the operational use of the equipment for a one year time period. Recommended spare parts that are not "off the shelf" and have a delivery lead time greater than one month from receipt of order shall be so noted.

2.9 OPERATIONAL AND MAINTENANCE ILLUSTRATIONS

Manuals shall contain illustrations for locating and identifying all components significant to operations and maintenance. Line drawings, photographs or halftones shall show the configuration and parts relationship to aid in removal and disassembly procedures. Free hand sketches shall not be acceptable. Where appropriate, the manual shall contain the following diagrams:

(a) Simplified functional block
(b) Locator
(c) Piping
(d) Hydraulic
(e) Schematic
(f) Flow Control
(g) Electrical
(h) Process Flow
(i) Instrumentation

Symbols used on illustrations or diagrams shall be ANSI standards or common to the trade or industry. Where nonstandard symbols are used, explanations shall be provided.

2.10 OVERHAUL INSTRUCTIONS
(NOT USED)

2.11 EQUIPMENT WARRANTIES

The O&M manuals shall contain warranty documents for all equipment items that are listed in the manual. The warranty shall specify the time that the warranty is in effect from final turnover by the Contractor to the COR. The warranty shall also include:

(a) Equipment name and description as marked on the equipment nameplate.
(b) Name, address, phone number, and name of principal contact of the manufacturer or supplier.
(c) Local authorized service agency of the manufacturer or supplier including name, address, phone number, and principal contact.
(d) Manufacturer's warranty statement that specifies the scope of warranty coverage.
(e) The manufacturer's specified method or procedure for obtaining warranty service.
(f) Supplemental information regarding factors that might invalidate the warranty.

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01720

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PANEL BOARD REPLACEMENT POWER SERVICES BUILDING JUNE 7, 2010
MEMPHIS AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC)FAA-ZME-805681

SECTION 01730 - OSHA SAFETY REQUIREMENTS

PART 1 – GENERAL

1.1 SCOPE

A. This section identifies some of the requirements of the OSHA Construction Standard.

B. Formulation of a site specific safety plan

1.2 CONTRACTOR RESPONSIBILITY

A. General Safety Provisions - The Contractor shall bear full responsibility to provide safe working conditions for its employees and Contractors. The Contractor shall not permit any employee or Subcontractor to work in surroundings or under working conditions that are unsanitary, hazardous, or dangerous to the health and safety of the employee.

B. Accident Prevention - The Contractor shall bear the responsibility of maintaining an accident prevention program such that frequent and regular inspections of the job site, materials and equipment are made by a competent person designated by the employer.

C. Use of Equipment - The Contractor shall not permit the use of any machinery, tool, material, or equipment that is not in compliance with OSHA regulations. The employer shall permit only those employees qualified by training and/or experience to operate equipment and machinery.

1.3 SUBMITTALS

A. Submittals required include, but are not necessarily limited to, the following:

1. Contractor Safety Plan

1.4 CONTRACTOR RESPONSIBILITY

A. The FAA shall not be held responsible for safety inspections to assure Contractor conformance with the OSHA safety regulations. The FAA, however, reserves the right to notify the Contractor of any deficiencies regarding worker safety.

B. The FAA will evaluate the Contractor on its safety performance, including that of its Subcontractors. The number and severity of safety and security violations will be considered in this evaluation. Contractor safety violations are cause for termination for default, may result in notification of the Contractor's bonding company, and will affect the Contractor's opportunity to propose on future work. Failure to correct such deficiencies may impact the Contractor's ability to work on future FAA contracts.

1.5 OSHA REGULATIONS

A. The Contractor shall comply with the latest Occupational Safety and Heath Administration regulations (CFR 29 Part 1926) regarding safety in the work area.

B. The Contractor shall be responsible for obtaining copies of non-FAA referenced documents without additional cost to the FAA. If Contractor requests a copy of FAA directives, they may be obtained by contacting the Contracting Officer.

C. The Contractor is not relieved from adhering to other OSHA requirements not listed herein. The Contractor shall consult the latest referenced OSHA documents for safety regulations.

1. Documents:
   a) OSHA Documents:
      1) CFR 29 Part 1926Safety and Health Regulations for Construction
      2) CFR 29 Part 1910 General Industry Standards Applicable to Construction Industry
   b) FAA Documents:
      1) FAA Order 3900.49 Control of Hazardous Energy During Maintenance, Servicing and Repair

1.6 SAFETY PLAN

The contractor must develop and implement a site specific comprehensive Health and Safety Plan (HASP) based on the scope of work, for his or her employees as well as others in the area and the properties around. It shall cover all aspects of onsite construction operations and activities associated with the contract. This plan must comply with 29 CFR 1926, FAA Order 3900.19B, other applicable health and safety regulations and any project-specific requirements. The contractor must provide the Contracting Officer with a copy of this plan. Acceptance of the contractor's HASP only signifies that the plan generally conforms to the requirements of the contract. It does not relieve the contractor of the responsibility for providing with a safe and healthful work environment. At a minimum the HASP shall address the following:

A. Workplace address

B. Name and address of the principal contractor

C. Key Personnel, phone nos and addresses

D. Estimated duration of the work

E. Hazard assessment and identification of the hazards in the scope of work

F. Mitigation of hazards and proposed control measures for the risks

G. Hazard Communication methods

H. How the controls will be implemented

I. Personal Protective Equipment

J. Training

K. Temperature Extreme

L. Medical Surveillance

M. Exposure Monitoring and Air Sampling

N. Site Control

O. Emergency Response/Contingency Plan

P. Emergency Action Plan

Q. Confined Space Entry

R. Spill Containment

S. Documentation and Record Control

T. Arrangements for monitoring and reviewing controls

U. Lock-out and Tag-out

The plan must be written so it is easy to understand, signed and dated by the General Contractor. It must be available for the length of the project. The General Contractor cannot allow work to start unless the plan has been discussed with or a copy given to all relevant people and the plan is readily available for inspection. The plan must be amended if there are changes in how risks will be managed. The General Contractor must inform any affected person of the change.

PART 2 – MATERIAL

NOT USED

PART 3 – EXECUTION

3.1 CFR 29 PART 1926 - SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

A. This section contains a partial listing of the referenced OSHA standards. The Contractor is responsible for adhering to all applicable regulations including those not specifically referenced herein.

1. Subpart D (Occupational Health and Environmental Controls) - Contractor shall furnish adequate supply of potable water in containers clearly marked as potable water. Containers containing non-potable water shall be clearly marked. Contractor shall furnish toilet facilities based on the number of employees present on the job-site. A minimum of 1 facility is required for less than 20 employees. See CFR 29 Part 1926 Subpart D for complete requirements.

2. Subpart E (Personal Protective Equipment) - The Contractor shall provide adequate protection for the head, hearing, and eyes for all employees working in an area where hazards to the head, ear and eyes exist. See CFR 29 Part 1926 Subpart E for complete requirements.
3. Subpart I (Tools) - All hand tools and power tools and similar equipment whether furnished by the Contractor or the employee shall be maintained and operated in a safe condition. Personal protection shall be used when applicable. The use of tools shall be limited to the intended use of said tools. See CFR 29 Part 1926 Subpart I for complete requirements.
4. Subpart K (Electrical) - The Contractor shall furnish ground fault protection for all electrical equipment used on the jobsite. Extension cords shall be three wire ground in good shape. Installation of the facilities will require energizing numerous circuits. The Contractor shall protect against electrical shock by methods such as posting warning signs, supplying insulated gloves, locking out and tagging de-energized circuits, and other similar methods. See CFR 29 Part 1926 Subpart K for complete requirements.

3.2 CFR 29 PART 1910 - GENERAL INDUSTRY STANDARDS APPLICABLE TO CONSTRUCTION INDUSTRY

A. This section contains a partial listing of the referenced OSHA standards. The Contractor is responsible for adhering to all applicable regulations including those not specifically referenced herein.

