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Motors and Generators

National Electrical Manufacturers Association

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GENERATING SET APPLICATIONS

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Foreword

The standards appearing in this publication have been developed by the Motor and Generator Section and approved for publication as standards of the National Electrical Manufacturers Association. They are intended to assist users in the proper selection and application of motors and generators. These standards are revised periodically to provide for changes in user needs, advances in technology, and changing economic trends. All persons having experience in the selection, use, or manufacture of electric motors and generators are encouraged to submit recommendations that will improve the usefulness of these standards. Inquiries, comments, and proposed or recommended revisions should be submitted to the Motor and Generator Section by contacting:

Senior Technical Director, Operations
National Electrical Manufacturers Association
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The best judgment of the Motor and Generator Section on the performance and construction of motors and generators is represented in these standards. They are based upon sound engineering principles, research, and records of test and field experience. Also involved is an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. For machines intended for general applications, information as to user needs was determined by the individual companies through normal commercial contact with users. For some motors intended for definite applications, the organizations that participated in the development of the standards are listed at the beginning of those definite-purpose motor standards.

Practical information concerning performance, safety, test, construction, and manufacture of alternating-current and direct-current motors and generators within the product scopes defined in the applicable section or sections of this publication is provided in these standards. Although some definite-purpose motors and generators are included, the standards do not apply to machines such as generators and traction motors for railroads, motors for mining locomotives, arc-welding generators, automotive accessory and toy motors and generators, machines mounted on airborne craft, etc.

In the preparation and revision of these standards, consideration has been given to the work of other organizations whose standards are in any way related to motors and generators. Credit is hereby given to all those whose standards may have been helpful in the preparation of this volume.

NEMA MG 1-2014 is a revision of MG 1-2011. Prior to publication, the NEMA Standards and Authorized Engineering Information that appear in this publication unchanged since the preceding edition were reaffirmed by the Motor and Generator Section.

The standards or guidelines presented in a NEMA standards publication are considered technically sound at the time they are approved for publication. They are not a substitute for a product seller's or user's own judgment with respect to the particular product referenced in the standard or guideline, and NEMA does not undertake to guaranty the performance of any individual manufacturer's products by virtue of this standard or guide. Thus, NEMA expressly disclaims any responsibility for damages arising from the use, application, or reliance by others on the information contained in these standards or guidelines.

This standards publication was developed by the Motors and Generator Section. Section approval of the standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the Motors and Generator Section was composed of the following members:

Baldor Electric A Member of the ABB Group - Fort Smith, AR
Bluffton Motor Works Bluffton - IN
Brook Crompton North America - Toronto, ON
Cummins, Inc.—Minneapolis, MN

GE Industrial Solutions - Plainville, CT
Nidec Motor Corporation - Saint Louis, MO
NovaTorque, Inc. - Fremont, CA
Ram Industries—Leesport, PA
Regal-Beloit Corporation—Beloit, WI, composed of:
- Leeson Electric—Grafton, WI
- Lincoln Motors—Cleveland, OH
- Marathon Electric Manufacturing Corporation—Wausau, WI
- Electra-Gear—Union Grove, WI

Schneider Electric - Palatine, IL
SEW-Eurodrive, Inc.—Lyman, SC
Siemens Industry, Inc.—Norcross, GA
Sterling Electric, Inc.—Indianapolis, IN
TECO-Westinghouse Motor Co.—Round Rock, TX
Toshiba International Corporation—Houston, TX
WEG Electric Motor Corp.—Duluth, GA

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Section I
GENERAL STANDARDS APPLYING TO ALL MACHINES
Part 1
REFERENCED STANDARDS AND DEFINITIONS

1.1 REFERENCED STANDARDS

The following publications are adopted in whole or in part as indicated, by reference in this standards publication. The latest revision or edition of the applicable publication should be referred to for current requirements.

