PART 1 GENERAL

1.01 SCOPE
A. The Contractor shall engage the acceptance testing and startup services of the field engineering service division of a major electrical distribution equipment manufacturer which maintains division-wide recognized specialized testing capabilities for the purpose of performing tests as herein specified.

1.02 RELATED SECTIONS

Note to Spec. Writer:
Refer to all specification sections covering equipment for which startup is required.

1.03 APPLICABLE CODES, STANDARDS AND REFERENCES
A. All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.
   1. National Electrical Manufacturer’s Association – NEMA
   2. American National Standards Institute – ANSI
   3. Institute of Electrical and Electronic Engineers – IEEE
   7. Insulated Power Cable Engineers Association – IPCEA
   8. Association of Edison Illuminating Companies – AEIC
   9. Occupational Safety and Health Administration – OSHA
  10. State and local codes and ordinances
  11. Applicable Independent Testing Associations Specifications
B. All inspections and tests shall utilize the following references:
   1. Project design specifications
   2. Project design drawings
   3. Manufacturer’s instruction manuals applicable to each particular apparatus.

1.04 QUALIFICATIONS OF TESTING COMPANY
A. The testing plan and procedures shall be reviewed and approved by one of the field engineering division’s registered professional electrical engineers. The registered
professional engineer shall be a full time employee of the engineering service testing group with at least 10 years of field experience testing electrical apparatus.

B. The engineering service testing group shall be an independent division of a major electrical equipment manufacturer.

C. The engineering service division site lead engineer or project manager shall be a degreed engineer, who is a full-time employee, with at least 10 years of experience testing electrical apparatus, and has obtained factory training. All other employees working on this project shall have had specific factory, and/or field training in accordance with division-wide standards.

D. To ensure compliance with quality control standards, the engineering service division shall conduct periodic audits of test procedures and test record forms to ensure compliance with industry standards. A Quality Assurance Manager, not reporting to the operation center completing the field testing services, must complete such audits. The name of the Quality Assurance Manager, or separate audit agency, shall be submitted for approval prior to award of any contract or completion of any fieldwork.

E. All test records shall be recorded onto standardized test forms. All data shall be uploaded to a central computer in a data-secured environment; therefore ensuring no changes can be incorporated into the final test records. These records shall be retrievable for a period of not less than five years, based on a mutually agreed periodic maintenance plan, separate from this contract.

F. Should repairs be required, the engineering service division shall maintain dedicated locations that perform remanufacturing and reconditioning of electrical equipment. All repairs shall be conducted under the direction of a quality control and reconditioning standard pursuant to ISO9001 compliance. A quality certificate, computer database and final test records shall document the progress of each piece of electrical equipment through the repair or reconditioning process. All work shall be performed in accordance with industry standards. Documentation of periodic audits, as specified in item D above, shall also be maintained for the dedicated remanufacturing and reconditioning facility.

G. The engineering service testing group shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

H. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

I. Instruments shall be calibrated in accordance with the following frequency schedule:
   1. Field instruments – six to twelve months
   2. Laboratory instruments – twelve months

J. Dated calibration labels shall be visible on all test equipment.

K. Records must be kept up to date, which show date and results of all instruments calibrated or tested.

L. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.
1.05 SUBMITTALS

A. The test report shall include the following:
   1. Summary of project
   2. Description of equipment tested
   3. Description of test
   4. Test results
   5. Conclusions and recommendations
   6. Appendix, including appropriate test forms
   7. List of test equipment used and calibration date
   8. Conditions for future access to secured computer database of all Test Data.

B. Furnish three copies of the completed report to the project engineer no later than 30 days after completion of the project, unless directed otherwise.

1.06 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
   3. Applicable state and local safety operating procedures.

B. All tests shall be performed with apparatus de-energized except where otherwise specified.

C. The engineering service testing group’s lead test engineer for the project shall be a designated safety representative and shall be present on the project and supervise testing operations and safety requirements.

D. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose in accordance with the appropriate test procedures.

E. In all cases, work shall not proceed until the safety representative has determined that it is safe to do so.

F. The engineering service testing group shall have available sufficient protective barriers and warning signs, where necessary, to conduct specified tests safely.

G. The owner’s safety procedures shall be reviewed and understood by the engineering service testing group personnel.

PART 2 PRODUCTS

2.01 EQUIPMENT EVALUATION PREPARATION

A. The electrical contractor shall torque down all accessible bolts; perform continuity checks on all branch and control wiring; and perform rotational tests for all motors prior to and in addition to tests performed by the engineering service testing group, specified herein.
Contractor shall remove metal shavings and thoroughly clean and vacuum equipment before testing or energizing.

