SECTION 26 0800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of this section is to specify the Division 26 responsibilities and participation in the commissioning process.

B. Work under this contract shall conform to requirements of Division 01, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of electrical systems which are part of this project.

C. Commissioning work shall be a team effort to ensure that all electrical equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance. Commissioning shall coordinate system documentation, equipment start-up, and verification and performance testing.

D. The commissioning team shall be made up of representatives from the University, design professionals, major equipment suppliers, and construction trades. The trades represented on the commissioning team shall include, but not be limited to, sheet metal, piping and fitting, controls, test and balance, and electrical. The lead person for each trade who will actually perform or supervise the work is to be designated as the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.

E. The Commissioning Authority shall have responsibility for coordinating and directing each step of the commissioning process. The Authority shall be a true third party, not affiliated with any of the companies involved with the project design.

F. Electrical system installation, start-up, testing, preparation of O&M manuals, and operator training are the responsibility of the Division 26 Contractors, with coordination, observation, verification and commissioning the responsibility of Division 01, Section 01 9113. The 01 9113 commissioning process does not relieve Division 26 from the obligations to complete all portions of work in a satisfactory and fully operational manner.

G. Refer to Division 01, Section 01 9113, for a full list of commissioning related definitions. A few critical definitions are included below:

1. *Commissioning*. A systematic process that provides documented confirmation that specific and interconnected fire and life safety systems function according to the intended design criteria set forth in the project documents and satisfy the University's operational needs, including compliance requirements of any applicable laws, regulations, codes, and standards requiring fire and life safety systems.
2. *Commissioning Authority (CxA*). The qualified person, company, or agency that plans, coordinates, and oversees the entire Cx process.
3. *Commissioning Plan*. The document prepared for each project, which identifies the processes and procedures necessary for a successful Cx process.

4. *Commissioning Record*. The complete set of commissioning documentation for the project, which is turned over to the University at the end of the construction phase.
5. *Functional Testing.* Tests performed to verify compliance with manufacturers' specifications, applicable codes and standards, and the project BOD and OPR.

1.2 RELATED SECTIONS

A. Division 01 Section 01 9113 - General Commissioning Requirements

B. Division 21 Section 21 0800 - Commissioning of Fire Suppression

C. Division 22 Section 22 0800 - Commissioning of Plumbing Systems

D. Division 23 Section 23 0800 - Commissioning of HVAC Systems

E. Division 25 Section 25 0800 - Commissioning of Integrated Automation

F. Individual Division 01, 21, 22, 23, 25, and 26 sections contain requirements related to the commissioning process.

1.3 ROLES AND RESPONSIBILITIES

A. Refer to Section 01 9113 for Commissioning Authority, University, Architect, and General Contractor roles and responsibilities.

B. Refer to Section 21 0800 for fire protection contractor roles and responsibilities.

C. Refer to Section 22 0800 for plumbing contractor roles and responsibilities.

D. Refer to Section 23 0800 for HVAC contractor roles and responsibilities.

E. Refer to Section 25 0800 for integrated automation contractor roles and responsibilities.

F. Electrical Contractor

1. Include cost to complete commissioning requirements for electrical systems in the contract price.
2. Include requirements for submittal data, O&M data, and training in each purchase order or sub contract written.
3. Ensure cooperation and participation of specialty sub-contractors such as communications, data, etc.
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend Construction Phase coordination meeting scheduled by the Commissioning Authority.
6. Conduct electrical system orientation and inspection when equipment is set.
7. Respond to (in writing) and address items documented in the Contractor Commissioning Issues Log.
8. Submit copies of all test results to the CxA.

9. Complete Pre-Functional Checklists for all equipment.

    a. If no other system is agreed upon by Commissioning Team, Mechanical Contractor shall be responsible for completion of Pre-Functional Checklists for all equipment for which it issued a purchase order.
    b. Mechanical Contractor shall coordinate completion of Pre-Functional Checklists with all other contractors that have made connections to equipment for which it issued a purchase order.
    c. Remedy any deficiencies identified in Pre-Functional Checklists and notify CxA in writing that deficiencies have been addressed.

10. Assist the Commissioning Authority in all Pre-Functional Checklist verifications and Functional Performance Tests.
11. Prepare preliminary schedule for electrical system orientation and inspections, O&M manual submission, training sessions, emergency generator testing, equipment start up, and task completion for use by the Commissioning Authority. Update schedule as appropriate throughout the construction period.
12. Attend initial training session.
13. Conduct electrical system orientation and inspection at the equipment placement completion stage.
14. Update drawings to the record condition to date, and review with the Commissioning Authority.
15. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority for review prior to the completion of construction.
16. Notify the Commissioning Authority a minimum of two weeks in advance, so that witnessing equipment and system start-up and testing can begin.
17. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.
18. Provide a complete set of as-built records to the Commissioning Authority.

