ANSI/NETA MTS-2007

AMERICAN NATIONAL STANDARD

STANDARD FOR MAINTENANCE TESTING SPECIFICATIONS

for Electrical Power Distribution Equipment and Systems

Secretariat
InterNational Electrical Testing Association

Approved by
American National Standards Institute

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InterNational Electrical Testing Association
2700 W. Centre Ave., Suite A
Portage, MI 49024
269.488.6382 · FAX 269.488.6383
www.netaworld.org
neta@netaworld.org
Jayne Tanz - Executive Director

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   - 3.2 Testing Personnel
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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InterNational Electrical Testing Association
2700 W. Centre Avenue, Suite A
Portage, MI 49024
Voice: 888.300.6382 Facsimile: 269.488.6383
E-mail: neta@netaworld.org • Web: www.netaworld.org

Standards Review Council

The following persons were members of the NETA Standards Review Council which approved this document.

Charles K. Blizard, Sr.
Timothy J. Cotter
Diane W. Hageman
Roderic L. Hageman
Ralph Patterson
Alan D. Peterson
Jayne Tanz
Ron Widup

Maintenance Testing Specifications Section Panel Members

The following persons were members of the Section Panel which balloted on this document for submission to the NETA Standards Review Council.

Skip Adkins
Mark Baldwin
Ken Bassett
Tom Bishop
Alan Bump
John Cadick
Keith Campbell
Dick Dickens
Rick Eynon
Scott Falke
David Geary
Don Genutis
Dave Haines
Paul Hartman
Gary Hartshorn
Matt Harwich
Kerry Heid
Patrick Herbert
Dave Huffman
Stuart Jackson
Jim Jordan
Kevin Keelan
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Andrew Kobler
Mark Lautenschlager
Andrew Leoni
Dick Lussier
Raymundo Marquez
Larry Miller
Joe Nims
Roy Nordyke
Pedro Nunz
Jerry Parnell
Darwin Pressley
Mose Ramieh
Kevin Rettich
Mark Rivard
Randall Sagan
Peter Sammy
Richard Sobhraj
Larry Stovall
Tim Thomas
Rod Tower
Wally Vahlstrom
Chris Werstiuk
John White
J.P. Wolff
Jaime Ybarra

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The following persons were voting members of the InterNational Electrical Testing Association when this document was approved.

Advanced Testing Systems	Patrick MacCarthy
American Electrical Testing Co.	Charles Blizard
Apparatus Testing and Engineering	James Lawler
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Burlington Electrical Testing Company, Inc.	Walter Cleary
DYMAX Service, Inc.	Gene Philipp
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Electrical Engineering Consulting & Testing	Barry W. Tyndall
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Magna Electric Corporation	Kerry Heid
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InterNational Electrical Testing Association
2700 W. Centre Avenue, Suite A • Portage, MI 49024
Voice: 888.300.6382 Facsimile: 269.488.6383
Email: neta@netaworld.org • Web: www.netaworld.org
Jayne Tanz, CMP - Executive Director

FOREWORD

(This Foreword is not part of American National Standard ANSI/NETA MTS-2007)

The InterNational Electrical Testing Association (NETA) was formed in 1972 to establish uniform testing procedures for electrical equipment and apparatus. NETA developed specifications for the acceptance of new electrical apparatus prior to energization and for the maintenance of existing apparatus to determine its suitability to remain in service. The first NETA *Acceptance Testing Specifications for Electrical Power Equipment and Systems* was produced in 1972. Upon completion of this project, the NETA Technical Committee began work on a maintenance document, and *Maintenance Testing Specifications for Electrical Power Equipment and Systems* was published in 1975.

Since 1975, several revisions of the *Maintenance Specifications* have been published; in 1989 the NETA Technical Committee, with approval of the Board of Directors, set a four-year review and revision schedule. Unless it involves a significant safety or urgent technical issue, each comment and suggestion for change is held until the appropriate review period. Each edition includes new and completely revised sections. The document uses the standard numbering system of ANSI and IEEE. Since 1989, revised editions of the *Maintenance Testing Specifications* have been published in 1993, 1997, 2001, and 2005.