American National Standards Institute (ANSI)
11 West 42nd Street
New York, NY 10036

ANSI B92.1 *Involute Splines and Inspection*
ANSI C84.1 *Electric Power Systems and Equipment-Voltage Ratings (60 Hz)*
ANSI S12.12 *Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity*
ANSI S12.51 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Precision Methods for Reverberation Rooms*
ANSI S12.53-1 *Acoustics–Determination of Sound Power Levels of Noise Sources–Engineering Methods for Small, Movable Sources in Reverberant Fields–Part 1: Comparison Method for Hard-Walled Test Rooms*
ANSI S12.53-2 *Acoustics–Determination of Sound Power Levels of Noise Sources–Engineering Methods for Small, Movable Sources in Reverberant Fields–Part 2: Methods for Special Reverberation Test Rooms*
ANSI S12.54 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Engineering Method in an Essentially Free Field Over a Reflecting Plane*
ANSI S12.55 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Precision Methods for Anechoic and Hemi-Anechoic Rooms*
ANSI S12.56 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Survey Method Using an Enveloping Measurement Surface Over a Reflecting Plane*
ANSI S12.57 *Standard Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Comparison Method in Situ*

American Society for Testing and Materials (ASTM)
1916 Race Street
Philadelphia, PA 19103

ASTM D149-97a *Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies*
ASTM D635 *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position*

Canadian Standards Association
178 Rexdale Boulevard
Toronto, Ontario, Canada M9W 1R3

CSA 390 *Energy Efficiency Test Methods for Three-Phase Induction Motors*
CSA 747 *Energy Efficiency Test Methods for Small Motors*

Institute of Electrical and Electronics Engineers (IEEE)[1]
445 Hoes Lane
Piscataway, NJ 08855-1331

ANSI/IEEE Std 1 *General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation*
ANSI/IEEE Std 43 *Recommended Practice for Testing Insulation Resistance of Rotating Machinery*
ANSI/IEEE Std 100 *Standard Dictionary of Electrical and Electronic Terms*
IEEE Std 112 *Standard Test Procedure for Polyphase Induction Motors and Generators*
IEEE Std 114-2010 Standard Test Procedure for Single-Phase Induction Motors
ANSI/IEEE Std 115 *Test Procedures for Synchronous Machines*
ANSI/IEEE Std 117 *Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery*
ANSI/IEEE Std 275 *Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-Wound Pre-Insulated Stator Coils, Machines Rated 6900V and Below*
ANSI/IEEE Std 304 *Test Procedure for Evaluation and Classification of Insulation System for DC*
IEEE Std 522 *IEEE Guide for Testing Turn to Turn Insulation of Form-Wound Stator Coils for Alternating-Current Rotating Electric Machine*

Society of Automotive Engineers (SAE)
3001 West Big Beaver
Troy, MI 48084

ANSI/SAE J429 *Mechanical and Material Requirements for Externally Threaded Fasteners*

International Electrotechnical Commission (IEC)[1]
3 Rue de Varembé, CP 131, CH-1211
Geneva 20, Switzerland

IEC 60034-1 *Rotating Electrical Machines–Part One: Rating and Performance*
IEC 60034-14 *Rotating Electrical Machines–Part 14: Mechanical Vibration of Certain Machines with Shaft Heights 56 mm and Higher—Measurement, Evaluation and Limits of Vibration Severity*
IEC 60034-30-1 *Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code)*
IEC 60034-8 *Rotating Electrical Machines–Part Eight: Terminal Markings and Direction of Rotation*

International Organization for Standardization (ISO)[1]
1, rue de Varembe
1211 Geneva 20
Switzerland

ISO 10816-3 *Mechanical Vibration–Evaluation of Machine Vibration by Measurements on Non-Rotating Parts–Part 3: Industrial Machines with Nominal Power Above 15 kW and Nominal Speeds Between 120 r/min and 15,000 r/min when measured in situ.*

ISO 3741 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Precision Methods for Reverberation Rooms*

ISO 3743-1 *Acoustics–Determination of Sound Power Levels of Noise Sources– Engineering Methods for Small, Movable Sources in Reverberant Fields– Part 1: Comparison Method in Hard-Walled Test Rooms*

ISO 3743-2 *Acoustics–Determination of Sound Power Levels of Noise Sources - Engineering Methods for Small, Movable Sources in Reverberant Fields– Part 2: Method for Special Reverberation Test Rooms*

ISO 3744 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Engineering Method Employing an Enveloping Measurement Surface in an Essentially Free Field Over a Reflecting Plane*

ISO 3745 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Precision Methods for Anechoic and Hemi-Anechoic Rooms*

