

## SECTION 26 08 00 - ELECTRICAL ACCEPTANCE TESTING

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. The work required under this section of the specifications consists of the start-up testing and inspection of the electrical equipment designated within. All labor and testing equipment which is required shall be provided under this section of the specifications.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.3 GENERAL

- A. The Contractor shall engage the services of an approved testing organization to provide start-up testing and inspection of the electrical equipment as specified in this section.
- B. The testing organization shall be a full service company that employs factory trained test engineers capable of trouble shooting as well as identifying equipment problems. All work outlined shall be performed under the full time on-site supervision of a graduate engineer with a minimum of five years of field testing experience. The test, plan, procedures, and report shall be reviewed and approved by one of the testing company's electrical engineers. Upon request, the testing company shall submit proof of its qualifications.
- C. The testing organization shall provide the equipment and technical personnel to perform such tests and inspections. The contractor shall, at his expense, furnish any personnel necessary to assist in the testing and inspection.
- D. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date the tests were completed, and the initials of the engineer who performed the tests.
- E. The tests shall insure that the equipment is operational and functioning within industry standards and manufacturer's tolerances. Forward all test reports to the Architect at least two weeks prior to the project final inspection for review. Reports shall be bound as required by Division 1 of this specification.

#### 1.4 QUALITY ASSURANCE

- A. Industry Referenced Standards. The testing and inspection shall comply with all applicable sections of the following codes and standards:
  - 1. American National Standards Institute - ANSI
  - 2. American Society for Testing and Materials - ASTM
  - 3. Association of Edison Illuminating Companies - AEIC
  - 4. Institute of Electrical and Electronics Engineers - IEEE
  - 5. Insulated Power Cable Engineers Association - IPCEA

6. International Electrical Testing Association - NETA Acceptance Testing Specifications
7. National Electrical Code - NEC
8. National Electrical Manufacturers Association - NEMA
9. National Fire Protection Association - NFPA
10. State and Local Codes and Ordinances
11. National Electrical Contractors' Association (NECA) Standards of Installation

- B. The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

#### 1.5 SUBMITTALS

- A. Refer to BASIC ELECTRICAL REQUIREMENTS for submittal requirements.

#### 1.6 DIVISION OF RESPONSIBILITY

- A. The Contractor shall:

1. Perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
2. Supply a suitable and stable source of electrical power to each test site.
3. Notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

- B. The testing firm shall:

1. Notify the Architect prior to commencement of any testing.
2. Report to the Architect any system, material or workmanship which is found defective on the basis of acceptance tests.
3. Maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

#### 1.7 SAFETY AND PRECAUTIONS

- A. Safety practices shall comply with applicable state and local safety orders as well as with the Occupational Safety and Health Act of 1970 (OSHA). Compliance with the National Fire Protection Association standard NFPA 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.
- B. Tests shall only be performed on apparatus which is de-energized. The testing company's lead test engineer for the project shall be a designated safety representative and shall supervise testing observations and safety requirements. Work shall not proceed until he has determined that it is safe to do so.
- C. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

#### 1.8 REPORTS

- A. The test report(s) shall include the following sections:

1. Scope of testing
  2. Electrical equipment tested
  3. Description of test procedures
  4. Test results
  5. Conclusions and recommendations
  6. Appendix, including test forms
- B. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the engineer who tested the equipment and the date of the test completion. All test reports shall bear the seal of an electrical engineer registered in the project state.
- C. Record copies of the completed test report shall be submitted no more than 14 days after completion of the testing and inspection.

## 1.9 TEST EQUIPMENT

- A. All test equipment shall be in good mechanical and electrical condition. All field instruments shall have been calibrated within six months of the testing date, and dated calibration labels shall be visible on the testing equipment. Submit calibration certification in the final report.

## PART 2 - PRODUCTS

### 2.1 GENERAL MATERIALS REQUIREMENTS

- A. All materials are specified under other sections of this specification. All testing equipment required shall be provided under this section of the specifications.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT TO BE TESTED

- A. Equipment shall be tested in accordance with the following scopes of work.
1. Medium Voltage Cables, Terminations, and Splices
  2. Liquid Filled Transformers
  3. Dry Type Transformers
  4. Low Voltage Switchgear and Switchboards
  5. Low Voltage Power Circuit Breakers and Insulated Case Circuit Breakers
  6. Molded Case Circuit Breakers
  7. Motor Control Centers and Motor Controllers
  8. Automatic Transfer Switches
  9. Engine Driven Emergency Power Supply
  10. Lighting Control System
  11. Grounding System
  12. Cables, 600 Volts
  13. Ground Fault Systems

