

SECTION 26 08 00 – ELECTRICAL TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of materials to performance test electrical systems and equipment.
 - 1. Items Supplied Under This Section:
 - a. Electrical System Testing
 - b. Thermographic Testing
 - c. Ground System Testing
 - d. Insulation Testing
 - e. Equipment Testing
 - f. Performance Test
 - g. Test Procedure
 - h. Test Report

- B. Related Sections:
 - 1. Division 1 – General Conditions
 - 2. Division 26 Sections, As Applicable

1.02 REFERENCES

- A. Applicable Documents and Testing Requirements of:
 - 1. America National Standards Institute (ANSI): as applicable, including:
 - a. ANSI C2, National Electrical Safety Code.
 - b. ANSI Z244.1 American National Standards for Personnel Protection.
 - 2. National Electrical Manufacturer's Association (NEMA): as applicable, including:
 - a. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
 - b. NEMA ICS 7.1 - Safety Standards for Construction and Guide for selection, Installation, and Operation of Adjustable Speed Drive Systems.
 - c. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
 - d. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
 - 3. American Society for Testing and Materials (ASTM), as applicable.
 - 4. Institute of Electrical and Electronics Engineers (IEEE), as applicable, including:
 - a. IEEE C.57.13, IEEE Standard Requirements for Instrument Transformers.
 - 5. National Fire Protection Association (NFPA), as applicable, including:
 - a. NFPA 70 - National Electrical Code (NEC).
 - b. NFPA 70E - Electrical Safety Requirements for Employee Workplaces.
 - c. NFPA 72 - National Fire Alarm Code (NFAC).
 - 6. International Electrical Testing Association (IETA) as applicable, including:

- a. Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
7. Insulated Cable Engineer's Association (ICEA), as applicable.
8. State and Local Codes and Ordinances as applicable
9. Occupational Safety and Health Administration (OSHA), as applicable, including: Title 29, Parts 1907, 1910 and 1936.
10. International Electrical Testing Association (IETA) as applicable, including:
 - a. ATS-2013: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
 - b. MTS-2011: Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems.

1.03 SUBMITTALS

- A. Submit documentation as required by this Section of the Contract to the Design Engineer in strict accordance with the provisions of Section 16050 for review, comments and subsequent approval.
- B. Submission to include the following:
 1. Field inspection report as required for each item of material and/or equipment outlined herein.
 2. Manufacturer's directions for use of ground megger with proposed method indicated.
- C. Test Reports:
 1. Provide test reports for all testing, both that conducted by the Contractor as well as that by the Testing Laboratory. Each test report shall comply, where applicable, to all stipulations specified in Section 16050 for Operation, Maintenance and Installation Manuals with reference to preparation, paper requirements, indexing and binders. Include in each test report the following:
 - a. Summary of project.
 - b. Description of equipment tested.
 - c. Description of test.
 - d. Test results.
 - e. Conclusions and recommendations.
 - f. Appendix, including appropriate test forms.
 - g. Identification of test equipment used.
 - h. Signature of responsible test organization authority.
 - i. Furnish five copies of each completed report to the Design Electrical Engineer no later than 30 days after completion of each test. Assemble and certify the testing firm each final test report, which must be submitted to the Design Engineer for review, comments and subsequent approval.

1.04 QUALITY ASSURANCE

- A. Qualifications of Testing Laboratory: Select an independent nationally recognized testing laboratory that is independent from electrical contractor that either is a member

of The International Electrical Testing Association or meets the following qualifications:

1. Is nationally recognized as an electrical testing laboratory.
2. Has been regularly engaged in the testing of electrical systems and equipment for at least 2 years.
3. Is independent from the electrical contractor, the Owner, the Engineer and all other contractors on the job.
4. Has at least one Professional Engineer on staff that is licensed in the State where the project site is located.
5. Derives more than 75 percent of its income from electrical testing.
6. Owns or leases sufficient calibrated equipment to do the testing required.
7. Has a means to trace all test instrument calibration to The National Institute of Standards and Technology.

- B. Membership in the International Electrical Testing Association (NETA) shall be considered evidence of meeting items A.1 through and including A.5.
- C. Testing shall be done under the supervision of a technician certified by International Electrical Testing Association or by technicians that are both certified by the National Society of Professional Engineers and experienced in electrical testing with 5 years of testing experience.
- D. The testing laboratory shall supervise or perform all testing of equipment and oversee setting of all circuit breakers and calibration of all instruments.
- E. The testing firm used must be approved by the Engineer.
- F. Include the cost of such tests in the Contractors Bid Price for the applicable bid item.

