General Purpose Form-wound Squirrel Cage Induction Motors—185 kW (250 hp) through 2240 kW (3000 hp)

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General Purpose Form-wound Squirrel Cage Induction Motors—185 kW (250 hp) through 2240 kW (3000 hp)

1 Scope

1.1 General

1.1.1 This standard covers the requirements for form-wound induction motors for use in general purpose petroleum, chemical and other industrial severe duty applications and with the following characteristics:

a) rated 185 kW [250 horsepower (hp)] through 2240 kW (3000 hp) for four-, six-, and eight-pole speeds;

b) rated less than 600 kW (800 hp) for two-pole (3000 or 3600 RPM) motors of totally enclosed construction;

c) rated less than 930 kW (1250 hp) for two-pole motors of WP-II type enclosures;

d) rated less than 375 kW (500 hp) for vertical motors;

e) drive centrifugal loads;

f) drive loads having inertia values not exceeding those listed in NEMA MG 1 Part 20; and

g) operated as motors, not induction generators.

NOTE Motors larger than that covered above and motors in other applications should be specified in accordance with API 541.

1.1.2 Application of the API Monogram—If the product is manufactured at a facility licensed by API and it is intended to be supplied bearing the API Monogram, the requirements of Annex A apply.

1.1.3 A datasheet is provided in Annex B. The purchaser is not required to complete and provide the datasheet for pre-configured or catalog based motors manufactured with standard features. However, the purchaser shall provide the completed datasheet to specify motor requirements for a specific application and/or with options and features beyond the above description. A datasheet guide, which provides detailed information to assist with completion of the datasheet, is provided in Annex C.

1.2 Usual Service Conditions

Unless otherwise specified, motors conforming to this standard shall be suitable for operation within their rating under the following service conditions:

a) exposure to an ambient temperature in the range of –18 °C to 40 °C (0 °F to 104 °F);

b) exposure to a maximum altitude of 1000 m (3300 ft) above sea level;

c) indoor or outdoor severe duty applications, such as humid, chemical (corrosive), or salty atmospheres;

d) horizontal foot mounted;

e) installation in a Class I, Zone 2 or Division 2 hazardous (classified) location;

f) constant frequency sinusoidal input power;

g) not subject to frequent transient overvoltages (e.g. switching surges, lightning surges); and

h) direct coupled without a gear, fluid coupling, or other speed modification device.

1.3 Unusual Service Conditions

Unusual service conditions shall be brought to the attention of those responsible for the design, manufacture, application, and operation of the motor. Among such unusual conditions are:

a) exposure to:

   1) combustible, explosive, abrasive, or conductive dust;

   2) dirty operating conditions where the accumulation of dirt will interfere with normal ventilation;

   3) nuclear radiation;

   4) abnormal shock, vibrations, or mechanical loading from external sources;

   5) abnormal axial or side thrust imposed on the motor shaft;

   6) altitude or ambient temperature outside the range covered in 1.2;

   7) reciprocating or positive displacement loads; and

   8) offshore applications;

b) conditions under which the variation from rated voltage or frequency, or both, exceeds the limits given in NEMA MG 1 (or IEC 60034-1);

c) conditions under which the AC supply voltage is unbalanced by more than the limits given in NEMA MG 1 (or IEC 60034-1);

d) operation at speeds other than rated speed;

e) operation on an adjustable speed drive;

f) load inertia greater than and/or starting conditions more severe than given in NEMA MG 1;

g) orientation of a foot-mounted motor in any position other than horizontal;

h) vertical flange-mounted motors;

i) coupled through a belt, gear, fluid coupling or other speed modification device; and

j) requirements for enclosure purging or pre-start ventilation.

NOTE A bullet (●) at the beginning of a paragraph indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the datasheets (see Annex B); otherwise it should be stated in the quotation request or in the order.

1.4 Dimensions and Standards

● **1.4.1** Both the SI and U.S. customary system of units and dimensions are used in this standard. Data, drawings, and hardware (including fasteners) related to equipment supplied to this standard shall use the system of units specified by the purchaser. An alternate system of units for hardware (including fasteners and flanges) may be substituted if mutually agreed upon by the purchaser and the vendor.

• **1.4.2** This document recognizes two different systems of standards for the manufacturing and testing of electrical motors: the North American ANSI, IEEE, and NEMA standards and the international IEC and ISO standards. The North American standards are the base documents. When specified by the purchaser, the corresponding international standards are acceptable for use as alternatives; however, this shall not be construed that they are identical to the North American standards. The selection of which system of standards to be utilized shall depend upon the motor's application and site location.