The *NETA Maintenance Testing Specifications* was developed for use by those responsible for the continued operation of existing electrical systems and equipment to guide them in specifying and performing the necessary tests to ensure that these systems and apparatus perform satisfactorily, minimizing downtime and maximizing life expectancy. This document aids in ensuring safe, reliable operation of existing electrical power systems and equipment. Maintenance testing can identify potential problem areas before they become major problems requiring expensive and time-consuming solutions.

In the early 1990's, NETA's Board of Directors approved the concept of issuing a maintenance testing standard for each of the major components identified in Section 7 of the *Maintenance Testing Specifications* with the goal of each one becoming an ANSI Standard. In 2001 the NETA Board of Directors revised their decision to standardize each subsection of Section 7 of the *Maintenance Testing Specifications* and decided instead to put the document forth in its entirety as a candidate for recognition as an American National Standard.

NETA applied for accreditation as a Standards Developer for the American National Standards Institute and was approved as an organizational member in 1996. NETA's scope of standards activity is different from that of the IEEE, NECA, NEMA, and UL. In matters of testing electrical equipment and systems NETA continues to reference other standards developers' documents where applicable.

NETA's review and updating of presently published specifications takes into account both national and international standards. The use of our document is not restricted to the United States but is also used internationally. NETA firmly endorses a global standardization. IEC standards as well as American consensus standards are taken into consideration by NETA's Section Panels and reviewing committees.

Suggestions for improvement of this standard are welcome. They should be sent to the InterNational Electrical Testing Association, 2700 W. Centre Ave., Suite A, Portage, MI 49024.

PREFACE

It is recognized by the Association that the needs for maintenance 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

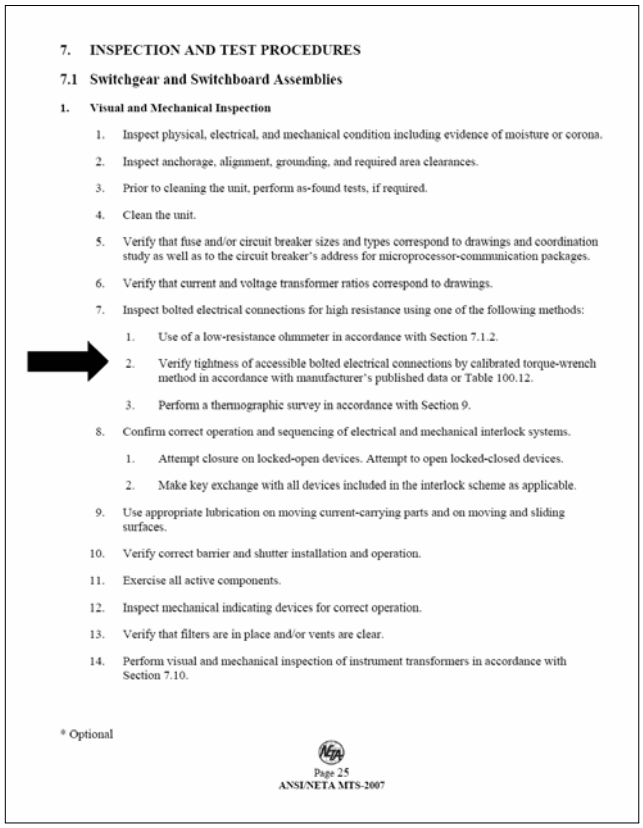
Section 7 Structure
Section 7 is the main body of the document with specific information on what to do relative to the inspection and maintenance testing of electrical power distribution equipment and systems. It is not intended that this document explain how to test specific pieces of equipment or systems.

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

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. Inspect physical, electrical, and mechanical condition including evidence of moisture or corona.
2. Inspect anchorage, alignment, grounding, and required area clearances.
3. Prior to cleaning the unit, perform as-found tests, if required.
4. Clean the unit.
5. Verify that fuse and/or 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 a 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 all devices included in the interlock scheme as applicable.
9. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
10. Verify correct barrier and shutter installation and operation.
11. Exercise all active components.
12. Inspect mechanical indicating devices for correct operation.
13. Verify that filters are in place and/or vents are clear.
14. Perform visual and mechanical inspection of instrument transformers in accordance with Section 7.10.