G. Equipment Suppliers and Miscellaneous Contractors

1. Include cost for commissioning requirements in the contract price.
2. Provide submittals, and appropriate O&M manual section(s).
3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
4. Participate in training sessions as scheduled by the Commissioning Authority.
5. Demonstrate performance of equipment as applicable.

1.4 SCOPE OF WORK

A. Commissioning work of Division 26 shall include, but not be limited to:

1. Testing and start-up of the equipment.
2. Completion of Functional Checklists.
3. Cooperation with the Commissioning Authority.
4. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.
5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
6. Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification.
7. Providing training and demonstrations for the systems specified in this Division.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:

1. Indoor lighting and controls including power transfer schemes, emergency lighting, and outdoor lighting.
2. Emergency power monitoring and operation
3. Electrical support for mechanical equipment listed in Section 23 0800 - Commissioning of HVAC Systems

C. System components which will not be functionally performance tested but will be included in the commissioning scope for conformance to the design documents, verification of specified Contractor testing, construction phase observation, and training verification shall include:

1. Primary switchgear
2. Primary transformer
3. Main switchgear
4. Distribution switchgear
5. Distribution Switchboards
6. Panel boards
7. Isolation power systems
8. Power conditioners
9. Power factor correction
10. Paralleling gear
11. Automatic transfer switch
12. Lighting protection
13. Grounding system
14. SCADA system
15. Lighting and lighting controls

D. Timely and accurate documentation is essential for the commissioning process to be effective. Documentation required as part of the commissioning process shall include but not be limited to:

1. Commissioning Process Reports, which may include the following:

    a. Commissioning Field Reports
    b. Design Team Issues Log
    c. Contractor Commissioning Issues Log on the WCxS
    d. Meeting minutes

2. Pre-start, and start-up procedures
3. Pre-functional Checklists
4. Functional Test Procedures
5. Training agenda and materials
6. As-built records
7. Commissioning report
8. Operation and maintenance (O&M) manuals
9. Mapping of reports into maintenance programs

E. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the commissioning process:

1. Functional Checklists are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. Verification is completed by the Division 23, 26, and 28 contractors and documented using Functional Checklists.
2. Functional Performance Tests (FPT) shall determine if the electrical system is operating in accordance with the design intent. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.

F. Comprehensive training of O&M personnel shall be performed by the Electrical Contractor, and where appropriate, by other sub-contractors, and vendors prior to turnover of building to the University. The training shall include classroom instruction, along with hands-on instruction on the installed equipment and systems.

1.5 DOCUMENTATION

A. The Commissioning Authority shall oversee and maintain the development of the document process. The GC shall facilitate project documentation through the web-based commissioning software. The commissioning documentation shall include, but not be limited to, the following:

1. Commissioning Plan
2. Commissioning Schedule
3. Document Request Log
4. Commissioning RFIs
5. Commissioning Field Reports
6. Design Team Issues Log on the WCxS
7. Contractor Commissioning Issues Log on the WCxS
8. Pre-Functional Checklists
9. Functional Performance Tests

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. The appropriate Contractor(s) shall furnish all special tools and equipment required for testing during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for approval. The University shall furnish necessary utilities for the commissioning process.

2.2 TEST EQUIPMENT – PROPRIETARY

A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the University upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 GENERAL

A. A pre-construction meeting of all commissioning team members shall be held at a time and place designated by the University. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

B. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and commissioning procedures undertaken. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, and change orders.

C. A Commissioning Plan shall be developed by the Commissioning Authority. The Contractor shall assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If contractor initiated system changes have been made that alter the commissioning process, the Commissioning Authority shall notify the University.

D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division 26 contractor. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

A. The Contractor shall provide skilled technicians to start-up and debug all systems within Division 26. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.

C. The Commissioning Authority reserves the right to question the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the University, with input from the contractor,

equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the University shall have final jurisdiction over any additional work done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the University, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the University reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

C. The University's contract with the Commissioning Authority includes up to two tests of each piece of equipment or system included in the commissioning scope. Commissioning Authority time and expenses required for retests beyond two, if required, due to incomplete installation or otherwise, will be paid by the University and reimbursed by the contractor.

3.4 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s), suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5 SEASONAL COMMISSIONING

A. Seasonal commissioning pertains to testing under full load conditions during peak heating and peak cooling seasons, as well as part load conditions in the spring and fall. Initial commissioning shall be done as soon as contract work is completed, regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

B. Heating equipment shall be tested during winter design extremes. Cooling equipment shall be tested during summer design extremes with a fully occupied building. Each contractor and supplier shall be responsible to participate in the initial and the alternate peak season tests of the systems as required to demonstrate performance.

