ANSI/NETA ATS-2009

AMERICAN NATIONAL STANDARD

STANDARD FOR ACCEPTANCE TESTING SPECIFICATIONS for Electrical Power Equipment and Systems

Secretariat
InterNational Electrical Testing Association

Approved by
American National Standards Institute

– This page intentionally left blank –

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

Caution Notice: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by
InterNational Electrical Testing Association
3050 Old Centre Avenue, Suite 102
Portage, MI 49024
888.300.6382 · FAX 269.488.6383
www.netaworld.org
neta@netaworld.org
Jayne Tanz - Executive Director

Copyright Information and
Alteration of Content

2009 ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems (ANSI/NETA ATS-2009) is protected under the copyright laws of the United States, and all rights are reserved. Further, the ANSI/NETA ATS-2009 may not be copied, modified, sold, or used except in accordance with such laws and as follows:

Purchasers may reproduce and use all or a portion of the ANSI/NETA ATS-2009 provided *ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems* are clearly identified in writing as the source of all such uses or reproductions.

Section 7 of the *ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems* may be reproduced and used on a "cut and paste" basis for the particular type of equipment to be tested.

The following sections of the *ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems* must be incorporated by reference as part of any subsection:

3. Qualifications of Testing Organization and Personnel
   - 3.1 Testing Organization
   - 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 Precautions
   - 5.2 Suitability of Test Equipment
   - 5.3 Test Instrument Calibration
   - 5.4 Test Report

The purchaser is required to include the above sections with any section(s) of 7.

InterNational Electrical Testing Association
3050 Old Centre Avenue, Suite 102
Portage, MI 49024
E-mail: neta@netaworld.org • Web: www.netaworld.org

Standards Review Council

These specifications were submitted for public comment and reviewed by the NETA Standards Review Council.

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

Ballot Pool Members
Of
ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, 2009

Ken Bassett
Tom Bishop
Scott Blizard
Michel Castonguay
Rick Eynon
David Geary
Don Genutis
Paul Hartman
Gary Hartshorn
David Huffman
Stuart Jackson
Jim Jordan
Scott Kinney
Andrew Kobler
Benjamin Lanz
Mark Lautenschlager
Joe Nims
Jerry Parnell
Jaime Ybarra
Mose Ramieh
Randall Sagan
Peter Sammy
Richard Sobhraj
Larry Stovall
Tim Thomas
Alan Turpen
Wally Vahlstrom
Chris Werstiuk
John White
JP Wolff

NETA Accredited Companies

The following in a lisiting of all NETA Accredited Companies as of the date this document was approved by ANSI as an American National Standard, February 19, 2009.

A&F Electrical Testing, Inc.	Kevin Chilton
Advanced Testing Systems	D. Patrick MacCarthy
American Electrical Testing Co.	Scott A. Blizard
Apparatus Testing and Engineering	James Lawler
Applied Engineering Concepts	Michel Castonguay
Burlington Electrical Testing Company, Inc.	Walter Cleary
C.E. Testing, Inc.	Mark Chapman
DYMAX Holdings, Inc.	Gene Philipp
Eastern High Voltage	Joseph Wilson
Electric Power Systems, Inc.	Steve Reed
Electrical and Electronic Controls	Michael Hughes
Electrical Energy Experts, Inc.	William Styer
Electrical Engineering Consulting & Testing, P.C.	Barry W. Tyndall
Electrical Equipment Upgrading, Inc.	Kevin Miller
Electrical Reliability Services	Lee Bigham
Electrical Testing Services	Frank Plonka
Electrical Testing, Inc.	Steve Dodd
Elemco Testing Co. Inc.	Robert J. White
ESCO Energy Services	Lynn Hamrick
Hampton Tedder Technical Services	Matt Tedder
Harford Electrical Testing Co., Inc.	Vincent Biondino
High Energy Electrical Testing, Inc.	James P. Ratshin
High Voltage Maintenance Corp.	Tom Nation
HMT, Inc.	John Pertgen
Industrial Electric Testing, Inc.	Gary Benzenberg
Industrial Electronics Group	Butch E. Teal
Infra-Red Building and Power Service	Thomas McDonald
M&L Power Systems Maintenance, Inc.	Darshan Arora
Magna Electric Corporation	Kerry Heid
Magna IV Engineering – Edmonton	Wayne Sheridan