1.05 GENERAL REQUIREMENTS

- A. Field Inspection:
 1. This Contractor is responsible for a complete inspection of all equipment, prior to testing and energizing to ascertain that it is free from any damage, scratches, or missing components and that all power connections are correct, and that they are tight in conformance with recommended standard practice. The inspection is to also include a check of control wiring, terminal connections and all bolts and nuts.
 2. Perform field inspection by this Contractor during a time when the Field Engineer and the Design Engineer are present to witness each inspection and its performance.
 3. Correct any deficiencies found during the inspection by this Contractor prior to the energizing and testing of the equipment.

1.06 SCHEDULING

- A. Schedule all testing with work of other contractors to ensure an orderly sequence of startup and completion of work.

1.07 UNDERGROUND CONDUIT SYSTEM INSPECTION

- A. General Requirements: Perform inspection of the underground conduit systems installation by a representative of the Engineer as the work progresses. Inspect each of the following prior to proceeding to the next phase of the installation.
 - 1. Trench bed.
 - 2. Lower sand bed.
 - 3. Lower concrete protection slab, where indicated or required.
 - 4. Upper sand bed for conduits.
 - 5. Each layer of conduits.
 - 6. Soil backfill.
 - 7. Warning Tape.
 - 8. Soil backfill.
- B. Failure to comply with any of the above, indicated sequential inspection requirements is just cause for the Engineer to request removal of the work and reinstall as per these specifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRICAL INSPECTIONS AND TESTS

- A. Perform, supervise, and furnish all test equipment needed to perform tests and provide safety measures, procedures and equipment required for each test.
- B. Schedule all testing with the Engineer. Perform testing in the presence of the Engineer except when the Engineer approves in writing conducting a specific test without the Engineer's presence.
- C. Notify all involved parties including the Engineer prior to tests, advising them of the test to be performed and the scheduled date and time.
- D. Coordinate the tests with others involved.
- E. Prepare written test procedures and forms used in the test reports and submit for approval prior to commencement of testing.

required.

3. The testing firm is to have a designated safety representative on the project to supervise operations with respect to safety.

3.02 TESTING TO BE PERFORMED BY CONTRACTOR

- A. Continuity Test: Make test for continuity and correctness of wiring and identification on all conductors installed.
- B. Wire and Cable:
 1. Test all wires and cables sized No. 2 and larger in accordance with NETA ATS- 2013.
 2. Perform visual, mechanical, and electrical tests on all No. 4 and No. 6 power cables that operate at voltages exceeding 150 volts to ground in accordance with NETA ATS-2013.
 3. Perform visual, mechanical, and electrical tests on all other wires and cables in accordance with NETA ATS-2013.
 4. Replace any wires which have been damaged.
 5. Correct causes of all readings which do not meet the acceptable minimum insulation readings as stated in NETA ATS-2013. Exceed the nominal expected temperatures for the actual load.
 6. Retest items requiring correction.
- C. Surge Protective Device (SPD):
 1. Visually and mechanically inspect the SPD unit and connections.
 2. Use an AC voltmeter to check all voltages and ensure that normal operating voltages of the power system match the voltage rating on the SPD nameplate.
 3. Check LED status indicators on the display panels and suppression modules to confirm normal status.
 4. Press the alarm test button to confirm the audible alarm and LED.
 5. Operate the alarm silence switch to confirm proper operation.
- D. Ground Fault Circuit Interrupter (GFCI) Receptacles:
 1. Test all GFCI receptacles as specified in Section 16140.
- E. Lighting Tests
 1. Emergency, standby, equipment and lighting test: Trip incoming utility power and ascertain that all standby and emergency lighting equipment operates properly.
 2. Operate battery systems for emergency lighting without power for 90 minutes and correct all defects and retest.
- F. Initial Mechanical Performance Test
 1. Provide on-site electricians and support to the general contractor during the mechanical performance test.
 2. With the personnel of the Owner observing, demonstrate to the satisfaction of the Engineer the mechanical performance of each item of equipment when operated in accordance with the design intent indicated by the Drawings and described in the

