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3. Qualifications
4. Division of Responsibility
5. General

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This document should not be confused with federal, state, or municipal specifications or regulations, insurance requirements, or national safety codes. While the Association recommends reference to or use of this document by government agencies and others, use of this document is purely voluntary and not binding.
FOREWORD

(The Foreword is not part of American National Standard ANSI/NETA MTS-2015)

The InterNational Electrical Testing Association (NETA) was formed in 1972 to establish uniform testing procedures for electrical equipment and apparatus. NETA has been an Accredited Standards Developer for the American National Standards Institute since 1996. NETA’s scope of standards activity is different from that of 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 standards takes into account both national and international standards. NETA’s standards may be used internationally as well as in the United States. NETA firmly endorses a global standardization. IEC standards as well as American consensus standards are taken into consideration by NETA’s ballot pools and reviewing committees.


In 2005, this document was approved for the first time as an American National Standard. It was published as a revised American National Standard in 2011. The 2015 Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems is the most current revision of this document, and was approved as a revised American National Standard on December 3, 2014.

The ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems 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.
PREFACE

(This Preface is not part of American National Standard ANSI/NETA MTS-2015)

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:

Notation of Changes
Material included in this edition of the document but not part of the previous edition is marked with a black vertical line to the left of the insertion of text, deletion of text, or alteration of text.

Document Structure
The document is divided into thirteen separate and defined sections:

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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 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, four main bodies of information:

A. Visual and Mechanical Inspection
B. Electrical Tests
C. Test Values – Visual and Mechanical
D. Test Values – Electrical
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 C. Test Values – Visual and Mechanical. For example, Section 7.1 Switchgear and Switchboard Assemblies, item 7.1.A.7.2 calls for verifying tightness of connections using a calibrated torque wrench method. Under the Test Values – Visual and Mechanical Section 7.1.C.2, the expected results for that particular task are listed within Section C, with reference back to the original task description on item 7.1.A.7.2.

7. INSPECTION AND TEST PROCEDURES

7.1 Switchgear and Switchboard Assemblies

A. Visual and Mechanical Inspection

1. Inspect physical, electrical, and mechanical condition including evidence of moisture or corrosion.
2. Inspect mechanical alignment, grounding, and required area clearances.
3. Prior to cleaning the unit, perform as-found tests, if required.
4. Close 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 or more of the following methods:
   1. Use of a low-resistance ohmmeter in accordance with Section 7.1.B.1.
   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: 
   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 current barrier and shunt installation and operation.
11. Examine all voltmeter 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

7. INSPECTION AND TEST PROCEDURES (continued)

7.1 Switchgear and Switchboard Assemblies

2. Verify correct function of control transfer relays located in switchgear with multiple power sources.
10. Perform system function tests in accordance with Section 8.

C. 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.A.7.3)
2. Bolt torque levels should be in accordance with manufacturer’s published data. In the absence of manufacturer’s published data, see Table 100:12. (7.1.A.7.2)
3. Results of the thermographic survey shall be in accordance with Section 9. (7.1.A.7.1)

D. 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, see Table 100.1. Values of insulation-resistance less than these values are considered to have failed the test.
3.  If no evidence of distress or insulation failure is observed by observation of the test, the test dielectric withstand voltage 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 times minimums.
5. Results of electrical tests on instrument transformers should be in accordance with Section 6.
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
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.B.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.
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?

If/When Applicable

The phrases "if applicable", "when applicable", and any variation thereof do not occur in this standard. This standard assumes that if devices or pieces of equipment are not present, they will not be subject to testing or verification.

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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ANSI/NETA MTS-2015
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, are within applicable standards and manufacturer’s tolerances, and 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.
2. APPLICABLE REFERENCES

2.1 Codes, Standards, and Specifications

All inspections and field tests shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein.