NOTE The purchaser should be aware that specific requirements contained within corresponding standards may differ.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Standard 541, *Form-wound Squirrel Cage Induction Motors—375 kW (500 Horsepower) and Larger*

API Standard 670, *Machinery Protection Systems*

ABMA Standard 20 [1], *Radial Bearings of Ball, Cylindrical Roller and Spherical Roller Types—Metric Design*

AISI [2], *Standards of the American Iron and Steel Institute*

ANSI/ASA S12.54 [3], *Acoustics—Determination of sound power levels and sound energy levels of noise sources using sound pressure—Engineering method in an essentially free field over a reflecting plane*

ASTM A976 [4], *Standard Classification of Insulating Coatings for Electrical Steels by Composition, Relative Insulating Ability and Application*

ASTM D790, *Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials*

CENELEC EN 60751 [5], *Industrial platinum resistance thermometers and platinum temperature sensors*

IEC 60034 (all parts) [6], *Rotating electrical machines*

IEC 60072 (all parts), *Dimensions and output series for rotating electrical machines*

IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

IEC 60404-1-1, *Magnetic materials*—Part 1-1: *Classification—Surface insulations of electrical steel sheet, strip and laminations*

IEEE 43 [7], *IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery*

IEEE 112, *IEEE Standard Test Procedure for Polyphase Induction Motors and Generators*

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1 American Bearing Manufacturers Association, 2025 M Street, NW, Suite 800, Washington, DC 20036, www.abma-dc.org.
2 American Iron and Steel Institute, 1540 Connecticut Avenue, NW, Suite 705, Washington, DC 20036, www.steel.org.
3 Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, NY 11747-4300, www.acousticalsociety.org.
4 ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
5 European Committee for Standardization (CEN-CENELEC), Avenue Marnix 17, B-1000, Brussels, Belgium, www.cen.eu.
6 International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211, Geneva 20, Switzerland, www.iec.ch.
7 Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08854, www.ieee.org.

IEEE 303, *IEEE Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations*

IEEE 522, *IEEE Guide for Testing Turn Insulation of Form-Wound Stator Coils for Alternating-Current Electric Machines*

IEEE 620, *IEEE Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines*

IEEE 1776, *IEEE Recommended Practice for Thermal Evaluation of Unsealed or Sealed Insulation Systems for AC Electric Machinery Employing Form-Wound Pre-Insulated Stator Coils for Machines Rated 15 000 V and Below*

ISO 15 [8], *Rolling bearings—Radial bearings—Boundary dimensions, general plan*

ISO 68-1 (DIN/ISO 68-1), *ISO General purpose screw threads—Basic profile—Part 1 Metric screw threads*

ISO 178, *Plastics—Determination of flexural properties*

ISO 492, *Rolling bearings—Radial bearings—Geometrical product specifications (GPS) and tolerance values*

ISO 3744, *Acoustics—Determination of sound power levels and sound energy levels of noise sources using sound pressure—Engineering method for an essentially free field over a reflecting plane*

ISO 5753-1, *Rolling bearings—Internal clearances*—Part 1: *Radial internal clearance for radial bearings*

NEMA MG 1 [9], *Motors and Generators*

NFPA 70 [10], *National Electrical Code*

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1
accelerating torque
Accelerating torque of a motor is the difference between the input torque to the rotor and the sum of the load and loss torque; the net torque available for accelerating the rotating parts.

3.2
adjustable speed drive
ASD
Refers to the electronic equipment used to regulate the operating speed of the motor and driven equipment by controlling the frequency and voltage.

NOTE Other terms commonly used are variable speed drive (VSD), adjustable frequency drive (AFD), and variable frequency drive (VFD); however, use of these terms is discouraged.

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[8] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.
[9] National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1752, Rosslyn, Virginia 22209, www.nema.org.
[10] National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169-7471, www.nfpa.org.

3.3
breakdown torque
Breakdown torque of a motor is the maximum torque developed with rated voltage applied at rated frequency without an abrupt drop in speed.

3.4
dN factor
The product of bearing bore size, as measured in millimeters, and rated speed, in revolutions per minute.

3.5
lateral critical speed
Shaft rotational speed at which the rotor-bearing-support system is in a state of resonance.

NOTE The basic identification of critical speeds is made from the natural frequencies of the system and of the forcing phenomena. If the frequency of any harmonic component of a periodic forcing phenomenon is equal to or approximates the frequency of any mode of rotor vibration, a condition of resonance may exist. If resonance exists at a finite speed, that speed is called a critical speed. This standard is concerned with actual resonant speeds rather than various calculated values. Actual critical speeds are not calculated undamped values but are critical speeds confirmed by test-stand data. Critical speeds above the maximum test speed should be calculated damped values.

3.6
locked-rotor torque
Locked-rotor torque of a motor is the minimum torque that it will develop at rest for all angular positions of the rotor with rated voltage applied at rated frequency.