### 3.2 MEDIUM VOLTAGE SWITCHGEAR

- A. Visual and Mechanical Inspection
  - 1. Verify that the enclosure interiors are clean of accumulated dust, dirt, films, and other foreign material.
  - 2. Inspect and clean all bus and support insulators.
  - 3. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
  - 4. Exercise all active components. Lubricate as required.
  - 5. Check for proper anchorage, required clearances, physical damage, and proper alignment.
  - 6. Check for proper travel and alignment of drawout circuit breakers.
  - 7. Check breaker connections to bus.
  - 8. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
  - 9. Inspect for missing or loose hardware or accessories.
  - 10. Inspect ground bus connections.
  - 11. Operate key and door interlock devices to assure proper operation.
- B. Electrical Tests
  - 1. Insulation Resistance Test. Megger main secondary bus and feeder circuits phase-to-phase and phase-to-ground.
  - 2. Energize any space heater circuits to insure proper operation.
  - 3. Perform phasing check on double-ended switchgear.
- C. Instruments and Meter Tests
  - 1. Inspect panel mounted instruments and meters. Clean and check for calibration accuracy. Make minor adjustments, as necessary.

### 3.3 LIQUID FILLED TRANSFORMERS

- A. Visual and Mechanical Inspection
  - 1. Check primary, secondary, and ground connections.
  - 2. Clean and inspect bushings.
  - 3. Inspect bushing clamps and gaskets.
  - 4. Inspect cover and hand hole gasket seals.
  - 5. Inspect tap changer seals.
  - 6. Check for oil leaks and external damage to radiators.
  - 7. Check liquid level.
  - 8. Check accessory devices for condition and proper operation.
- B. Electrical Tests
  - 1. Insulation Resistance Test: Megger transformer windings high to low and ground, low to high and ground, and high and low to ground.
  - 2. Perform turns Ratio Test.
  - 3. Where auxiliary cooling has been provided, verify proper operation of such equipment.
  - 4. Include measured secondary voltage (line-to-line and line-to-ground) for each transformer in the test report. Verify that the taps on all transformers with primary voltages above 600 volts are set to deliver voltage indicated in the Contract Documents with the system in full operation. Secondary voltage readings, at each transformer, phase to phase neutral, and

phase load readings shall be recorded and tap positions of transformer taps noted. This test shall be conducted with a calibrated voltmeter.

5. Each ground rod installation shall be tested after all connections to ground rods are made before grounding conductor connection is made to the transformer. Ground rod installations shall be tested by "fall of potential" measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested.
6. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within 70' of the grounding system being tested. Test data shall indicate placement of auxiliary electrodes with respect to systems being tested, date readings were taken and lowest resistance recorded.

### 3.4 DRY TYPE TRANSFORMERS

#### A. Visual and Mechanical Inspection

1. With case covers removed, inspect transformer core and coil assembly and enclosure interior. Cloth wipe and/or brush major insulating surfaces.
2. Check primary, secondary, and ground connections.
3. Check tap connections and tap changer.
4. Inspect all bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect insulators, spacers, and windings.
6. Inspect for adequate electrical clearance.
7. Check base or support insulators, including vibration isolation supports.
8. Check accessory devices for condition and proper operation.
9. Verify that the transformers have been provided with adequate spacing for ventilation.

#### B. Electrical Tests

1. Insulation Resistance Test: Megger transformer windings high to low and ground, low to high and ground, and high and low to ground.
2. Perform turns Ratio Test.
3. Where auxiliary cooling has been provided, verify proper operation of such equipment.
4. Include measured secondary voltage (line-to-line and line-to-ground) for each transformer in the test report. Verify that the taps on all transformers with primary voltages above 600 volts are set to deliver voltage indicated in the Contract Documents with the system in full operation. Secondary voltage readings, at each transformer, phase to phase neutral, and phase load readings shall be recorded and tap positions of transformer taps noted. This test shall be conducted with a calibrated voltmeter.
5. Each ground rod installation shall be tested after all connections to ground rods are made before grounding conductor connection is made to the transformer. Ground rod installations shall be tested by "fall of potential" measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested.
6. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within 70' of the grounding system being tested. Test data shall indicate placement of auxiliary electrodes with respect to systems being tested, date readings were taken and lowest resistance recorded.

