

# **Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems**



**These specifications have been developed  
by the  
InterNational Electrical Testing Association**

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- 4. Division of Responsibility
  - 4.1 The Owner's Representative
  - 4.2 The Testing Organization
- 5. General
  - 5.1 Safety and Precaution
  - 5.2 Suitability of Test Equipment
  - 5.3 Test Instrument Calibration
  - 5.4 Test Report

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## PREFACE

It is recognized by the Association that the needs for acceptance testing of commercial, industrial, governmental, and other electrical power systems vary widely. Many criteria are used in determining what equipment is to be tested and to what extent.

To help the user better understand and navigate more efficiently through this document, we offer the following information:

### The Document Structure

The document is divided into twelve separate and defined sections:

| Section    | Description  |
|------------|--|
| Section 1  | General Scope  |
| Section 2  | Applicable References                                |
| Section 3  | Qualifications of Testing Organization and Personnel |
| Section 4  | Division of Responsibility                           |
| Section 5  | General  |
| Section 6  | Power System Studies                                 |
| Section 7  | Inspection and Test Procedures                       |
| Section 8  | System Function Test                                 |
| Section 9  | Thermographic Survey                                 |
| Section 10 | Electromagnetic Field Testing                        |
| Tables     | Reference Tables                                     |
| Appendices | Various Informational Documents                      |

### Section 7 Structure

Section 7 is the main body of the document with specific information on what to do relative to the inspection and acceptance testing of electrical power distribution equipment and systems. It is not intended that this document list how to test specific pieces of equipment or systems.

### Expected Test Results

Section 7 consists of sections specific to each particular type of equipment. Within those sections there are, typically, three main bodies of information:

1. Visual and Mechanical Inspection
2. Electrical Tests
3. Test Values



## PREFACE (Continued)

### Results of Visual and Mechanical Inspections

Some, but not all, visual and mechanical inspections have an associated test value or result. Those items with an expected result are referenced under Section 3.1 Test Values – Visual and Mechanical. For example, Section 7.1 Switchgear and Switchboard Assemblies, item 7.1.1.7.2 calls for verifying tightness of connections using a calibrated torque wrench method. Under the Test Values – Visual and Mechanical Section 7.1.3. 1.2, the expected results for that particular task are listed within Section 3.1, with reference back to the original task description on item 7.1.1.7.2.

#### 7. INSPECTION AND TEST PROCEDURES

##### 7.1 Switchgear and Switchboard Assemblies

###### 1. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, grounding, and required area clearances.
4. Verify the unit is clean.
5. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
6. Verify that current and voltage transformer ratios correspond to drawings.
7. Inspect bolted electrical connections for high resistance using one of the following methods:
  1. Use of a low-resistance ohmmeter in accordance with Section 7.1.2.
  2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12.
  3. Perform thermographic survey in accordance with Section 9.
8. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
  1. Attempt closure on locked-open devices. Attempt to open locked-closed devices.
  2. Make key exchange with devices operated in off-normal positions.
9. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
10. Inspect insulators for evidence of physical damage or contaminated surfaces.
11. Verify correct barrier and shutter installation and operation.
12. Exercise all active components.
13. Inspect mechanical indicating devices for correct operation.
14. Verify that filters are in place and vents are clear.
15. Perform visual and mechanical inspection of instrument transformers in accordance with Section 7.10.

#### 7. INSPECTION AND TEST PROCEDURES

##### 7.1 Switchgear and Switchboard Assemblies (continued)

4. Verify correct function of control transfer relays located in the switchgear with multiple control power sources.
9. Voltage Transformers
  1. Perform secondary wiring integrity test. Verify correct potential at all devices.
  2. Verify secondary voltages by energizing the primary winding with system voltage.
10. Perform current-injection tests on the entire current circuit in each section of switchgear.
  1. Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 ampere flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
  - \*2. Perform current tests by primary injection with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
11. Perform system function tests in accordance with Section 8.
12. Verify operation of cubicle switchgear/switchboard space heaters.
13. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.
3. Test Values
- 3.1 Test Values – Visual and Mechanical
  1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. (7.1.1.7.1)
  2. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.12. (7.1.1.7.2)
  3. Results of the thermographic survey shall be in accordance with Section 9. (7.1.1.7.3)
- 3.2 Test Values – Electrical





## PREFACE (Continued)

### Results of Electrical Tests

Each electrical test has a corresponding expected result, and the test and the result have identical numbers. If the electrical test is item four, the expected result under the Test Values section is also item four. For example, under Section 7.15.1 Rotating Machinery, AC Induction Motors and Generators, item 7.15.1.2.2 (item 2 within the Electrical Tests section) calls for performing an insulation-resistance test in accordance with IEEE Standard 43. Under the Test Values – Electrical section, the expected results for that particular task are listed in the Test Values section under item 2.