3.7
observed
The purchaser shall be notified of the timing of the inspection or test. However, the inspection or test shall be performed as scheduled, and if the purchaser or his or her representative is not present, the vendor shall proceed to the next step.

3.8
power factor
Power factor of an AC motor is the ratio of the kilowatt input to the kVA input and is usually expressed as a percentage.

3.9
pull-up torque
Pull-up torque of an AC 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 that do not have a definite breakdown torque, the pull-up torque is the minimum torque developed up to the rated speed.

3.10
purchaser
The agency that issues the order and specification to the vendor.

3.11
reed frequency
Term used to designate the cantilevered bending mode (lateral frequency) about a fixed base.

3.12
service factor
Service factor of a motor is a multiplier which is applied to the rated power to indicate a permissible power loading that may be carried under the conditions specified for the service factor (see NEMA MG 1).

NOTE IEC standards do not recognize service factor.

3.13
static deflection
Static deflection of a motor is the distance the center of gravity of a vertical motor would be displaced downward from its original position if the motor were horizontally mounted. This value assumes that the motor uses its normal mounting and fastening means but that the foundation to which it is fastened does not deflect.

NOTE See NEMA MG 1 Part 20.

3.14
stiff-shaft motor
A motor that operates below its first mechanical rotor-system resonant speed, as excited by a rotor unbalance.

NOTE Other terms commonly used are stiff-rotor motor, rigid-rotor motor, and rigid-shaft motor.

3.15
vendor
The agency that supplies the equipment.

NOTE Supplier is also used interchangeably with vendor in this standard.

3.16
witnessed
Means that a hold shall be applied to the production schedule and the inspection or test shall be carried out with the purchaser or his or her representative in attendance. For vibration, unbalance response, and heat run tests, this requires confirmation of the successful completion of a preliminary test.

4 Basic Design

4.1 General

4.1.1 The equipment (including auxiliaries) covered by this standard shall be suitable for the specified operating conditions and shall be designed and constructed for a minimum service life of 25 years and, except for required bearing maintenance, at least five years of uninterrupted continuous operation. It is recognized that this is a design criterion and that uninterrupted operation for this time period involves factors beyond the vendor's control.

4.1.2 Motors shall have a 1.0 service factor rating. Motors shall be capable of continuous operation at rated load and temperature rise in accordance with 4.3.1 when operated, both mechanically and electrically, at rated power, voltage, and frequency. In applications that require an overload capacity, a higher base rating, instead of a service factor rating, shall be used to avoid exceeding the temperature rise specified in 4.3.1 and to provide adequate torque capacity.

• **4.1.3** Unless otherwise specified, the A-weighted maximum sound pressure level of the motor shall not exceed 85 dBA at any location at a reference distance of 1 meter (3 ft) with the motor operating at no load, full voltage, rated frequency, and sinusoidal power. The measuring and reporting of sound pressure level data shall be in accordance with ANSI S12.54 or ISO 3744.

• **4.1.4** The motor and all of its auxiliary devices shall be suitable for and in accordance with the area classification system specified by the purchaser on the datasheets. Auxiliary devices shall be listed or certified, where required, in accordance with the area classification system specified.

NOTE See IEEE 303, IEEE 1349, and IEC 60079 for additional guidance and information on the application of motors and accessories in hazardous locations.

4.2 Electrical Design

4.2.1 General

Unless otherwise specified, motor electrical performance and characteristics shall be in accordance with NEMA MG 1.

4.2.2 Voltage and Frequency

The standard three phase voltage ratings are:

a) 60 Hz: 2300 V, 4000 V, and 6600 V;

b) 50 Hz: 3000 V, 3300 V, 6000 V, and 6600 V.

Dual voltage motors are acceptable only for 2300/4000 V ratings.

NOTE When motors supplied under this standard are to be applied on a non-sinusoidal source and/or an adjustable speed application, the vendor should be consulted to determine if the motor will operate successfully over the required speed range. Refer to NEMA MG 1 Part 30 or IEC 60034-17. Proper selection of the motor and drive is required to avoid the following conditions:

1) motor RMS (root mean square) current exceeding the continuous sinusoidal nameplate rating due to excessive voltage harmonics or improper volt/hertz levels;
2) excessive winding temperature due to insufficient cooling, excessive torque levels, improper volt/hertz levels, or increased losses due to harmonics;
3) insufficient motor accelerating torque at reduced speeds due to insufficient volt/hertz levels or limitations in the drive's short-time current capacity;
4) increased noise levels due to increased fan noise (above base speed), excitation of mechanical resonances, or magnetic noise caused by supply source harmonics;
5) mechanical failure of the motor or coupling due to torque pulsations, operation at or near mechanical resonances, or excess speed;
6) winding failures due to repetitive high-amplitude voltage spikes created by the drive's carrier frequency and motor feeder cable system;
7) damage to the motor and drive due to improper application of power factor correction capacitors or harmonic filters;
8) higher motor temperatures that may limit application in Zone 2 or Division 2 hazardous (classified) locations;
9) shaft-to-bearing voltages/currents resulting from common mode currents flowing through stray system capacitances to ground via the bearings (these currents are induced from the ASD's high rate of change (dv/dt) of output voltage); and
10) extended operation at slow speed causing insufficient cooling or lubrication.

