NIST HANDBOOK 150-10
2007 Edition

National Voluntary Laboratory Accreditation Program

EFFICIENCY OF ELECTRIC MOTORS

Carroll S. Brickenkamp
Lawrence I. Knab

National Voluntary Laboratory Accreditation Program
Standards Services Division
Technology Services

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William A. Jeffrey, Director

NVLAP®	**DEPARTMENT OF COMMERCE** National Institute of Standards and Technology National Voluntary Laboratory Accreditation Program	**ISSUE DATE:** March 19, 2009
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		LAP: Efficiency of Electric Motors Program
SUBJECT: Changes to NVLAP Efficiency of Electric Motors Program		

This bulletin announces a change in the NVLAP Efficiency of Electric Motors (EEM) Program.

Effective on the issue date of this bulletin, the references section (1.4) of NIST Handbook 150-10, *Efficiency of Electric Motors*, 2007 Edition, is revised as specified in 1) and 2) below.

1) Reference 1.4 d):

IEEE Standard 112-1996, *Test Procedure for Polyphase Induction Motors and Generators*, Test Method B, and the correction to the calculation at item (28) in section 10.2 Form B-Test Method B issued by IEEE on January 20, 1998,

is replaced with:

IEEE 112-2004, *IEEE Standard Test Procedure for Polyphase Induction Motors and Generators*, Test Method B, and the correction to the calculation at item (28) in section 10.2 Form B-Test Method B issued by IEEE on November 4, 2004.

2) Reference 1.4 f):

NEMA Standards Publication MG 1-1993, *Motors and Generators*, with Revisions 1, 2, 3, and 4,

is replaced with:

NEMA MG 1-2006, *Motors and Generators*, plus Revision 1.

There are no significant technical differences in these references. The changes were made to be consistent with current industry practices and in support of the Department of Energy proposed rule on small electric motors as designated in 10 CFR Part 431, [Docket No. EERE–2008–BT–TP–0008], RIN 1904–AB71, Energy Conservation Program: Test Procedures for Electric Motors.

This bulletin should be inserted into NIST Handbook 150-10 (EEM Program-Specific Handbook) until the next edition of the handbook is released, at which time the reference changes will be incorporated into the handbook.

This bulletin has also been posted to the NVLAP web site at (http://www.nist.gov/nvlap).

Questions concerning the EEM requirements for accreditation should be directed to Jon Crickenberger at 301-975-5305, or <jon.crickenberger@nist.gov>.

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Contents

Foreword

The NIST Handbook 150 publication series sets forth the procedures, requirements, and guidance for the accreditation of testing and calibration laboratories by the National Voluntary Laboratory Accreditation Program (NVLAP). The series is comprised of the following publications:

- NIST Handbook 150, *NVLAP Procedures and General Requirements*, which contains the general procedures and requirements under which NVLAP operates as an unbiased third-party accreditation body;

- NIST Handbook 150-xx program-specific handbooks, which supplement NIST Handbook 150 by providing additional requirements, guidance, and interpretive information applicable to specific NVLAP laboratory accreditation programs (LAPs).

The program-specific handbooks are not stand-alone documents; they are companion documents to NIST Handbook 150. They tailor the general criteria found in NIST Handbook 150 to the specific tests, calibrations, or types of tests or calibrations covered by a LAP.

NIST Handbook 150-10, *NVLAP Efficiency of Electric Motors*, presents the technical requirements and guidance for the accreditation of laboratories under the NVLAP Efficiency of Electric Motors LAP. The 2007 edition incorporates changes resulting from the release of the newest editions of ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, and NIST Handbook 150, as well as the latest U.S. Department of Energy (DOE) testing requirements. The 2007 edition of NIST Handbook 150-10 supersedes and replaces the 1995 edition.

The handbook was revised with the participation of technical experts in the field of efficiency of electric motors testing and was approved by NVLAP. The following main changes have been made to this handbook with respect to the previous edition:

- all references to applicable international guides, national and international standards, and U.S. regulations have been updated;

- on-site assessment checklists are no longer included, in order that they may be provided as separate documents, which may be updated at different intervals than the handbook;

- the body of the handbook has been restructured to conform with internationally accepted rules for the structure and drafting of standards, where appropriate, to promote ease of use and understanding;

- updated federal regulations that cover requirements for determining the efficiency of electric motors have been included.

This handbook is also available on the NVLAP web site (http://www.nist.gov/nvlap).

Questions or comments concerning this handbook should be submitted to NVLAP, National Institute of Standards and Technology, 100 Bureau Drive, Stop 2140, Gaithersburg, MD, 20899-2140; phone: 301-975-4016; fax: 301-926-2884; e-mail: nvlap@nist.gov.

Introduction

As part of broader energy conservation issues, the Energy Policy and Conservation Act (Public Law 94-163) was passed in 1975 in response to the oil crisis of the early 1970s. It has been amended several times, most notably in 1992 by the Energy Policy Act (EPAct) (Public Law 102-486). The *Energy Conservation Program for Consumer Products other than Automobiles* was added and includes energy efficiency test procedures and standards for various industrial equipment and, in particular, certain electric motors. The Energy Policy and Conservation Act, as amended by EPAct (EPCA), establishes definitions, test procedures, labeling provisions, energy efficiency standards, and compliance certification requirements for electric motors.

Section 345(c) of EPCA (42 U.S.C. 6316(c)) requires electric motor "manufacturers to certify, through an independent testing or certification program nationally recognized in the United States, that such motor meets the applicable [nominal full-load efficiency standard]."

