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)
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)
3 Rue de Varembé, CP 131, CH-1211
Geneva 20, Switzerland

IEC 60034-1	*Rotating Electrical Machines–Part One: Rating and Performance*
IEC 60034-8	*Rotating Electrical Machines–Part Eight: Terminal Markings and Direction of Rotation*
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)*

**International Organization for Standardization (ISO)
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 20816	*Mechanical vibration–Measurement and evaluation of machine vibration–Part 1: General guidelines*
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*

National Electrical Manufacturers Association (NEMA)
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

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.

1.5.2 Direct-Current Large Machine

A direct-current large machine is a machine having a continuous rating greater than 1.25 horsepower per rpm for motors or 1.0 kilowatt per rpm for generators.

Classification According to Application

(Some of the definitions in this section apply only to specific types or sizes of machines).

1.6 General Purpose Motor

1.6.1 General-Purpose Alternating-Current Motor

A general-purpose alternating-current motor is an induction motor, rated 500 horsepower and less, which incorporates all of the following:

a. Open or enclosed construction
b. Rated continuous duty
c. Service factor in accordance with 12.51
d. Class A or higher rated insulation system with a temperature rise not exceeding that specified in 12.42 for Class A insulation for small motors or Class B or higher rated insulation system with a temperature rise not exceeding that specified in 12.43 for Class B insulation for medium motors.

It is designed in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application.

1.6.2 General-Purpose Direct-Current Small Motor

A general-purpose direct-current small motor is a small motor of mechanical construction suitable for general use under usual service conditions and has ratings and constructional and performance characteristics applying to direct-current small motors as given in Parts 4, 10, 12, and 14.

1.7 General-Purpose Generator

A general-purpose generator is a synchronous generator of mechanical construction suitable for general use under usual service conditions and has ratings and constructional and performance characteristics as given in Part 32.

1.8 Industrial Small Motor

An industrial small motor is an alternating-current or direct-current motor built in either NEMA frame 42, 48, or 56 suitable for industrial use.

It is designed in standard ratings with standard operating characteristics for use under usual service conditions without restriction to a particular application or type of application.

1.9 Industrial Direct-Current Medium Motor

An industrial direct-current motor is a medium motor of mechanical construction suitable for industrial use under usual service conditions and has ratings and constructional and performance characteristics applying to direct current medium motors as given in Parts 4, 10, 12, and 14.

1.10 Industrial Direct-Current Generator

An industrial direct-current generator is a generator of mechanical construction suitable for industrial use under usual service conditions and has ratings and constructional and performance characteristics applying to direct current generators as given in Part 4 and 15.

1.11 Definite-Purpose Motor

A definite-purpose motor is any motor designed in standard ratings with standard operating characteristics or mechanical construction for use under service conditions other than usual or for use on a particular type of application.

1.12 General Industrial Motors

A general industrial motor is a large dc motor of mechanical construction suitable for general industrial use (excluding metal rolling mill service), which may include operation at speeds above base speed by field weakening and has ratings and constructional and performance characteristics applying to general industrial motors as given in Part 23.

1.13 Metal Rolling Mill Motors

A metal rolling mill motor is a large dc motor of mechanical construction suitable for metal rolling mill service (except for reversing hot-mill service) and has ratings and constructional and performance characteristics applying to metal rolling mill motors as given in Part 23.

1.14 Reversing Hot Mill Motors

A reversing hot mill motor is a large dc motor of mechanical construction suitable for reversing hot mill service, such as blooming and slabbing mills, and has ratings and constructional and performance characteristics applying to reversing hot mill motors as given in Part 23.

1.15 Special-Purpose Motor

A special-purpose motor is a motor with special operating characteristics or special mechanical construction, or both, designed for a particular application and not falling within the definition of a general-purpose or definite-purpose motor.

1.16

[Section deleted]

Classification According to Electrical Type

1.17 General

1.17.1 Electric Motor

An electric motor is a machine that transforms electric power into mechanical power.

1.17.2 Electric Generator

An electric generator is a machine that transforms mechanical power into electric power.

1.17.3 Electric Machines

1.17.1.1 Asynchronous Machine

An asynchronous machine is an alternating-current machine in which the rotor does not turn at a synchronous speed.

1.17.1.2 Direct-Current (Commutator) Machine

A direct-current (commutator) machine is a machine incorporating an armature winding connected to a commutator and magnetic poles which are excited from a direct-current source or permanent magnets.

1.17.1.3 Induction Machine

An induction machine is an asynchronous machine that comprises a magnetic circuit interlinked with two electric circuits or sets of circuits, rotating with respect to each other and in which power is transferred from one circuit to another by electromagnetic induction.

1.17.1.4 Synchronous Machine

A synchronous machine is an alternating-current machine in which the average speed of normal operation is exactly proportional to the frequency of the system to which it is connected.

1.18 Alternating-Current Motors

Alternating-current motors are of three general types: induction, synchronous, and series-wound and are defined as follows:

1.18.1 Induction Motor

An induction motor is an induction machine in which a primary winding on one member (usually the stator) is connected to the power source, and a polyphase secondary winding or a squirrel-cage secondary winding on the other member (usually the rotor) carries induced current.

1.18.1.1 Squirrel-Cage Induction Motor

A squirrel-cage induction motor is an induction motor in which the secondary circuit (squirrel-cage winding) consists of a number of conducting bars having their extremities connected by metal rings or plates at each end.

1.18.1.2 Wound-Rotor Induction Motor

A wound-rotor induction motor is an induction motor in which the secondary circuit consists of a polyphase winding or coils whose terminals are either short-circuited or closed through suitable circuits.

1.18.2 Synchronous Motor

A synchronous motor is a synchronous machine for use as a motor.

1.18.2.1 Direct-Current-Excited Synchronous Motor

Unless otherwise stated, it is generally understood that a synchronous motor has field poles excited by direct current.

1.18.2.2 Permanent-Magnet Synchronous Motor

A permanent-magnet synchronous motor is a synchronous motor in which the field excitation is provided by permanent magnets.

1.18.2.3 Reluctance Synchronous Motor

A reluctance synchronous motor is a synchronous motor similar in construction to an induction motor, in which the member carrying the secondary circuit has a cyclic variation of reluctance providing the effect of salient poles, without permanent magnets or direct-current excitation. It starts as an induction motor, is normally provided with a squirrel-cage winding, but operates normally at synchronous speed.