NETA Accredited Companies

Magna IV Engineering, Ltd. – BC	Cameron Hite
MET Electrical Testing Co., Inc.	William McKenzie
Nationwide Electrical Testing, Inc.	Shashikant B. Bagle
North Central Electric, Inc.	Robert Messina
Northern Electrical Testing, Inc.	Lyle Detterman
Orbis Engineering Field Services, Ltd.	Lorne Gara
Phasor Engineering	Rafael Castro
Potomac Testing, Inc.	Ken Bassett
Power & Generation Testing, Inc.	Mose Ramieh
Power Engineering Services, Inc.	Miles R. Engelke
Power Plus Engineering, Inc.	Salvatore Mancuso
Power Products & Solutions, Inc.	Ralph Patterson
Power Services, Inc.	Gerald Bydash
Power Systems Testing Co.	David Huffman
Power Test, Inc.	Richard Walker
Power Testing and Energization, Inc.	Chris Zavadlov
Powertech Services, Inc.	Jean A. Brown
PRIT Service, Inc.	Roderic Hageman
Reuter & Hanney, Inc.	Michael Reuter
REV Engineering, Ltd.	Roland Davidson
Scott Testing, Inc.	Russ Sorbello
Shermco Industries, Inc.	Ron Widup
Sigma Six Solutions, Inc.	John White
Taurus Power and Controls, Inc.	Rob Bulfinch
Tony Demaria Electric, Inc.	Anthony Demaria
Trace Electrical Services & Testing, LLC	Joseph Vasta
Utilities Instrumentation Service, Inc.	Gary Walls
Utility Service Corporation	Alan Peterson

NOTICE

In no event shall the InterNational Electrical Testing Association be liable to anyone for special, collateral, incidental, or consequential damages in connection with or arising out of the use of these materials.

This document is subject to periodic review, and users are cautioned to obtain the latest edition. Comments and suggestions are invited from all users for consideration by the Association in connection with such review. Any such suggestions will be fully reviewed by the Association after giving the commenter, upon request, a reasonable opportunity to be heard.

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.

InterNational Electrical Testing Association
3050 Old Centre Avenue, Suite 102 • 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 ATS-2009)

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.

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 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 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 Section Panels and reviewing committees.

The *NETA Acceptance Testing Specifications* was developed for use by those responsible for assessing the suitability for initial energization of electrical power equipment and systems and to specify field tests and inspections that ensure these systems and apparatus perform satisfactorily, minimizing downtime and maximizing life expectancy.

Since 1972, several revisions of the *Acceptance Testing 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 *Acceptance Testing Specifications* have been published in 1991, 1995, 1999, 2003, and 2007.

On February 19, 2009, the American National Standards Institute approved the NETA *Acceptance Testing Specifications for Electrical Power Equipment and Systems* as an American National Standard.

Suggestions for improvement of this standard are welcome. They should be sent to the InterNational Electrical Testing Association, 3050 Old Centre Avenue, Suite 102, Portage, MI 49024.

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:

Notation of Changes
Material included in this edition of the document but not part of the 2007 edition is marked with a black vertical line in the margin to the left of the insertion of text, deletion of text, or alteration of text.

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.