Section 431.36(a) of Title 10, Code of Federal Regulations (CFR) Part 431 (10 CFR Part 431), provides two equivalent ways to fulfill the compliance certification requirements under section 345(c) of EPCA:

(1) A manufacturer may certify, through an independent testing program nationally recognized in the United States, that a covered motor meets the standard; or

(2) A manufacturer may certify, through an independent certification program nationally recognized in the United States, that a covered motor meets the standard.

The procedures by which a manufacturer may certify the energy efficiency of its electric motors, either through a certification program or an accredited testing program, are set forth in section 431.17 of 10 CFR Part 431, and in particular, subsections 431.17(a)(5) and (b).

The Efficiency of Electric Motors (EEM) laboratory accreditation program was originally developed at the request of the National Electrical Manufacturers Association (NEMA) to assist the electric motor industry in complying with the statutory requirements for electric motors. NVLAP coordinated the development of the EEM program with NEMA and DOE.

Accreditation under NVLAP for the efficiency of electric motors fulfills the applicable requirements of 10 CFR Part 431 for accreditation as an independent testing program nationally recognized in the United States. (See section 431.18 of 10 CFR Part 431.) The names and contact information for NVLAP-accredited laboratories are published on the NVLAP web site <http://www.nist.gov/nvlap>.

The authors gratefully acknowledge the important contributions of the following: regulatory and technical input and review by Jim Raba of DOE; technical input and review by Walter Martiny, Robert Bartheld, and Vern Nielsen; and editing by Vanda White of NVLAP.

1 General information

1.1 Scope

1.1.1 NIST Handbook 150-10 establishes the technical requirements and provides guidance for the accreditation of laboratories under the NVLAP Efficiency of Electric Motors Laboratory Accreditation Program (EEM Program). It supplements the NVLAP procedures and general requirements found in NIST Handbook 150, *NVLAP Procedures and General Requirements*, by tailoring the general criteria found in NIST Handbook 150 to the specific tests and types of tests covered by the EEM Program.

1.1.2 NIST Handbook 150, NIST Handbook 150-10, and their respective checklists (see 1.6) constitute the collective body of requirements that must be met by a laboratory seeking NVLAP accreditation for the EEM Program.

1.1.3 This handbook is intended for information and use by accredited EEM laboratories, assessors conducting on-site assessments, laboratories seeking accreditation, other laboratory accreditation systems, users of laboratory services, and others needing information on the requirements for accreditation under the EEM Program.

1.2 Organization of handbook

The numbering and titles of the first five clauses of this handbook match those of NIST Handbook 150. The primary subclauses in clauses 4 and 5 (e.g., 4.1, 4.2, etc.) are also numbered and titled to correspond with those of NIST Handbook 150, even when there are no requirements additional to those in NIST Handbook 150.

1.3 Program description

1.3.1 Statutory and regulatory requirements

1.3.1.1 The Energy Policy and Conservation Act as amended by the Energy Policy Act

In sum, section 340(13)(A) of EPCA defines “electric motor” as any motor that is “general purpose T-frame, single speed, foot-mounting, polyphase squirrel-cage induction of the National Electrical Manufacturers Association (NEMA) Designs A and B, continuous-rated, operating on 230/460 volts and constant 60 hertz line power, as defined in NEMA Standards Publication MG1-1987,” Section 342(b)(1) of EPCA then prescribes efficiency standards for electric motors that are 0.75 kW (1 hp) to 150 kW (200 hp) and manufactured (alone or as a component of another piece of equipment), except for definite purpose motors, special purpose motors, and those motors exempted by the Secretary of Energy. Further, section 343(a)(5)(A) EPCA requires that the testing procedures for motor efficiency shall be the test procedures specified in NEMA Standards Publication MG1-1987, and the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 112, Test Method B for motor efficiency, as in effect on October 24, 1992. (Whereas NEMA MG1-1987 required “efficiency and losses” to be determined in accordance with IEEE Standard 112, NEMA MG1-1993 with Revision 1 and subsequent revisions permits such determinations based on application of either IEEE Standard 112 or Canadian Standards Association (CSA) Standard C390.) Also, see 1.3.1.2.

1.3.1.2 Implementing and clarifying Regulations of 1999

Under sections 343(a)(5)(B) and (C) of EPCA, DOE can amend the test procedures for motor efficiency to include updates to IEEE Standard 112 Test Method B when it sets forth a rule on motor efficiency. When the current final rule for motor efficiency was promulgated in 1999, DOE adopted the latest edition of IEEE Standard 112 (the 1996 version) with corrections. See 5.4.1.2 for these corrections. At the same time, DOE prescribed the CSA Standard C390-93 Test Method (1), *Energy Efficient Test Methods for Three-Phase Induction Motors*. In sum, the Federal regulations that implement EPCA became effective November 4, 1999, and are codified at 10 CFR Part 431, *Energy Efficiency Program for Certain Commercial and Industrial Equipment*. The methods to determine motor efficiency are incorporated by reference in 10 CFR Part 431, and are:

a) IEEE Standard 112-1996 Test Method B, *Input-Output with Loss Segregation*, with IEEE correction notice of January 20, 1998 with exceptions. See appendix B to subpart B of 10 CFR Part 431 – *Uniform Test Method for Measuring Nominal Full Load Efficiency of Electric Motors*, 2. Test procedures, (2) (i) through (ix);

b) CSA International (or Canadian Standards Association) Standard C390-93 Test Method (1), *Input-Output Method with Indirect Measurement of the Stray-Load Loss and Direct Measurement of the Stator Winding (I^2R), Rotor Winding (I^2R), Core and Windage-Friction Losses*;

c) National Electrical Manufacturers Association (NEMA) Standards Publication MG1-1993 with Revisions 1, 2, 3, and 4, and paragraph 12.58.1, *Determination of Motor Efficiency and Losses*.