### 3.5 LOW VOLTAGE SWITCHGEAR AND SWITCHBOARDS

- A. Visual and Mechanical Inspection
  - 1. Verify that the contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign materials.
  - 2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
  - 3. Check for proper travel and alignment of any drawout or plug-in circuit breakers.
  - 4. Check breaker connections to bus.
  - 5. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections. Refer to manufacturer's instructions for proper torque values.
  - 6. Inspect for missing or loose hardware or accessories.
  - 7. Inspect ground bus connections.
  - 8. Operate key and door interlock devices to assure proper operation.
  - 9. Inspect for labels, and nameplate compliance with up-to-date circuit connections.
  - 10. Verify that potential transformers, including their overcurrent protection and current transformers, meet specified requirements.
  - 11. Check switchboard anchorage, area clearances, and alignment and fit of components.
- B. Electrical Tests
  - 1. Insulation Resistance Test: Megger main secondary bus and feeder circuits phase-to-phase and phase-to-ground.
  - 2. Energize any space heater circuits to insure proper operations.
  - 3. Insulation resistance test of buses and portions of control wiring that disconnect from solid state devices through normal disconnecting features. Insulation resistance less than 100 megohms is not acceptable.
- C. Check phase rotation with a Biddle phase rotation meter. Check phasing of alternate supply sources to the same bus.
- D. Instruments and Meter Tests
  - 1. Inspect panel mounted instruments and meters. Clean and check for calibration accuracy. Make minor adjustments as necessary.
  - 2. Ratio and polarity tests on current and voltage transformers.
  - 3. Calibrate ammeters and voltmeters at midscale. Use check instruments with documented up-to-date calibration traceable to NIST standards.
  - 4. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformer and control power wiring.
  - 5. Calibrate watt-hour and demand meters to 0.5 percent, and verify meter multipliers. Use check instruments with documented up-to-date calibration traceable to NIST standards.
- E. Infrared Scanning:
  - 1. Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of switchboard bus joints and connections. Open or remove metal doors, covers, inspection plates, and barriers to make joints and connections accessible to a portable scanner.

3. Follow-up Infrared Scanning: Perform 2 additional follow-up infrared scans of the same joints and connections, one 4 months after Substantial Completion and one 11 months after Substantial Completion.
4. Record of Infrared Scanning: Report shall identify all connections checked and describe results of scanning. Include graphic indication of scanning results, notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 LOW VOLTAGE POWER CIRCUIT BREAKERS AND INSULATED CASE CIRCUIT BREAKERS

#### A. Visual and Mechanical Inspection

1. Remove each draw-out type circuit breaker.
2. Inspect arc chutes of power circuit breakers.
3. Inspect circuit breaker for defects or damage.
4. Inspect and check contacts. Check alignment, over-travel, and pressure. Adjust if necessary.
5. Inspect finger clusters on line and load stabs of draw-out circuit breakers.
6. Check for proper mechanical operation. Lubricate where necessary.
7. Check auxiliary devices for proper operation.
8. Check breaker racking device (if applicable) for alignment and friction-free operation. Lubricate if necessary.

#### B. Electrical Tests

1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device by primary injection and calibrate to settings provided [by the Owner's engineer.] Static overcurrent trip devices shall be tested per the manufacturer's instructions. Test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
  - a. Test for minimum pick-up current.
  - b. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
  - c. Where short time delay characteristics are provided, test short time pick-up and delay.
  - d. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.
  - e. Where ground fault protection is provided, test ground fault pick-up and delay.
  - f. Check reset characteristics of trip unit.
4. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm contacts, and auxiliary contacts.

### 3.7 MOLDED CASE CIRCUIT BREAKERS

#### A. Visual and Mechanical Inspection

1. Inspect cover and case, and check for broken or loose terminals.
2. Operate breaker to check operation.

#### B. Electrical Tests (200 ampere trip and larger)

1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device and calibrate [to settings provided by the engineer.] Where primary injection testing is specified, test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
  - a. All trip units shall be tested by primary injection.
  - b. Static overcurrent trip devices shall be tested per manufacturer's instructions.
  - c. Test for minimum pick-up current.
  - d. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
  - e. Where short time delay characteristics are provided, test short time pick-up and delay.
  - f. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.
  - g. Where ground fault protection is provided, test ground fault pick-up and delay.
  - h. Check reset characteristics of trip unit.
4. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

### 3.8 MOTOR CONTROL CENTERS AND MOTOR CONTROLLERS

- A. Visual and Mechanical Inspection
  1. Verify that the contractor has cleaned structure interiors and starter cells of accumulated dust, dirt, oil films, and other foreign material.
  2. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
  3. Check mechanical operation of starters for freedom from binding.
  4. Check motor circuit protector setting and overload relay heater size against contractor furnished list of motor nameplate full load current values.
- B. Electrical Tests
  1. Verify operation of each starter.
  2. Test each overload relay by current injection through relay heaters. Record heater catalog numbers for each starter and submit list for maintenance. List shall contain circuit number, description of equipment and motor full load amps.
  3. Contact Resistance Test. Ductor across main pole contacts of each breaker or switch with device closed and latched to check for good, low resistance contact.
  4. Test overcurrent trip device of each circuit breaker trip device by current injection.