4.2.3 Motor Design and Starting Characteristics

4.2.3.1 Motors with power/speed ratings defined per NEMA MG 1 Part 12 [which covers up to 375 kW (500 hp), depending on speed] shall meet the requirements for Design B torque and current characteristics. Where applicable, the torque and current characteristics shall meet the requirements of IEC 60034-12 Design N.

4.2.3.2 Motor ratings above those defined for NEMA Design B shall meet, as a minimum, the standard torque characteristics defined in NEMA MG 1 Part 20. Where applicable, the torque characteristics shall meet the requirements of IEC 60034-12 Design N.

4.2.3.3 Motors shall be capable of accelerating a load with 80 % of rated voltage at the motor terminals where the load torque requirement varies with the square of the speed and the full-load torque requirement is equal to or less than the rated full-load torque of the motor. The load inertia for this condition shall be less than or equal to the maximum inertia given within NEMA MG 1 for four-pole and slower motors, and less than or equal to one half the inertia listed for two-pole motors.

4.2.3.4 When the motor speed-torque curve at the conditions specified in 4.2.3.3 is plotted over the load speed-torque curve, the motor developed torque shall exceed the load torque by a minimum of 10 % (motor rated torque as base) at all locations throughout the speed range up to the motor breakdown torque point.

• **4.2.3.5** When specified and when the purchaser provides particular load torque and inertia data, the motor vendor shall validate with the proposal that the 10 % minimum accelerating torque is maintained at 80 % rated voltage.

4.2.3.6 The motor shall be designed for a lifetime minimum of 5000 full voltage starts. Design features outlined in 4.3 shall be demonstrated in the stator construction and/or documented as part of the design. The rotor design shall have proven field service and shall be demonstrated or documented to include features of 4.4.5.

4.2.3.7 With rated voltage and frequency applied, the motor locked-rotor current shall not be less than 450 % of the full-load current. Additionally, the locked-rotor current shall not exceed the values given in NEMA MG 1 Part 12, where applicable. For motors larger than those listed in NEMA MG 1 Part 12, the locked-rotor current shall not exceed 650 % of the full-load current, including any tolerances in the calculations and uncertainties in the test methods.

4.3 Winding and Insulation Systems

4.3.1 Stator windings shall have an epoxy based, vacuum pressure impregnated, nonhygroscopic insulation system, including lead and coil connections. If bus bars are used as interface connections, they shall have the same insulation properties as would wire lead and coil connections. As a minimum, the insulation system shall meet the criteria for Class F insulation listed in NEMA MG 1 or IEC 60034-18-31, as applicable. The allowable temperature rise above ambient, 40 °C (104 °F) shall not exceed that listed for Class B insulation. For ambient temperatures above 40 °C (104 °F), the allowable temperature rise shall be reduced by the amount equal to the temperature above 40 °C (104 °F), so as not to exceed the total temperature limits (ambient, rise and hot spot) for Class B insulation. For windings operating at 6000 V (line-line) or greater, the use of partial discharge suppressant materials is required.

4.3.2 The insulation system shall be capable of withstanding the surge test specified in 6.1.4.

4.3.3 All stator insulation systems shall be service proven and shall have been subjected to thermal evaluation in accordance with IEEE 1776 or IEC 60034-18-31, as applicable.

4.3.4 The stator windings, including the lead connections, shall have a sealed insulation system that is capable of withstanding a sealed winding conformance test in accordance with NEMA MG 1 Part 20. The sealed insulation system shall be a proven design with temperature classification per IEEE 1776 or IEC 60034-18-31, as applicable. This standard shall not be interpreted to require a sealed winding conformance test unless specified by the purchaser.

4.3.5 The entire stator winding insulation system including winding connections and terminal leads shall be sufficiently secured to prevent insulation cracking and fatigue as a result of motion and vibrations during starting, operation and electrical transient conditions which produce electromechanical forces in the stator windings. The windings shall withstand electromagnetic and mechanical forces under normal operating conditions, the starting requirements specified in 4.2.3.3 and 4.2.3.6, and the forces associated with phase-to-phase and three phase short circuits with 110 % of rated voltage.

4.3.6 The insulation system, including leads, shall be compatible with mineral oil based lubricants. Type test and/or design information shall be supplied when requested on identical lead insulating material to verify this requirement has been satisfied.