1.3.1.3 Labeling requirements for electric motors

Section 342(b)(1) of EPCA establishes minimum nominal full-load efficiency levels for the most common sizes and types of motors in use. In sum, electric motors covered under EPCA, which are either manufactured alone or as a component of another piece of equipment, must comply with the EPCA efficiency levels and be labeled with a nominal full-load efficiency and a compliance certification (CC) number. This efficiency value is selected from NEMA Standards Publication MG1-1993 with revisions 1, 2, 3, and 4, paragraph 12.58.1, and a table of "nominal full-load efficiencies" that is derived from the measurement of a motor's "average full-load efficiency" (using the IEEE Standard 112-1996 Test Method B or CSA Standard C390-93 Test Method (1) procedures). Also, see 1.5.

1.3.2 Scope of Efficiency of Electric Motors Program

1.3.2.1 The NVLAP EEM Program provides for laboratory accreditation to ensure that a testing laboratory is competent to test any motor for energy efficiency, and in particular for a motor that is covered under 10 CFR Part 431 and thereby provide adequate assurance of compliance with EPCA's energy efficiency requirements. (The EEM Program is not restricted only to motors that are covered under Federal regulations.)

1.3.2.2 For purposes of 10 CFR Part 431 and EPCA, the test procedures for measuring the energy efficiency of an electric motor shall be the test procedures specified in appendix B to subpart B of 10 CFR Part 431.

1.3.2.3 For purposes of accreditation, IEEE Standard 112-1996, Method B is considered equivalent to the CSA Standard C390-93, Test Method (1).

1.3.2.4 The power range for testing motors in accordance with IEEE Standard 112-1996, Method B or CSA Standard C390-93, Test Method (1) is not limited to the 0.75 kW (1 hp) to 150 kW (200 hp) range provision of EPCA. Some laboratories seeking NVLAP accreditation consistent with the applicable provisions in 10 CFR Part 431 may have the capability to test a motor rated above 150 kW (200 hp). Consequently, the scope of the EEM program covers the entire range of motors that can be tested competently within the limits of IEEE Standard 112, Test Method B and CSA Standard C390, Test Method (1). Furthermore, a laboratory may for any reason request accreditation to perform testing in accordance with methods other than IEEE Standard 112-1996 Method B or CSA Standard C390-93, Test Method (1), such as IEEE Standard 112-2004 or CSA Standard C390-98 (R2005). However, test methods other than IEEE Standard 112-1996 and CSA Standard C390-93 per se cannot be used for compliance certification under section 431.36 of 10 CFR Part 431.

1.3.2.5 Testing for safety performance of an electric motor is outside the scope of the accreditation program.

1.4 References

The following documents are referenced in this handbook. If no date is given in the reference, then the latest edition applies within one year of publication or within another time limit specified by regulations or other requirement documents.

a) NIST Handbook 150, *NVLAP Procedures and General Requirements*

b) 10 CFR Part 431, *Energy Efficiency Program for Certain Commercial and Industrial Equipment***,** Subpart B: Electric Motors

c) 64 FR 54114 (October 5, 1999) Part III Department of Energy, Office of Energy Efficiency and Renewable Energy, 10 CFR Part 431, *Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures, Labeling, and Certification Requirements for Electric Motors; Final Rule*

d) IEEE Standard 112-1996, *Test Procedure for Polyphase Induction Motors and Generators*, Test Method B, and the correction to the calculation at item (28) in section 10.2 Form B-Test Method B issued by IEEE on January 20, 1998

e) CSA International Standard C390-93, *Energy Efficiency Test Methods for Three-Phase Induction Motors*, Test Method (1) *Input-Output Method with Indirect Measurement of the Stray-Load Loss and Direct Measurement of the Stator Winding (I^2R), Rotor Winding (I^2R), Core and Windage-Friction Losses*

f) NEMA Standards Publication MG1-1993, *Motors and Generators*, with Revisions 1, 2, 3, and 4

g) ASTM E178, *Standard Practice for Dealing with Outlying Observations*

1.5 Terms and definitions

For the purposes of this handbook, the terms and definitions given in NIST Handbook 150 and section 431.12 of 10 CFR Part 431 apply.

1.6 Program documentation

1.6.1 General

Assessors use NVLAP checklists to ensure that each laboratory receives an assessment comparable to that received by others and to assure completeness, uniformity, and objectivity. Checklists assist assessors in documenting the assessment to the NVLAP requirements found in NIST Handbook 150, this handbook, and the checklists themselves. Checklists contain definitive statements or questions about all aspects of the NVLAP requirements for accreditation, and form part of the On-Site Assessment Report (see NIST Handbook 150). The current version of each checklist is available from the NVLAP web site at <http://www.nist.gov/nvlap>.

1.6.2 NIST Handbook 150 Checklist

All NVLAP programs use the NIST Handbook 150 Checklist (formerly called the General Operations Checklist), which contains the requirements published in NIST Handbook 150. The checklist items are numbered to correspond to clauses 4 and 5 and annexes A and B of NIST Handbook 150.

1.6.3 NIST Handbook 150-10 Checklist

The NIST Handbook 150-10 Checklist (also referred to as the EEM Program-Specific Checklist) addresses requirements specific to efficiency of electric motors testing, including testing requirements, with an emphasis on observing and performing tests, testing accuracy, instrumentation, calibration, personnel competency, and test reporting. The checklist contains requirements expressed at a more detailed level than found in this handbook.

1.6.4 Test Method Review Summary

The assessor uses the Test Method Review Summary to review the laboratory's ability to perform the EEM test method. The review of the test method by the assessor ranges from observing tests to having laboratory staff describe the test procedures. The assessor notes on the Test Method Review Summary the depth into which each part of the test method was reviewed (Observed Test, Examined Apparatus, Walked/Talked Through Test, Listened to Description of Procedures). Since the EEM Program is limited to IEEE Standard 112 Method B and CSA Standard C390-93 Method 1, the test method review is in depth.