### 3.9 AUTOMATIC TRANSFER SWITCHES

- A. Visual and Mechanical Inspection
  1. Verify that contractor has cleaned enclosure interiors and all components of accumulated dust, dirt, oil films, and other foreign material.
  2. Inspect all electrical and mechanical components for condition and any evidence of defect or failure.
  3. Perform inspection checks on individual components as recommended by the manufacturer.

4. Inspect connections for looseness. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Check for proper mechanical operation and lubricate, as necessary.
7. Check transfer mechanism for alignment and friction-free operation. Lubricate, as necessary.
8. Check all connecting wiring for condition.

B. Electrical Tests

1. Use test switch, when available, to check the electrical operation of the transfer switch.
2. When a test switch is not available, a failure of the normal source power will be simulated by disconnecting a voltage sensing lead.
3. Test and adjust all sensing relays, and other devices specifically associated with the transfer switch.
4. Contact Resistance Test: Ductor across main pole contacts of power switching circuit breakers, switches or contactor contacts with device closed and latched to check for good, low resistance contact.

3.10 EMERGENCY POWER SUPPLY-ENGINE DRIVEN

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check output circuit breaker(s) bus connection.
4. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Inspect grounding system connections.
7. Operate key and door interlock devices to assure proper operation.
8. Inspect all associated systems and circuits for proper operation, including but not limited to the fuel supply system, jacket heater, battery charger, engine mounted control panel, remote monitoring and control panel, emergency cut-off, battery lighting system, exhaust system, radiator system, and ventilator system.
9. Inspect anchoring and vibration isolation systems.

B. Electrical Tests.

1. Insulation resistance test: Megger main poles of output circuit breaker(s) pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts of output circuit breaker(s) with breaker closed and latched to check for good, low resistance contact.
3. Follow completely the load testing procedures of the latest issue of NFPA-110 for EPS systems, including prior notification of the local inspection authority having jurisdiction. Include all measured data and conditions in the final report. All non-compliance items shall be corrected by the contractor and retested until full compliance with NFPA-110 is achieved.

3.11 LIGHTING CONTROL SYSTEM

- A. Visual and Mechanical Inspection
  - 1. Inspect each device for physical damage.
  - 2. Check for proper labeling of conductors
  - 3. Inspect all system lamps and LED's for proper operation. Replace all non-operational equipment.
  - 4. Check all cabinet doors, latches, and hinges for proper operation. Adjust, lubricate, and/or repair as required.
  
- B. Electrical Tests
  - 1. Verify the absence of unwanted voltages between circuit conductors and ground that would constitute a hazard or prevent proper system operation.
  - 2. Meggar test all conductors (other than those intentionally grounded) for isolation from ground.
  - 3. Test all conductors (other than those intentionally connected together) for conductor-to-conductor isolation using as insulation testing device.
  - 4. The control unit shall be tested to verify it is in the proper operating condition as detailed in the manufacturer's manual.
  - 5. Each control circuit shall be tested to confirm proper operation of the circuit. [Monitor the system with all building equipment energized, such as variable speed controllers, to verify the absence of control inhibiting electrical noise.]

### 3.12 GROUNDING SYSTEM

- A. Visual and Mechanical Inspection
  - 1. Inspect wiring system outlet and junction boxes for proper grounding. Green grounding conductor shall be connected to outlet and junction boxes. Inspect a minimum of 5% of project boxes.
  - 2. Verify connections of grounds for the secondary of separately derived grounding systems, i.e. at dry type transformers. Note type of connection, i.e. mechanical or exothermic.
  - 3. Verify proper connection to all components of building service entrance grounding system. Note all system components which are interconnected and type of connection either mechanical or exothermic. Note depth of driven ground rods.
  
- B. Electrical Tests
  - 1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Instrumentation utilized shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.
  - 2. When sufficient spacing of electrodes described above is impractical, perform ground-impedance measurements utilizing either the intersecting curves method or the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81.)
  