1.18.3 Series-Wound Motor

A series-wound motor is a commutator motor in which the field circuit and armature are connected in series.

1.19 Polyphase Motors

Alternating-current polyphase motors are of the squirrel-cage induction, wound-rotor induction, or synchronous types.

1.19.1 Design Letters of Polyphase Squirrel-Cage Medium Motors

Polyphase squirrel-cage medium induction motors may be one of the following:

1.19.1.1 Design A

A Design A motor is a squirrel-cage motor designed to withstand full-voltage starting and developing locked-rotor torque as shown in 12.38, pull-up torque as shown in 12.40, breakdown torque as shown in 12.39, with locked-rotor current higher than the values shown in 12.35.1 for 60 hertz and 12.35.2 for 50 hertz and having a slip at rated load of less than 5 percent.[1]

1.19.1.2 Design B

A Design B motor is a squirrel-cage motor designed to withstand full-voltage starting, developing locked-rotor, breakdown, and pull-up torques adequate for general application as specified in 12.38, 12.39, and 12.40, drawing locked-rotor current not to exceed the values shown in 12.35.1 for 60 hertz and 12.35.2 for 50 hertz, and having a slip at rated load of less than 5 percent.[1]

[1] Motors with 10 or more poles shall be permitted to have slip slightly greater than 5 percent.

1.19.1.3 Design C

A Design C motor is a squirrel-cage motor designed to withstand full-voltage starting, developing locked-rotor torque for special high-torque application up to the values shown in 12.38, pull-up torque as shown in 12.40, breakdown torque up to the values shown in 12.39, with locked-rotor current not to exceed the values shown in 12.35.1 for 60 hertz and 12.35.2 for 50 hertz, having a slip at rated load of less than 5 percent.

1.19.1.4 Design D

A Design D motor is a squirrel-cage motor designed to withstand full-voltage starting, developing high locked rotor torque as shown in 12.38, with locked rotor current not greater than shown in 12.35.1 for 60 hertz and 12.35.2 for 50 hertz, and having a slip at rated load of 5 percent or more.

1.20 Single-Phase Motors

Alternating-Current single-phase motors are usually induction or series-wound although single-phase synchronous motors are available in the smaller ratings.

1.20.1 Design Letters of Single-Phase Small Motors

1.20.1.1 Design N

A Design N motor is a single-phase small motor designed to withstand full-voltage starting and with a locked-rotor current not to exceed the values shown in 12.33.

1.20.1.2 Design O

A Design O motor is a single-phase small motor designed to withstand full-voltage starting and with a locked-rotor current not to exceed the values shown in 12.33.

1.20.2 Design Letters of Single-Phase Medium Motors

Single-phase medium motors include the following:

1.20.2.1 Design L

A Design L motor is a single-phase medium motor designed to withstand full-voltage starting and to develop a breakdown torque as shown in 10.34 with a locked-rotor current not to exceed the values shown in 12.34.

1.20.2.2 Design M

A Design M motor is a single-phase medium motor designed to withstand full-voltage starting and to develop a breakdown torque as shown in 10.34 with a locked-rotor current not to exceed the values shown in 12.33.

1.20.3 Single-Phase Squirrel-Cage Motors

Single-phase squirrel-cage induction motors are classified and defined as follows:

1.20.3.1 Split-Phase Motor

A split-phase motor is a single-phase induction motor equipped with an auxiliary winding, displaced in magnetic position from, and connected in parallel with the main winding.

Unless otherwise specified, the auxiliary circuit is assumed to be opened when the motor has attained a predetermined speed. The term “split-phase motor” used without qualification, describes a motor to be used without impedance other than that offered by the motor windings themselves, with other types being separately defined.

1.20.3.2 Resistance-Start Motor

A resistance-start motor is a form of split-phase motor having a resistance connected in series with the auxiliary winding. The auxiliary circuit is opened when the motor has attained a predetermined speed.

1.20.3.3 Capacitor Motor

A capacitor motor is a single-phase induction motor with a main winding arranged for direct connection to a source of power and an auxiliary winding connected in series with a capacitor. There are three types of capacitor motors, as follows:

1.20.3.3.1 Capacitor-Start Motor

A capacitor-start motor is a capacitor motor in which the capacitor phase is in the circuit only during the starting period.

1.20.3.3.2 Permanent-Split Capacitor Motor

A permanent-split capacitor motor is a capacitor motor having the same value of capacitance for both starting and running conditions.

1.20.3.3.3 Two-Value Capacitor Motor

A two-value capacitor motor is a capacitor motor using different values of effective capacitance for the starting and running conditions.

1.20.3.4 Shaded-Pole Motor

A shaded-pole motor is a single-phase induction motor provided with an auxiliary short-circuited winding or windings displaced in magnetic position from the main winding.

1.20.4 Single-Phase Wound-Rotor Motors

Single-phase wound-rotor motors are defined and classified as follows:

1.20.4.1 Repulsion Motor

A repulsion motor is a single-phase motor which has a stator winding arranged for connection to a source of power and a rotor winding connected to a commutator. Brushes on the commutator are short-circuited and are so placed that the magnetic axis of the rotor winding is inclined to the magnetic axis of the stator winding. This type of motor has a varying-speed characteristic.

1.20.4.2 Repulsion-Start Induction Motor

A repulsion-start induction motor is a single-phase motor having the same windings as a repulsion motor, but at a predetermined speed the rotor winding is short-circuited or otherwise connected to give the equivalent of a squirrel-cage winding. This type of motor starts as a repulsion motor but operates as an induction motor with constant speed characteristics.

1.20.4.3 Repulsion-Induction Motor

A repulsion-induction motor is a form of repulsion motor which has a squirrel-cage winding in the rotor in addition to the repulsion motor winding. A motor of this type may have either a constant-speed (see 1.30) or varying-speed (see 1.31) characteristic.

1.21 Universal Motors

A universal motor is a series-wound motor designed to operate at approximately the same speed and output on either direct-current or single-phase alternating-current of a frequency not greater than 60 hertz and approximately the same rms voltage.

1.21.1 Series-Wound Motor

A series-wound motor is a commutator motor in which the field circuit and armature circuit are connected in series.

