SECTION 28 08 11
ELECTRICAL TESTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, materials, temporary wiring, testing equipment, load banks, technical supervision and services, and perform operations required for testing of electrical equipment and installations and related work as specified herein and as shown on the drawings.

B. Work Included: The work shall include, but not be limited to, the following:
1. Preliminary inspections and tests.
2. Electrical acceptance tests.
3. Operational tests.

C. Related Work Specified Elsewhere
1. Basic Electrical Requirements
2. Basic Electrical Materials and Methods
3. Other Division 16 sections.

1.02 DESCRIPTION

A. Preliminary testing and visual inspections shall be conducted prior to acceptance and operational tests to avoid delays.

B. Electrical acceptance tests shall be conducted to assure that electrical materials, and their installations are in accordance with contract documents, regulatory agencies, applicable codes and standards listed herein, and that they may be energized.

C. Operational tests shall be conducted to assure capability of equipment and systems to perform as specified and designed.

1.03 QUALITY ASSURANCE

A. Testing and testing equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Regulatory Requirements: Comply with provisions of the applicable electrical code and standards.
2. Comply with latest edition of relevant IEC/S standards for equipment testings.
3. Comply with applicable provisions of IEE wiring regulations or NFMA equal regulations.

B. Personnel engaged in the testing of electrical equipment and systems shall have a minimum of five (5) years of continuous experience in the testing of the equipment and systems to be tested. Submit evidence of such qualifications to the Project manager

C. Contractor shall furnish testing equipment as required. Testing equipment, meters and instruments shall have been properly calibrated and certified within six (6) months prior to testing and shall be in satisfactory condition to perform its functions.

D. Contractor shall provide an appropriate and stable source of electrical power to the test locations.

E. Perform tests in the presence of the Project manager.

F. Electrical equipment and installation shall meet acceptance and operational tests. Promptly repair or replace defective work and repeat the tests until the particular system and component parts thereof receive the approval of the Project manager. Any damages resulting from tests shall be repaired and/or damaged materials replaced, to the satisfaction of the Project manager.

G. It is essential that certain trades and manufacturer's technical representatives be present during the testing. These representatives shall include:

1. Electrical subcontractor who is thoroughly familiar with the project as to its intent, what equipment has been provided and how it is supposed to operate.
2. Supplier of equipment particularly where packaged equipment has been provided.
3. Manufacturer's representative who is thoroughly familiar with the operation of the equipment.

H. The operation of the electrical installation by the Project Manager does not constitute an acceptance of the electrical installations. Final acceptance will depend on Contractor's demonstration of compliance with contract documents, completion of adjustments as specified and required, and submission of required documentation and certification of approval by governing authorities.

I. Continuity tests shall be performed using direct current and audible bells or buzzers. Use of telephones is not acceptable.

J. Safety devices such as rubber gloves and blankets, glow detectors, hot sticks, helmets, eye shields, protective screens and barriers, danger signs, etc. shall be used to adequately protect and warn personnel in the vicinity of the tests.

1.04 SCHEDULING

A. Scheduling of tests shall be as approved by the Project manager.

B. Schedule tests so that equipment can be energized immediately after completing the tests and approval of the reports.

C. Notify the Project manager two (2) weeks prior to testing.

1.05 SUBMITTALS

A. Submit the following in accordance with the requirements specified under "Submittals" in Section 16010.

1. Submit two (2) copies of test reports including actual readings and corrected readings after each test period.

2. Submit four (4) bound copies of final approved test reports at the completion of tests.

3. Test reports shall be signed by the persons performing the tests and the witnesses to the tests and include, but not be limited to, the following data.

a. Date of test.

b. Description of equipment tested.

c. Description of test.

d. Test results.

e. Conclusions and recommendations.

f. Identification of test equipment.

4. Include copies of the final approved test reports in the maintenance manuals.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

B. Cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

C. Testing of outdoor equipment shall not be performed during inclement weather. Ground resistance tests on direct buried ground conductors or rods shall not be performed within 48 hours after rainfall.

D. Megger and high potential testing shall not be performed during periods of high relative humidity. A guard shall be stationed at each location where exposed cables, buswork, connections or other components exist during megger and high potential testing.

E. Equipment shall be thoroughly cleaned prior to testing. Vacuum the interiors of cubicles and remove foreign material. Insulators, bushings and bus supports shall be wiped clean with a lint free cloth.