1. Section 1910.147 - Contractor shall maintain a written hazardous energy control procedure in accordance with CFR 29 1910.147. The written procedure shall describe contractor's responsibilities regarding shift changes or personnel changes. A specific coordinated lockout/tagout procedure shall be recorded in writing and signed by the Contractor and Contracting Officer with copies to each party.
2. Section 1910.120 - The Contractor shall develop and implement an Emergency Response and Contingency Plan in accordance with OSHA Standard 29 CFR 1910.120. In the event of an emergency associated with remedial action, the Contractor shall, without delay, take diligent action to remove or otherwise minimize the cause of the emergency; alert the Contractor; and institute whatever measures might be necessary to prevent any repetition of the conditions of actions leading to, or resulting in, the emergency. Emergency contact names and telephone numbers shall be posted at all project phones and in site-support vehicles as well as included within the plan.

PART 4 – QUALITY ASSURANCE

NOT USED

* * * END OF SECTION 01730 * * *

SECTION 01800 CONTRACT CLOSE OUT

PART 1 - GENERAL

1.1 SUMMARY

The contractor shall require each subcontractor engaged upon the work to bear full responsibility for cleaning up during and immediately upon completion of his work. All rubbish, waste, tools, equipment and other apparatus caused by or used in the execution of his work shall be removed. This shall in no way be construed to relieve the contractor of his primary responsibility for maintaining the building and the site clean and free of debris, and leaving all work in a clean and proper condition acceptable to the COR. All exposed floor surfaces shall be protected against all mechanical damage, mortar or plaster droppings, oil, grease, or other damage that will stain or soil the finish. Protection shall be maintained until all work has been completed.

A. Rubbish removal. - Immediately after unpacking, all packing material, case lumber, wrappings, or other rubbish, flammable or otherwise, shall be collected and removed from the building and the premises.

B. Overall cleaning.- Immediately before the final inspection, the entire exterior and interior of the building and the surrounding areas shall be thoroughly cleaned by the contractor, including but not limited to the following:

1. All construction facilities, debris and rubbish shall be removed from the building and the site.
2. All finished surfaces disturbed by this construction shall be swept, dusted, vacuumed, washed or polished as required.
3. All tools, scaffolding, temporary utility connections or buildings, belonging to the contractor or used under his direction shall be removed from the site.

1.2 PROJECT RECORD DOCUMENTS

A. Maintenance of documents.- The following documents shall be maintained at the project site:

1. Contract drawings
2. Contract specifications
3. Addenda
4. Reviewed shop drawings
5. Change orders
6. Field test reports
7. Project correspondence
8. Software information specific to this project
9. Other modifications to contract

B. Storage and use of documents. - Store record documents apart from documents used for construction; do not use record documents for construction purposes. Keep documents in clean, dry, legible condition; provide file cabinets and racks for storage of drawings.

C. Marking devices. - Use red colored pencil for all marking.

D. Recording and labeling. - Label each document "Project Record" in 1-inch high printed block letters. Keep record documents current. Do not conceal or cover up any item of work until the information has been recorded.

E. Submittals. - At completion of project, deliver record documents to COR. Accompany submittal with transmittal letter containing the following:

1. Date
2. Project title and number
3. Contractor's name and address.
4. Title and number of each record document
5. Certification that each document as submitted is complete and accurate.
6. Signature of contractor, or his authorized representative

1.3 CONTRACT DOCUMENTS

A. Contract drawings.- Legibly mark to record actual construction:

1. Horizontal and vertical location of underground and overhead utilities and appurtenances referenced to permanent surface improvements.
2. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
3. Field changes of dimension and detail.
4. Changes made by change order or field order.
5. Details not on originally specified drawings.

B. Contractor specifications and addenda.- Legibly mark each section to record:

1. Manufacturer, trade name, catalog number, and supplier of each item of equipment actually installed.
2. Changes made by change order or field order.
3. Other matters not originally specified.

C. Shop drawings. - Shop drawings shall be maintained as record documents; legibly annotate drawings to record changes made after review.

1.4 COMPLETION CERTIFICATE

When the contractor considers the work complete, the contractor shall submit written certification that contract documents have been reviewed; work has been inspected for compliance with contract; equipment and systems have been tested in the presence of the RE and are operational. Second, the contractor also certifies that the required operational, and maintenance manuals, data, and parts list have been submitted and approved; spare parts have been provided as required; required instruction of maintenance personnel has been accomplished; work is completed, premises cleaned and ready for inspection; and the warranty certificates from all new equipment manufacturers have been provided.

1.5 FINAL INSPECTION

A written request for a final inspection shall be sent to the Resident Engineer fourteen (14) calendar days prior to the requested inspection date. The final inspection shall be scheduled at a mutually agreed upon date, and will be acknowledged by the Resident Engineer. The contractor shall develop his own pre-final inspection and correct all deficiencies prior to requesting the final inspection. The pre-final report shall accompany the final inspection request.

If, during the final inspection, the Resident Engineer, in concurrence with the inspection team and the Contracting Officer, determines that the contractor was not ready for the final inspection, based on the contractor not meeting all of the contractual requirements, all costs incurred by the Government for additional inspections shall be deducted from the contract (including but not limited to: travel cost, per diem, salaries of all concerned parties, consultant engineer personnel, and FAA personnel required to participate in the final inspection). This dollar amount shall be the actual cost incurred by the FAA to perform the final inspection.

1.6 PUNCH LIST

During the final inspection, the Resident Engineer, in coordination with the regional office and local FAA personnel shall develop a list (Punch List) of all deficiencies (unsatisfactory work, latent or patent defects, etc.). A copy of the punch list will be furnished to the contractor as a draft list after the final inspection, while the original copy will be forwarded to the Contracting Officer. The inspection team shall generate only one official punch list.

The Contracting Officer will furnish to the contractor the official punch list within fourteen calendar days after completion of the final inspection. The contractor shall be allowed 30 calendar days to correct all deficiencies noted.

1.7 ACCEPTANCE OF WORK

The contractor shall correct discrepancies noted during the final inspection, clean the premises, and notify the Resident Engineer that the work is ready for acceptance. The Resident Engineer shall verify that the official punch list has been accomplished and initialize and date each item as it is completed.

END OF SECTION 01800

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SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. General:

1. Materials and equipment shall comply with all requirements of the contract documents. 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. Wherever standards have been established by Underwriters' Laboratories, Inc., the material shall bear the UL label.

B. This Section includes the following electrical materials and methods:

1. Supporting devices for electrical components.
2. Electrical demolition.
3. Cutting and patching for electrical construction.
4. Touchup painting.

C. Applicable provisions of this Project include the following:

1. Removal of existing electrical equipment in accordance with demolition drawings and specifications.
2. Equipment, wiring devices, and electrical connections required for installation of electrical equipment.
3. Raceways and wiring for power and controls.
4. Grounding systems.

D. Provide products which conform to and installation that complies with the requirements of Uniform Federal Accessibility Standards (UFAS).

E. Space requirements: Electrical equipment sizes indicated on the Drawings are generally based on specified manufacturer.

1. Verify that the equipment proposed will fit in the space indicated on the Drawings. Coordinate building dimensions with architectural and structural drawings. Equipment furnished and installed under other Sections of this specification shall be coordinated with electrical equipment installed under this Section.
2. Maintain clearances required by NEC around electrical equipment. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.

1.2 REFERENCE STANDARDS

A. General: Comply with the standards in effect as of the date of the Contract Documents as applicable to the extent specified in Division 16. The rules, regulations and reference specifications enumerated in these specifications shall be considered as minimum requirements. 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. Adherence to this specification shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship when so required by the contract Drawings or special contracts provisions

B. National Fire Protection Association (NFPA)

1. 70 2008 National Electrical Code

C. National Electrical Contractors Association (NECA)

1. Standard of Installation.

D. National Electrical Manufacturers Association (NEMA)

1. WC5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. WC7: Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

E. Occupational Safety and Health Administration (OSHA)

1. 29CFR-1910.7: Description and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

F. Underwriters Laboratories (UL)

1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.3 SUBMITTALS

A. Product data for each type of product specified as required in each specification section.

B. Project Record Documents: Maintain at the job site a separate set of white prints of the Contract Documents for the purpose of recording the system and dimension changes of those portions of work in which actual construction is significantly at variance with the Contract Documents. Upon acceptance of the project, submit documents to the COTR, with verification of data accuracy. Mark the Drawings with colored pencil. Prepare the Drawings as the work progresses. Upon completion of work submit Drawings clearly indicating the following:

1. Locations of devices, conduits, equipment and other pertinent items.
2. Schematic and interconnection wiring diagrams of the completed power and control system incorporating the data derived from the equipment shop drawings. The drawings shall be detailed to wire and terminal block numbers, conductor color coding, device designations, locations, and reflect identifications established at the site.