1.21.2 Compensated Series-Wound Motor

A compensated series-wound motor is a series-wound motor with a compensating field winding. The compensating field winding and the series field winding shall be permitted to be combined into one field winding.

1.22 Alternating-Current Generators

Alternating-current generators are of two basic types-induction and synchronous, and are defined as follows:

1.22.1 Induction Generator

An induction generator is an induction machine driven above synchronous speed by an external source of mechanical power for use as a generator.

1.22.2 Synchronous Generator

A synchronous generator is a synchronous machine for use as a generator.

Note: Unless otherwise stated it is generally understood that a synchronous generator has field poles excited by direct current.

1.23 Direct-Current Motors

Direct-current motors are of four general types: shunt-wound, series-wound, compound-wound, permanent magnet, and are defined as follows.

1.23.1 Shunt-Wound Motor

A shunt-wound motor is either a straight shunt-wound motor or a stabilized shunt-wound motor.

1.23.1.1 Straight Shunt-Wound Motor

A straight shunt-wound motor is a direct-current motor in which the field circuit is connected either in parallel with the armature circuit or to a separate source of excitation voltage. The shunt field is the only winding supplying field excitation.

1.23.1.2 Stabilized Shunt-Wound Motor

A stabilized shunt-wound motor is a direct-current motor in which the shunt field circuit is connected either in parallel with the armature circuit or to a separate source of excitation voltage and which also has a light series winding added to prevent a rise in speed or to obtain a slight reduction in speed with increase in load.

1.23.2 Series-Wound Motor

A series-wound motor is a motor in which the field circuit and armature circuit are connected in series.

1.23.3 Compound-Wound Motor

A compound-wound motor is a direct-current motor which has two separate field windings-one, usually the predominating field, connected as in a straight shunt-wound motor, and the other connected in series with the armature circuit.

1.23.4 Permanent Magnet Motor

A permanent magnet motor is a direct-current motor in which the field excitation is supplied by permanent magnets.

1.24 Direct-Current Generators

Direct-current generators are of two general types—shunt-wound and compound-wound—and are defined as follows:

1.24.1 Shunt-Wound Generator

A shunt-wound generator is a direct-current generator in which the field circuit is connected either in parallel with the armature circuit or to a separate source of excitation voltage.

1.24.2 Compound-Wound Generator

A compound-wound generator is a direct-current generator which has two separate field windings—one, usually the predominating field, connected as in a shunt-wound generator, and the other connected in series with the armature circuit.

Classification According to Environmental Protection and Methods of Cooling

Details of protection (IP) and methods of cooling (IC) are defined in Part 5 and Part 6, respectively. They conform to IEC Standards.

1.25 Open Machine (IP00, IC01)

An open machine is one having ventilating openings which permit passage of external cooling air over and around the windings of the machine. The term “open machine”, when applied in large apparatus without qualification, designates a machine having no restriction to ventilation other than that necessitated by mechanical construction.

1.25.1 Dripproof Machine (IP12, IC01)

A dripproof machine is an open machine in which the ventilating openings are so constructed that successful operation is not interfered with when drops of liquid or solid particles strike or enter the enclosure at any angle from 0 to 15 degrees downward from the vertical.

The machine is protected against solid objects greater than 1.968 inches (50 mm).

1.25.2 Splash-Proof Machine (IP13, IC01)

A splash-proof machine is an open machine in which the ventilating openings are so constructed that successful operation is not interfered with when drops of liquid or solid particles strike or enter the enclosure at any angle not greater than 60 degrees downward from the vertical.

The machine is protected against solid objects greater than 1.968 inches (50 mm).

1.25.3 Semi-Guarded Machine (IC01)

A semi-guarded machine is an open machine in which part of the ventilating openings in the machine (usually in the top half), are guarded as in the case of a “guarded machine” but the others are left open.

1.25.4 Guarded Machine (IC01)

A guarded machine is an open machine in which all openings giving direct access to live metal or rotating parts (except smooth rotating surfaces) are limited in size by the structural parts or by screens, baffles, grilles, expanded metal, or other means to prevent accidental contact with hazardous parts.

The openings in the machine enclosure shall be such that (1) a probe such as that illustrated in Figure 1-1 when inserted through the openings, will not touch a hazardous rotating part; (2) a probe such as that illustrated in Figure 1-2 when inserted through the openings, will not touch film-coated wire; and (3) an articulated probe such as that illustrated in Figure 1-3 when inserted through the openings, will not touch an uninsulated live metal part.

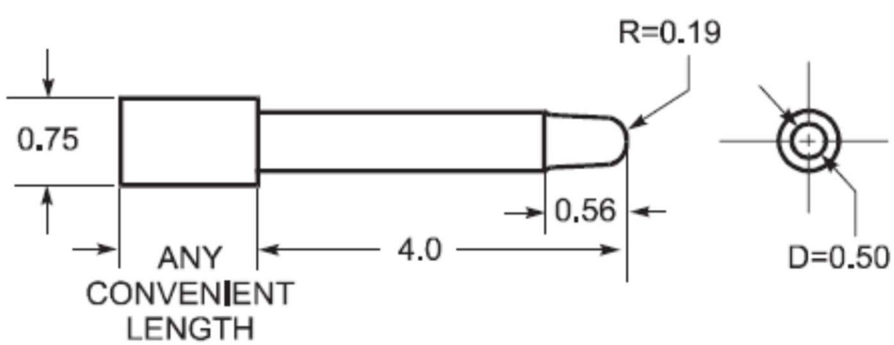

Figure 1-1
Probe for Hazardous Rotating Parts
(all dimensions in inches)

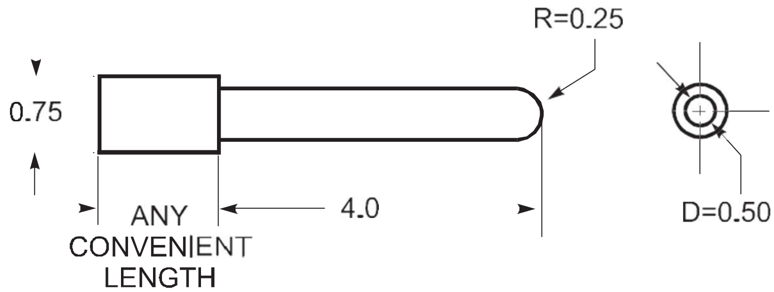

Figure 1-2
Probe for Film-Coated Wire
(all dimensions in inches)

Both joints of this finger may bend through an angle of 90°, but in one and the same direction only.