3.6 CONSTRUCTION PHASE OBSERVATION

A. Scope of Construction Phase Observation

1. The Commissioning Authority will conduct periodic observations during the construction phase to monitor progress and compliance with the design intent and contract documents.
2. Commissioning Authority observations will coincide with design team observations and are not intended to take the place of this work.

B. Documentation and Reporting

1. Issues identified by the Commissioning Authority during construction phase will be documented on the Issues Log on the WCxS and distributed to Commissioning Team members.
2. Progress during the construction phase will also be documented by the Commissioning Authority using Commissioning Process Reports.

3.7 ACCEPTANCE PROCEDURES

A. Pre-Functional Checklists

1. Scope of Pre-Functional Checklists

a. Tests and verifications included in the Pre-Functional Checklists shall determine if all components, equipment, systems, and interfaces between systems are installed and are ready to operate in accordance with contract documents.

2. Participants in Pre-Functional Checklists

The Commissioning Authority shall be responsible for preparing the scope of these checklists, which will be completed by the installing contractors and then verified (via spot checking and Functional Performance Testing). Participating contractors, manufacturers, suppliers, etc. shall include all costs to do the work involved in these tests in their proposals. Following is a list of tasks and supporting information that shall be required:

a. HVAC Contractor - provide the services of a technician(s) who is (are) familiar with the construction and operation of this system. Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
b. Controls Contractor - provide the services of a controls engineer who is familiar with the details of the project. Provide details of the control system, schematics, and a narrative description of control sequences of operation.
c. Electrical Contractor - provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces, and interlocks.

3. Documentation and Reporting Requirements

a. Pre-Functional Checklists shall be provided for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested shall have a different entry line with space provided for comments. The checklists will include spaces for each party to sign off on.
b. Completed checklists shall be submitted to the Commissioning Authority for acceptance and inclusion in the commissioning report.

4. Acceptance of Pre-Functional Checklists

a. The Commissioning Authority will select, at random, 10% of the checklists for verification, 100% of the Fire Alarm checklist.
b. If 10% or more of the checklists are found to be inaccurate for each system or equipment type, all of the checklists for that system or equipment type will be rejected. Complete, accurate checklists will need to be resubmitted.

B. Functional Performance Testing

1. Scope of Functional Performance Testing

a. Functional performance tests shall determine if the electrical system is operating in accordance with the final design intent. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.

2. Submittals

a. Detailed procedures for each series of tests will be developed by the Commissioning Authority for review and acceptance by the University. The procedures shall include samples of the data sheets that will be part of the reports.

3. Participants in Functional Performance Tests

a. Participants in the functional performance tests shall be the same as those listed in the Functional Checklists.

4. Functional Performance Test Procedures

a. The Commissioning Authority shall supervise and direct all functional performance tests.

1) Set the system equipment into the operating mode to be tested (i.e. normal shut-down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
2) The Commissioning Authority shall inspect and verify the position of each device and interlock identified in the test procedure. Each item shall be signed off as acceptable (yes) or failed (no).
3) This test shall be repeated for each operating cycle that applies to the mechanical system being tested.
4) Operating checks shall include all safety cutouts, alarms, and interlocks with smoke control and life safety systems during all modes of operation of the electrical system.
5) If during a test an operating an operating deficiency is observed, appropriate comments will be added to the web based commissioning software.

b. If deficiencies are identified during Functional Performance Testing, the Construction Manager/General Contractor will be notified, and action taken to remedy the deficiency. The final completed functional test procedures on the WCxS will be reviewed by the Commissioning Authority to determine if testing is complete and the system is functioning in accordance with the contract documents.

5. Documentation and Reporting Requirements

a. All measured data, data sheets, and a comprehensive summary, describing the operation of the electrical system at the time of testing shall be submitted to the Commissioning Authority.
b. A preliminary functional performance test report shall be prepared by the Commissioning Authority and submitted to the Design Professional for review. Any identified deficiencies need to be evaluated by the Design Professional and

Construction Manager/General Contractor to determine if they are part of the contractor's or sub-contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s), and the specific functional performance test repeated.

c. If it is determined that the electrical system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the University must decide whether any required modifications needed to bring the performance of the electrical system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the University shall determine if a portion or all required functional performance tests should be repeated, and a revised report submitted.