C. Samples of color, lettering style, and other graphic representation required for each identification product for Project.

D. Operation and Maintenance Instructions:

1. Reference Material: Provide copies of operating and maintenance instructions, equipment service manuals, catalog cuts. The material shall include equipment model and serial numbers, performance characteristics, and power and utility requirements. Final acceptance of this equipment is contingent upon submission of required documents to, and approval by, the COTR prior to equipment or facility turnover.
2. Minimum Data Required: Operating and maintenance instructions shall contain the following minimum data and shall comply with submittal requirements specified in individual Sections of the Specifications. Training for the operation and maintenance of special equipment shall be conducted by a certified technician from the manufacturer.

   a. Operating instructions shall include illustrations and explanations for controls, initial set points, and startup and shutdown procedures for both normal and emergency conditions.
   b. Maintenance instructions shall include periodic inspection and lubrication requirements, and when applicable, equipment performance verification requirements. Include a list of required tools and equipment to maintain the system.
   c. Troubleshooting and fault diagnosis data shall list trouble symptoms, instructions necessary to determine cause of trouble and the action required to restore equipment to operating condition.
   d. Repair instructions shall include equipment disassembly, repair, replacement, and reassembly. Checkout or test data shall also be provided. Reprogramming instructions shall be provided for equipment having a programmable memory. Repacking instructions shall be provided for sending equipment to the manufacturer or to a repair depot for repairs.
   e. A parts list shall be furnished that includes part names and part numbers that are shown on illustrations or tables. The parts list shall identify the actual manufacturer of the part; replacement cost, and shall also contain a notation of identifying products as Commercial grade for common non-special design hardware.
   f. The instructions shall contain a list of spare parts recommended by the equipment manufacturer to support the operation of the equipment for a one-year time period. Provide names, addresses, and telephone numbers of all service organizations that supply repair parts for the system or systems to be furnished.

g. The O&M data shall include overhaul instructions that are required to return the equipment to full operational capability in the event that the machinery stops working properly.

h. The O&M data shall contain the following:

1) Wiring diagrams;
2) Electrical schematics;
3) Control diagrams;
4) Wire terminal assignments;
5) Equipment layouts;
6) Record Electrical Drawings, modified to record actual conditions and modifications, including dimensions;
7) Approved Shop Drawings; and
8) A list of all subcontractors used on the project with address and phone number.

i. After final tests and adjustments have been completed, fully instruct the COTR and other personnel, as directed by the COTR, in details of operation and maintenance of special equipment, including control system as installed. Submit outline of proposed instruction course 21 days prior to start for approval by the COTR.

E. Operating Tests: An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service. After mechanical systems have been completely installed and balanced, test each system for proper operation. Tests shall be conducted in the presence of the COTR under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of the systems. Special tests on individual systems are specified under individual sections. Tests shall be scheduled and approved in writing by COTR at least 21 calendar days prior to conducting tests. Contractor shall demonstrate, to the COTR's satisfaction, proper operation of control devices by simulating actual operating conditions. Devices tested shall include, but not be limited to, flow and pressure controls, temperature controls, and system interlocks and alarms.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

C. Summary: Submit a summary of the Electrical Test Report and Motor Test Report, noting deviations from requirements listed below:

1. Maximum plus or minus five percent variation between nominal system voltage and no load voltage and between no load and full load voltage;
2. Variation between motor average phase current and measured individual phase currents does not exceed the manufacturer's specified limits; and;
3. Maximum plus or minus 20 percent variation between average phase current and measured individual phase currents for panelboards.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

C. Coordinate installing required supporting devices and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.

E. Coordinate connecting electrical service to components furnished under other Sections.

F. Coordinate requirements for access panels and doors where electrical items requiring access are covered by finished surfaces.

G. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

H. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

I. Interruption of Power: Contractor is advised that this facility includes a fully operational Air Route Traffic Control Center (ARTCC). The electrical power system is comprised of the types: critical, essential and building service. Work shall be performed on the three types as indicated on drawings. Unscheduled interruptions of the electrical service may cause aircraft accidents and loss of life. Contractor is advised that failure to establish and maintain proper means and methods during the Work, resulting in accidents or loss of life, may result in charges of criminal negligence.

1. Work requiring a temporary or permanent de-energizing of critical, essential, and building service power systems shall be scheduled and approved in writing by the COTR at least 48 hours in advance of performance of work.

2. Work may not commence until written authorization is received from the COTR.
3. Unscheduled interruptions of power shall not be allowed at any time.
4. Only Government personnel are authorized to energize or deenergize equipment, to operate circuit breakers, switches, or fuses in this facility. Only the FAA shall authorize the Utility Company to turn on, or turn off, the commercial power to this facility.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Channel and Angle Supports, Raceways Supports, Sleeves, and Fasteners: As specified in section 16190, " Supporting Devices".

2.2 TOUCH-UP PAINT

A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.

B. For Non-equipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

A. Where manufacturers recommended installation methods conflict with contract requirements, difference shall be resolved by the COTR.

B. The installation shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulation, the workers shall be properly certified and/or licensed.

C. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.

D. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

E. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations of new and existing equipment.

F. Give right of way to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING METHODS

A. Damp Locations: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Conform to manufacturers recommendations for selecting supports.

3.3 INSTALLATION

A. The rules, regulations, and reference documents indicated shall be considered as minimum requirements and shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship than are specified or when required by the Contract Drawings. Equipment shall be installed in a manner to provide proper working spaces, access, and space for removal of the equipment as required by the various equipment.

B. Contract Drawings: Where the Drawings schematically indicate the work, diagrammatically or otherwise, furnish and install equipment, material, and labor for a complete and proper installation. Ensure that electrical and communications Work is coordinated and compatible with Architectural, Mechanical and Structural Work.

C. Firestopping: Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping to reestablish the original fire-resistance rating of the assembly at the penetration.

D. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with Section 16190, "Supporting Devices", and with National Electrical Code (NEC) requirements.

E. Install identification devices where required in accordance with the requirements of Section 16195, "Electrical Identification". Engrave nameplates as indicated, to a maximum of 3 lines.

F. Wiring Methods:

1. General: All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.
2. Conductor routing: Panelboards, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures.
3. Conductor separation: Power conductors shall be routed separately from all other conductor types.

    a. 480/277V power cables shall be in separate raceways from 208/120V power cables.
    b. Power cables of less than 600 volts shall not be installed in the same duct with control, telephone, or signal type cables.

4. Neutral Conductor: Shared/common neutrals shall not be permitted, i.e., each overcurrent device shall have its own separate neutral conductor. Neutral conductor size shall not be less than the phase conductor size.
5. Ground Conductor: Shared/common grounding conductors shall not be permitted, i.e., each overcurrent device shall have its own separate ground conductor.

3.4 DEMOLITION

A. Where electrical work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.

C. Abandoned Work: Remove electrical conductors in their entirety. Cap and patch surface to match existing finish.

D. Removal: Remove demolished material from the Project site.

E. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.5 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.6 TOUCH-UP PAINTING

A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3.7 FIELD TESTING

A. General: Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system. Repair or replace equipment that does not meet test requirements and retest. Tests shall be scheduled and approved in writing by COTR at least 7 calendar days prior to conducting tests. Unless otherwise indicated, the contractor shall furnish all test instruments, materials and labor

necessary to perform tests designated in Division 16 Sections. All tests shall be performed in the presence of the COTR. All instruments shall have been calibrated within a period of two years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.

B. An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service. After mechanical systems have been completely installed and balanced, test each system for proper operation. Tests shall be conducted in the presence of the COTR under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of the systems. Special tests on individual systems are specified under individual sections. Provide 14 days written notice to the COTR for major tests. Contractor shall demonstrate, to the COTR's satisfaction, proper operation of control devices by simulating actual operating conditions.