Dimensions in millimeters.

Tolerances:
On angles: + 5°
On linear dimensions:
Less than 25 mm: ± 0.05
More than 25 mm: ± 0.2

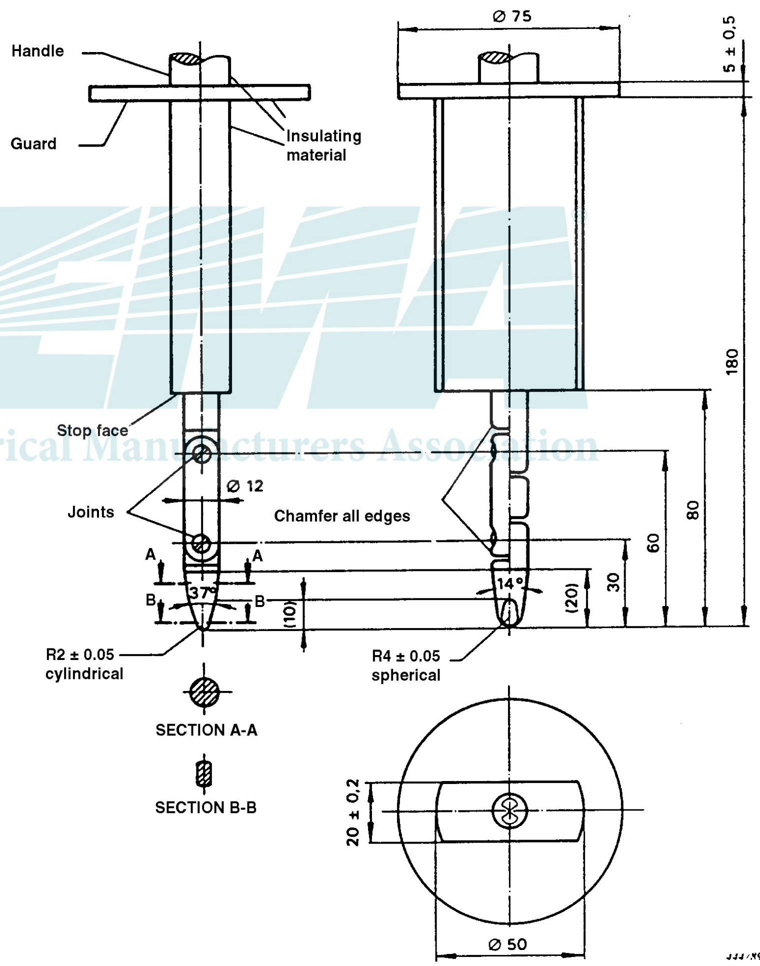

Figure 1-3
Articulated Probe for Uninsulated Live Metal Parts
(Reproduced with permission of IEC, which retains the copyright)

1.25.5 Dripproof Guarded Machine (IC01)

A dripproof guarded machine is a dripproof machine whose ventilating openings are guarded in accordance with 1.25.4.

1.25.6 Open Independently Ventilated Machine (IC06)

An open independently ventilated machine is one which is ventilated by means of a separate motor-driven blower mounted on the machine enclosure. Mechanical protection shall be as defined in 1.25.1 to 1.25.5, inclusive. This machine is sometimes known as a blower-ventilated machine.

1.25.7 Open Pipe-Ventilated Machine

An open pipe-ventilated machine is an open machine except that openings for the admission of the ventilating air are so arranged that inlet ducts or pipes can be connected to them. Open pipe-ventilated machines shall be self-ventilated (air circulated by means integral with the machine) (IC11) or force-ventilated (air circulated by means external to and not a part of the machine) (IC17). Enclosures shall be as defined in 1.25.1 to 1.25.5 inclusive.

1.25.8 Weather-Protected Machine

1.25.8.1 Type I (IC01)

A weather-protected Type I machine is a guarded machine with its ventilating passages so constructed as to minimize the entrance of rain, snow and air-borne particles to the electric parts.

1.25.8.2 Type II (IC01)

A weather-protected Type II machine shall have in addition to the enclosure defined for a weather-protected Type I machine, its ventilating passages at both intake and discharge so arranged that high-velocity air and air-borne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machine shall be so arranged by baffling or separate housings as to provide at least three abrupt changes in direction, none of which shall be less than 90 degrees. In addition, an area of low velocity not exceeding 600 feet per minute shall be provided in the intake air path to minimize the possibility of moisture or dirt being carried into the electric parts of the machine.

Note: Removable or otherwise easy to clean filters may be provided instead of the low velocity chamber.

1.26 Totally Enclosed Machine

A totally enclosed machine is so enclosed as to prevent the free exchange of air between the inside and outside of the case but not sufficiently enclosed to be termed air-tight and dust does not enter in sufficient quantity to interfere with satisfactory operation of the machine.

1.26.1 Totally Enclosed Nonventilated Machine (IC410)

A totally enclosed nonventilated machine is a frame-surface cooled totally enclosed machine which is only equipped for cooling by free convection.

1.26.2 Totally Enclosed Fan-Cooled Machine

A totally enclosed fan-cooled machine is a frame-surface cooled totally enclosed machine equipped for self exterior cooling by means of a fan or fans integral with the machine but external to the enclosing parts.

1.26.3 Totally Enclosed Fan-Cooled Guarded Machine (IC411)

A totally-enclosed fan-cooled guarded machine is a totally-enclosed fan-cooled machine in which all openings giving direct access to the fan are limited in size by the design of the structural parts or by screens, grilles, expanded metal, etc. to prevent accidental contact with the fan. Such openings shall not permit the passage of a cylindrical rod 0.75 inch in diameter, and a probe such as that shown in Figure 1-1 shall not contact the blades, spokes, or other irregular surfaces of the fan.

1.26.4 Totally Enclosed Pipe-Ventilated Machine (IP44)

A totally enclosed pipe-ventilated machine is a machine with openings so arranged that when inlet and outlet ducts or pipes are connected to them there is no free exchange of the internal air and the air outside the case. Totally enclosed pipe-ventilated machines may be self-ventilated (air circulated by means integral with the machine (IC31)) or force-ventilated (air circulated by means external to and not part of the machine (IC37)).