ISO 3746 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Survey Method Using an Enveloping Measurement Surface Over a Reflecting Plane*

ISO 3747 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Pressure–Comparison Method in Situ*

ISO 7919-1 *Mechanical Vibration of Non-Reciprocating Machines–Measurements on Rotating Shafts and Evaluation Criteria–Part 1: General Guidelines*

ISO 8528-3 *Reciprocating Internal Combustion Engine-Driven Alternating Current Generating Sets–Part 3: Alternating Current Generators for Generating Sets*

ISO 8528-4 *Reciprocating Internal Combustion Engine-Driven Alternating Current Generating Sets–Part 4: Controlgear and Switchgear*

ISO 8821 *Mechanical Vibration–Shaft and Fitment Key Convention*

ISO 9614-1 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Intensity–Part 1: Measurement at Discrete Points*

ISO 9614-2 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Intensity–Part 2: Measurement by Scanning*

ISO 9614-3 *Acoustics–Determination of Sound Power Levels of Noise Sources Using Sound Intensity–Part 3: Precision Method for Measurement by Scanning*

ISO R-1000 *SI Units and Recommendations for the Use of their Multiples and of Certain Other Units*

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NEMA MG 2 *Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators*

NEMA MG 3 *Sound Level Prediction for Installed Rotating Electrical Machines*

National Fire Protection Association (NFPA)
Batterymarch Park
Quincy, MA 02269

ANSI/NFPA 70 *National Electrical Code*®

Rubber Manufacturers Association
1400 K Street NW
Suite 300
Washington, DC 20005

Engineering Standards–Specifications for Drives Using Classical V-Belts and Sheaves (A, B, C, and D Cross-sections), 1988, 3rd Edition, Pub #IP-20

Engineering Standards–Specifications for Drives Using Narrow V-Belts and Sheaves 9N/9NX, 15N/15NX, 25N (metric) and 3V/3VX, 5V/5VX, and 8V (inch-pound) Cross-sections; 1991, 3rd Edition, Pub #IP-22

DEFINITIONS

(For definitions not found in Part 1, refer to IEEE Std 100 *Standard Dictionary of Electrical and Electronic Terms*).

CLASSIFICATION ACCORDING TO SIZE

1.2 MACHINE

As used in this standard a machine is an electrical apparatus which depends on electromagnetic induction for its operation and which has one or more component members capable of rotary movement. Specifically, the types of machines covered are those generally referred to as motors and generators as defined in Part 1.

1.3 SMALL (FRACTIONAL) MACHINE

A small machine is either: (1) a machine built in a two digit frame number series in accordance with 4.2.1 (or equivalent for machines without feet); or (2) a machine built in a frame smaller than that frame of a medium machine (see 1.4) which has a continuous rating at 1700-1800 rpm of 1 horsepower for motors or 0.75 kilowatt for generators; or (3) a motor rated less than 1/3 horsepower and less than 800 rpm.

1.4 MEDIUM (INTEGRAL) MACHINE

1.4.1 Alternating-Current Medium Machine

An alternating-current medium machine is a machine: (1) built in a three- or four-digit frame number series in accordance with 4.2.1 (or equivalent for machines without feet); and, (2) having a continuous rating up to and including the information in Table 1-1.

1.4.2 Direct-Current Medium Machine

A direct-current medium machine is a machine: (1) built in a three- or four-digit frame number series in accordance with 4.2.1 (or equivalent for machines without feet); and (2) having a continuous rating up to and including 1.25 horsepower per rpm for motors or 1.0 kilowatt per rpm for generators.

Table 1-1
ALTERNATING CURRENT MEDIUM MACHINE

Synchronous Speed, Rpm	Motors Hp	Generators, Kilowatt at 0.8 Power Factor
1201-3600	500	400
901-1200	350	300
721-900	250	200
601-720	200	150
515-600	150	125
451-514	125	100

1.5 LARGE MACHINE

1.5.1 Alternating-Current Large Machine

An alternating-current large machine is: (1) a machine having a continuous power rating greater than that given in 1.4.1 for synchronous speed ratings above 450 rpm; or (2) a machine having a continuous power rating greater than that given in 1.3 for synchronous speed ratings equal to or below 450 rpm.