#### 7. INSPECTION AND TEST PROCEDURES

##### 7.15.1 Rotating Machinery, AC Induction Motors and Generators

###### 1. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.
5. Inspect bolted electrical connections for high resistance using one of the following methods:
  1. Use of low-resistance ohmmeter in accordance with Section 7.15.1.2.
  2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.12.
  3. Perform thermographic survey in accordance with Section 9.
6. Perform special tests such as air-gap spacing and machine alignment, if applicable.
7. Verify the application of appropriate lubrication and lubrication systems.
8. Verify that resistance temperature detector (RTD) circuits conform to drawings.

###### 2. Electrical Tests – AC Induction

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, in accordance with Section 7.15.1.1.
2. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
  1. Machines larger than 200 horsepower (150 kilowatts):  
Test duration shall be ten minutes. Calculate polarization index.
  2. Machines 200 horsepower (150 kilowatts) and less:  
Test duration shall be one minute. Calculate dielectric-absorption ratio.
3. Perform dc dielectric withstand voltage tests on machines rated at 2300 volts and greater in accordance with ANSI/IEEE Standard 95.
4. Perform phase-to-phase stator resistance test on machines 2300 volts and greater.
- \*5. Perform insulation power-factor or dissipation-factor tests.

#### 7. INSPECTION AND TEST PROCEDURES

##### 7.15.1 Rotating Machinery, AC Induction Motors and Generators (continued)

5. Air-gap spacing and machine alignment shall be in accordance with manufacturer's published data. (7.15.1.1.6).

###### 3.2 Test Values – Electrical Tests

1. Compare bolted connection resistance values to values of similar connections. Investigate any values that deviate from similar bolted connections by more than 50 percent of the lowest value.
2. The dielectric absorption ratio or polarization index shall not be less than 1.0. The recommended minimum insulation resistance ( $IR_{1min}$ ) test results in megohms shall be corrected to 40° C and read as follows:
  1.  $IR_{1min} = kV + 1$  for most windings made before 1970, all field windings, and others not described in 2.2 and 2.3.  
(kV is the rated machine terminal-to-terminal voltage in rms kV)
  2.  $IR_{1min} = 100$  megohms for most dc armature and ac windings built after 1970 (form-wound coils).
  3.  $IR_{1min} = 5$  megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kV.

NOTE: Dielectric withstand voltage and surge comparison tests shall not be performed on machines having values lower than those indicated above.
3. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
4. Investigate phase-to-phase stator resistance values that deviate by more than 10 percent.
5. Power-factor or dissipation-factor values shall be compared to manufacturer's published data. In the absence of manufacturer's published data these values will be compared with previous values of similar machines.
6. Tip-up values shall indicate no significant increase in power factor.
7. If no evidence of distress, insulation failure, or lack of waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.
8. Bearing insulation-resistance measurements shall be within manufacturer's published tolerances. In the absence of manufacturer's published tolerances, the comparison shall be made to similar machines.

\* Optional



## **PREFACE (*Continued*)**

### **Optional Tests**

The purpose of these specifications is to assure that all tested electrical equipment and systems supplied by either contractor or owner are operational and within applicable standards and manufacturer's published tolerances and that equipment and systems are installed in accordance with design specifications.

Certain tests are assigned an optional classification. The following considerations are used in determining the use of the optional classification:

1. Does another listed test provide similar information?
2. How does the cost of the test compare to the cost of other tests providing similar information?
3. How commonplace is the test procedure? Is it new technology?

### **Manufacturer's Instruction Manuals**

It is important to follow the recommendations contained in the manufacturer's published data. Many of the details of a complete and effective testing procedure can be obtained from this source.

### **Summary**

The guidance of an experienced testing professional should be sought when making decisions concerning the extent of testing. It is necessary to make an informed judgment for each particular system regarding how extensive a procedure is justified. The approach taken in these specifications is to present a comprehensive series of tests applicable to most industrial and larger commercial systems. In smaller systems, some of the tests can be deleted. In other cases, a number of the tests indicated as optional should be performed.

Likewise, guidance of an experienced testing professional should also be sought when making decisions concerning the results of test data and their significance to the overall analysis of the device or system under test. Careful consideration of all aspects of test data, including manufacturer's published data and recommendations, must be included in the overall assessment of the device or system under test.

The Association encourages comment from users of this document. Please contact the NETA office or your local NETA Accredited Company.

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## **1. GENERAL SCOPE**

1. These specifications cover the suggested field tests and inspections that are available to assess the suitability for initial energization of electrical power distribution equipment and systems.
2. The purpose of these specifications is to assure that tested electrical equipment and systems are operational and within applicable standards and manufacturer's tolerances and that the equipment and systems are installed in accordance with design specifications.
3. The work specified in these specifications may involve hazardous voltages, materials, operations, and equipment. These specifications do not purport to address all of the safety issues associated with their use. It is the responsibility of the user to review all applicable regulatory limitations prior to the use of these specifications