1.26.5 Totally Enclosed Water-Cooled Machine (IP54)

A totally enclosed water-cooled machine is a totally enclosed machine which is cooled by circulating water, the water or water conductors coming in direct contact with the machine parts.

1.26.6 Water-Proof Machine (IP55)

A water-proof machine is a totally enclosed machine so constructed that it will exclude water applied in the form of a stream of water from a hose, except that leakage may occur around the shaft provided it is prevented from entering the oil reservoir and provision is made for automatically draining the machine. The means for automatic draining may be a check valve or a tapped hole at the lowest part of the frame which will serve for application of a drain pipe.

1.26.7 Totally Enclosed Air-to-Water-Cooled Machine (IP54)

A totally enclosed air-to-water-cooled machine is a totally enclosed machine which is cooled by circulating air which in turn, is cooled by circulating water. It is provided with a water-cooled heat exchanger, integral (IC7_W) or machine mounted (IC8_W), for cooling the internal air and a fan or fans, integral with the rotor shaft (IC_1W) or separate (IC_5W) for circulating the internal air.

1.26.8 Totally Enclosed Air-to-Air-Cooled Machine (IP54)

A totally enclosed air-to-air-cooled machine is a totally enclosed machine which is cooled by circulating the internal air through a heat exchanger which in turn, is cooled by circulating external air. It is provided with an air-to-air heat exchanger, integral (IC5_), or machine mounted (IC6_), for cooling the internal air and a fan or fans, integral with the rotor shaft (IC_1_) or separate (IC_5_) for circulating the internal air and a fan or fans, integral with the rotor shaft (IC_1) or separate, but external to the enclosing part or parts (IC_6) for circulating the external air.

1.26.9 Totally Enclosed Air-Over Machine (IP54, IC417)

A totally enclosed air-over machine is a totally enclosed frame-surface cooled machine intended for exterior cooling by a ventilating means external to the machine.

1.26.10 Explosion-Proof Machine[2]

An explosion-proof machine is a totally enclosed machine whose enclosure is designed and constructed to withstand an explosion of a specified gas or vapor which may occur within it and to prevent the ignition of the specified gas or vapor surrounding the machine by sparks, flashes, or explosions of the specified gas or vapor which may occur within the machine casing.

1.26.11 Dust-Ignition-Proof Machine[3]

A dust-ignition proof machine is a totally enclosed machine whose enclosure is designed and constructed in a manner which will exclude ignitable amounts of dust or amounts which might affect performance or rating, and which will not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specific dust on or in the vicinity of the enclosure.

Successful operation of this type of machine requires avoidance of overheating from such causes as excessive overloads, stalling, or accumulation of excessive quantities of dust on the machine.

1.27 Machine with Encapsulated or Sealed Windings

1.27.1 Machine with Moisture Resistant Windings[4]

A machine with moisture-resistant windings is one in which the windings have been treated such that exposure to a moist atmosphere will not readily cause malfunction. This type of machine is intended for exposure to moisture conditions that are more excessive than the usual insulation system can withstand.

Alternating-current squirrel-cage machines of this type shall be capable of passing the test described in 12.63 as demonstrated on a representative sample or prototype.

1.27.2 Machine with Sealed Windings

A machine with sealed windings is one which has an insulation system which, through the use of materials, processes, or a combination of materials and processes, results in windings and connections that are sealed against contaminants. This type of machine is intended for environmental conditions that are more severe than the usual insulation system can withstand.

Alternating-current squirrel-cage machines of this type shall be capable of passing the tests described in 12.62 or 20.18.

Classification According to Variability of Speed

1.30 Constant-Speed Motor

A constant-speed motor is one in which the speed of normal operation is constant or practically constant; for example, a synchronous motor, an induction motor with small slip, or a dc shunt-wound motor.

1.31 Varying-Speed Motor

A varying-speed motor is one in which the speed varies with the load, ordinarily decreasing when the load increases; such as a series-wound or repulsion motor.

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[2] See ANSI/NFPA 70 National Electrical Code®, Article 500 for Hazardous Locations, Class I, Groups A, B, C or D.

[3] See ANSI/NFPA 70 National Electrical Code®, Article 500 for Hazardous Locations, Class II, Groups E, F or G.

[4] This machine shall be permitted to have any one of the enclosures described in 1.25 or 1.26.

1.32 Adjustable-Speed Motor

An adjustable-speed motor is one in which the speed can be controlled over a defined range, but when once adjusted remains practically unaffected by the load.

Examples of adjustable-speed motors are a direct-current shunt-wound motor with field resistance control designed for a considerable range of speed adjustment, or an alternating-current motor controlled by an adjustable frequency power supply.

1.33 Base Speed of an Adjustable-Speed Motor

The base speed of an adjustable-speed motor is the lowest rated speed obtained at rated load and rated voltage at the temperature rise specified in the rating.

1.34 Adjustable Varying-Speed Motor

An adjustable varying-speed motor is one in which the speed can be adjusted gradually, but when once adjusted for a given load will vary in considerable degree with change in load such as a dc compound-wound motor adjusted by field control or a wound-rotor induction motor with rheostatic speed control.

1.35 Multispeed Motor

A multispeed motor is one which can be operated at any one of two or more definite speeds, each being practically independent of the load; for example, a dc motor with two armature windings or an induction motor with windings capable of various pole groupings. In the case of multispeed permanent-split capacitor and shaded pole motors, the speeds are dependent upon the load.

Rating, Performance, and Test

1.40 Rating of a Machine

The rating of a machine shall consist of the output power together with any other characteristics, such as speed, voltage, and current, assigned to it by the manufacturer. For machines which are designed for absorbing power, the rating shall be the input power.

1.40.1 Continuous Rating

The continuous rating defines the load which can be carried for an indefinitely long period of time.

1.40.2 Short-Time Rating

The short-time rating defines the load which can be carried for a short and definitely specified time, less than that required to reach thermal equilibrium, when the initial temperature of the machine is within 5ºC of the ambient temperature. Between periods of operation the machine is de-energized and permitted to remain at rest for sufficient time to re-establish machine temperatures within 5ºC of the ambient before being operated again.

1.41 Efficiency

1.41.1 General

The efficiency of a motor or generator is the ratio of its useful power output to its total power input and is usually expressed in percentage.