B. The electrical contractor shall supply a suitable and stable source of test power for testing at each test site. The engineering service testing group shall specify requirements.

C. The electrical contractor shall notify the engineering service testing group when equipment becomes available for electrical tests. Work shall be coordinated to expedite project scheduling.

D. The customer designated project engineer or consultant will supply a complete set of as-built electrical plans, specifications and any pertinent change orders to the engineering service testing group prior to commencement of testing.

E. The engineering service testing group shall notify the project engineer prior to commencement of any testing.

F. The engineering service testing group shall be responsible for implementing all final settings and adjustments on protective devices and electrical equipment in accordance with the project engineer's specified values or a coordination study performed by the engineer of record or the testing group's licensed professional engineer.

G. Any system, material or workmanship which is found defective on the basis of electrical tests shall be reported directly to the project engineer.

H. The engineering service testing group shall maintain a written record of all tests and upon completion of the project, assemble and certify a final test report.

PART 3 EXECUTION

3.01 FIELD TESTING

A. The field engineering service testing group shall provide all material, equipment, labor and technical supervision to perform electrical equipment tests and inspections. The field engineering service division of the equipment manufacturer shall administer all acceptance and start-up testing, and power system studies, as referenced in other specification sections.

B. Equipment warranty shall be extended to two years from date of commissioning when service representatives employed by the equipment manufacturer perform startup.

C. The intent of these tests is to assure that all electrical equipment is operational within industry standards and manufacturer's tolerances and that equipment is installed and functioning in the system in the manner intended by the engineer.

D. Upon completion of the tests and inspections noted in these specifications, a label shall be attached to all serviced devices. These labels will indicate date serviced and the engineering service testing group responsible.

E. The tests and inspections shall determine suitability for initial continued reliable operation.
3.02 SWITCHBOARD ACCEPTANCE TESTING FOR MAIN SERVICE EQUIPMENT

A. Examine the Main switchboard(s), including breakers, and accessories for:
   1. Doors, panels, and sections for alignment, dents, scratches, fit, and missing hardware
   2. Shipped loose and shipped short components.
   3. Shipping damage
   4. Loose or obviously damaged components.
   5. Proper identification.
   6. Physical damage from installation.
   7. If the unit was placed in temporary storage, verify and record that proper procedures were observed. Remove temporary heater wiring and shipping braces.

B. Inspect
   1. Shipping Splits to insure that all bus connections were properly connected and all control wiring splits have been properly terminated.
   2. Inspect all grounding connections for cleanliness and alignment.
   3. Main Bonding Jumper for proper size and termination (Refer to NEC Article 250, Section 250-102, Equipment Bonding Jumpers).
   4. Insulators for evidence of physical damage or contaminated surfaces.
   5. Surge Arrester and/or Surge Suppression size, type, installation and connection to determine if they are in accordance with the drawings (Refer to NEC Article 280)
   6. Control power & instrument transformers, if applicable.
   7. Wiring for damaged insulation, broken leads, tightness of connections, proper crimping, and overall general condition.

C. Verify structure, grounding, cables and bus assembly:
   1. Anchorage (per local codes, wind and seismic considerations).
   2. Required area clearances, correct alignment and cleanliness.
   3. Verify the grounding electrode conductor is properly sized (in accordance with NEC Article 250, Table 250-66) and terminated.
   4. The proper grounding of instruments, panels and connections (Refer to NEC Article 250, Part J, Sections 250-170 through 250-178).
   5. Conductor identification (as applicable).
   6. Cable termination tightness.
   7. That all cables have been properly installed, routed and supported and are clear of energized parts.
   8. That conduits and conduit bushings are correctly installed.
   9. Tightness of accessible bolted electrical connections, especially shipping splits, by calibrated torque-wrench method in accordance with manufacturers published data.
D. Verify Control & Instrumentation:
   1. That all VT and CT ratios properly correspond to drawings and that polarity is correct.
   2. That shorting screws and bars are removed from CT’s and terminal blocks as required.
   3. That primary and secondary fuse ratings or circuit breakers match drawings.
   4. Meter scaling and type match drawings.

E. Set Meter, Relay, & Breaker Trip settings
   1. The meter, protective relay, breaker settings (& PFC choices) must be supplied from a Power System Study performed by a licensed professional engineer prior to commissioning.
   2. Set meter, relay, & breaker trip setting per above study.

F. Ductor testing
   1. Inspect shipping splits for mechanical connection assuring adequate surface contact.
   2. Ground bonding & shipping splits shall be tested with ductor tester (Digital low ohm resistance meter) to insure connection is a low resistance connection. Test from one fixed bus to adjacent fixed bus through the shipping split connector to measure both connection points.
   3. Microhm values shall not vary more than 50% from other phase readings and meet the manufactures published data based on bus size, ampcalities and material.