1. American National Standards Institute – ANSI

2. ASTM International – ASTM

   - ASTM D 92  
     Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

   - ASTM D 445 
     Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)

   - ASTM D 664 
     Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration

   - ASTM D 877 
     Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids using Disk Electrodes

   - ASTM D 923 
     Standard Practices for Sampling Electrical Insulating Liquids

   - ASTM D 924 
     Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids

   - ASTM D 971 
     Standard Test Method for Interfacial Tension of Oil against Water by the Ring Method

   - ASTM D 974 
     Standard Test Method for Acid and Base Number by Color-Indicator Titration

   - ASTM D 1298 
     Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

   - ASTM D 1500 

   - ASTM D 1524 
     Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field
2. APPLICABLE REFERENCES

2.1 Codes, Standards, and Specifications (continued)

ASTM D 1533  Standard Test Methods for Water in Insulating Liquids by Coulometric Karl Fischer Titration


ASTM D 2029  Standard Test Methods for Water Vapor Content of Electrical Insulating Gases by Measurement of Dew Point

ASTM D 2129  Standard Test Method for Color of Clear Electrical Insulating Liquids (Platinum-Cobalt Scale)

ASTM D 2284  Standard Test Method of Acidity of Sulfur Hexafluoride

ASTM D 2285  Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin against Water by the Drop-Weight Method

ASTM D 2477  Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Insulating Gases at Commercial Power Frequencies


ASTM D 2759  Standard Practice for Sampling Gas from a Transformer under Positive Pressure


ASTM D 3612  Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography

ASTM D 3613  Standard Practice for Sampling Electrical Insulating Oils for Gas Analysis and Determination of Water Content

3. Association of Edison Illuminating Companies – AEIC

4. Canadian Standards Association – CSA
2. APPLICABLE REFERENCES

2.1 Codes, Standards, and Specifications (continued)

5. Electrical Apparatus Service Association – EASA
   ANSI/EASA AR100  Recommended Practice for the Repair of Rotating Electrical Apparatus

6. Institute of Electrical and Electronic Engineers – IEEE
   ANSI/IEEE C37  Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses
   ANSI/IEEE C57  Distribution, Power, and Regulating Transformers
   ANSI/IEEE C62  Surge Protection
   ANSI/IEEE 43  IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery
   ANSI/IEEE 48  IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
   ANSI/IEEE 81.2  IEEE Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
   ANSI/IEEE 95  IEEE Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage
   IEEE 100  The Authoritative Dictionary of IEEE Standards Terms
   IEEE 141  IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants (Red Book)
   ANSI/IEEE 142  IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book)
   ANSI/IEEE 241  IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
   ANSI/IEEE 242  IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book)
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<td>ANSI/IEEE 399</td>
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<td>IEEE Standard for High-Potential-Test Requirements for Excitation Systems for Synchronous Machines</td>
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<td>IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book)</td>
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<td>IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications</td>
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<tr>
<td>ANSI/IEEE 493</td>
<td>IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)</td>
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<td>ANSI/IEEE 519</td>
<td>IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems</td>
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<td>ANSI/IEEE 602</td>
<td>IEEE Recommended Practice for Electric Systems in Health Care Facilities (White Book)</td>
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<td>IEEE 1100</td>
<td>IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book)</td>
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<tr>
<td>ANSI/IEEE 1106</td>
<td>IEEE Recommended Practice for Maintenance, Testing, and Replacement of Nickel-Cadmium Batteries for Stationary Applications</td>
</tr>
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</table>
2. APPLICABLE REFERENCES

2.1 Codes, Standards, and Specifications (continued)

ANSI/IEEE 1159  \textit{IEEE Recommended Practice on Monitoring Electrical Power Quality}

ANSI/IEEE 1188  \textit{IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications}

IEEE 1584  \textit{IEEE Guide for Performing Arc-Flash Hazard Calculations}

IEEE 1584a  \textit{IEEE Guide for Performing Arc-Flash Hazard Calculations – Amendment 1}

7. Insulated Cable Engineers Association – ICEA

ANSI/ICEA S-93-639/NEMA WC 74  \textit{5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy}

ANSI/ICEA S-94-649  \textit{Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts}

ANSI/ICEA S-97-682  \textit{Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts}

8. InterNational Electrical Testing Association – NETA

ANSI/NETA ETT  \textit{Standard for Certification of Electrical Testing Technicians}

| ANSI/NETA ATS  \textit{Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems}|
2. APPLICABLE REFERENCES

2.1 Codes, Standards, and Specifications (continued)

   
   NEMA AB4 Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications

   ANSI/NEMA C84.1 Electrical Power Systems and Equipment Voltage Ratings (60 Hz)