* Optional

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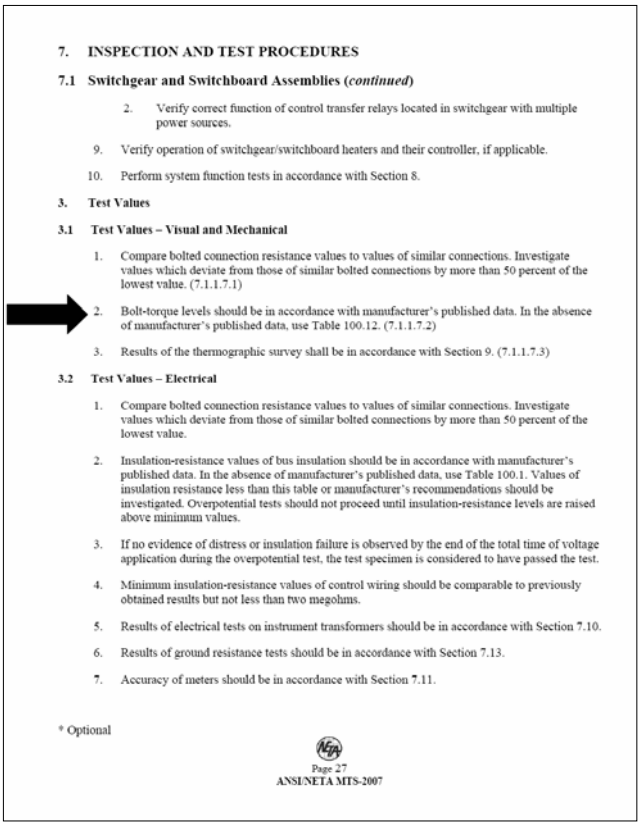

7. INSPECTION AND TEST PROCEDURES

7.1 Switchgear and Switchboard Assemblies (*continued*)

2. Verify correct function of control transfer relays located in switchgear with multiple power sources.
9. Verify operation of switchgear/switchboard heaters and their controller, if applicable.
10. Perform system function tests in accordance with Section 8.

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 should 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

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.
2. Insulation-resistance values of bus insulation should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. Overpotential tests should not proceed until insulation-resistance levels are raised above minimum values.
3. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the overpotential test, the test specimen is considered to have passed the test.
4. Minimum insulation-resistance values of control wiring should be comparable to previously obtained results but not less than two megohms.
5. Results of electrical tests on instrument transformers should be in accordance with Section 7.10.
6. Results of ground resistance tests should be in accordance with Section 7.13.
7. Accuracy of meters should be in accordance with Section 7.11.

* Optional

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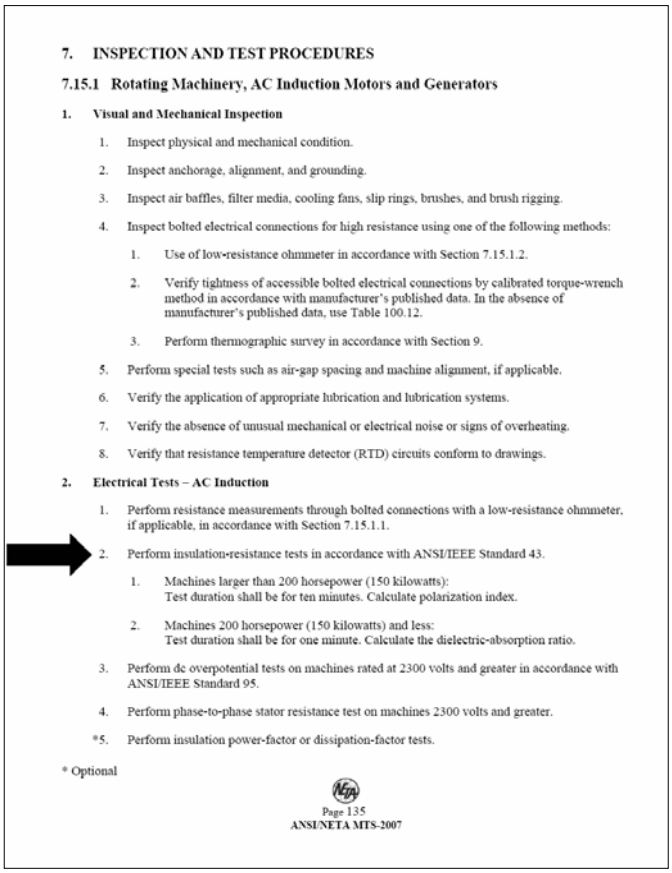
Results of Electrical Tests