1.6.5 NVLAP Lab Bulletins

NVLAP Lab Bulletins are issued to laboratories and assessors when needed, to clarify program-specific requirements and to provide information about program additions and changes.

2 LAP establishment, development and implementation

This clause contains no information additional to that provided in NIST Handbook 150, clause 2.

3 Accreditation process

3.1 General

An overview of the laboratory accreditation process is provided in NIST Handbook 150, clause 3, and includes information pertaining to application for accreditation; on-site assessment; proficiency testing; accreditation decision; granting accreditation; renewal of accreditation; changes to scope of accreditation; monitoring visits; and suspension, denial, revocation, and voluntary termination of accreditation.

3.2 Management system review

3.2.1 Prior to applying to NVLAP for accreditation, a laboratory shall have a fully implemented management system. A copy of the management system documentation, including a cross-reference document, shall be sent to NVLAP with the application forms. This requirement applies to both applicant laboratories and laboratories already accredited by NVLAP (see 4.2.2).

3.2.2 The cross-reference document shall verify that all requirements of this handbook and clauses 4 and 5 and annexes A and B of NIST Handbook 150 are addressed and their locations clearly identified in the management system documentation. The cross-reference requirement is satisfied if the management system documentation is organized and numbered the same as the NIST Handbook 150 Checklist.

3.2.3 Prior to the on-site assessment, the assigned assessor reviews all relevant management system documentation for conformity with NVLAP requirements, including the requirements of this handbook and NIST Handbook 150. During this review, the assessor may request additional management system documents and/or records, which will be returned upon request.

3.3 On-site assessment

3.3.1 The purpose of the on-site assessment is to determine whether the laboratory is following its documented management system and to assess the competence of the laboratory's delivery of its testing services.

3.3.2 The on-site assessment will take place at the laboratory site. Prior to the visit, the NVLAP assessor provides a preliminary agenda, which may change due to findings observed during the on-site assessment. Efforts will be made to minimize disruption to the normal working routines during the assessment. The assessor will need time and workspace to complete assessment documentation during his/her time at the laboratory site.

3.3.3 All laboratory equipment required to perform accredited testing shall be available for assessment and in good working order. The laboratory shall be prepared to demonstrate selected test methods as requested by the assessor. The assessment will cover the requirements identified in this handbook, NIST Handbook 150, the EEM Program-Specific Checklist, the laboratory's management system documentation, and the laboratory's written detailed test instructions.

3.3.4 The laboratory shall make available all supporting technical information in a format that is conducive to a detailed review. The assessor may request additional information to clarify issues regarding nonconformities or to delve more deeply into technical issues. For the EEM program, the test

method review is in depth, as only IEEE Standard 112-1996, Method B and CSA Standard C390-93, Method (1) comprise the program.

3.3.5 The activities covered during a typical on-site assessment are described below.

a) *Opening meeting:* The NVLAP assessor will meet with laboratory management, supervisory personnel, and other appropriate staff members to explain the purpose of the on-site assessment and to discuss the schedule for the assessment activities. Information provided by the laboratory on its application form may be discussed during this meeting.

b) *Staff interviews:* The assessor will ask the laboratory manager to assist in arranging times for individual interviews with laboratory staff members. The assessor will interview staff members filling key positions (e.g., Laboratory Manager, Technical Director, Quality Manager, Authorized Representative, Approved Signatories) and staff members who have an effect on the outcome of the testing, including staff who conduct the testing. The assessor does not need to talk to all staff members; however, the assessor will select staff members representing all aspects of the laboratory. These interviews are conducted to determine if the staff members are properly trained, assigned, and supervised, and are technically competent for the tasks assigned to them.

c) *Records review:* The assessor will review laboratory documentation, including the management system documentation, equipment and maintenance records, record-keeping procedures, testing procedures, laboratory test records and reports, personnel competency records, personnel training plans and records, and safeguards for the protection of sensitive and proprietary information. The assessor will review the laboratory's own detailed instructions (see 5.4.1) to perform EEM testing according to the standard test procedures for which it seeks accreditation, the range of motors and conditions it can test, and the descriptions of the maintenance and calibration of its specific equipment. The assessor will also review:

   1) sample identification and tracking procedures and copies of completed test reports;

   2) records of internal audits, use of quality control procedures, and participation in NVLAP proficiency testing or other similar programs;

   3) personnel records, including résumés and job descriptions of key personnel and competency evaluations for all staff members who routinely perform the test method for which accreditation is sought;

   4) calibration records and certificates.

   Laboratory staff shall be available to answer questions; however, the assessor may wish to review the documents and records alone. The assessor usually does not ask to remove any laboratory documents or records from the laboratory premises.

   NVLAP assessors do not need access to employee information that may be considered sensitive or private such as salary, medical information, or performance reviews for work done outside the scope of the laboratory's accreditation. However, this information is often stored together with technical information that an assessor will need to check (e.g., job descriptions, résumés, and technical performance reviews). In these cases, the assessor will work with the laboratory to ensure the review is performed without violating individual privacy. At the discretion of the laboratory, a member of its human resources department may be present during the review of personnel information.

d) *Internal audit and management review:* The assessor will review and discuss with the laboratory staff the laboratory's internal audit and management review activities, which are separate and distinct activities. The discussion will include all aspects of those activities including the management system procedures, the audit findings, the root cause determination, the actions taken to resolve problems identified, the actions taken to prevent recurrence, and the results of the management review.

e) *Equipment and software:* The assessor will examine and determine the suitability of all equipment and facilities required to perform the standard test methods for which the laboratory is accredited (or is seeking accreditation). The appropriate environmental conditions required for testing will be assessed. The assessor will observe the demonstration of selected procedures by appropriate personnel assigned to conduct the tests, and will interview those personnel. The assessor will review test data, examine hardware and software for function and appropriateness, and review software validation and verification procedures.

f) *Demonstrations:* The demonstrations requested may be selective or all-inclusive. The assessor will observe the demonstration of testing procedures by technical personnel assigned to conduct the tests, and will discuss the tests with the technical personnel to assure their understanding of the procedures. The demonstrations shall include sample test motor(s), preparation of devices, establishment of test conditions, and the setup/use of major equipment. The assessor will use the Test Method Review Summary (see 1.6.4) and the EEM Program-Specific Checklist (see 1.6.3) in reviewing and summarizing the laboratory's ability to conduct the test methods.