   NEMA MG1 Motors and Generators


   ANSI/NFPA 70 National Electrical Code

   ANSI/NFPA 70B Recommended Practice for Electrical Equipment Maintenance

   ANSI/NFPA 70E Standard for Electrical Safety in the Workplace

   ANSI/NFPA 99 Standard for Healthcare Facilities


   ANSI/NFPA 110 Emergency and Standby Power Systems

   ANSI/NFPA 780 Installation of Lightning Protection Systems

11. Occupational Safety and Health Administration – OSHA

12. State and local codes and ordinances

13. Underwriters Laboratories, Inc. – UL
2. APPLICABLE REFERENCES

2.2 Other Publications

Manufacturer’s instruction manuals for the equipment to be tested.

*A Stitch in Time...The Complete Guide to Electrical Insulation Testing*, Megger.


*Instruction Book PC – 2000 for Wecosol™ Fluid-Filled Primary and Secondary Unit Substation Transformer*, ABB Power T&D.

2.3 Contact Information

ABB Power T&D
Small Transformer Division
PO Box 920
South Boston, VA 24592
(434) 572-5695
www.abb.com

American National Standards Institute – ANSI
25 West 43rd Street 4th Fl.
New York, NY 10036
(212) 642-4900
www.ansi.org

ASTM International – ASTM
100 Barr Harbor Drive
W. Conshohocken, PA 19428
(610) 832-9585
www.astm.org

Association of Edison Illuminating Companies – AEIC
600 N. 18th Street; PO Box 2641
Birmingham, AL 35291
(205) 257-2530
www.aeic.org

Canadian Standards Association – CSA
178 Rexdale Boulevard
Toronto, ON M9W 1R3
(416) 747-4000
www.csa.ca
2. APPLICABLE REFERENCES

2.3 Contact Information (continued)

Electrical Apparatus Service Association – EASA
1331 Baur Boulevard
St. Louis, MO 63132
(314) 993-2220
www.easa.com

Institute of Electrical and Electronic Engineers – IEEE
PO Box 1331
Piscataway, NJ 08855
(732) 981-0060
www.ieee.org

Insulated Cable Engineers Association – ICEA
c/o Global Document Engineers
15 Inverness Way East
Englewood, CO 80112
(303) 397-7956
www.icea.net

International Electrotechnical Commission – IEC
Contact through American National Standards Institute

InterNational Electrical Testing Association – NETA
3050 Old Centre Ave. Suite 102
Portage, MI 49024
(269) 488-6382 or (888) 300-NETA (6382)
www.netaworld.org

The McGraw-Hill Companies
P.O. Box 182604
Columbus, OH 43272
(877) 833-5524
www.mcgraw-hill.com

Megger
4271 Bronze Way
Dallas, TX 75237
(214) 723-2861
www.megger.com

National Electrical Manufacturers Association – NEMA
1300 N. 17th St. Suite 1847
Rosslyn, VA 22209
(703) 841-3200
www.nema.org
2. **APPLICABLE REFERENCES**

2.3 **Contact Information (continued)**

- National Institute of Standards and Technology
  100 Bureau Drive
  Gaithersburg, SD  20899
  (301) 975-6478
  www.nist.gov

- National Fire Prevention Association – NFPA
  1 Battery March Park
  PO Box 901
  Quincy, MA 02269-9101
  (617) 984-7247
  www.nfpa.org

- Occupational Safety and Health Administration – OSHA
  U.S. Department of Labor
  Occupational Safety and Health Administration
  Office of Public Affairs – Room N3647
  200 Constitution Avenue
  Washington, D.C. 20210
  (202) 693-1999
  www.osha.gov

- Square D Company, Anderson Product Division
  P.O. Box 455
  Leeds, AL  35094
  (205) 699-2411
  [www.schneider-electric.com](http://www.schneider-electric.com)

- Taylor and Francis Books, Inc. – CRC Press
  2000 NW Corporate Blvd.
  Boca Raton, FL  33431
  (561) 361-6000
  www.crcpress.com

- Underwriters Laboratories, Inc. – UL
  333 Pfingsten Road
  Northbrook, IL  60062
  (847) 272-8800
  www.ul.com