1.41.2 Energy Efficient Polyphase Squirrel-Cage Induction Motor

An energy efficient polyphase squirrel-cage induction motor is one having an efficiency in accordance with 12.59 or 20.21 B.

1.41.3 Premium Efficiency Motor

A premium efficiency motor is one having an efficiency in accordance with 12.60 or 20.21 C.

1.42 Service Factor—AC Motors

The service factor of an AC motor is a multiplier which, when applied to the rated horsepower, indicates a permissible horsepower loading which may be carried under the conditions specified for the service factor (see 14.37).

1.43 Speed Regulation of DC Motors

The speed regulation of a dc motor is the difference between the steady no-load speed and the steady rated-load speed expressed in percent of rated-load speed.

1.43.1 Percent Compounding of Direct-Current Machines

The percent of the total field-ampere turns at full load that is contributed by the series field.

NOTES:

1. The percent compounding is determined at rated shunt field current.

2. The percent regulation of a compound-wound dc motor or generator is related to but not the same as percent compounding.

1.44 Voltage Regulation of Direct-Current Generators

The voltage regulation of a direct-current generator is the final change in voltage with constant field rheostat setting when the specified load is reduced gradually to zero, expressed as a percent of rated-load voltage the speed being kept constant.

Note: In practice, it is often desirable to specify the overall regulation of the generator and its driving machine, thus taking into account the speed regulation of the driving machine.

1.45 Secondary Voltage of Wound-Rotor Motors

The secondary voltage of wound-rotor motors is the open-circuit voltage at standstill, measured across the slip rings, with rated voltage applied on the primary winding.

1.46 Full-Load Torque

The full-load torque of a motor is the torque necessary to produce its rated horsepower at full-load speed. In pounds at a foot radius, it is equal to the horsepower times 5252 divided by the full-load speed.

1.47 Locked-Rotor Torque (Static Torque)

The locked-rotor torque of a motor is the minimum torque which it will develop at rest for all angular positions of the rotor, with rated voltage applied at rated frequency.

1.48 Pull-Up Torque

The pull-up torque of an alternating-current motor is the minimum torque developed by the motor during the period of acceleration from rest to the speed at which breakdown torque occurs. For motors which do not have a definite breakdown torque, the pull-up torque is the minimum torque developed up to rated speed.

1.49 Pushover Torque

The pushover torque of an induction generator is the maximum torque which it will absorb with rated voltage applied at rated frequency, without an abrupt increase in speed.

1.50 Breakdown Torque

The breakdown torque of a motor is the maximum torque which it will develop with rated voltage applied at rated frequency, without an abrupt drop in speed.

1.51 Pull-Out Torque

The pull-out torque of a synchronous motor is the maximum sustained torque which the motor will develop at synchronous speed with rated voltage applied at rated frequency and with normal excitation.

1.52 Pull-In Torque

The pull-in torque of a synchronous motor is the maximum constant torque under which the motor will pull its connected inertia load into synchronism, at rated voltage and frequency, when its field excitation is applied.

The speed to which a motor will bring its load depends on the power required to drive it, and whether the motor can pull the load into step from this speed, depends on the inertia of the revolving parts, so that the pull-in torque cannot be determined without having the Wk^2 as well as the torque of the load.

1.53 Locked-Rotor Current

The locked-rotor current of a motor is the steady-state current taken from the line, with the rotor locked and with rated voltage (and rated frequency in the case of alternating-current motors) applied to the motor.

1.54 No-Load Current

No-load current is the current flowing through a line terminal of a winding when rated voltage is applied at rated frequency with no connected load.

1.55 Temperature Tests

Temperature tests are tests taken to determine the temperature rise of certain parts of the machine above the ambient temperature, when running under a specified load.

1.56 Ambient Temperature

Ambient temperature is the temperature of the surrounding cooling medium, such as gas or liquid, which comes into contact with the heated parts of the apparatus.

Note: Ambient temperature is commonly known as “room temperature” in connection with air-cooled apparatus not provided with artificial ventilation.

1.57 High-Potential Tests

High-potential tests are tests which consist of the application of a voltage higher than the rated voltage for a specified time for the purpose of determining the adequacy against breakdown of insulating materials and spacings under normal conditions (see Part 3).

1.58 Starting Capacitance for a Capacitor Motor

The starting capacitance for a capacitor motor is the total effective capacitance in series with the starting winding under locked-rotor conditions.

1.59 Radial Magnetic Pull and Axial Centering Force

1.59.1 Radial Magnetic Pull

The radial magnetic pull of a motor or generator is the magnetic force on the rotor resulting from its radial (air gap) displacement from magnetic center.

1.59.2 Axial Centering Force

The axial centering force of a motor or generator is the magnetic force on the rotor resulting from its axial displacement from magnetic center.

Unless other conditions are specified, the value of radial magnetic pull and axial centering force will be for no load, with rated voltage, rated field current, and rated frequency applied as applicable.

1.60 Induction Motor Time Constants

1.60.1 General

When a polyphase induction motor is open-circuited or short-circuited while running at rated speed, the rotor flux-linkages generate a voltage in the stator winding. The decay of the rotor-flux linkages, and the resultant open-circuit terminal voltage or short-circuit current, is determined by the various motor time constants defined by the following equations:

1.60.2 Open-Circuit AC Time Constant

$$T''_{do} = \frac{X_M + X_2}{2\pi f r_2} \ (second)$$

1.60.3 Short-Circuit AC Time Constant

$$T''_{d} = \frac{X_S}{X_1 + X_M} T''_{do} \ (seconds)$$

1.60.4 Short-Circuit DC Time Constant

$$T_a = \frac{X_S}{2\pi f r_1 \left[1 + \frac{LL_S}{kW_1}\right]} \ (seconds)$$

1.60.5 X/R Ratio

$$X/R = \frac{X_S}{r_1 \left[1 + \frac{LL_S}{kW_1}\right]} \ (radians)$$

1.60.6 Definitions (See Figure 1-4)

r_1 = Stator dc resistance per phase corrected to operating temperature
r_2 = Rotor resistance per phase at rated speed and operating temperature referred to stator
X_1 = Stator leakage reactance per phase at rated current
X_2 = Rotor leakage reactance per phase at rated speed and rated current referred to stator
X_S = Total starting reactance (stator and rotor) per phase at zero speed and locked-rotor current
XM = Magnetizing reactance per phase
LL_S = Fundamental-frequency component of stray-load loss in kW at rated current
kW_1 = Stator I^2R loss in kW at rated current and operating temperature
f = Rated frequency, hertz
s = Slip in per unit of synchronous speed