The assessor may select and trace the history of one or more motors from receipt to final issuance of the test reports.

g) *Proficiency testing:* The assessor will discuss all aspects of proficiency testing results with appropriate staff. Test methodology and records documenting the laboratory's execution of the testing will be reviewed and discussed. Any unusual trends or outlying results will be discussed.

NVLAP reserves the right to provide a motor as a proficiency test sample. The assessor may request testing or a demonstration using this or another motor.

h) *On-site assessment report:* The assessor will complete an On-Site Assessment Report, which summarizes the findings and clearly lists all nonconformities and comments (positive or negative). This report normally consists of the On-Site Assessment Summary, the On-Site Assessment Narrative Summary, the NIST Handbook 150 Checklist, the EEM Program-Specific Checklist, and the Test Method Review Summary. The first page of the report shall be signed by the assessor and the laboratory's Authorized Representative or designee to acknowledge receiving the on-site report, but this does not necessarily indicate agreement by the laboratory. A copy of the report is given to the laboratory representative for retention and the assessor sends the original to NVLAP. All observations made by the assessor are held in the strictest confidence.

i) *Closing meeting:* The assessor will conduct a closing meeting with the laboratory manager, supervisory personnel, and other appropriate staff members to discuss the findings. During the visit the assessor will have categorized all problems identified as nonconformities and comments. They will be discussed at the closing meeting and resolutions may be mutually agreed upon. The assessor will specifically note items that have been corrected during the on-site assessment along with any recommendations for other action(s). The process for resolving nonconformities

identified during the on-site is documented in NIST Handbook 150. Disagreements between the laboratory and an assessor may be referred to NVLAP for resolution.

3.3.6 The laboratory shall resolve or formulate a plan to resolve all nonconformities and provide a response to NVLAP within 30 days from the date of the on-site assessment. In the case of an initial accreditation, all nonconformities shall be satisfactorily resolved before accreditation can be granted.

3.3.7 The laboratory shall review all comments for potential improvements in efficiency of electric motors testing.

3.4 Proficiency testing

3.4.1 NIST Handbook 150 defines proficiency testing and describes how it is included in the accreditation process. Special proficiency testing rounds may be scheduled separately for specific needs. Proficiency testing fees are required.

3.4.2 As NVLAP prescribes, NVLAP or a proficiency testing contractor conducts rounds at regular intervals. Test motors along with instructions for motor handling, preparation, conditioning, mounting, and testing, and data forms are provided to the participating laboratories. The completed test data forms are sent by the participating laboratories to NVLAP or, as directed, to the proficiency testing contractor. The results of all participants are summarized in a NVLAP Tech Brief, which is edited and sent by NVLAP to the participants. The identity and performance of individual laboratories are kept confidential.

3.4.3 Laboratories renewing accreditation shall have satisfactorily participated in all required proficiency testing during their previous accreditation period. Laboratories applying for initial accreditation shall also participate satisfactorily in proficiency testing (or a suitable alternative, if available), provided the proficiency testing is offered during the application period, before accreditation will be granted.

Failure to participate in proficiency testing or return the completed test data forms by the deadline is considered a nonconformity and may result in suspension of laboratory accreditation.

3.4.4 Generally, it is required that the specific proficiency test procedure be conducted in accordance with the applicable standard test method. At times, however, NVLAP may specify special conditions to assure uniformity in procedures and test conditions among participants. These may include the number of replicate measurements, special conditions of temperature, or other test parameters. Also, proficiency testing may consist of several parts in order that the operation of a laboratory might be evaluated. Portions of the standard test procedure may be emphasized, such as measurement, instrumentation, hardware, and data analysis. **The proficiency testing shall not be contracted out to another laboratory.**

3.4.5 Proficiency test data are analyzed by NVLAP using statistical procedures to determine distributions and parameters, such as averages, standard deviations, and outliers (see ASTM E178). Using the test data from proficiency testing, the laboratory shall monitor its own testing performance. Procedures for receiving, analyzing, and monitoring the laboratory's own test results shall be documented in its management system.

3.4.6 Unsatisfactory performance in proficiency testing (e.g., outlying results) is a technical nonconformity that must be resolved by the laboratory to maintain its accreditation. If the laboratory performs unsatisfactorily in any proficiency test, it shall take corrective action to investigate and resolve

nonconformities in a timely manner, according to the requirements of NIST Handbook 150 for the control of nonconforming work. Unsatisfactory performance in proficiency testing may result in suspension or revocation of accreditation.

3.4.7 The results of proficiency testing shall be made available to NVLAP assessors for use during laboratory on-site assessment visits. Any problems indicated by proficiency testing shall be discussed with appropriate laboratory personnel responsible for developing and implementing plans for resolving the problems.

4 Management requirements for accreditation

4.1 Organization

There are no requirements additional to those set forth in NIST Handbook 150.