3.8 SYSTEMS MANUAL:

A. The Systems Manual shall be submitted in paper AND/OR electronic format and shall contain the following major sections:

1. System Descriptions:

a. Each major system shall be described, typewritten, in general terms, including major components, interconnections, theory of operation, theory of controls, unusual features and major safety precautions. This information should correlate with information provided in the manufacturers' instructions book. This section shall include, but not be limited to, the following data:

1) Detailed description of each system and each of its components with diagrams and illustrations where applicable.
2) Wiring and control diagrams with data to explain detailed operation and control of each component
3) Control sequences describing start-up, all modes of operation, and shut down
4) Corrected shop drawings
5) Approved product data including all performance curves and rating data
6) Copies of approved certifications and laboratory or factory test reports (where applicable)
7) Copies of warranties

b. System diagrams, described in the following section, shall be incorporated in the appropriate systems descriptions. These should be reduced in size or folded to usefully fit into the manual.

2. Operating Instructions:

a. Condensed, typewritten, suitable for posting, instructions shall be provided for each major piece of equipment. Where more than one (1) common unit is installed, one instruction is adequate. The instructions shall provide procedures for:

1) Starting up the equipment/system
2) Shutting down the equipment/system
3) Operating the equipment in emergency or unusual conditions
4) Safety precautions
5) Trouble shooting suggestions

6) Other pertinent data applicable to the operation of particular systems or equipment

b. The instructions shall be suitable for posting adjacent to the equipment concerned.
c. The contractor shall provide instructions for (at minimum):

1) Transformers
2) Primary switchgear and substations
3) Secondary Switchgear and Switchboards
4) Automatic transfer switches
5) Emergency power systems
6) Electrical distribution systems
7) Lighting control systems
8) Fire alarm systems
9) Security systems
10) Clock systems
11) Paging systems
12) Uninterruptible power systems/Inverters
13) SCADA system

3. Ongoing and Preventive Maintenance:

a. Condensed, typewritten procedures for recommended ongoing and preventive maintenance actions shall be provided for each category of equipment/system listed above. This information shall include, but not be limited to the following:

1) Maintenance and overhaul instructions.
2) Parts list, including source of supply and recommended spare parts.
3) Name, address, and 24 hour telephone number of each subcontractor who installed equipment and systems, and local representative for each type of system.
4) Other pertinent data applicable to the maintenance of particular systems or equipment.

b. These recommended preventive maintenance actions shall be categorized by the following recommended frequencies:

1) Weekly
2) Monthly
3) Quarterly
4) Semi Annual
5) Annual
6) Other

B. Posted Operating Instructions and Diagrams:

1. Operating Instructions:

a. Copies of operating instructions provided in the operating manual shall be posted in the near vicinity of each piece of applicable equipment. The instructions shall be mounted neatly in frames under Plexiglas, where they can be easily read by operating personnel. Instructions mounted outdoors shall be suitably protected from weather.

2. Posted Systems Diagrams:

   a. Simplified one-line diagrams of the systems listed shall be developed using AutoCAD and posted neatly under Plexiglas in the main or most appropriate equipment room for easy reference by operating and maintenance personnel. These drawings shall be done in a professional manner which is acceptable to the University. The diagrams shall show each component including all devices installed in the system, with name and identifying number. Explanatory notes, where needed, shall be provided.

      1) Electrical one-line diagrams
      2) Other systems as applicable
      3) Emergency lighting
      4) Generators and Transfer Switches
      5) Grounding System

   b. These diagrams shall be suitable for reduction in size and use in the operating manual system descriptions previously covered.

3.9 OPERATING AND MAINTENANCE TRAINING:

A. The Electrical Contractor, and appropriate sub-contractors, shall provide comprehensive operating and maintenance instruction on building systems prior to delivery. The instruction shall include classroom instruction delivered by competent instructors based upon the contents of the operating manual. Emphasis shall be placed upon overall systems diagrams and descriptions, and why systems were designed as they were. The classroom instruction shall also include detailed equipment instruction by qualified manufacturer representatives for which operating instructions are provided. The manufacturer representative training shall emphasize operating instructions, and preventive maintenance as described in the operating manual. At a minimum, the training sessions shall cover the following items:

   1. Types of installed systems
   2. Theory of operation

      a. Design intent
      b. Occupied vs. unoccupied or partial occupancy
      c. Seasonal modes of operation
      d. Emergency conditions, transfer schemes, and procedures
      e. Other issues important to facility operation

   3. System operations
   4. Service, maintenance, diagnostics and repair
   5. Use of reports and logs
   6. Troubleshooting, investigation of malfunctions, and determining reasons for the problem

B. Each classroom training period shall be followed by an inspection, explanation and demonstration of the system concerned by the instructors. All equipment listed in 3.07 A shall be started up and shut down, with the exception of sprinkler systems.

C. The contractor shall be responsible for organizing, arranging, and delivering this instruction in an efficient and effective manner on a schedule agreeable to the University.

D. The contractor shall provide, at or before substantial completion, a proposed agenda and schedule of the above training for approval by the Commissioning Authority and the University.

END OF SECTION 26 0800

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