C. Complete the Electrical Test Report included as Attachment No. 1. Provide the requested information for each panelboard and its power supply conductors. Perform insulation resistance tests in compliance with Section 16120, "Wire and Cables", on wires including the neutral before connection to source and to loads. Complete the Conductor Megger test – Attachment 2.

END OF SECTION 16050

ATTACHMENT NO. 1
Electrical Test Report

Project Name _____ Date _____ Sheet No. ___ of ___
Project No._____ Address_____

SERVICE TRANSFORMER SIZE			
NL SERVICE VOLTAGE			
FL SERVICE VOLTAGE			
PANEL OR SWBD SERVED FROM			
PANEL OR SWITCHBOARD			
LOCATION			
MANUFACTURER			
TYPE			
FEEDER OC PROTECTION			
FEEDER CONDUCTOR SIZE			
GROUND CONDUCTOR SIZE			

MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	B	C	A	B	C	A	B	C
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									
CONDUCTOR INSUL RESISTANCE Ø AB									
CONDUCTOR INSUL RESISTANCE Ø BC									
CONDUCTOR INSUL RESISTANCE Ø CA									
CONDUCTOR INSUL RESISTANCE TO GROUND									
NEUTRAL INSUL RES TO GR W/GR CONN REMOVED									

ATTACHMENT NO. 2

Megger Test Report
600 V CABLE INSULATION AND CONTINUITY TEST
(power/control wire & cable)

Project Name _____ Date _____ Sheet No. ____ of ____
Project No._____ Address_____

NOTE: 500 VOLT MEGOHMETER, MEGGER ALL PHASES, RECORD MINIMUM READING

Panel No. Ckt. No. Feeder No.	VOLTS	A-B	A-C	B-C	A-N	B-N	C-N	A-G	B-G	C-G	N-G	SUPERVISOR O.K.

DISTRIBUTION: CENTRAL RECORDS
RE/ENGINEER
CONTRACTOR

_____
RE/ENG/DATE

_____
Contractor Supervisor/Date

SECTION 16100 – RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, and boxes, for electrical wiring.

B. Raceways include the following:

1. Flexible metal conduit (FMC).
2. Rigid galvanized steel (RGS).
3. Liquid tight flexible metal conduit (LFMC).

C. Boxes, enclosures, and cabinets include the following:

1. Device boxes.
2. Outlet boxes.
3. Pull and junction boxes.

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. C80.1: Rigid Steel Conduits

B. Federal Standards (FS)

1. W-C-586: Conduit outlet boxes, bodies, and entrance caps.
2. W-C-566 Flexible Metal Conduit.

C. National Electrical Contractors Association (NECA)

D. National Electrical Manufacturers Association (NEMA)

1. OS1: Sheet-steel outlet boxes, device boxes, covers, and box supports.

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

F. Underwriters Laboratories (UL)

1. 1: Flexible metal conduit.
2. 50: Enclosures for electrical equipment.
3. 486A: Wire connectors for use with copper conductors.
4. 514A: Metallic outlet boxes.
5. 514B: Fittings for conduit and outlet boxes.
6. 6: Rigid metal conduits.

1.3 SUBMITTALS

A. Product catalog cut data for raceway, fittings and boxes. Identify each selection to show compliance with spec.

1.4 QUALITY ASSURANCE

A. Comply with latest edition of the NFPA 70 "National Electrical Code" for components and installation.

1. Boxes shall be sized in accordance with NEC Article 370.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

C. Comply with NECA "Standard of Installation."

D. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Enclosures shall conform to NEMA standards.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering Products that may be incorporated in the Work include, but are not limited to, the following:

1. Metal Conduit and Tubing:

a. Allied Tube and Conduit, Grinnell Co.
b. Wheatland

2. Conduit Bodies and Fittings:

a. Emerson Electric Co., Appleton Electric Co.
b. Hubbell, Inc., Killark Electric Manufacturing Co.
c. General Signal, O-Z/Gedney Unit.
d. Crouse Hinds

3. Boxes, Enclosures, and Cabinets:

a. Hoffman Engineering Co., Federal-Hoffman, Inc.
b. General Signal, O-Z/Gedney.

c. Raco, Inc., Hubbell Inc.
d. Spring City Electrical Manufacturing Co.
e. Thomas & Betts Corp/ Steel City.
f. Crouse Hinds

2.3 METAL CONDUIT AND TUBING

A. Galvanized Rigid Steel Conduit: ANSI C80.1

B. Flexible Metal Conduit; Zinc-coated steel: UL 1 and Federal Specification WW-C-566.

1. Conduit connectors shall be threaded with insulated throat. Use Steel City XC-342.

C. Fittings: UL 514B and NEMA FB 1, compatible with conduit and of the threaded type. Set Screw fittings are not allowed.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1 and UL 514A.

B. Flush Outlet Boxes: UL 514A hot-dip galvanized steel, 2-1/8 inches deep by four inches square, with extension ring where necessary.

C. Boxes for exterior lighting fixtures: Surface mounted waterproof with gasket from floodlight manufacturer as noted on the plans..

D. Fittings: UL 514B

2.5 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1 and UL 514A.
B. Cast Metal boxes, gasketed
Type FSCT/FSD
Type LB

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways and boxes, for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine raceways prior to installation. No crushed or deformed raceway shall be installed.

3.2 WIRING METHODS

A. Indoors: Use the following wiring methods:

1. Rigid galvanized steel conduit shall be used for all panelboard feeders and branch circuits.

2. Flexible steel metal conduit shall be used under computer raised floors as noted on the drawings.

3. Boxes and Enclosures: NEMA Type 1

B. Outdoors and underground:
   1. Rigid galvanized steel conduit and fittings with PVC coating.
   2. LMFC(sealtite) to exterior light fixtures per drawing details.

3.3 INSTALLATION

A. Install raceways, boxes, as indicated, according to manufacturer's written instructions. Install to withstand seismic forces per IBC 2003 Group B Category II as indicated in Section 16190, 'Supporting Devices."

B. The minimum size raceway shall be 3/4 inch except for exterior lighting LFMC shall be ½ inch.

C. RACEWAYS:

   1. Raceways shall not be attached to the ceiling suspension system.
   2. Do not anchor or strap raceways to wall furring channels or to other raceways.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation. Raceways shall be fished and swabbed before conductors are pulled.

G. Support raceways and boxes as specified in Section 16190 "Supporting Devices."

   1. Boxes for fixtures on suspended ceilings shall be supported independently of the ceiling supports.
   2. Boxes shall not be supported from sheet-metal roof decks.

H. Use temporary closures to prevent foreign matter from entering raceway.

I. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. No run shall contain more than four (4) 90 degree bends, or the equivalent. Provide pull-boxes, junction boxes, and conduit bodies as required to meet the bends criteria.

J. Use raceway fittings compatible with raceway and suitable for use and location.

K. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.

L. Wall Penetrations:

   1. Penetrations through walls shall be sealed.

M. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Use insulating bushings for all conduits to protect conductors.

N. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, or where conduits enter enclosures without threaded hubs, use two locknuts, one inside and one outside the box to securely bond the conduit to the enclosure. In addition a bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation.

O. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

P. Metal conduits shall be mechanically and electrically continuous between outlets, junction and pull boxes, panels, cabinets and similar equipment. Conduits shall enter and be secured to enclosures so that each system is electrically continuous throughout.

Q. Provide grounding connections for raceway, boxes, and components. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

1. Provide grounding bushings for all feeder conduits at switchgear, switchboards, motor control centers, panelboards, transformers, pull boxes, and all other termination points.

2. Where knockouts are used, provide double locknuts, one on each side with a grounding bushing or grounding locknut used on the inside (use grounding bushings on conduit 1" and larger).

R. Field Cut Conduit: Where conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. The cut ends of the field-cut conduit shall be reamed to remove burrs and sharp edges.

S. Boxes: Shall be provided in the wiring or raceway system for pulling wires, making connections, and mounting devices or fixtures. Each box shall have the volume required by NFPA 70 for the number and size of conductors in the box.