- applicable sections of the Specifications.
3. Correct all deficiencies and demonstrate that they have been corrected.
 4. Without reliance on Owner's personnel, operate and maintain the equipment in continuous, day to day, 24 hour operation until commencement of the Final Mechanical Performance Test.
 5. During this interim, instruct and train the Owner's personnel in their duties.
 6. Final Mechanical Performance Test: During a 48-hour period.
 - a. With equipment in continuous normal operation, under supervision turn operation of the plant over to the personnel of the Owner beginning with the final tests.
 - b. Demonstrate that equipment is coordinated and that installation complies with the applicable Drawings and Specifications.
 - c. Measure all major feeders, the total power, total power factor, current on all lines, and voltage, phase and phase to ground, and on all phases.
 - d. Measure all motors over 5 horsepower, power, power factor and voltage under load.
 - e. Correct all deficiencies and demonstrate that they have been corrected.
 - f. Owner will pay operating costs for the Final Mechanical Performance Tests.
 - g. Test will be considered complete after a continuous 48-hours of satisfactory operation without any failure of equipment.
- G. Test Interim:
1. Contractor's Personnel, without reliance of Owner's Personnel, are to operate and maintain the equipment in continuous, day to day, 24 hour operation except as otherwise approved by the Engineer until commencement of the Final Mechanical Performance Test.
 2. During this interim the Contractor's Personnel are to instruct and train the Owner's Personnel in their duties.
- H. Final Mechanical Performance Test: Final Mechanical Performance Test is to cover a 48 hour period while the plant is in continuous, normal operation.
1. With equipment in continuous, normal operation, the Personnel of the Owner are to assume day to day operation of the equipment under the direct supervision of the Contractor's Personnel beginning with the Final Tests.
 2. Contractor's Personnel are to demonstrate to the satisfaction of the Engineer that equipment is coordinated and that installation complies with the applicable Drawings and Specifications.
 3. Performance Tests are to be considered concluded at the end of the forty-eight hour period designated for the tests if the Engineer is satisfied with the test results or should deficiencies be found as a result of said test, then when the deficiencies have been corrected to the satisfaction of the Engineer.
- I. Operating Costs: Costs for Final Mechanical Performance Tests: The Owner will pay operating costs for the Final Mechanical Performance Tests except those costs for chemicals required to complete Process Performance Tests and Acceptance Tests, if required on equipment.

3.03 TESTING TO BE PERFORMED BY TESTING LABORATORY

- A. Select, hire and pay an independent, nationally-recognized electrical testing laboratory to perform all testing specified in this article. Obtain Owner's approval of the testing laboratory and the testing laboratory proposed test procedure prior to commencement of any tests.
- B. Set all adjustments for all overcurrent protection devices in accordance with the protection and coordination study of Section 16050.
- C. Visually and mechanically inspect and electrically test items as scheduled in attached schedule for equipment in attached schedule equipment as listed in attached schedule in using the procedures of NETA ATS-2013. When a test for a particular item is not called out in ATS, test using the procedures in NETA MTS-2011.
- D. Thermographic Inspection:
 - 1. Perform thermographic inspection of the electrical equipment and installations as listed below in accordance with NETA ATS-2013, and as detailed below. The following equipment is to be scanned:

a. Service Entrance Panelboards	all ratings
b. Distribution Panelboards	50-Ampere and larger
c. Lighting Panelboards	50-Ampere and larger
d. Power Panelboards	50-Ampere and larger
e. Dry Type Transformers	10 kVA and Larger
f. Individually Mounted Circuit Breakers	100 amp and larger
g. Disconnect Switches	100 amp and larger
h. Individually Mounted Motor Starters	Size 1 and larger
i. Motors	30 HP and larger
 - 2. Provide report including the following items:
 - a. Items scanned
 - b. Whether item passed or failed
 - c. All items in NETA ATS-2013
 - d. The probable cause
 - e. Severity of defect
 - f. Recommended corrective measures
 - g. Video recording of test.
 - 3. Scan using an infrared camera with video scanner output to a display screen with a range of at least 1 degree C to 75 degrees C with an accuracy of 0.1 degree C and with the following equipment:
 - a. One 7 degree telephoto lens
 - b. One 20 degree wide angle lens
 - c. One 40 degree extra-wide angle lens
 - 4. Record output of camera during testing onto a DVD or store digital images of each piece of equipment inspected onto a CD as a record of the temperature variations. Record either by order or by digital imprinting the actual equipment being scanned. Turn off recordings during inactive periods or edit DVD to eliminate dead periods.
 - 5. Display data on a monitor capable of providing both a gray step mode and color