4.2 Management system

4.2.1 The laboratory shall ensure that the requirements of NIST Handbook 150 are met so that staff are knowledgeable of the electronic- or paper-based documentation system and can demonstrate, if authorized, the retrieval of needed documents and/or records.

4.2.2 The laboratory shall create a cross-reference document allowing the laboratory and a NVLAP assessor to verify that all requirements of clauses 4 and 5 and annexes A and B of NIST Handbook 150 and the corresponding NIST Handbook 150-10 are addressed in the management system documentation. The cross-reference document requirement can be satisfied in a number of ways. One way is to number and organize the management system documentation to be the same as the NIST Handbook 150 Checklist.

4.2.3 The laboratory shall have readily available the regulation(s)` and the applicable version of the standard(s) for the test methods for which accreditation has been requested.

4.2.4 If a customer, for whatever reason (e.g., regulatory requirement), requires accreditation to versions of a test method that are not the latest published version, then the laboratory shall document that requirement and shall have readily available the required version of the test method.

4.2.5 When a test method references another test method, guide, practice, or specification, the laboratory shall have readily available the referenced documents, where relevant.

4.2.6 In addition to the information specified in NIST Handbook 150, the management system documentation shall include:

a) testing facilities and scope of relevant services offered; specifically the range of ratings of motors that the laboratory can test according to IEEE Standard 112-1996, Method B (CSA Standard C390-93, Method 1) (see Note 1);

b) policy and procedures for use of subcontractors, if applicable;

c) procedures for receipt, identification, and tracking of motor test samples;

d) procedures by which the laboratory describes the motor test samples and the criteria for determining if the motor is acceptable for testing;

e) procedures and actions concerning damaged or altered test motors;

f) procedures for maintenance and calibration of the equipment used in conducting the tests on efficiency of electric motors;

g) descriptions of the procedures, practices, and equipment that the laboratory uses in conducting efficiency measurements of electric motors according to IEEE Standard 112-1996 Method B or CSA Standard C390-93 Method 1 or both (see Note 2);

h) procedures for the laboratory's participation in NVLAP proficiency testing, including receiving, analyzing, and monitoring the laboratory's results, and a description of any corrective actions taken because of the results;

i) the personnel training and competency evaluations, which demonstrate that the test procedures are being followed correctly.

NOTE 1 The type and size of motors that fall within the scope of the IEEE Standard 112-1996, Test Method B (CSA Standard C390-93, Test Method (1)) test procedure is broad. In some cases, a laboratory's test equipment may be limited such that the laboratory cannot measure the efficiency of the complete range of motors covered by the standard

NOTE 2 The standardized efficiency test procedure has been developed to be generally applicable to a variety of electric motors that differ by factors such as size, shape, power, and speed. As a consequence, a laboratory needs to document specific details of the motor test equipment that it uses to conduct efficiency tests of motors. The detailed descriptions of the test equipment and instrumentation must include the operation and calibration procedures (see also 5.4.1.1).

4.3 Document control

There are no requirements additional to those set forth in NIST Handbook 150.

4.4 Review of requests, tenders and contracts

There are no requirements additional to those set forth in NIST Handbook 150.

4.5 Subcontracting of tests and calibrations

There are no requirements additional to those set forth in NIST Handbook 150.

4.6 Purchasing services and supplies

The laboratory shall evaluate vendors and verify or test incoming equipment, materials, and supplies that affect the quality and accuracy of the test results. Records that these items have been reviewed for technical completeness shall be examined by the assessor.

Examples for the EEM Program include:

a) calibration service providers/calibration certificates;

b) general laboratory equipment and supplies, including

— thermocouples,

— thermocouple wire;

c) data processing and acquisition equipment.

4.7 Service to the customer

There are no requirements additional to those set forth in NIST Handbook 150.

4.8 Complaints

There are no requirements additional to those set forth in NIST Handbook 150.

4.9 Control of nonconforming testing and/or calibration work

There are no requirements additional to those set forth in NIST Handbook 150.

4.10 Improvement

There are no requirements additional to those set forth in NIST Handbook 150.

4.11 Corrective action

There are no requirements additional to those set forth in NIST Handbook 150.

4.12 Preventive action

There are no requirements additional to those set forth in NIST Handbook 150.

4.13 Control of records

4.13.1 In addition to the requirements in 4.13.2.1 of NIST Handbook 150 to identify the personnel responsible for sampling, testing, calibration and checking results, the personnel responsible for motor preparation, and where appropriate, the associated date(s), shall also be identified in the records (test/calibration/verification, etc.; hard copy and electronic).

4.13.2 Records will be reviewed during the on-site assessment either in total or by selective sampling.

4.13.3 The records to be maintained include (but are not limited to):

a) acceptance/rejection of motors submitted for test (see 4.2.6 d));

b) comprehensive logs for tracking motors and test activities;

c) original data collected by laboratory;

d) calibration and verification data;

e) data and results of quality control;

f) equipment and maintenance records;

g) test reports.

4.13.4 Test records, sufficient to reconstruct the test report, shall be kept for a period of at least three years following the issuance of a test report, unless a longer period is required by the customer, regulation, or the laboratory's own procedures.

4.13.5 In reporting the results of the motor tests, efficiency is calculated from the raw data using procedures described in Method B of IEEE Standard 112 and/or Method 1 of CSA Standard C390.

4.14 Internal audits

4.14.1 The internal audit shall cover compliance with NVLAP, the laboratory management system, as well as regulatory, contractual, and testing requirements.

4.14.2 An applicant laboratory shall conduct at least one complete internal audit prior to the first on-site assessment. The records will be reviewed by the NVLAP assessor before or during the on-site assessment visit.

4.14.3 For accredited laboratories, internal audit reports conducted since the previous on-site assessment shall be made available for review.