1. Outlet boxes: Each outlet box shall have a machine screw which fits into a tapped hole in the box for the ground connection.
2. Mounting light fixtures: Boxes for mounting fixtures shall be not less than 4 inches square.
3. Concealed wiring: Boxes installed for concealed wiring shall be provided with extension rings or plaster covers. The front edge of the box shall be flush or recessed not more than 1/4" from the finished wall surface.

T. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.4 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 16100

SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA)

WC5: Thermoplastic insulated wire and cable for the transmission and distribution of electrical energy.

B. Federal Standards (FS)

1. W-S-610: Splice connectors
2. QQ-W-343: Wire, electrical, copper, insinuated.

C. National Electrical Contractors Association (NECA)

1. Standard of Installation

D. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

E. Underwriters Laboratories (UL)

1. 486A: Wire connectors for use with copper conductors.
2. 486C: Splicing wire connectors.

1.3 SUBMITTALS

A. Product data for wires and cables. Provide catalog cuts with selections identified to show compliance with spec.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, NEC, for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the NEC, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

1.5 SEQUENCING AND SCHEDULING

A. Coordination: Coordinate layout and installation of cable with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the COR.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable according to NEMA WC-26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Wires and Cables:

a. American Insulated Wire Corporation, Leviton Manufacturing Co.
b. Brand-Rex Cable Systems, Brintec Corp.
c. Carol Cable Company, Inc.
d. Senator Wire & Cable Co.
e. Southwire Co.

2. Connectors for Wires and Cables:

a. AFC, Monogram Co.
b. AMP, Inc.
c. Anderson, Square D Co.
d. Electrical Products Division, 3M Co.
e. O-Z/Gedney Unit, General Signal.

2.2 BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3.2 "Applications" Article.

B. Thermoplastic Insulation: Conform to NEMA WC 5.

C. Solid conductor for 10 AWG and smaller; stranded conductor for larger than 10 AWG.

D. All wire and conduit sizes are based on copper conductors per NEC 70.

E. Size: Minimum 12 AWG. Minimum 10 AWG for 120 volt circuits where circuit length (one way) exceeds 75 feet from source, and 10 AWG for 277 volt circuits where circuit length (one way) exceeds 150 feet from source.

F. Material: Copper only

G. Conductor Color Codes:

1. Feeder conductors to panels and three phase circuits shall be factory color coded as indicated:

a. 208/120 Volt System:

1)Phase A: Black
2)Phase B: Red
3)Phase C: Blue
4)Neutral: White
5)Ground: Green

b. 480/277 Volt System:

1)Phase A: Yellow
2)Phase B: Brown
3)Phase C: Orange
4)Neutral: Grey
5)Ground: Green

2. Single-phase branch circuits shall be factory color coded as stated above.

2.3 CONNECTORS AND SPLICES

A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with Project's installation requirements and as specified in Part 3.2 "Applications" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Verify that the duct or conduit is open, continuous, and clear of debris before installing cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Indoor Branch Circuits: Type THHN/THWN, copper conductor, 75 degree C insulation rating in raceway.
B. Exterior Branch Circuits: Type THHN/THWN, copper conductor, 75 degree C insulation rating in raceway.

C. Feeders: Type THHN/THWN, copper conductor, 75 degree C rating insulation in raceway.

3.3 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation."

B. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.

1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor nor insulation, and must be non-flammable.
2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

C. Cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation or damage to the outer protective covering.

D. The ends of cables shall be sealed with moisture-seal tape before pulling, and shall be left sealed until connections are made.

E. Conductor Splices:

1. Splices shall be made only at outlets, junction boxes, or accessible raceways.
2. Splices shall be made with solderless connectors conforming to FS W-S-610.
3. Wire nuts may only be used to splice conductors sized No. 10 AWG and smaller.
4. Compression connectors shall be used to splice conductors No. 8 and larger.
5. All splices, including those made with insulated wire nuts, shall be insulated with electrical tape or heat-shrink tubing to a level equal to that of the factory insulated conductors.
6. Splicing of existing ungrounded feeder conductors in new panelboards if shown on the drawings is permitted using approved insulated multi -cable connector blocks (i.e. "Polaris).
7. Splices shall be made with solderless connectors conforming to UL 486A, UL 486C, and UL 486E.
8. Install splices and insulating tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
9. Use splice and tap connectors that are compatible with conductor material.
10. Splicing methods and material shall be of a type recommended by the manufacturer of the splicing material for the particular type of cable being spliced and shall be approved by the COR prior to installation.
11. Critical power feeders and branch circuits shall not be spliced.

F. Wiring at Outlets: Install with at least 3 inches of slack conductor at each outlet, per NEC 300.14.

G. Connect outlets and components to wiring and to ground as indicated. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

H. Conductors for emergency lighting, telco/LAN, security, and sprinkler alarm systems shall be kept completely independent from any other system as well as each other.

I. A splice shall not be pulled into a duct or conduit under any circumstance.

K. Separate neutral and ground wires shall be provided for each overcurrent protection device. Each branch circuit shall have its own neutral and ground conductor. Common neutral or ground conductors are not acceptable.

L. Install conductors only after the raceway system is complete.

M. Identify each circuit phase conductor and associated neutral with "Brady" markers each end to designate associated panelboard circuit breaker.

3.4 FIELD QUALITY CONTROL

A. Insulation Resistance Tests: Feeder and Branch Circuit insulation tests shall be performed after installation, but before connection to equipment.

1. Conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 megohms when measured with a 500-volt DC insulation resistance. The contractor shall submit a letter type test report to the COR prior to final inspection of the Work. The report shall list the tests performed and results obtained.

2. Contractor shall use Megger Test Report Form form located at the end of Section 16050, "Basic Electrical materials and Methods".

B. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION 16120

SECTION 16190 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors and associated fastenings.

1.2 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC)

B. Underwriters Laboratories (UL)

1.3 SUBMITTALS

A. Product catalog cut data for each type of product specified with selection identified to show compliance with specifications.

B. Shop drawings of supports to meet seismic requirements for IBC 2003 Group B Category II.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70.

B. Electrical components shall be listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

2.2 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as indicated.

C. U-Channel Systems: 16-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

D. Support systems shall be capable of carrying the weight of the box and its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Raceway Supports: Comply with the NEC and the following requirements:

1. Neither raceways nor boxes shall be fastened to suspended ceiling supports.

END OF SECTION 16190

SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations.

1.2 REFERENCE STANDARDS

A. Applicable only to the extent specified.

B. American National Standards Institute (ANSI)

1. A 13.1: Scheme for the Identification of Piping Systems.
2. C2: National Electrical Safety Code.

C. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

1.3 SUBMITTALS

A. Samples for each color, lettering style, and other graphic representation required for tubing, tags, labels, markers, and other identification materials; samples of labels and signs.

B. Shop drawings showing installation method for each type of identification device.

1.4 QUALITY ASSURANCE

A. Components and installation shall comply with NFPA 70.

B. Comply with the requirements of ANSI A13.1 with regard to type and size of lettering for raceway and cable labels.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.
B. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.
2. Legend: Indicates voltage and service.

C. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend overlaminated with clear, weather- and chemical-resistant coating.

D. Heat Shrink Tubing: Preprinted, embossed, permatized, 20-year life. Size to suit conductors; lettering shall be legible after heat shrinking.

E. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

F. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch wide.

G. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with pre-printed numbers and letters.

H. Plasticized Card-stock Tags: Vinyl cloth with pre-printed legends. Orange background, except as otherwise indicated, with eyelet for fasteners.

I. Brass Tags: Metal tags with stamped legend, punched for fasteners. Dimensions: 2 inches by 2 inches by 0.05 inch.

2.2 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Engraving Stock: melamine plastic laminate, 1/16-inch minimum thick for signs up to 20-sq. in., 1/8 inch thick for larger sizes.

1. Engraved Legend: White letters on black field.
2. Punched for mechanical fasteners.

C. Interior Warning and Caution Signs: Pre-printed aluminum, baked enamel finish with 1/4-inch grommets in corners for mounting.

1. Color, size and legend: appropriate to the application.
2. Punched for fasteners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6-nylon cable ties with the following features:

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50-lb. minimum.
3. Temperature Range: Minus 40 to 185 deg F.
4. Color: As indicated where used for color-coding.

B. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime Surfaces: For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty, acrylic-resin block filler. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.
3. Apply one intermediate and one finish coat of silicone alkyd enamel.
4. Apply primer and finish materials according to manufacturer's instructions.

G. Identify Raceways with Color Banding: Band exposed and accessible raceways of the systems listed below for identification.

1. Bands: Pretensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of 2-color markings in contact, side by side.
2. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25 feet in congested areas.
3. Colors: As follows:

b) Fire-Suppression Supervisory and Control System: Red and yellow.
c) Security System: Blue and yellow.
d) Mechanical and Electrical Supervisory System: Green and blue.
e) Telecommunications System: Green and yellow.

H. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

I. Color-Code Conductors: The following field-applied color-coding methods may be used in lieu of factory-coded wire listed in Section 16120 "Wires and Cables" for sizes larger than No. 4 AWG. Contractor shall demonstrate non-availability of factory colored wire before using this application.

1. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

a. Where conductors are color coded by this method, they shall be color coded in accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors in accessible raceways shall be color coded so that by removing or opening any cover, the coding will be visible.
b. Phase, ground, and neutral conductors shall be color coded in accordance with Section 16120, "Wires and Cables."

2. Green insulated conductors shall not be re-identified for purposes other than grounding.
3. White or neutral gray conductors shall not be re-identified for purposes other than grounded neutrals.

J. Apply identification to conductors as follows:

1. Conduits and Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Power and Lighting Circuits at Enclosure and at terminations: Identify each conductor with panel designation, circuit number, voltage, and phase.
3. Control and Communications Circuits at Enclosure and at terminations: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

K. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.
2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, and other emergency operations.

L. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Provide equipment, required under Division 16, as follows: with nameplate indicating equipment name, system voltage(s) and phase (for example: EF203, 480V, 3 phase). Except as otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch-high label; where 2 lines of text are required, use 2-inch-high label. Apply labels for each unit of the following categories of equipment:

a) Panelboards, electrical cabinets, and enclosures.
b) Access doors and panels for concealed electrical items.
c) Motor starters.
d) Control devices.

2. Label conduit at each end and at pull boxes with characters a minimum 1/4-inch high.
3. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION 16195

SECTION 16452 - GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes solid grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

1.2 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

B. Underwriters Laboratories (UL)

1. 467: Grounding and bonding equipment.
2. 486A: Wire connectors and soldering lugs for use with copper conductors.

1.3 SUBMITTALS:

A. Product catalog cut data for grounding hardware. Identify selection to show compliance with the specification.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, National Electrical Code.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ILSCO.
2. Kearney.
3. Thomas & Betts, Electrical.

2.2 GROUNDING AND BONDING PRODUCTS

A. Products: Of types indicated and of sizes and ratings to comply with the NEC. Where types, sizes, ratings, and quantities indicated are in excess of requirements above, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE GROUNDING CONDUCTORS

A. Comply with Section 16120 "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

1. Material: Copper. Use only insulated copper wire
2. Size: Minimum allowable size shall not be less than #12 AWG, in addition to compliance with NEC.

B. Equipment Grounding Conductors: Insulated with green color insulation.

2.4 MISCELLANEOUS CONDUCTORS

A. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted.

B. Ground Strap: Provide a flexible ground strap, #6 AWG or braided equal, for electrical continuity at each flexible duct connection of each air handler, and fan.

PART 3 - EXECUTION

3.1 APPLICATION

A. General: FAA grounding requirements often exceed those of NEC; therefore, grounding system shall be as indicated in Contract Drawings, and as specified herein.

B. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper

conductors unless otherwise indicated. When these conductors are not sized nor shown on the Contract Drawings, size them in accordance with Table 250-122 of the NEC, "Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment. In no case, however, shall these conductors be smaller than No. 12 AWG.

1. Install green, equipment grounding conductor with all feeder and branch circuit conductors for each overcurrent device.

C. Conduit or cable shields shall not be used as the equipment grounding conductor.

3.2 INSTALLATION

A. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.

B. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors .

C. 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. Uninsulated conductors shall not be used. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Where aluminum raceways are used, the jumpers shall be bonded with approved connectors for the dissimilar metals. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.

3.4 SYSTEM AND EQUIPMENT GROUNDING

A. Install a grounding conductor for each overcurrent device. The equipment grounding conductor shall be installed in the same conduit as the branch or feeder conductors. Grounding conductor shall have insulation rating equivalent to phase conductor insulation. Insulated grounding conductors shall be connected to the ground terminal at both ends and to junction, transition, pull and fixtures boxes along the route. Under no circumstances shall this conductor be omitted from the electrical system, nor shall a separate grounding system, such as the signal grounding, be used as a substitute.

B. Metallic raceway housing the equipment grounding conductor shall be mechanically and electrically continuous.

C. Where there are parallel conductors of a feeder installed in more than one raceway, install an equipment grounding conductor in each raceway.

D. Ground the ends of all conduit runs using grounding bushings, except for receptacle and lighting branch circuits.

B. Splices of grounding conductors inside conduits are not acceptable.

END OF SECTION 16452

SECTION 16460 - TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general-purpose dry-type transformers with windings rated 600 V or less.

1.2 REFERENCE STANDARDS

A. Institute of Electrical and Electronic Engineers (IEEE)

1. 141: Recommended practice for electric power distribution.
2. C2: National electrical safety code.
3. C57.12.80: Terminology for power and distribution transformer.
4. C57.12.91: Test code for dry-type distribution and power transformers.

B. National Electrical Manufacturer Association (NEMA)

1. ST20: Dry type transformers for general applications.

C. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

D. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

E. Underwriters Laboratories (UL)

1. 486A: Wire connectors and soldering lugs for use with copper conductors.

1.3 SUBMITTALS

A. Product data for each product specified, including dimensioned plans, sections, and elevations. Show minimum clearances and installed features and devices.

B. Shop Drawings for wall brackets and platforms for transformers.

C. Wiring diagrams of products differentiating between manufacturer-installed and field-installed wiring.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article.

F. Operation and maintenance data for materials and products to include in the "Operating and Maintenance Manual."

G. Field test reports of tests and inspection conducted according to Part 3 of this Section.

H. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

I. Sound Level Test Reports: Certified copies of manufacturer's sound level tests applicable to equipment for this Project.

1.4 QUALITY ASSURANCE

A Manufacturer Qualifications: A firm experienced in manufacturing components that comply with the requirements of these Specifications and that have a record of successful in-service performance.

B. Comply with NFPA 70 "National Electrical Code. "

C. Comply with IEEE C2 "National Electrical Safety Code."

D. Listing and Labeling: Products are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 TRANSFORMERS, GENERAL

A. Transformers: Factory-assembled and -tested, air-cooled (Class AA) units of types specified, designed for 60-Hz service in accordance with IEEE C57.12.80. Unless otherwise indicated, minimum Basic Impulse Insulation Levels (BIL) shall be in accordance with IEEE 141.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

D. Internal Coil Connections: Brazed type.

2.2 GENERAL-PURPOSE, DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20 "Dry-Type Transformers for General Applications."

B. Transformers: Two-winding type, 3-phase units using 1 coil per phase in primary and secondary.

C. Windings: All copper.

D. Low Sound Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE Standard C57.12.91 or the following, whichever is more stringent:

1. 45 dB for transformers rated over 9 KVA but not over 50 KVA.

E. Features and Ratings: As follows:

1. Enclosure: Indoor, ventilated, drip-proof.

a. Three phase transformer larger than 15 KVA shall be fully encased in steel enclosures.
b. Enclosures shall be bonded to the grounding system.
c. Surface temperature shall not exceed 65 degrees C when the transformer is operating continuously at rated load with an ambient temperature of 40 degrees C.

F. Insulation Class: 220 deg C class for transformers larger than 25 KVA.

1. Insulation Temperature Rise: 115 deg C maximum rise above 40 deg C.

G. Taps: For transformers 3 KVA and larger, full capacity taps in high-voltage winding are as follows:

1. 15 KVA through 500 KVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.