- C. Equipment Grounds
  - 1. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.
  
- D. Test Values

1. The main ground electrode system impedance-to-ground should be no greater than five (5) ohms for commercial or industrial systems and one (1) ohm or less for generating stations, transmission stations, and large industrial systems. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

### 3.13 MEDIUM VOLTAGE CABLES, TERMINATIONS, AND SPLICES

#### A. Visual and Mechanical Inspection

1. Visually inspect all primary cable terminations and splices.
2. Verify that splices and terminations are made and installed in accordance with the recommendations of the manufacturer of the specific cable, terminators and splice kits used on this project.

#### B. Electrical Tests

1. D.C. testing applies to new cables and/or new cables and terminations only. Existing cables or terminations shall be not be D.C. tested. Arrange and schedule testing such that new cables and terminations are available for testing prior to connecting to existing medium voltage system.
2. Perform a high voltage D.C. test on each cable after installation but prior to termination. Each section of primary cable shall be given a high voltage D.C. test after cables are installed, in accordance with ICEA test procedure for high voltage cable for the KV rating of the cable being tested. Conduct test with all splices made but without cables being connected to transformers. Open all apparatus switches and place load break elbows in parking stands so test results will be applicable to cable only. Test shall consist of the application of a D. C. voltage to cable section for a period of fifteen minutes and the leakage current recorded after 15, 30, 45 and 60 seconds and at one minute intervals thereafter for the complete period. Record test results graphically recorded for each cable section. Test data shall indicate cable section tested, temperature and relative humidity at the time tests are made.

### 3.14 CABLES - 600V

#### A. Visual and Mechanical Inspection

1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

#### B. Electrical Tests

1. Perform insulation-resistance test on each feeder on the riser diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
2. Perform continuity test to insure proper cable connection.

#### C. Test Values

1. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.

### 3.15 BUSWAYS

- A. Visual and Mechanical Inspection
  - 1. Inspect bus for physical damage and proper connection in accordance with single-line diagram.
  - 2. Inspect for proper bracing, suspension alignment, and enclosure ground.
  - 3. Check tightness of bolted joints by using calibrated torque wrench in accordance with manufacturer's published data.
  - 4. Check for proper physical orientation per manufacturer's labels to ensure proper cooling. Perform continuity tests on each conductor to verify that proper phase relationships exist.
  - 5. Check outdoor busway for removal of "weep-hole" plugs, if applicable, and the proper installation of joint shield.
  
- B. Electrical Tests
  - 1. Measure insulation resistance of each bus run phase-to-phase and phase-to-ground for one (1) minute in accordance with manufacturer's published data.
  - 2. Perform ac or dc overpotential tests on each bus run phase-to-phase and phase-to-ground. Potential application shall be for one (1) minute and in accordance with ANSI C37.20.2 and C37.20.3
  - 3. Perform contact-resistance test on each connection point of uninsulated bus. On insulated bus, measure resistance of bus section and compare values with adjacent phases.
  - 4. Perform phasing test on each bus tie section energized by separate sources. Tests must be performed from their permanent sources.
  
- C. Test Values
  - 1. Bus bolt-torque values shall be in accordance with manufacturer's recommendations.
  - 2. Insulation-resistance test voltages and resistance values shall be in accordance with manufacturer's specifications.
  - 3. Overpotential test shall be evaluated as pass/fail.

### 3.16 GROUND-FAULT SYSTEMS (NEC 230-95)

- A. Visual and Mechanical Inspection
  - 1. Inspect for physical damage and compliance with drawings and specifications.
  - 2. Inspect neutral main bonding connection to assure:
    - a. Zero-sequence sensing system is grounded.
    - b. Ground-strap sensing systems are grounded through sensing device.
    - c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
    - d. Grounded conductor (neutral) is solidly grounded.
  - 3. Inspect control power transformer to ensure adequate capacity for system.
  - 4. Manually operate monitor panels (if present) for:
    - a. Trip test
    - b. No trip test
    - c. Nonautomatic reset
  - 5. Record proper operation and test sequence.
  - 6. Set pickup and time-delay settings in accordance with the settings provided.
  
- B. Electrical Tests
  - 1. Measure system neutral insulation to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.

2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
  3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
  4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
  5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
  6. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.
- C. Test Parameters
1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.
  2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
  3. Relay pickup value shall be within +/- 10% of setting and in no case greater than 1200A.

END OF SECTION 26 08 00