4.14.4 Internal audits are separate and distinct from management reviews (see 4.15).

4.15 Management reviews

4.15.1 Periodic reviews of the management system shall reflect adherence to NVLAP requirements and the laboratory's quality objectives.

4.15.2 Management reviews shall review all nonconformities and may reflect positive aspects of the management system.

4.15.3 An applicant laboratory shall perform at least one complete management review prior to the first on-site assessment. The records will be reviewed by the NVLAP assessor before or during the on-site assessment visit.

4.15.4 The report of the management review shall be available during the NVLAP on-site assessment.

5 Technical requirements for accreditation

5.1 General

There are no requirements additional to those set forth in NIST Handbook 150.

5.2 Personnel

5.2.1 Personnel records

5.2.1.1 ***Key NVLAP accreditation personnel —*** The laboratory shall maintain a list of personnel designated to fulfill NVLAP requirements including: Laboratory Director, Technical Director, Team Leaders, NVLAP Authorized Representative, NVLAP Approved Signatories, and the staff responsible for conducting the testing.

5.2.1.2 ***All testing laboratory staff —*** The laboratory shall document and maintain records on the required qualifications of each staff member, including a résumé of qualifications; laboratory testing procedures to which the person is assigned and authorized to perform; and the results of periodic testing performance (competency) reviews (see also 5.2.3.4), which may include intra-operator tests and interlaboratory tests.

5.2.1.3 ***Notification of changes —*** The laboratory shall notify NVLAP when key personnel (see 5.2.1.1) are added to or removed from the staff. Notification to NVLAP of personnel changes shall include a current résumé for each new staff member.

5.2.2 Specific experience and competence of technical director

The laboratory's technical director (or an appropriate supervisor) shall be experienced in efficiency of electric motors testing and shall have the technical competence and the supervisory capability to direct the work of professionals and technicians in efficiency of electric motors testing.

5.2.3 Competency reviews

5.2.3.1 The EEM Program Specific Checklist lists specific personnel competency requirements as related to testing.

5.2.3.2 The laboratory shall evaluate the competency of each staff member for each test method the staff member is authorized to conduct.

5.2.3.3 For each staff member, the staff member's immediate supervisor, or a designee appointed by the Laboratory Director, shall conduct annually an assessment and an observation of performance competency.

5.2.3.4 These annual performance competency reviews shall be documented, dated, signed by the supervisor and the employee, retained in the personnel file and be available for review by the assessor. For the purpose of on-site assessments, a separate personnel folder of information specific to applicable NVLAP requirements may be provided instead of the complete folder, which may contain confidential information not needed for the assessment.

5.2.4 Training

5.2.4.1 The laboratory shall have a description of its training program for ensuring that staff is able to perform tests properly.

5.2.4.2 The training program shall be updated and current staff members shall be given additional training when test methods are updated or procedures change, or when the individuals are assigned new responsibilities.

5.2.4.3 Each staff member may receive training for assigned duties either through on-the-job training, formal classroom study, attendance at conferences, or another appropriate mechanism.

5.2.4.4 The laboratory shall ensure that each new staff member is trained for the testing duties assigned. Minimum training requirements are described in the EEM Program-Specific Checklist.

5.2.4.5 Training materials that are maintained within the laboratory shall be kept up-to-date, including applicable versions of standard test methods, as well as appropriate reference documents, texts, and scientific and industry periodicals. These materials shall be readily available to the laboratory staff.

5.2.5 Subcontractors

Individuals hired to perform testing activities are sometimes referred to as *subcontractors*. NVLAP does not make a distinction between full-time laboratory employees and individuals hired on a contract to work in that laboratory. NVLAP requires that the EEM testing laboratory maintain responsibility for and control of any work performed within its scope of accreditation. The laboratory shall ensure all individuals performing testing activities satisfy all NVLAP requirements, irrespective of the means by which individuals are compensated (e.g., the laboratory must ensure all test personnel receive proper training and supervision and are subject to annual performance reviews, etc.).

5.3 Accommodation and environmental conditions

5.3.1 The laboratory workspace and environmentally controlled spaces shall be checked for the required conditions.

5.3.2 Monitoring and control devices shall be functioning properly so as to maintain and record the required environmental conditions.

5.3.3 Specific environmental requirements for EEM laboratories are provided in the EEM Program-Specific Checklist.

5.4 Test and calibration methods and method validation

5.4.1 Standard test methods

5.4.1.1 The management system documentation shall contain or make reference to detailed written instructions of the procedures, practices, instructions and equipment that the laboratory uses in conducting the test methods for which it seeks or holds accreditation. These detailed instructions, including those for equipment operation, calibration checks, and quality control checks, shall address any laboratory-specific information not contained in the standard method. When necessary, the test method shall be supplemented with additional detailed instructions beyond the test method to ensure consistent application.

5.4.1.2 For compliance with the DOE requirements (also see Introduction) in the NVLAP EEM Program, laboratories shall use the test procedures described under section 431.16 of 10 CFR Part 431.

5.4.2 Off-site testing

5.4.2.1 A laboratory may be accredited for tests conducted at locations other than the laboratory's own facilities provided the testing complies with all NVLAP requirements. Examples of off-site testing are sampling and testing at off-site locations, such as a manufacturing facility, warehouse, or construction site.

5.4.2.2 The laboratory shall maintain records of its off-site testing.

5.4.2.3 If a laboratory selects off-site testing to be included in its scope of accreditation, it shall provide to the NVLAP assessor the following:

a) complete step-by-step procedure for personnel to follow when performing the standard off-site test;

b) demonstration of the test procedure;

c) folder or file containing raw data from off-site tests;

d) test reports and test data sheets;

e) demonstration of compliance with NVLAP calibration and traceability requirements;

f) evidence that adequate supervision during the off-site testing is provided by a qualified staff member of the accredited laboratory.