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. Inspect physical and mechanical condition.
   2. Inspect anchorage, alignment, and grounding.
   3. Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.
   4. 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.
   5. Perform special tests such as air-gap spacing and machine alignment, if applicable.
   6. Verify the application of appropriate lubrication and lubrication systems.
   7. Verify the absence of unusual mechanical or electrical noise or signs of overheating.
   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 for ten minutes. Calculate polarization index.
      2. Machines 200 horsepower (150 kilowatts) and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
   3. Perform dc overpotential 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.

* Optional

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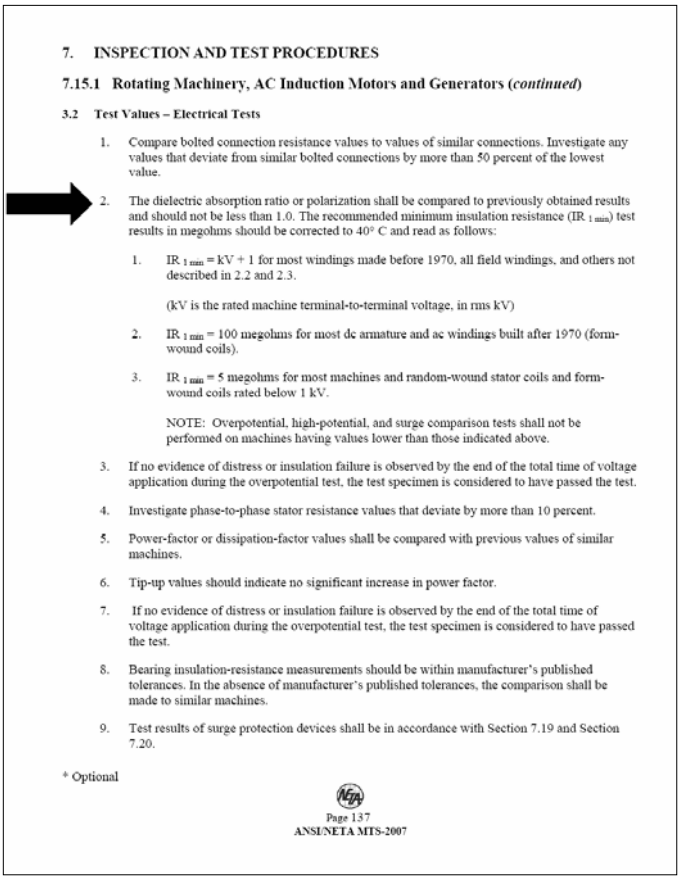

7. INSPECTION AND TEST PROCEDURES

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

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 shall be compared to previously obtained results and should not be less than 1.0. The recommended minimum insulation resistance ($IR_{1\ min}$) test results in megohms should be corrected to 40° C and read as follows:
      1. $IR_{1\ min}$ = 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. $IR_{1\ min}$ = 100 megohms for most dc armature and ac windings built after 1970 (form-wound coils).
      3. $IR_{1\ min}$ = 5 megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kV.

         NOTE: Overpotential, high-potential, 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 overpotential 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 with previous values of similar machines.
   6. Tip-up values should indicate no significant increase in power factor.
   7. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the overpotential test, the test specimen is considered to have passed the test.
   8. Bearing insulation-resistance measurements should be within manufacturer's published tolerances. In the absence of manufacturer's published tolerances, the comparison shall be made to similar machines.
   9. Test results of surge protection devices shall be in accordance with Section 7.19 and Section 7.20.

* Optional

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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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Charles K. Blizard, Sr.
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CONTENTS (*continued*)

TABLES

APPENDICES

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1. GENERAL SCOPE

1.1 Maintenance Testing Specifications

1. These specifications cover the suggested field tests and inspections that are available to assess the suitability for continued service and reliability 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 suitable for continued service.

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 problems associated with their use. It is the responsibility of the user to review all applicable regulatory limitations prior to the use of these specifications.