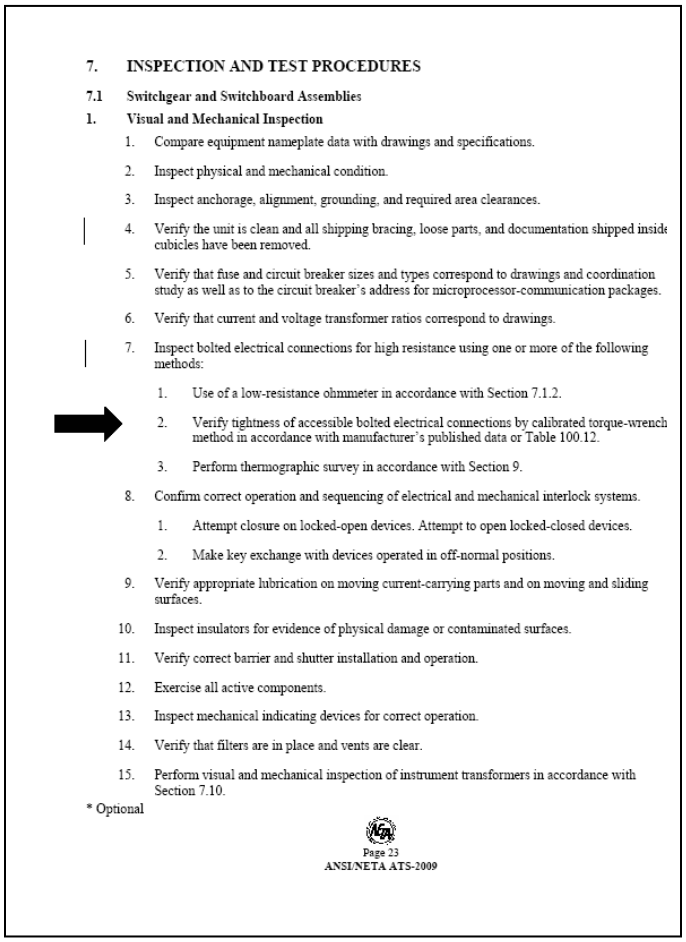
Expected Test Results
Section 7 consists of sections specific to each particular type of equipment. Within those sections there are, typically, three main bodies of information:

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

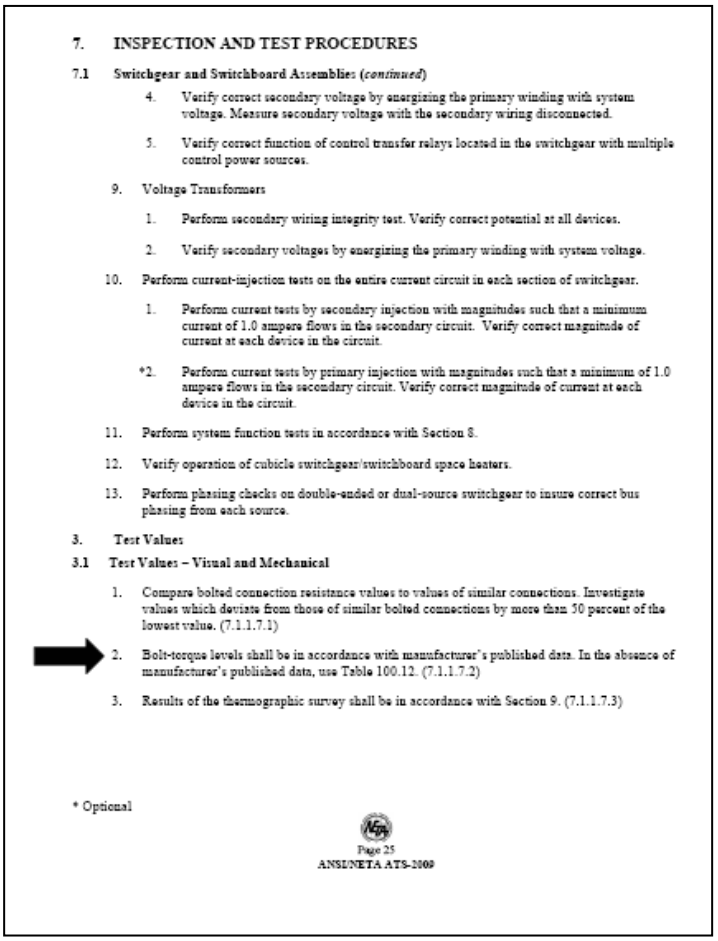
7.1 Switchgear and Switchboard Assemblies

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 and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
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 or more 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.