- monitor. These capabilities allow distinct temperature levels to be shown in black and white or color on the thermogram.
6. Submit three copies of report and two copies of the DVD or CD.
 7. Include DVD or CD of thermographs of the defective equipment and installations.
Also include in report.
 8. Submit both copies of the report to the Engineer who will make the determination of corrective measurements.
- E. Low Voltage Molded Case Circuit Breaker Tests:
1. Visually and mechanically inspect and electrically test all low voltage circuit breakers in frame sizes rated 100-amperes or more in accordance with NETA ATS-2013.
 2. Acceptable values are as stated in NETA ATS-2013.
- F. Metering Tests:
1. Visually and mechanically inspect and electrically test all meters using standards traceable to The National Institute of Standards and Technology in accordance with NETA ATS-2013.
 2. Meters should be accurate to within their stated calibration.
- G. Grounding Electrode System Tests:
1. Visually and mechanically inspect and electrically test all made grounding electrode systems in accordance with NETA ATS-2013. For the point-to-point tests of NETA ATS-2013, measurements are only required for equipment conductors run with services, and feeders and branch circuits rated over 400 amperes.
 2. Determine acceptable values as follows:
 - a. Main service entrance ground: 5 ohms.
 - b. Emergency/standby generator ground grid: 5 ohms.
 - c. Panelboards ground bus: 10 ohms.
 - d. Manhole ground rod electrodes: 25 ohms
 - e. Prior to the electric service being energized and prior to the installed products being covered, measure the ground system resistance to earth in the presence of the Engineer.
 - f. Grounds not otherwise covered in this Specification with a maximum of 25 ohms.
- H. Dry-Type Transformers Tests:
1. Visually and mechanically inspect and electrically test low voltage dry-type transformers in sizes rated over 7.5 kVA, 3-phase and rated less than 500 kVA, 3- phase in accordance with NETA ATS-2013.
 2. Acceptable test values are as stated in NETA ATS-2013.
- I. Ground Fault Protection Testing:
1. Visually and mechanically inspect and electrically test all ground fault protection systems in accordance with NETA ATS-2013.
 2. Acceptable test values are as stated in NETA ATS-2013.

- J. AC Motor Testing:
 - 1. Visually and mechanically inspect and electrically test all AC motors rated 10-horsepower or more in accordance with NETA ATS-2013.
 - 2. Acceptable test values are as stated in NETA ATS-2013.
 - 3. Immediately report all motors, which fail inspection to the Engineer for correction.

- K. Low Voltage Motor Starter Tests:
 - 1. Visually and mechanically inspect and electrically test all low voltage motor starters rated 10-horsepower or more in accordance with NETA ATS-2013.
 - 2. Acceptable values are as stated in NETA ATS-2013.

- L. Harmonic Testing
 - 1. Conduct harmonic testing at:
 - a. Main Distribution Panelboard.
 - b. Points of Common Coupling (PCC). PCC defined as nearest switchboard or panelboard which directly serves each variable frequency drive.
 - c. Generator terminals.
 - d. Transformer primary terminals.
 - 2. Measure and record the following data at each location where harmonic testing is required:
 - a. Current Distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic.
 - b. Voltage Distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic.
 - c. Voltage Notching: Notch area (volt-microseconds) and depth (volts).
 - d. For record purposes measure and record on all 3-phases, actual plant load at all switchboard and panelboard buses.
 - 3. Conduct harmonic testing with harmonic producing loads in operation. Record the following information for variable frequency drives, taken at the time harmonic distortion measurements are made:
 - a. Output frequency.
 - b. Output current.
 - c. Output voltage.
 - d. Output power factor when motor metering includes this capability.
 - 4. Conduct harmonic testing with variable frequency drives operating at full load and half load.
 - 5. Test report shall include the following calculated values at each location where harmonic testing is required:
 - a. Total demand distortion (TDD).
 - b. Individual harmonic current distortion in percent of the maximum demand load current up to and including the 35th harmonic.

3.04 TESTING TO BE PERFORMED BY MANUFACTURER'S REPRESENTATIVE

- A. AC Variable Frequency Drive (VFD) Tests:
 - 1. On completion of the installation, the initial start-up shall be performed by a factory-

trained representative of the AC drive manufacturer. Two copies of operating and maintenance instruction books shall be supplied for the test of the AC drives.

2. Provide equipment manufacturer's certification that the AC drives are installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service engineer.
3. Instruct Owner's personnel regarding equipment operation and maintenance procedures.
4. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

- B. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

3.05 CORRECTION OF DEFICIENCIES

- A. Report all unacceptable values immediately. Correct all deficiencies found in work of this contract and separately report deficiencies in work of items of other contracts.
 1. Retest items requiring correction. Correct or have corrected any remaining deficiencies and retest until work is acceptable.

3.06 RETESTING

- A. After equipment has been in service for a period of nine months repeat the following tests:
 1. Thermographic testing. Correct all causes of readings above the nominal expected reading for the load encountered.
 2. Insulation tests of all motors over 100 horsepower, switchgear, switchboards, and transformers over 50 kVA.

END OF SECTION