G. Test of the phase loss & undervoltage relay
   1. Test the phase loss relay, either separate or integral to the multimeter, to activate contact.
   2. Test the undervoltage relay, either separate or integral to the multimeter, to activate contact.
   3. If contact is hooked to the Capacitor trip & Shunt trip combo on main breaker, insure main breaker trips.
   4. If contact reports to energy management system, insure energy management system receives loss of phase/voltage signal.

H. Ground Fault Testing
   1. Inspect switchboard main bonding jumper for proper size and termination on source side of neutral disconnect link.
   2. Inspect Grounding electrode conductor to assure proper size and secure termination to ground bus.
   3. Inspect switchboard neutral bus downstream of the neutral disconnect link to verify the absence of ground connections.
   4. Set Ground fault setting per calculations in E above.
5. Verify Ground Fault System Performance for correct response of the circuit-interrupting device by secondary (or primary if local inspector requires) ground sensor current injection. Record ground fault pickup current. Verify breaker trips and indicator works.

6. Verify Ground fault does not pick-up at 90% of pickup setting.

7. Record settings, results, and any other notations on the Low Voltage Breaker data form.

3.03 CABLE TESTING

A. Insulation System – To insure integrity of the cable insulation system after shipping, site storage, and pulling through conduit an insulation resistance test will reveal insulation deformities and moisture in the cable that otherwise might cause an untimely premature cable failure possibly damaging equipment or personnel. Perform the following on all customer power cables to and from main switchboard. This would include cables from utility transformer to MSB and cables from MSB to all secondary switchboards or distribution panels.

B. Visually inspect visible portion of cables for observable defects.

C. Insure all solid-state devices are disconnected from the system prior to meggering. Typically but not all-inclusive would be Meters, trip units with voltage sensing, and TVSS units.

D. Isolate cables by opening breakers. Meggering thru equipment like motors or transformers will produce erroneous readings.

E. Perform insulation-resistance tests on each line and load cable, phase-to-phase, phase-to-ground, phase-to-neutral and neutral-to-ground in each conduit. Megger at 1000 Vdc for 600 volt cable and 500 Vdc for 300 volt cable for one minute.

F. Insulation resistance shall be above 100 ohms and preferably above one megohm.

G. Insure cable termination connections are tight after testing.

3.04 CAPACITOR BANK TESTING

A. Inspection.
   1. Visually inspect for obvious shipping damage.
   2. Verify all connections are tight.

B. Setup controller to step in all banks with thresholds.

C. Verify no harmonic interaction is occurring using a power quality meter recording harmonics to the 50th over a 24-hour period to insure IEEE 519 compliance.

D. Train district personnel on the operation of the controller.
   1. Training is to include review of original analysis, verification, review controller operation, safe practices with capacitors, fusing indicators (internal & external)

3.05 RESTORATION OF EQUIPMENT AND REPORTS
A. Before energizing:
   1. Remove and account for all test equipment, jumper wires, and tools used during testing.
   2. Remove and account for safety grounds and tools.
   3. Replace all barriers and covers, close all doors, and secure all latches.
   4. Remove safety locks and tags.
   5. Insure all adjustable meters, relays and trip devices are properly set in accordance with the coordination study.
   6. Apply testing label to equipment

B. Note corrective actions taken, deficiencies, recommendations and any general comments.

C. Finish recording data on test forms, completely filling in the blanks. Enter into electronic database as required in section 1.04.E

D. Turn in 3 copies of report to engineer for approval.

3.06 FOLLOW UP TESTING
A. Included in above cost as part of original project.
B. One month prior to the expiration of the factory warranty schedule & perform a thermal scan of all breaker to cable, breaker, bus connections, cable to panel chassis. Scope is to include main transformer connections, main switchboard, all secondary switchboards, transformers, and panels. Tests are to be done with building normal loaded for 2 hours, not in with partial or unloaded condition.

C. Thermal scans temperatures shall be evaluated as follows (based on comparable size or adjacent phases and loaded breakers, bus connections, and terminations)
   1. 1-3 degrees C rise, Investigate as to the cause of temp rise.
   2. 4 – 15 degree C rise, Repair as soon as possible.
   3. 16 or higher degree C rise, Repair immediately.

D. Insure that all bus and breaker to cable connections are tight.
E. Note corrective actions taken, deficiencies, recommendations and any general comments.
F. Finish recording data on test forms, completely filling in the blanks.
G. Turn in 3 copies of report to engineer for approval.