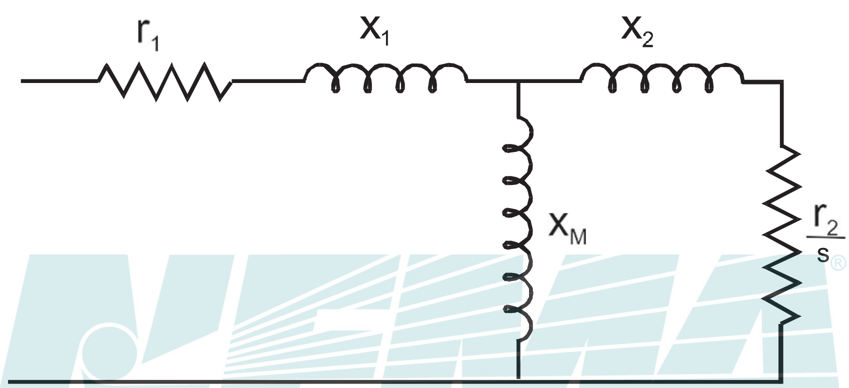

Figure 1-4
Equivalent
Circuit

Complete Machines and Parts

1.61 Synchronous Generator—Complete

1.61.1 Belted Type

A belted-type generator consists of a generator with a shaft extension suitable for the driving pulley or sheave, with either two or three bearings as required, and with rails or with a sliding base which has provision for adjusting belt tension.

1.61.2 Engine Type

An engine-type generator consists of a stator, rotor (without shaft), foundation caps or sole plates, and brush rigging support. No base, bearings, shaft, shaft keys, or foundation bolts are included in generators of this type.

1.61.3 Coupled Type

A coupled-type generator consists of a generator with shaft extension for coupling and with one or two bearings.

1.62 Direct-Current Generator—Complete

1.62.1 Belted Type

A belted-type generator consists of a generator with a shaft extension suitable for the driving pulley or sheave, with either two or three bearings as required, and with rails or with a sliding base which has provision for adjusting belt tension.

1.62.2 Engine Type

An engine-type generator consists of a field frame, armature (without shaft), foundation caps or sole plates (when required), and a brush rigging support. No base, bearings, shaft, shaft keys, or foundation bolts are included in generators of this type.

1.62.3 Coupled

Type A coupled-type generator consists of a generator with a shaft extension suitable for coupling, with either one or two bearings as required.

1.63 Face and Flange Mounting

1.63.1 Type C Face

A Type C face-mounting machine has a male pilot (rabbet) fit with threaded holes in the mounting surface. The mounting surface shall be either internal or external to the pilot fit (see Figure 4-3).

1.63.2 Type D Flange

A Type D flange-mounting machine has a male pilot (rabbet) fit with clearance holes in the mounting surface. The mounting surface is external to the pilot fit (see Figure 4-4).

1.63.3 Type P Flange

A Type P flange-mounting machine has a female pilot (rabbet) fit with clearance holes in the mounting surface. The mounting surface is external to the pilot fit (see Figure 4-5).

Classification of Insulation Systems

1.65 Insulation System Defined

An insulation system is an assembly of insulating materials in association with the conductors and the supporting structural parts. All of the components described below that are associated with the stationary winding constitute one insulation system and all of the components that are associated with the rotating winding constitute another insulation system.

1.65.1 Coil Insulation with its Accessories

The coil insulation comprises all of the insulating materials that envelop and separate the current-carrying conductors and their component turns and strands and form the insulation between them and the machine structure, including wire coatings, varnish, encapsulants, slot insulation, slot fillers, tapes, phase insulation, pole-body insulation, and retaining ring insulation when present.

1.65.2 Connection and Winding Support Insulation

The connection and winding support insulation includes all of the insulation materials that envelop the connections, which carry current from coil to coil, and from stationary or rotating coil terminals to the points of external circuit attachment; and the insulation of any metallic supports for the winding.

1.65.3 Associated Structural Parts

The associated structural parts of the insulation system include items such as slot wedges, space blocks and ties used to position the coil ends and connections, any non-metallic supports for the winding, and field-coil flanges.

1.66 Classification of Insulation Systems

Insulation systems are divided into classes according to the thermal endurance of the system for temperature rating purposes. Four classes of insulation systems are used in motors and generators, namely Classes A, B, F, and H. These classes have been established in accordance with IEEE Std 1.

Insulation systems shall be classified as follows:

Class A- An insulation system, which by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class A temperature specified in the temperature rise standard for the machine under consideration.

Class B- An insulation system, which by experience or accepted test, can be shown to have suitable thermal endurance when operating at the limiting Class B temperature specified in the temperature rise standard for the machine under consideration.

Class F- An insulation system, which by experience or accepted test, can be shown to have suitable thermal endurance when operating at the limiting Class F temperature specified in the temperature rise standard for the machine under consideration.

Class H- An insulation system, which by experience or accepted test, can be shown to have suitable thermal endurance when operating at the limiting Class H temperature specified in the temperature rise standard for the machine under consideration.

“Experience”, as used in this standard, means successful operation for a long time under actual operating conditions of machines designed with temperature rise at or near the temperature rating limit.

“Accepted test”, as used in this standard, means a test on a system or model system which simulates the electrical, thermal, and mechanical stresses occurring in service.

Where appropriate to the construction, tests shall be made in accordance with the following applicable IEEE test procedures:

a. Std 43
b. Std 117
c. Std 275
d. Std 304

For other constructions for which tests have not been standardized, similar procedures shall be permitted to be used if it is shown that they properly discriminate between service-proven systems known to be different.

When evaluated by an accepted test, a new or modified insulation system shall be compared to an insulation system on which there has been substantial service experience. If a comparison is made on a system of the same class, the new system shall have equal or longer thermal endurance under the same test conditions; if the comparison is made with a system of a lower temperature class, it shall have equal or longer thermal endurance at an appropriately higher temperature. When comparing systems of different classes, an appropriate higher temperature shall be considered to be 25 degrees Celsius per class higher than the temperature for the base insulation system class.