H. Electrostatic Shielding: Each winding is independently single shielded with a full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Coil leads and terminal strips are arranged to minimize capacitive coupling between input and output connections.
2. Shield Terminal: Separate; marked "Shield" for grounding connection.
3. Capacitance: Shield limits capacitance between primary and secondary to a maximum of 33 picofarads over a frequency range of 20 Hz to 1 MHz.
4. Common-Mode Noise Attenuation: Minus 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
5. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.

I. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 30 kVA.

J. Terminal Compartments: Dry type transformers shall be provided with a suitable terminal compartment to accommodate the required primary and secondary wiring connections, and a side or bottom conduit entrance. Transformers rated greater than 25 KVA shall have terminal boards

equipped with factory installed clamp-type connectors. The terminal compartment temperature shall not exceed 75 degrees C when the transformer is operating continuously at rated load with an ambient temperature of 40 degrees C.

2.3 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests conform to referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project where specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with manufacturer's requirements in accordance with the direction of the COTR.

3.2 INSTALLATION

A. Arrange equipment to provide adequate spacing for access and for cooling air circulation.

B. Identify transformers and install warning signs according to Section 16075, "Electrical Identification."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A.

D. Conduit connections to transformers shall be made with flexible metal conduit nominally 12 inches in length but not more than 36 inches in length.

E. Install to withstand forces for the UBC seismic zone indicated in Section 16050, "Basic Electrical Materials and Methods."

3.3 GROUNDING

A. Ground transformers and systems served by transformers according to Division 16 Section 16452 "Grounding. "

3.4 FIELD QUALITY CONTROL

A. Tests: The Contractor shall perform testing under this Section. Include the following minimum inspections and tests according to the manufacturer's instructions. Conform to IEEE Standard Test Code C57.12.91 for dry-type units, test method, and data correction factors.

1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.

   a. Include internal inspection through access panels and covers.
   b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL standard 486A.

2. Insulation Resistance: Perform megohm meter test of primary and secondary winding-to-winding and winding-to-ground. Use a minimum test voltage of 1,000 VDC. Minimum insulation resistance shall be 500 megohms.
3. Duration of Each Test: 10 minutes.
4. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.

B. Test Failures: Correct deficiencies identified by tests and retest. Verify that equipment meets the specified requirements at no additional cost to the FAA. If substantial deficiencies are recognized, replace transformer at the sole discretion of the COTR, and retest at no additional cost to the Government.

3.5 ADJUSTING

A. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

END OF SECTION 16460

SECTION 16470 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes lighting and power panel boards and associated auxiliary equipment rated 600 V and less.

1.2 REFERENCE STANDARDS

A. Federal Standards (FS)

1. W-P-115: Panel, power distribution.

B. National Electrical Manufacturers Association (NEMA)

1. 250: Enclosures for electrical equipment (1000 volts or less).
2. PB1: Panel boards
3. AB1: Molded case circuit breakers and molded case switches.

C. National Fire Protection Association (NFPA).

1. 70: National Electrical Code (NEC).

D. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

E. Underwriters Laboratories (UL)

1. 50: Electrical cabinets and boxes.
2. 67: Panel boards.
3. 486A: Wire connectors and soldering lugs for use with copper conductors.
4. 489: Molded case circuit breakers and circuit breaker enclosures.

1.3 SUBMITTALS

A. Product Data: For each type of panel board, accessory item, and component specified.

B. Shop Drawings: For panel boards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA 250, Type 1
2. Bus configuration and current ratings
3. Short-circuit current rating of panel board.

4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Panel board Schedules: For installation in panel boards. Submit final versions after load balancing.

E. Maintenance Data: For panel board components included in the maintenance manuals specified in Section 16050, "Basic Electrical Materials and Methods". Include manufacturer's written instructions for testing circuit breakers.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

B. Comply with NFPA 70, "National Electrical Code."

C. Comply with NEMA PB 1, "Panel boards."

D. Single Source Responsibility: Panel boards and circuit breakers located in the panel boards shall be the product of a single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Corp.; Westinghouse & Cutler-Hammer Products
2. General Electric Co.; Electrical Distribution & Control Div
3. Square D Co.

2.2 PANELBOARD FABRICATION

A. Panelboards shall be circuit breaker equipped, dead-front type, and shall conform to Federal Specification W-P-115, Type I, Class 1.

B. Enclosures: UL 50, galvanized steel, flush- or surface-mounted cabinets as indicated. Panelboards shall be listed and labeled by Underwriters Laboratories, Inc. in accordance with UL Standard 67, and shall conform to the latest requirements of the National Electric Code and of NEMA Standard PB 1, Type 1, Class 1, unless otherwise indicated to meet environmental conditions at installed locations. Do not provide with prepunched conduit knockouts.

C. Directory Frame: Metal, mounted inside each panelboard door.

D. Bus: Hard drawn copper of 98 percent conductivity meet UL 67 temperature rise limits, and have a current density of 1000 amperes per square inch. Bus bars shall be sequence-phased, and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short

circuits. Solderless terminations shall be suitable for copper UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards.

1. Phase bus bars shall be copper or plated copper.
2. Neutral bus bar shall be copper or plated copper, and insulated from panelboard.
3. Capacity as indicated on Drawings, or equal to or greater than the panelboard OCPD.

E. Main and Neutral Lugs: Compression type.

1. The neutral bar shall be fully rated and capable of being located in either corner of the enclosure at the line end to facilitate conductor termination, and shall be insulated from panelboard.

F. Equipment Ground Bus: Ground bus shall be copper, and adequate for feeder and branch-circuit equipment ground conductors with 25% additional space for future conditions. Lugs shall be sized to accommodate grounding conductors shown on plans.

1. The ground bus shall be securely bonded to the cabinet and shall be separate from the neutral bus.
2. The number of terminations shall be equal to the number of poles in the panelboard.
3. The ground bus bar shall be structurally integral to the panelboard, or attached to the panelboard with a bolt, nut, and lockwasher.

a. If ground bus bar is mounted to enclosure with screw threads only, (i.e. tapped blind hole), a separate bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar.

1) Bond conductor shall have same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.

G. Short circuit rating: Panelboards shall be fully rated in AIC. (10,000 AIC, 120/208V; 14,000 AIC, 277/480V)

H. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the over-current protective device ampere ratings indicated for future installation of devices.

I. Include the following special features for panelboards.

1. Hinged Front Door in Door Construction: Entire front trim hinged to box with standard door within hinged trim cover (one piece front with two doors). The smaller door, when open, provides access to device handles and rating labels and shall be lockable. The larger door, when open, provides access to conductors and wiring terminals. Door hinges shall be continuous piano hinges which are welded to the door(s) and bolt on front.

a. All door hinges shall be concealed.

2. Minimum gutter wiring bending space---For bus ratings of 100 to 225 amps, the minimum top and bottom wiring space to be 5.5 inches and the minimum right and left wiring space to be 6 inches. For bus ratings of 250 amp to 400 amp, the minimum top and bottom wiring space to be 10 inches and the minimum right and left wiring space to be 5 inches. Larger bus ratings shall comply with the manufacturer's UL listing and not less than NEC 408.55(Tables 312.6A and Tables 312.6B).

3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.

4. Sub-feed: Over-current protective device or lug provision.

J. Doors shall have flush type cylinder locks and catches. All locks in a project shall be keyed alike, and 2 keys shall be furnished with each lock.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, UL 489, FS W-C-375 and the following requirements.

1. Molded case
2. Bolt-on breaker type. Stab-in and plug-in types are not acceptable.
3. Quick make, quick break connections with mechanical trip free switching mechanism
4. Inverse time, thermal over-current trip;
5. Instantaneous magnetic trip;
6. Thermal trip calibrated for 40 deg C ambient temperature;
7. Provide breakers with number of poles, voltage rating, current rating, and frame size as indicated on the drawings.
8. Multiple circuit breakers shall have an internal, common trip mechanism;
9. Trip-indicating feature;
10. Single-pole breakers shall be full size modules;
11. Two and three pole breakers shall be sized in multiples of a single-pole breaker;
12. Branch circuits shall be connected to the individual circuit number, as indicated on the Drawing;
13. UL marked as suitable for use with 75 deg C wire.
14. Devices with an adjustable magnetic trip shall be factory set to the "Low" value.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices and interrupting capacity rating as indicated on the Drawings.

C. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for over-current protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with manufacturer's requirements in accordance with the direction of the COR.

3.2 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting Heights, top of trim: 81 inches above finished floor, unless otherwise indicated. Panelboards with a height greater than 90 inches shall be mounted at height required for working clearances.

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. Circuit Directory: Type directory to include installed circuit loads after balancing panelboard loads. The directory shall be arranged so that typed entries simulate circuit breaker positions in the panelboard. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards: Stub four 3/4-inch EMT empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in, Section 16195 "Electrical Identification."

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic nameplates mounted with corrosion-resistant screws. Provide with panel name, voltage and phase.

3.4 GROUNDING

A. Make equipment grounding connections for panelboards as indicated, and in accordance with, Section 16452 "Grounding."

B. Provide ground continuity to main electrical ground bus as indicated.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.

2. Make continuity tests of each circuit.

B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and marred finishes to match original finish.

END OF SECTION 16470

SECTION 16476 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes individually mounted switches used for the following:.

1. Three Pole double throw disconnect switch for transformer at panel GLB.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturer Association (NEMA)

1. KS1: Enclosed and miscellaneous distribution equipment switches (600 volts maximum).

B. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

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C. Underwriters Laboratories (UL)

1. 486A: Wire connectors and soldering lugs for use with copper conductors.

1.3 SUBMITTALS

A. Product Data for switches, , and accessories specified in this Section. Include the following:

1. Catalog cut, descriptive data , dimension and ratings

B. Source Limitations: Obtain disconnect switches from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide disconnect switches specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

E. Single Source Responsibility: All enclosed switches shall be the product of a single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide disconnect switches by one of the following:

1. Eaton Corp.; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution and Control Division.
3. Square D Co.

2.2 DISCONNECT SWITCHES

A. General: Switches shall be of the voltage and current ratings indicated on the Drawings, and each shall be capable of 100% load break and load make. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current carrying parts shall be of high conductiivity copper unless otherwise specified, and shall be designed to carry rated current without excessive heating. Switch contacts shall be silver tungsten or plated to minimize corrosion, pitting and oxidation and to assure suitable conductivity.

A. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD, lockable handle, with padlocks.

B. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches level and plumb.

C. Install wiring between disconnect switches, panelboards and transformer.

D. Connect disconnect switches and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

E. Identify each disconnect switch with an engraved micarta nameplate showing: Name, Voltage and Phase

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements..

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 16476

SECTION 16481 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes AC motor control devices rated 600 V and below that are supplied as enclosed units.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturer Association (NEMA)

0. ICS2: Standard for Industrial Control Devices, Controllers and Assemblies.
1. 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

B. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).

C. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7 Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL).

D. Underwriters Laboratories (UL)

1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. 508: Electrical Industrial Control Equipment.

1.3 DEFINITIONS

A. Motor Controller: A device that controls, protects, and energizes an electric motor, and where required, controls its speed or the torque or power delivered by it.

1.4 SUBMITTALS

A. Product data for products specified in this Section. Include dimensions, ratings, and data on features and components.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance Data: For products to include in the maintenance manuals.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suit actual motor nameplate full-load currents.

E. Qualification Data for Field Testing Agency: Certificates, signed by Contractor, certifying that agency complies with requirements specified in Article 1.5 "Quality Assurance".

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide controllers from manufacturers regularly engaged in the manufacture of equipment of the types and capacities indicated, with such products in satisfactory use in similar service for not less than 5 years. Manufacturer must also maintain, within 100 miles of the project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Field Testing Agency Qualifications: An independent testing agency with experience and capability to satisfactorily conduct testing indicated without delaying the Work. Evaluation criteria shall be according to ASTM E 699.

C. Components and Installation: NFPA 70 "National Electrical Code."

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

E. NEMA Compliance: NEMA ICS 2.

F. UL Compliance: UL 508.

G. Single-Source Responsibility: Obtain similar motor-control devices from a single manufacturer.

1.6 COORDINATION

A. General: Coordinate and provide motor controllers and control devices with necessary auxiliary contacts for proper interface with requirements in Section 15975, "Control Systems-Electronic and Direct Digital Control".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Allen-Bradley Co.
2. Cooper Industries, Inc., Crouse-Hinds ECM
3. Cutler Hammer Products
4. General Electric Co.
5. Reliance Electric Co.
6. Siemens Energy & Automation, Inc.
7. Square D Co.

2.2 MOTOR CONTROLLERS, GENERAL

A. Coordinate the features of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, the duty cycle of the motor, drive, and load, and the pilot device, and control circuit affecting controller functions. Provide controllers that are horsepower rated to suit the motor controlled and are of the manual reset type.

B. Contacts shall open each ungrounded connection to the motor.

C. Overload Relays: Motors, 1/8 horsepower or larger, shall have overload protection in each phase, or other equally rated method in accordance with NFPA 70. Overload relays shall be ambient-compensated type with inverse time-current characteristic. Provide with heaters or sensors matched to nameplate full-load current of the specific motor to which connected with appropriate adjustment for duty cycle.

1. Provide with reset button in an accessible location.

D. Enclosures: For individually mounted motor controllers and control devices, comply with NEMA Standard 250. Provide enclosures suitable for the environmental conditions at the controller location. Provide NEMA Type 1 oversized enclosures except as otherwise indicated.

1. Outdoor: NEMA 250, Type 4X, oversized stainless steel.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Description: Provide full-voltage, non-reversing, across-the-line, magnetic controller, horsepower rated, tested and labeled at NEMA size indicated on the drawings, with field replaceable main contacts, external manual resets, ambient compensated melting-alloy overload protection in all phases and low voltage release and the following accessories.

1. Auxiliary contacts: Two normally open and two normally closed contacts;
2. Pilot lights;
3. Start-stop pushbutton; or three position "Hand-Off-Automatic" switch.

B. Each 3-phase magnetic motor controller shall provide reversal and phase loss protection. Protective device shall cause controller to open upon loss of any one phase or reversal of phases.

C. Control Circuit: Provide control power transformer with 120 volt AC secondary holding coil with fused primary and secondary integral with controller where no other supply of 120 V control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

D. Combination Motor Controller units for MCC's shall be equipped with terminals for separate source control power. A control power fuse shall be provided and the other secondary lead will be grounded in the unit, plus the unit disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open.

E. Combination Controller: Motor circuit protector; molded-case circuit-breaker type with magnetic-only trip element calibrated to coordinate with the actual locked-rotor current of the connected motor and the controller overload relays. Provide breakers that are factory assembled with the controller,

interlocked with unit cover or door, and arranged to disconnect the controller. Provide motor-circuit protectors with field-adjustable trip elements.

F. Enhanced-Protection Overload Relay: Provide overload relays with NEMA Class 10 tripping characteristics where indicated. Select to protect motor against voltage unbalance and single phasing.

2.4 AUXILIARY CONTROL DEVICES

A. General: Factory installed in controller enclosure except as otherwise indicated. Where separately mounted, provide NEMA 1 enclosure except as otherwise indicated.

1. Outdoor location: NEMA 250, Type 4X, stainless steel.

B. Push-button Stations, Pilot Lights, and Selector Switches: Heavy- duty type.

C. Control Relays: Auxiliary and adjustable time-delay relays.

D. Current Sensors: Coordinate with controls.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with manufacturer's requirements in accordance with the direction of the COR.

3.2 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Use magnetic starters for 3-phase motors up to 5 hp not requiring automatic or remote control.

E. Push-button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

F. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

3.3 INSTALLATION

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

C. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Section 16190, "Supporting Devices".

3.4 IDENTIFICATION

A. Identify motor-control components with laminated engraved nameplates with name, voltage and phase.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Section 16120, "Wires and Cables".

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic control devices where available.

1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.

B. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Test per Section 16050, paragraph 3.7.
2. Testing Equipment: Use instruments bearing records of calibration within 3 months of testing.
3. Provide two (2) weeks advance notice to the COR prior to testing and schedule test at least one (1) week in advance of the test commencement.

C. Remove and replace malfunctioning units with new units, and retest.

3.8 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

END OF SECTION 16481