F. Preliminary tests and visual inspections of the electrical installation including verification checks of factory wiring shall be conducted prior to electrical acceptance and operational tests to avoid delays, and to assure that equipment and installations are free of faulty conditions prior to the application of test voltages.

G. Where the equipment or system under test is interrelated with and depends upon other equipment, systems and/or controls for proper operation, functioning and performance, the latter shall be operated simultaneously with the equipment or system under test.

H. Test fuses for continuity.

I. Test current transformers for continuity and proper polarity.

J. Test potential transformers for continuity and absence of short circuits.

K. Set protective devices in accordance with the approved coordination study.

L. If generators, motors or transformers require drying out to obtain the required insulation valves, the drying method shall be in accordance with the manufacturer's recommendations.

M. Verify that shipping devices and restraints have been removed.

3.03 APPLICATION

A. Equipment that can be paralleled under any conditions including interlock defeat shall be tested for proper phasing using hot-phase hot-stick or other approved methods. This includes, but is not limited to, primary selector switches, automatic transfer switches, tie breakers and busses, etc. at medium and low voltage levels.

B. Full load currents of feeders serving single phase loads shall be measured to assure an equal load balance on each phase. Branch circuits shall be reconnected if necessary to achieve this balance.

C. Megger values specified are minimum acceptable values at an ambient temperature of 16 degrees C and low relative humidity. Contractor shall convert readings to equivalent values at 16 degrees C if measurements are taken under other conditions.

D. The phase rotation at busses, panels, switchboards, switchgear, etc. shall be checked and verified using a phase sequence meter for consistency and conformity to recognized standards, i.e. A-B-C left to right, top to bottom, front to back, when facing front of the equipment, and to provide an A-B-C (1-2-3) clockwise rotation. Where electrical installations and extensions of existing systems, or in new buildings at existing sites, phase rotation shall conform to the existing.

3.04 TESTS

A. Low Voltage Wire and Cable (600 Volts and Less)

1. Wire and cable shall be tested for continuity, freedom from short circuits and grounds by a1000vdc.Megger to assure adequate insulation resistances for each conductor.

2. Test Voltages: Megger instrument shall be 1000 volts DC applied for one minute.

3. Acceptable Test Results: Insulation resistance between phase conductors and any phase conductor to ground shall be not less than 2 mega-ohms for connected conductors and 100 mega-ohms for disconnected conductors.

B. Motor Control Centers and Panel boards

1. Equipment shall be tested for continuity, freedom from short circuits, and grounds and meggered to assure adequate resistances.

2. Test Voltages: Megger instrument shall be 1,000 volts DC for equipment rated 415 volts and 500 volts DC for equipment rated 250 volts, applied for one minute.

3. Acceptable Test Results: Insulation resistance phase to phase and any phase to ground shall be not less than 100 mega-ohms for equipment rated 415 volts and 25 mega-ohms for equipment rated 240 volts.

C. Motors
1. Motors shall be tested for freedom from short circuits and grounds meggered to assure adequate resistances.

2. Test Voltages: Megger instrument shall be 2,500 volts DC for testing 4,000 volt motors, 1,000 volts DC for testing 415 volt motors and 500 volts DC for testing 240 volt motors, applied for one minute.

3. Acceptable Test Results: Insulation resistance phase to ground shall be not less than 20 mega-ohms for 415 volt 3-phase motors and 5 mega-ohms for 240 volt single phase motors.

4. Apply voltage momentarily and check each motor for correct direction of rotation. Correct if necessary.

5. Measure full load current readings of each motor and verify that the correct size heater elements have been

provided for each starter overload relay.
Where current flow exceeds the motor's nameplate value, install a "DO NOT OPERATE" tag, advise the Project manager and notify the Contractor to immediately correct the condition. If power factor correction capacitors are connected on the load side of the overload heaters, include the capacitive reactance determining the proper overload heater size.

6. Submit a tabulation of each motor indicating the equipment identification, motor horsepower, voltage, measured full load current and heater rating and manufacturer's catalog number.

D. Grounding System

1. General

a. Tests on individual ground rods shall be performed with each rod isolated from each other and the grounding system.

b. Tests on the grounding system shall be made after installation and interconnection of the ground system elements including individual ground rods, ground grid cables, connections to structural steel, reinforcing bars, incoming water piping, ground busses on walls and within equipment, etc.