4.3.7 Conductors from the stator windings to the main terminals shall be insulated and be separated from ground planes so that the effects of partial discharge are minimized. The number of these stator conductors shall be the fewest practical to minimize the number of connection points. These conductors shall have Class F (minimum) insulation and in total be sized for a minimum of 125 % of rated current while not exceeding Class B temperature rise. Conductors shall be braced and protected from chafing against the motor frame and terminal box. If electrical grade fiberglass is used for bracing purposes, it shall be vacuum pressure impregnated so as to be made nonhygroscopic.

4.3.8 The type of slot wedges used (magnetic or non-magnetic) shall be indicated on the vendor's datasheet. If a magnetic wedge system is used, it shall comply with all of the following.

a) The magnetic slot wedge material shall be of the amorphous or composite design, be Class F insulation as a minimum, and have a minimum flexural strength at 120 °C of 150 MPa (22,000 psi) as measured using ISO 178 or ASTM D790.

b) The magnetic slot wedge design shall be a system that includes rigid slot wedge material and a global vacuum pressure impregnation (VPI) system.

c) The wedge-to-slot interface shall be a tight fit that will support the wedge.

d) The wedge shall fit tight up against the coil so that the stick will bond to the coil but still permit the wedge to be properly inserted into the slot without damage.

NOTE Magnetic slot wedges may improve the efficiency and temperature rise performance of machines, but there have been wedge failures in some cases due to poor fit, weak materials, and inadequate impregnation. For machines that use magnetic wedges, the purchaser may evaluate the vendor's experience with the wedge system used.

4.4 Mechanical Design

4.4.1 Enclosures

4.4.1.1 General requirements include the following.

a) Enclosure parts shall be made of cast or nodular iron, cast steel, or steel plate.

b) All enclosure parts shall have a minimum rigidity equivalent to that of sheet steel with a nominal thickness of 3.0 mm ($^1/_8$ in.).

c) Designs in which the stator laminations form a part of the external enclosure are not acceptable.

d) The motor shall be totally enclosed fan-cooled (TEFC/IC411, minimum IP44) or weather-protected Type II (WP-II/ IC01, minimum IP24W) as defined in 4.4.1.2 and 4.4.1.3.

4.4.1.2 Totally enclosed fan-cooled (TEFC) motors shall meet the following criteria.

a) Fan covers shall be made of metal having a minimum rigidity equivalent to that of steel plate with a nominal thickness of 3.0 mm ($^1/_8$ in.). The air intake opening shall be guarded by a grill or a metal screen. Protective grills or metal screens shall be fabricated from not less than 1.25 mm (0.049 in.) AISI 300 series stainless steel [or European Standard (EN) equivalent] with a maximum mesh of 6.4 mm ($^1/_4$ in.). Where the motor will be installed offshore, AISI 316 (or EN equivalent) material shall be supplied.

b) Sheet metal covers or wrappers used to form air passages over the enclosure shall have a minimum rigidity equivalent to that of steel plate with a nominal thickness of 3.0 mm ($^1/_8$ in.).

c) Corrosion-resistant, replaceable automatic drainage fittings shall be provided and located as close as practical to the lowest point of the motor enclosure. These fittings shall be shown on the outline drawing.

4.4.1.3 Weather-protected Type II (WP-II) enclosures shall meet the following criteria.

a) Ventilation openings shall be limited to a maximum size of 6.4 mm (1/4 in.) by design or by the use of metal screens. The screens shall be fabricated from not less than 1.25 mm (0.049 in.) AISI 300 series stainless steel (or EN equivalent) with a maximum mesh of 6.4 mm (1/4 in.). Where the motor will be installed offshore, AISI 316 material (or EN equivalent) shall be supplied.

b) Motors shall be constructed so that any accumulation of water will drain from the motor.

c) Airflow inlet filters of standard types and sizes shall be furnished. Air filters shall be designed to permit easy removal and replacement while the motor is running.

d) Filters shall be of the reusable, cleanable type and shall be selected to remove 90 % of particulates 10 micron and larger or as specified on the datasheet. The entire filter element and assembly shall be constructed of AISI 300 series stainless steel (or EN equivalent). The screens downstream of the filters shall have a maximum mesh of 13 mm (1/2 in.).

e) Threaded connections shall be furnished for the future connection of an instrument to measure the pressure drop across the filters.

• f) When specified, a switch, gauge, or transmitter to measure the pressure drop across the filters shall be provided.

4.4.2 Frame and Mounting Plates

4.4.2.1 TEFC frames shall be of cast iron construction. WP-II frames shall be of cast or nodular iron, cast steel, or welded steel plate construction. The frame shall be provided with removable end brackets or end plates to permit removal of the rotor and facilitate replacement of stator coils.

