ELECTRICAL ACCEPTANCE TESTS

General

This guideline defines the standard tests that all electrical systems and equipment must pass prior to final acceptance by the University. These tests are in addition to acceptance tests specified by equipment manufacturers or defined in the other Design Guidelines sections. Obtain permission through the Design Manager before specifying tests less than or in excess of these tests.

Related Sections

Design Guidelines Technical Sections: All

U-M Master Specifications: All

References

NETA "Acceptance Testing Specifications"

NFPA 70, "National Electrical Code"

NFPA 72, "National Fire Alarm Code"

Scope of Work

Acceptance tests shall be performed and documented by an independent testing agency.

The Contractor shall provide all test equipment, materials and labor necessary to perform the tests, and coordinate with the other trades for necessary services, such as scaffolding and the uncoupling of motors.

Tests shall be performed in accordance with applicable codes, standards, and equipment manufacturers' instructions.

Tests shall consist of visual inspections, manual operations, and electrical testing under all normal and expected abnormal operating conditions.

The Owner shall be notified at least 3 working days in advance of all tests.

Tests shall be witnessed by the Owner unless such witnessing is waived in writing.

The Owner shall be provided with a written test report, signed and dated, for all tests.

Testing Criteria

Acceptance tests shall be performed in accordance with applicable codes, standards and manufacturers' instructions.

High potential tests shall be performed at a DC voltage equal to 80 percent of the factory DC test voltage. Do not perform more than one high potential test on any item without authorization from the Owner.

Dielectric absorption tests shall be performed with a 2,500 volt DC megger.

Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment.

Continuity checks shall be performed with a low voltage DC meter, light or bell.

The resistance to ground shall be measured using either the three point method or the fall-of-potential method.

Test instruments shall be calibrated to national standards to insure accuracy of tests. These calibration reports shall be made available to the Owner when requested. Depending upon frequency of use, the instruments shall be calibrated at least every 12-months.

Visual Inspections

Prior to manual operation and electrical testing, verify the following:

- The equipment complies with the contract documents and the shop drawing submittals.
- The equipment is completely and properly installed according to the contract documents and the manufacturer's instructions.
- Adequate working space exists around the equipment to fully open doors and access panels, and to access all components that require maintenance.
- The equipment is free from damage and defects.
- Shipping blocks and restraints have been removed.
- The equipment has been aligned.
- The equipment has been lubricated.
- The ventilation louvers are open and unobstructed.
- Electrical connections have been tightened.
- Voltages, phases, and rotation have been identified.
- Terminations have been identified.
- Equipment labels have been installed.
- The equipment has been calibrated.
- The equipment is ready to be electrically tested.

Manual Operations

Prior to electrical testing, verify the following:

- Mechanical components operate smoothly and freely.
- Mechanical stops, limit switches, etc., are properly adjusted.

Electrical Acceptance Tests

Duct Banks

A stiff bristled brush shall be pulled through each duct to clean out dirt and debris.

A solid mandrel rated for the inside diameter of the ducts and at least 5 inches long shall be pulled through each duct to verify the absence of kinks, flat spots, and other obstructions..

Medium Voltage Primary Cables

A continuity test, a 2,500 volt DC megger test, an AC high potential test, and a second 2,500 volt DC megger test shall be performed on 15 kV primary cables after the cables have been spliced or terminated. The high potential test shall be performed at 45kV for new cable installations and at 30kV when new cable has been spliced to existing cable.

600 Volt Power Cables

A continuity check and a 1,000 volt DC megger test shall be performed on 600 volt power cables No. 4 AWG and larger. The megger test shall be performed between each pair of conductors and from each conductor to ground. Each test shall be performed for 15 seconds or until the insulation resistance value stabilizes.

The insulation resistance between conductors, and from each conductor to ground, shall be 100 megohms minimum in one minute or less. In addition, the lowest insulation resistance value shall not differ from the highest value by more than 20 percent. If all megger readings for a given circuit or feeder are above 1000-meghoms, the 20% balance requirement may be waived.

Control Cables

A continuity check shall be performed on control and instrumentation wiring.

Substation Primary Switches

A continuity check, a 2,500 volt DC megger test, and a 21kV AC high potential test shall be performed on primary switches.

Substation Transformers

A DC megger test and a turns ratio test shall be performed on unit substation transformers. The DC megger test shall be performed at 2,500 volts on coils rated over 600 volts, and at 1,000 volts on coils rated 600 volts and below. A turns ratio test shall be performed on each tap.

Verify proper setting and operation of the fan control panel to insure it and the fans are operable and functional. Temperature-test the probes in each winding.

Substation Secondary Switchgear

A continuity check and a 1,000 volt DC megger test shall be performed on the buses and on the main, tie, and feeder breakers.

A ducter (contact resistance) test shall be performed on main, tie, and feeder breakers in unit-substations. Maximum readings shall not exceed manufacturer limits.

The overcurrent devices of substation breakers with electronic trip units shall be tested using the primary current injection method. Secondary current injection shall not be used.

Molded case circuit breakers with thermal/magnet trips shall not be primary current injection tested.

A 1,000 volt DC megger test and a turns ratio test shall be performed on CT's and PT's.

The metering shall be calibrated.

Engine-Generators and Automatic Transfer Switches

A continuity check and 1,000 volt DC megger test shall be performed on the generator windings, generator circuit breaker, power circuit portions of the automatic transfer switches, and the interconnecting power circuit wiring.