5.4.3 Additional requirements

The EEM Program-Specific Checklist contains additional requirements related to test methods, calibrations and conduct of tests.

5.4.4 Estimation of measurement uncertainty

At a minimum, the management system documentation shall list the important variables that substantially affect the uncertainty of the test results. The uncertainty shall be determined and reported when required by the test method, the regulator, or the customer.

5.5 Equipment

The EEM Program-Specific Checklist contains additional requirements related to testing equipment.

5.6 Measurement traceability

5.6.1 By definition, measurement traceability is an attribute of the measurement result. Therefore, it applies to the result of the test as it relates to a stated reference. However, traceability is established to the stated reference usually through the calibration of the measurement and test equipment (M & TE) used to conduct the test, and/or through the use of standard reference materials, each with a known value(s) and a previously established path of traceability. Uncertainty is also an attribute of the measurement result and is therefore necessary for traceability to exist.

5.6.2 To account for the effects on traceability of the calibration of M & TE, the laboratory shall determine equipment calibration, verification, and maintenance intervals based on the equipment's frequency of use and the environment in which it is used, and also in accordance with standard test methods, manufacturer's recommendations, or as specified in the EEM Program-Specific Checklist, whichever results in a shorter time between calibrations. Extension of the time interval between calibrations is acceptable if the laboratory can provide justification for increasing the interval.

5.6.3 Proper performance of the testing equipment shall be periodically verified as needed.

5.6.4 The reference standards used and the environmental conditions at the time of calibration shall be documented for all calibrations.

5.6.5 The following requirements apply for calibrations and calibration certificates.

a) Certificates are required for calibrations performed by outside services. A calibration certificate shall indicate uncertainty or accuracy tolerance limits, and traceability of reference standards.

b) Certificates may not be required when a laboratory performs its own calibration and records are kept. If the testing laboratory performs its own calibration, the identity of the personnel involved, the standard metrological procedures used, the environmental conditions, and the measurement uncertainty shall be documented. These records shall contain sufficient information to permit repetition of the calibration.

c) For calibrations performed by the testing laboratory, it shall have properly trained personnel who understand the importance of the various factors that affect the uncertainty of the calibration and its effect on the uncertainty of the final test result (see NIST Handbook 150, 5.4.6).

5.6.6 In addition to the information specified in NIST Handbook 150, 5.5.5, calibration or verification records shall include the following:

a) a list of all equipment variables requiring calibration, traceability, or verification;

b) range of calibration/traceability/verification;

c) resolution (precision or the number of digits read) of the instrument and its allowable error (i.e., tolerance);

d) periodic verification dates and schedule;

e) identity of the laboratory individual/group or external service responsible for calibration;

f) identity and source of reference standard(s) and traceability.

5.7 Sampling

There are no requirements additional to those set forth in NIST Handbook 150.

5.8 Handling of test and calibration items

There are no requirements additional to those set forth in NIST Handbook 150.

5.9 Assuring the quality of test and calibration results

There are no requirements additional to those set forth in NIST Handbook 150.

5.10 Reporting the results

5.10.1 General

5.10.1.1 Where appropriate, test reports shall clearly state that the test results apply to the product or system as tested and, if required, conform to regulatory requirements.

5.10.1.2 Additional requirements are provided in the EEM Program-Specific Checklist.

5.10.2 Data analysis and report generation

5.10.2.1 In some cases, raw data collected by computer are collated, reduced, analyzed, or otherwise treated for direct incorporation in the test report. Such treatment involving transmission of the data, writing, and generation of the test report is generally performed at the laboratory or at an area close to the facility and under the control of laboratory personnel. In such cases, the laboratory personnel responsible for the report writing and generation shall be available during the laboratory's on-site assessment to be interviewed by the assessor for evaluation of the laboratory's compliance with the NVLAP criteria for test reports. The assessor shall perform an independent calculation of the efficiency based on laboratory test results and compare the independently-calculated efficiency with that calculated by the laboratory.

5.10.2.2 At times, the final report may be written and generated at an off-site facility that is located some distance from the testing laboratory such that the assessor cannot interview the off-site personnel. In such a case, the laboratory shall have in place for assessor review appropriate written descriptions in the management system documentation of procedures and documentation for assuring the accuracy and validity of the data transmission, the incorporation and accurate analysis of the data in the test report, and the compliance of the test report with NVLAP criteria. Depending on the on-site laboratory evaluations of

these written descriptions, a visit to the off-site facility may be required. When warranted, an assessor will visit the off-site facility at additional cost to the laboratory before accreditation is granted or renewed.

5.10.2.3 When a test report is written at an off-site facility such that the assessor cannot interview the off-site personnel, the report shall include the names and addresses of both those responsible for conducting the laboratory tests and for writing and generating the test report. Copies of typical reports written at an off-site facility shall be available at the laboratory at the time of the on-site assessment and these typical reports shall be reviewed by the assessor for compliance with NVLAP requirements. The assessor shall perform an independent calculation of efficiency and compare it to that calculated at the off-site facility as required in 5.10.2.1.

5.10.2.4 If a laboratory uses several organizational departments for the discrete functions of testing, data collection, data processing, and test report preparation and generation, it is necessary that lines of responsibility with distinct supervisory positions be defined and that no conflicts exist. The assessor shall review the procedures and documentation of the lines of responsibility with distinct supervisory positions during the on-site assessment, and also shall verify that all NVLAP requirements regarding the writing and storage of reports are followed.

6 Additional requirements

There are no additional requirements beyond NIST Handbook 150 and its associated normative annexes, and any other normative references previously cited in this handbook.