4.4.2.2 Horizontal foot mounted motors shall be equipped with vertical jackscrews located at each foot to facilitate alignment.

• **4.4.2.3** Mounting plates (baseplates or soleplates), when specified, shall be machined steel plate and supplied with horizontal jackscrews (for motor movement in the horizontal plane) the same size as or larger than the vertical jackscrews. The lugs holding these jackscrews shall be attached to the mounting plates so that they do not interfere with the installation or removal of the drive element and the installation or removal of shims used for alignment.

4.4.2.4 The horizontal and vertical jackscrews shall be M16 ISO 68 (5/8 in. with UNC threads) minimum diameter.

4.4.2.5 The frame support or supports shall be provided with two pilot holes for dowels. The holes shall be within 45 degrees of vertical (as near the vertical as practical) and shall be located to provide adequate space for field drilling, reaming, and placement of dowels.

4.4.2.6 Lifting lugs, through holes, or eyebolts shall be provided for lifting major components and the assembled motor.

4.4.2.7 Mounting surfaces shall meet the following criteria.

a) They shall be machined to a finish of 6 micrometers (250 micro-in.) arithmetic average roughness (Ra) or better.

b) To prevent a soft foot, they shall be in the same horizontal plane within 125 micrometers (0.005 in.).

c) Each mounting surface shall be machined within a flatness of 40 micrometers per linear meter (0.0005 in. per linear ft) of mounting surface.

d) Different mounting planes shall be parallel to each other within 170 micrometers per meter (0.002 in. per ft).

e) The upper machined or spot faced surface shall be parallel to the mounting surface.

f) Hold-down bolt holes shall be drilled perpendicular to the mounting surface or surfaces, shall be machined or spot faced to a diameter two times that of the hole and, to allow for equipment alignment, shall be 13 mm (1/2 in.) larger in diameter than the hold down bolt.

4.4.3 Fans

Fan systems, blades, and housings shall be designed to prevent sparking as a result of mechanical contact or static discharge. Bi-directional fans are preferred. If a unidirectional fan is used, the rotation of the fan shall be indicated by a rotation arrow in accordance with 4.4.11 mounted on the motor.

4.4.4 Hardware

All the enclosure's bolts, studs, and other fastening devices up through M12 (1/2 in.) size, shall be AISI 300 series (or EN equivalent) stainless steel. Where the motor will be installed offshore AISI 316 material (or EN equivalent) shall be supplied.

4.4.5 Rotating Element

4.4.5.1 General

4.4.5.1.1 No shaft-straightening technique is permitted during or after fabrication of the rotor.

• **4.4.5.1.2** When non-contacting eddy current vibration probes are specified, the probe-mounting and shaft preparation requirements of API 541 shall apply.

4.4.5.2 Rotor Cage Material

Die cast aluminum rotor cages are acceptable for motors rated up to 750 kW (1000 hp). For motors rated above 750 kW (1000 hp), the cage construction shall be of fabricated copper or copper alloy. All brazing materials shall be phosphorous free to prevent hydrogen sulfide attack.

4.4.6 Dynamics

A stiff-shaft motor determined with the motor mounted on a massive foundation as described in API 541 shall be provided. Lateral natural frequencies, which can lead to resonance amplification of vibration amplitudes, shall be above the maximum normal operating speed frequency by at least 15 %. The motor shall be capable of demonstrating a minimum 15 % separation margin during an unbalance response (coast down) test.

4.4.7 Bearings, Bearing Housings, and Seals

4.4.7.1 Bearings

4.4.7.1.1 Hydrodynamic radial bearings with oil ring lubrication shall be provided for horizontal motors unless otherwise specified in 4.4.7.1.6.

4.4.7.1.2 Hydrodynamic radial bearings shall be split for ease of assembly. The bearings on each end of the motor shall be identical.

4.4.7.1.3 The design of the hydrodynamic bearing housing shall not require removal of the lower half of the end bell or plates, ductwork, or coupling hub to permit replacement of shaft seals or bearing liners, pads, or shells.

4.4.7.1.4 Hydrodynamic bearing temperatures shall not exceed 93 °C (200 °F) as measured by resistance temperature detectors (RTDs) with the motor operating at rated output and at the maximum rated ambient temperature indicated on the datasheet.

4.4.7.1.5 The fit between the outside of the bearing shell and the bearing housing of hydrodynamic bearings shall be zero clearance to an interference fit at ambient temperature.