Miscellaneous

1.70 Nameplate Marking

A permanent marking of nameplate information shall appear on each machine, displayed in a readily visible location on the machine enclosure.

1.70.1 Nameplate

A permanent marking of nameplate information shall appear on each machine, displayed in a readily visible location on the machine enclosure. If the electric machine is so enclosed or incorporated in the equipment that its rating plate will not be easily legible, the manufacturer should on request, supply a second rating plate to be mounted on the equipment.

1.70.2 Additional Nameplate Markings

In addition to the specific nameplate markings set forth in the various Parts for each particular size or type of machine, the following are examples of information that may also be included on a nameplate:

a. Manufacturer’s name, mark, or logo
b. Manufacturer’s plant location
c. Manufacturer’s machine code
d. Manufacturer’s model number or catalog number
e. Serial number or date of manufacture
f. Enclosure or IP code (see Part 5)
g. Method of cooling or IC code (see Part 6)
h. Applicable rating and performance standard(s): e.g., NEMA MG 1 or IEC 60034-1
i. Maximum momentary overspeed
j. For ac machines, the rated power factor
k. Maximum ambient if other than 40°C
l. Minimum ambient temperature
m. Maximum water temperature for water-air-cooled machines if greater than 25°C
n. Altitude if greater than 3300 ft (1000 m)
o. Connection diagram located near or inside the terminal box
p. Approximate weight of the machine, if exceeding 66 lbs (30 kg)
q. Direction of rotation for unidirectional machines, indicated by an arrow

1.71 Code Letter

A code letter is a letter which appears on the nameplate of an alternating-current motor to show its locked-rotor kVA per horsepower. The letter designations for locked rotor kVA per horsepower are given in 10.37.

1.72 Thermal Protector

A thermal protector is a protective device for assembly as an integral part of the machine and when properly applied, protects the machine against dangerous over-heating due to overload and in a motor, failure to start.

Note: The thermal protector may consist of one or more temperature sensing elements integral with the machine and a control device external to the machine.

1.73 Thermally Protected

The words "thermally protected" appearing on the nameplate of a motor indicate that the motor is provided with a thermal protector.

1.74 Over Temperature Protection

For alternating-current medium motors, see 12.56.

For direct-current medium motors, see 12.80.

1.75 Part-Winding Start Motor

A part-winding start polyphase induction or synchronous motor is one in which certain specially designed circuits of each phase of the primary winding are initially connected to the supply line. The remaining circuit or circuits of each phase are connected to the supply in parallel with initially connected circuits, at a predetermined point in the starting operation (see 14.38).

1.76 Star (Wye) Start, Delta Run Motor

A star (wye) start, delta run polyphase induction or synchronous motor is one arranged for starting by connecting to the supply with the primary winding initially connected in star (wye), then reconnected in delta for running operation.

1.77 Constant Flux

Constant flux operation at any point occurs when the value of air gap magnetic flux is equal to the value which would exist at the base rating (e.g., rated voltage, frequency, and load).

1.78 Deviation Factor

The deviation factor of a wave is the ratio of the maximum difference between corresponding ordinates of the wave and of the equivalent sine wave to the maximum ordinate of the equivalent sine wave when the waves are superimposed in such a way as to make this maximum difference as small as possible. The equivalent sine wave is defined as having the same frequency and the same rms value as the wave being tested.

1.79 Marking Abbreviations for Machines

When abbreviations are used for markings which are attached to the motor or generator (rating plates, connection, etc.), they shall consist of capital letters because the conventional marking machines provide only numbers and capital letters and shall be in accordance with the following:

Abbreviation	Marking Indicated	Abbreviation	Marking Indicated
A	Ampere	MAX	Maximum
AC	Alternating-current	MFD	Microfarad
AMB	Ambient	MG	Motor-generator
AO	Air over	MH	Milihenry
ARM	Armature	MHP	Milihorsepower
BB	Ball bearing	MIN	Minimum
BRG	Bearing	MIN	Minute
C	Celsius (Centigrade) degrees	MTR	Motor
CAP	Capacitor	NEMA or DES**	NEMA Design Letter
CCW	Counterclockwise	NO or #	Number
CL	Class or Classification	OZ-FT	Ounce-feet
CODE	Code Letter	OZ-IN	Ounce-inch
CONN	Connection	PF	Power factor
CONT	Continuous	PH	Phase, Phases or Number of Phases
CFM	Cubic feet per minute	PM	Permanent magnet
COMM	Commutating (interpole)	RB	Roller bearing
COMP	Compensating	RECT	Rectifier or rectified
CPD	Compound	RES	Resistance
C/S	Cycles per second	RHEO	Rheostat
CW	Clockwise	RMS	Root mean square
DC	Direct-current	ROT	Rotation
DIAG	Diagram	RPM	Revolutions per minute
EFF	Efficiency	RTD	Resistance temperature detector
ENCL	Enclosure	SB	Sleeve bearing
EXC	Exciter or Excitation	SEC	Second (time)
F	Fahrenheit, degrees	SEC	Secondary
FF	Form factor	SER	Serial or Serial number
FHP	Fractional horsepower	SF	Service factor
FLA	Full load amperes	SFA	Service factor amperes
FLD	Field	SH	Shunt
FR	Frame	SPL	Special
FREQ	Frequency	STAB	Stabilized or stabilizing
GEN	Generator	STD	Standard
GPM	Gallons per minute	TACH	Tachometer
GPS	Gallons per second	TC	Thermocouple
H	Henry	TEMP	Temperature
HI	High	TEMP RISE	Temperature rise
HP	Horsepower	TERM	Terminal
HR	Hour	TH	Thermometer
Hz	Hertz	TIME	Time rating
IND	Inductance or Induction	TORQ	Torque
INS	Insulation System Class	TYPE	Type
KVA	Kilovolt-ampere	V	Volt(s) or Voltage
KVAR	Reactive Kilovolt-ampere	VA	Volt-amperes
KW	Kilowatt	VAR	Reactive volt-amperes
L*	Line	W	Watt
LB-FT	Pound-feet	WDG	Winding
LO	Low	WT	Weight
LRA	Locked rotor amperes		

*Shall be permitted to be used in conjunction with a number.
**Used in conjunction with a letter.