A continuity check shall be performed on the control wiring.

The metering and time delay relays shall be calibrated and tested.

The manufacturer’s recommended normal start-up testing shall be performed.

A load bank test shall be performed on the generator with a load bank rated at 100% of full generator output for a period of at least 120 minutes.

If the engine is natural gas fueled and Compliant Capable rather than Certified as defined in EPA 2009 NSPS emissions standards, an EPA Initial Performance Test shall be performed. This test shall consist of three separate 1 hour runs at close to full load. It shall be performed in accordance with EPA test requirements, and the measured emissions shall be within EPA limits.

Normal power shall be shut off to each automatic transfer switch, one at a time. Each time the engine-generator shall start and the automatic transfer switches shall function according to the design intent.

Normal power shall be returned to the automatic transfer switches. The automatic transfer switches shall return to normal power and the engine-generator shall shut down according to the design intent.

The generator shall be tested for voltage and frequency stability. The automatic transfer switches shall be used to apply load to the generator according to the worst case step loading sequence defined in the generator specification. The generator voltage and frequency shall remain within the values listed in the generator specification.

The ATS maintenance bypass switches shall be inspected for proper labeling and tested for proper operation in all modes.

The generator and automatic transfer switch controls, gauges, status indicators, and alarms, including remote annunciators and devices in the Fire Command Center, shall be tested for proper operation..

Alarm outputs to the fire alarm and BAS systems shall be verified.

Transformers, Reactors, Switchboards, Panelboards, and Motor Control Equipment

A continuity check and a 1,000 volt DC megger test shall be performed on 1 and 3 phase distribution and isolation transformers, and on line reactors.

A 1,000 volt DC megger test shall be performed on buses, motor starters, circuit breakers, and disconnect switches. This test may be combined with the power cable megger test by testing the devices and terminated cables together.

A continuity check shall be performed on motor control circuits and control panel internal wiring.

An operational test shall be performed on the motor controls.

Motor heater sizes shall be checked for proper size.

Motors

A 1,000 volt megger test shall be performed on 460 volt, 3 phase motors. A 500 volt megger test shall be performed on 200 volt, 1 and 3 phase motors and on 120 volt, 1 phase motors.

Motors shall be “bumped” to verify proper direction of rotation.

Motors shall be run to verify proper ampere draw and the absence of vibration or overheating.

The Electrical Contractor shall assist the Temperature Control Contractor and the Mechanical Contractor and insure proper operation of safeties, interlocks and motor controls.

Capacitors

Capacitors shall be inspected for proper fuses before testing. A 1,000 volt DC megger test shall be performed on 460 volt, 3 phase capacitors, and a 500 volt megger test shall be performed on 200/240 volt, 3 phase capacitors. After each megger test, proper discharge shall be checked.

Grounding

The resistance to ground of each ground rod in a ground mat shall be measured before connection to the other ground rods. The resistance shall not exceed 10 ohms. If the reading exceeds 10 ohms, add one extension and drive it another 10 feet. Further testing of that rod is not needed.

The resistance to ground of the total ground system shall be measured with all connections completed. The resistance shall not exceed 2 ohms for switching stations, or utility (DTE) feed point services; or exceed 5 ohms for building service substations.

Ground rods for manholes and light poles need not be tested.

A continuity check shall be performed from equipment ground bus bars and ground lugs to the ground system.

Lighting Fixtures

Lighting fixtures shall be checked for proper assembly, proper louvers or lenses, proper lamps, proper ballasts, straight row alignment, proper aiming, and the absence of light leaks.

Battery-backed emergency lighting fixtures shall be checked for continuous operation for a minimum of 90 minutes.

Lighting Circuits

Lighting circuits shall be checked for proper switching, for proper circuiting according to the design documents, and for circuiting that matches the lighting panel schedule.

Lighting Controls and Dimming Systems

Lighting controls and dimming systems shall be tested to verify that they have the specified features and programmability, and that all controls are properly labeled.

Lighting controls and dimming systems shall be tested to verify that the control sequences noted in the contract documents and manufacturer's instructions are present and operable, that control and dimming are smooth and free of flicker, and that fading is properly timed.

Lighting controls and dimming systems shall be tested to verify that the emergency lights function upon a loss of normal power.

Fire Alarm Systems

Fire alarm systems shall be tested in accordance with NFPA 72.

Controls that interface with the fire alarm system shall be tested in cooperation with the Temperature Controls Contractor to insure proper operation of interfaced mechanical devices.

Alarm, supervisory, and trouble outputs to the MOSCAD and BAS systems shall be tested to insure that the signals are received by Public Safety or at Plant Operations.

Special Systems

Security systems, card access control systems, sound reinforcement systems, and other special systems shall be tested in accordance with test plans submitted by their manufacturers and approved by the Owner. These test plans shall verify compliance with specifications and proper operation including all inputs, outputs, alarms, and accessories under all modes of operation.

Heat Tracing Cables and Mats

A continuity check, a 500 volt DC megger test, and an operational test shall be performed on heat tracing circuits prior to insulation of the pipe or tank. Verify proper current draw and heating of the heat tracing.

The 500 volt DC megger test shall be repeated after the insulation is completely installed.

An operational test shall be performed on the controls and alarms.