• **4.4.7.1.6** When specified, antifriction bearings may be supplied for horizontal motors. The following conditions shall be met.

a) The dN factor shall be less than 300,000.

b) Bearings shall have an ABMA or ISO L10 life of at least 100,000 hours in direct coupled applications with continuous operation at rated conditions.

c) Ball and roller bearing manufacturing tolerance limits shall be ABEC 1 in accordance with ABMA 20 or ISO Normal in accordance with ISO 492. Ball bearings shall have internal clearances in accordance with ABMA 20 or ISO 5753-1, Group 3 (C/3 clearance) or Group 4 (C/4 clearance). Bearing dimensions shall be in accordance with ABMA 20 or ISO 15.

4.4.7.1.7 Antifriction bearings shall be used on vertical motors and shall meet the following requirements.

a) The dN factor shall be less than 300,000.

b) Bearings shall be rated for ABMA or ISO L10 life of at least 50,000 hours at rated conditions with the continuous maximum radial and thrust loads applied to motor.

c) Thrust bearings shall be rated for at least 5000 hours with continuous operation at 200 % of maximum up or down thrust load, whichever is greater.

d) All bearings designed to handle axial loads shall be located on the non-drive end.

e) Tandem or duplex antifriction bearings shall be permitted when required to handle the thrust load and shall be oil lubricated. In no case shall more than two bearings be stacked.

f) Grease lubricated bearings shall be regreasable. Fittings for grease lubricated bearings shall be arranged for safe and easy access to provide lubrication while the motor is in operation without removal of external covers.

g) When oil lubricated bearings are provided, the bearing lubrication shall be made with an internal lubricant recirculating system. The purchaser shall be advised if an external cooler is required. All oil lubricated bearings shall be furnished with oil level indicators.

h) Vertical motors designed for no external thrust loads shall have either ball or single row angular contact bearings that are mounted on top in either grease or oil lubrication.

i) Except for the angular-contact bearings and spherical roller thrust bearings, single- or double-row bearings shall be of deep groove (Conrad) type and shall have an internal clearance equivalent to ABMA 20 and ISO 5753-1, Group 3 (C/3 clearance). Filling slot (maximum-load) bearings shall not be used. Bearings shall be commercially available from more than one bearing manufacturer. Bearing dimensions shall be in accordance with ABMA 20 or ISO 15.

4.4.7.2 Bearing Housings

4.4.7.2.1 Bearing housings and shaft seals shall be designed to meet the requirements of IP55 per NEMA MG 1 or IEC 60034 as a minimum.

4.4.7.2.2 A permanent indication of the proper oil level to within 1 mm (0.04 in.) of the actual operating oil level shall be clearly marked on the outside of the bearing housing with metal tags, marks inscribed in the castings, or other durable means. If the oil level indicator breaks, any resulting drop in oil level shall not result in the loss of bearing lubrication, that is, reduction of the oil level below the level required for oil ring operation.

4.4.7.2.3 Hydrodynamic bearing housings on horizontal motors shall be equipped with constant level sight feed oilers, which are at least 0.25 liters (8 oz) in size and include a positive level positioner (not a set screw), glass container, protective wire cage, and supplemental support in addition to the piping.

4.4.7.2.4 Housings for ring oil lubricated bearings shall be provided with plugged ports positioned to allow visual inspection of the oil rings while the equipment is running.

4.4.7.2.5 Bearing housings shall be located by cylindrical precision dowels and/or rabbet fits.

4.4.7.3 Shaft Seals

4.4.7.3.1 Shaft seals for hydrodynamic radial bearings shall conform to the following.

a) Primary bearing housing/enclosure seals (both inboard and outboard) shall be made from a non-sparking material and shall be split labyrinth type.

b) The seals shall have a minimum life expectancy of five years under usual service conditions. Lip type seals shall not be used.

c) Oil shall not leak past the seals when the rotor is stationary or when operating within rated conditions.

4.4.7.3.2 Shaft Seals for antifriction bearings shall conform to the following.

a) All antifriction bearings shall have replaceable labyrinth shaft seals of the non-contact or non-contacting-while-rotating type with a minimum expected seal life of five years under usual service conditions.

b) Cast iron inner bearing caps shall be provided to minimize grease or oil migration to the motor interior.

4.4.7.4 Bearing Insulation

4.4.7.4.1 Both bearings shall be electrically insulated. A shorting device shall be provided in the bearing housing on the drive end.

4.4.7.4.2 The bearing insulation shall be permanent and non-deteriorating during assembly and disassembly of the bearing for the service life of the motor. The bearing insulation resistance shall be at least 10 megohms at a test voltage of 50 V DC minimum.

4.4.8 Lubrication

4.4.8.1 Hydrodynamic bearings shall use mineral oil and shall be arranged for ring-type lubrication in accordance with the bearing manufacturer's recommendations.

4.4.8.2 Oil lubricated antifriction bearings shall use mineral oil and be arranged for the type of lubricant circulation and cooling in accordance with the bearing manufacturer's recommendations for the application.