* Optional

Page 23
ANSI/NETA ATS-2009



7. INSPECTION AND TEST PROCEDURES

7.1 Switchgear and Switchboard Assemblies (*continued*)

4. Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
5. 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

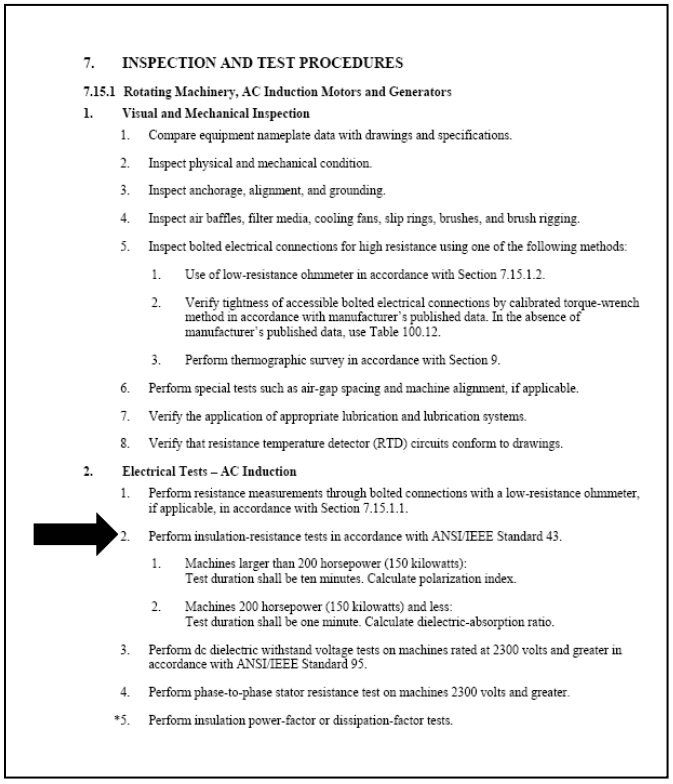
1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. (7.1.1.7.1)
2. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence 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)

* Optional

Page 25
ANSI/NETA ATS-2009

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.

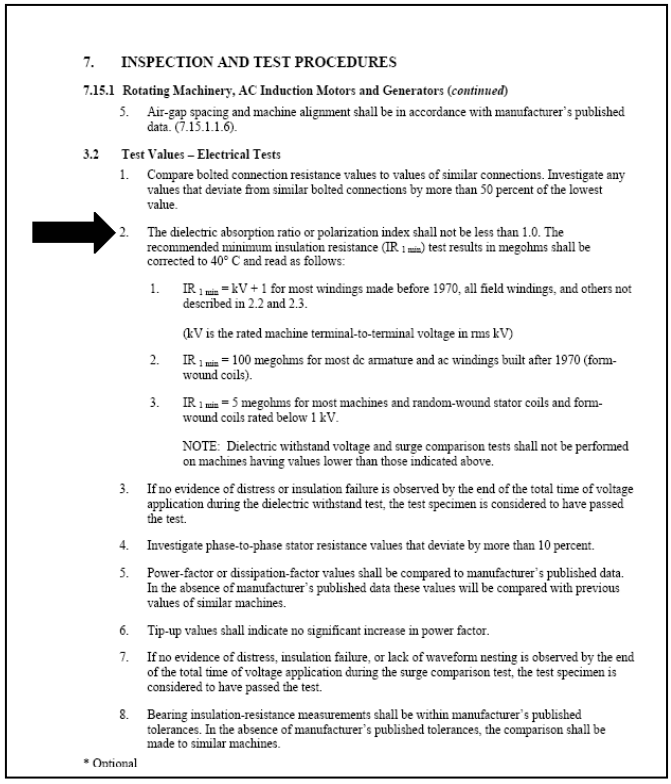


7. INSPECTION AND TEST PROCEDURES

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 ($IR_{1\ min}$) test results in megohms shall 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: 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

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.

Standards Review Council
InterNational Electrical Testing Association

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

– This page intentionally left blank –

CONTENTS

CONTENTS (*continued*)

CONTENTS (*continued)*

TABLES

CONTENTS (*continued)*

APPENDICES

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 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 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