SPECIAL SPECIFICATION

SECTION 16995S

ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The purpose of this section is to specify Division 16 responsibilities in the commissioning process which are being directed by the TE. Other electrical systems testing is required under the direction of the CM.

B. The list of commissioned equipment and systems is found in Section 01710S.

C. Commissioning requires the participation of Division 16 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 1. Division 16 shall be familiar with all parts of Division 1 and the commissioning plan issued by the TE and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.02 DEFINITIONS

A. Refer to section 01715S

1.03 RESPONSIBILITIES

A. Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor are as follows *(all references apply to commissioned equipment only)*:

B. Construction and Acceptance Phases

1. Include the cost of commissioning in the contract price.

2. In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.

3. Attend a commissioning scoping meeting and other necessary meetings scheduled by the TE to facilitate the Cx process.

4. Contractors shall provide normal cut sheets and shop drawing submittals to the TE of commissioned equipment.

5. Provide additional requested documentation, prior to normal O&M manual submittals, to the TE for development of start-up and functional testing procedures.

    a. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

    b. The Commissioning Agent may request further documentation necessary for the commissioning process.

    c. This data request may be made prior to normal submittals.

6. Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the TE for review and approval.

7. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

8. Provide assistance to the TE in preparation of the specific functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

9. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the TE. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to TE for review.

10. During the startup and initial checkout process, execute and document the electrical-related portions of the prefunctional checklists provided by the TE for all commissioned equipment.

11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the TE.

12. Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

14. Perform functional performance testing under the direction of the TE for specified equipment in Section 01710S. Assist the TE in interpreting the monitoring data, as necessary.

15. Correct deficiencies (differences between specified and observed performance) as interpreted by the TE, CM and A/E and retest the equipment.

16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

17. Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.

18. Provide training of the Owner's operating personnel as specified.
19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

20. Power System Studies

    a. Provide power system studies that include a complete short-circuit study, equipment evaluation study and protective device coordination study based on the installed electrical distribution system.

    b. Include in the study all portions of the electrical distribution system from the utility substation circuit breaker(s) and from alternate sources of power in the electrical distribution system under study.

    c. Cover normal system operating configuration plus any plausible alternate configurations and operations that could result in maximum fault condition.

d. Short-Circuit Study

(1) Perform short circuit study using the *power tools for windows* software package as produced by SKM, Inc.

(2) Include the following study input data: the utility source short-circuit single- and three-phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other circuit parameters as applicable.

(3) Calculate the short-circuit momentary and interrupting duty on the basis of maximum available fault current at each bus in the distribution system down to the following points in the low-voltage system:

(a) 480 volt system busses where available short circuit current is less than 14,000 amperes RMS symmetrical.

(b) 208 or 240 volt system busses where available short circuit current is less than 10,000 amperes RMS symmetrical.

e. Equipment Evaluation Study

(1) Perform an equipment evaluation study to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches and fuses.

(2) Tabulate and compare the short-circuit ratings of the devices with the available fault currents.

(3) Notify the Contract Administrator's Technical Representative of any problem areas or inadequacies in the electrical distribution system equipment.

f. Protective Device Coordination Study

(1) Perform protective device coordination study to select or to check the selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings.

(2) Perform protective device coordination study using the *power tools for windows* software as produced by SKM, Inc.

(3) Include in the coordination study all voltage classes of equipment from the utilities incoming line protective device down to and including each low voltage load protective rated 100 amperes and larger.

(4) Provide time-current characteristic plots of the specified protective devices on 11"x17" log-log coordination paper.

(a) Provide coordination plots for both phase and ground protective devices on a complete system basis.

(b) Include on plots complete titles, representative one-line diagram and legend, associated utility relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of circuit breaker trip curves, and fuse curves.

(c) Indicate on the plots the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91, cable damage curves, symmetrical and asymmetrical fault currents.

(d) Comply with NFPA-70, National Electrical Code. Maintain reasonable coordination intervals and separation of characteristic curves.

(e) Use sufficient curves to clearly indicate the coordination achieved to each utility breaker or fuse, primary feeder breaker or fuse, transformer primary protective device, main and tie secondary breakers, low-voltage feeder breakers, and load protective device rated 100 amperes or more. Use a maximum of eight protective device characteristic curves per plot.

(5) Provide the selection and settings of the protective devices in a separately tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings.

(6) Alert the Contract Administrator's Technical Representative to coordination discrepancies, problem areas, or inadequacies.

C. Warranty Period

1. Execute seasonal or deferred functional performance testing, witnessed by the TE, according to the specifications.

2. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

D. Electrical Designer/Engineer
   1. Refer to Section 01710S for the responsibilities of the Electrical Designer/Engineer.

1.04 RELATED WORK

A. Refer to Section 01710S for a listing of all sections where commissioning requirements are found.

B. Refer to Section 01710S for systems to be commissioned and section 01710S for functional testing requirements.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Division 16 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

B. Refer to Section 01710S for additional Division 16 requirements.

PART 3 - EXECUTION

3.01 SUBMITTALS

A. Division 16 shall provide submittal documentation relative to commissioning to the TE as requested by the TE. Refer to Section 01710S for additional Division 16 requirements.

3.02 STARTUP

A. The electrical contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01710S. Division 16 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional

testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the TE and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.03 FUNCTIONAL PERFORMANCE TESTS

A. Refer to Section 01710S for a list of systems to be commissioned and for a description of the process for specific details on the required functional performance tests.

3.04 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. Refer to Section 01710S for specific details on non-conformance issues relating to prefunctional checklists and tests.

B. Refer to Section 01710S for issues relating to functional performance tests.

3.05 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Division 16 shall compile and prepare documentation for all equipment and systems covered in Division 16 and deliver to the GC for inclusion in the O&M manuals, according to Section 01730.

B. The TE shall receive a copy of the O&M manuals for review.

3.06 TRAINING OF OWNER PERSONNEL

A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01710S for additional details.

B. The TE shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01710S for additional details.

C. Electrical Contractor. The electrical contractor shall have the following training responsibilities:

1. Provide the TE with a training plan two weeks before the planned training according to the outline described in Section 01710S.

2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.

3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.

6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

7. Training shall include:

    a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.

    b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

    c. Discuss relevant health and safety issues and concerns.

    d. Discuss warranties and guarantees.

    e. Cover common troubleshooting problems and solutions.

f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.

g. Discuss any peculiarities of equipment installation or operation.

h. The format and training agenda in *Guidelines for Commissioning HVAC Systems*, ASHRAE, 1989R, 1996 is recommended.

i. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.

8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.

9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.

10. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

11. Duration of Training: The electrical contractor shall provide training on each piece of equipment according to the following schedule or as specified in the associated specification section, whichever is greater.

a. 40 Fire Alarm System

b. 40 Lighting Controls

c. 16 Emergency Generator

d. 40 Security System

e. 16 Telecom and Data

f. 8 Variable Frequency Controllers (VFC)

g. 40 HPM Monitoring and Control System

h. 16 Flammable Gas Detection

i. 16 Liquid Leak Detection

j. 16 HFC-227ea Agent Extinguishing System

k. 16 Vehicle/Pedestrian Gates

3.07 DEFERRED TESTING

A. Refer to Section 01710S for requirements of deferred testing.

3.08 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 01710S and the filled out startup, initial checkout and prefunctional checklists.

END OF SECTION