2. Tests of Individual Ground Rods

a. Measure the resistance to earth of each individual ground rod using a Biddle Co. ground tester or two auxiliary ground rods as described in IEEE Standard 550 paragraph 3.4.2 using an alternating test current. Locate the auxiliary rods at sufficient distance from the rod under tests to insure that the regions in which their resistances are localized do not overlap. Calculated resistances to earth shall not exceed 2.5 ohms.

b. If the resistance is greater than 2.5 ohms, it shall be reduced by lengthening the rod or driving additional rods with a minimum separation of 3 m and connecting the rods together until the resistance is less than 2.5 ohms.

3. Tests of the Grounding System: Test ground system for continuity by applying a low voltage DC source of current, capable of furnishing up to 100 amperes.
The ground path using structural steel must conduct 100 amperes.
Resistance as calculated from the current and voltage shall not exceed 5 ohms.
E. Circuit and Motor Disconnects: Upon completion of the installation of electrical disconnects, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation and for verification of type and rating of fuses installed. Correct deficiencies, and then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

F. Receptacles

1. Upon completion of wire tests, check receptacles for proper voltages and phasing, utilizing a receptacle tester for 240 volt 15 and 20 ampere devices and a voltmeter for other devices.

2. Test three phase receptacles for proper phase rotation using a phase sequence meter.
3. Grounded receptacles shall be tested for location and the effectiveness of the ground insert.

4. Test ground fault circuit interrupter receptacles with both local and remote fault simulations in accordance with the manufacturer's recommendations.

G. Lighting Switches: Test lighting switches for correct operation with special emphasis on 3- and 4-way switches.

H. Lighting Fixtures: Verify proper operation of lighting fixtures.

I. Emergency Lighting Units - Battery Operated: After emergency lighting units have been installed and building circuits have been energized with the normal power source, apply and interrupt electrical energy to demonstrate proper operation. Remove and replace malfunctioning units with new units and proceed with retesting. Include the following tests:

1. Duration of supply.

2. Low battery voltage shutdown.

3. Normal transfer to battery source and retransfer to normal.

4. Low supply voltage transfer.

J. Control Circuits: Test control circuits for proper functioning and fail safe operation.

K. Television System: Upon completion of the installation of television system components, and after circuitry has been energized with the power source, test television systems to demonstrate capability and compliance with requirements including, but not limited to, video output signal strength at each television camera, monitor and receiver location. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance, otherwise remove and replace with new units and proceed with retesting.

L. Fire Alarm System

1. Provide the services of a factory-authorized service representative to supervise the field system pre- testing, testing, adjustment and programming.

2. Pre-testing: Upon completing installation of the system, align and adjust the system and perform pre-testing. Determine, through pre-testing, the conformance of the system to the requirements of the drawings and specifications. Correct deficiencies by replacing malfunctioning or damaged items with new items and retest until satisfactory performance and conditions are achieved.

3. Testing

a. Perform electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, measure and adjust each of the ionization detectors to the maximum stable sensitivity setting. This shall be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable.

b. The completed smoke detection system shall be tested to insure that it is operating properly. This test shall consist of exposing the installed units to a standard fire test. Failure of the devices to detect smoke shall be considered a failure of the system and detectors in that system shall be re-adjusted or replaced. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the Contractor shall readjust or replace the detector(s) and begin another ninety (90) day test period? The Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the Owner has obtained beneficial use of the building under tests.

c. Wiring shall be checked and tested to insure there are no grounds, opens or short circuits.

d. A checkout report shall be prepared and submitted, one copy of which shall be registered with the equipment manufacturer. The report shall include, but not be limited to:

1) A list of equipment installed and wired.

2) Indication that equipment is properly installed and functions and conforms with these specifications.

3) Test of individual zones as applicable.

4) Serial numbers, locations by zone and model number for each installed detector.

5) Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.

6) Response time on thermostats and flame detectors.

7) Technician's name, certificate number and date.

e. After completion of the tests and adjustments listed above, submit the following information to the Project Manager:

1) "As-built" conduit layout diagrams including wire color code and/or tag number.

2) "As-built" wiring diagrams.

3) Detailed catalog data on installed system components.

4) Copy of the test report.

END OF SECTION