4.4.8.3 Grease for antifriction lubricated bearings shall be rust inhibiting, compatible with polyurea thickened grease.

4.4.9 End Play and Couplings

4.4.9.1 Hydrodynamic radial bearing motors shall have a total end play of at least 13 mm (0.50 in.). The design of the motor shall ensure that the magnetic center is within 20 % of the total end float from the center of the end float limit indicators (e.g. 2.6 mm for a 13 mm total end float or 0.10 in. for a 0.50 in. total end float).

NOTE Hydrodynamic bearings with journal diameters below 110 mm (4.3 in.) may require a reduction in the total endplay to 10 mm (0.4 in.). The motor vendor should advise the purchaser of this condition in the proposal.

4.4.9.2 Flexible couplings used with hydrodynamic radial bearing motors shall be of the limited end float type. The total end float shall be limited to 5 mm (3/16 in.).

4.4.9.3 Hydrodynamic bearing equipped motors shall have a permanent indicator to show the actual limits of total rotor end float and magnetic center.

4.4.10 Stator Laminations

The insulating coatings applied to the laminations shall have a classification at least matching C-5 class per ASTM A976 (IEC60404-1-1). C-3 class lamination insulating coating shall not be used in any form. The stator core shall be capable of withstanding winding burnout for rewind at a stator core temperature of 400 °C (750 °F) without damage or loosening.

4.4.11 Nameplates, Rotation Arrows, and End Float Indicators

4.4.11.1 Nameplates, rotation arrows, and end float indicators shall be of AISI 300 series stainless steel (or EN equivalent), securely fastened by hardware of similar material, and attached at readily visible locations. All information (including title fields) shall be permanently inscribed, embossed or engraved. Nameplates shall be provided on the motor and on or adjacent to each auxiliary device or junction box.

4.4.11.2 As a minimum, the data listed below shall be included on the motor's nameplate(s):

a) manufacturer's name;

b) serial number;

c) horsepower or kilowatts;

d) voltages;

e) phase;

f) full-load power factor and efficiency;

g) frequency, in hertz;

h) for antifriction bearings, the ABMA or ISO bearing designation;

i) full-load current (amps);

j) locked-rotor current (amps) and safe stall time (hot and cold);

k) full-load speed, in revolutions per minute;

l) time rating;

m) temperature rise in degrees Celsius, the maximum ambient or cooling-air temperature for which the motor was designed, and the insulation system's class designation;

n) service factor;

o) number of starts per hour;

p) location of the magnetic center and end float limits;

q) enclosure type;

r) total motor mass and rotor mass in kg (lb); and

s) year of manufacture.

4.4.11.3 Separate connection diagrams or data nameplates shall be located near the appropriate connection box for the following:

a) motors with more than three power leads;

b) space heaters (operating voltage, wattage, and for Class I, Zone 2 or Division 2 locations, the temperature code for labeled space heaters or the maximum surface temperature for unlabeled space heaters);

c) temperature detectors (resistance, in ohms, and material type); and

d) connections for proper rotation (including bidirectional).

• **4.4.11.4** When specified, the purchaser's identification information shall be stamped on a separate nameplate.

4.5 Vertical Motors

4.5.1 Vertical motors provided per this specification shall be shaft down, flange mounted, with a solid shaft design and have provision for handling external momentary and continuous up and/or down axial thrust loads.

4.5.2 The motor vendor shall provide the following data to the purchaser:

a) motor mass;

b) center of gravity;

c) static deflection; and

d) the resulting reed frequency.

The static deflection and reed frequency shall be provided in two 90 ° planes. Data may be extrapolated from similar previously built units. It is the responsibility of the purchaser to design a suitable foundation system that satisfies the motor vibration requirements.

• **4.5.3** When specified, vertical motors shall be equipped with a non-reverse ratchet.

4.5.4 Shaft extension runout shall not exceed 38 microns (0.0015 in.).

4.5.5 Face and mounting rabbet runout levels shall not exceed the following:

AK (N)		AK (N)	
Dimension mm	**Runout** mm	**Dimension** in.	**Runout** in.
Below 305	0.05	Below 12	0.0020
305 to 609	0.09	12 to 24	0.0035
610 to 1016	0.11	24.01 to 40	0.0045
Over 1016	0.15	Over 40	0.0060
NOTE The "AK" or "N" dimension as referenced in NEMA MG 1 and IEC 60072, respectively, is the diameter of the male or female pilot on the face, flange, or base of the motor.			

4.5.6 For vertical motor bearing requirements, see 4.4.7.1.7.

5 Accessories

5.1 Terminal Boxes

• **5.1.1** Terminal boxes and auxiliary equipment enclosures shall be constructed of cast or nodular iron, cast steel, cast aluminum, steel or stainless steel plate, or aluminum plate with a minimum rigidity equivalent to that of steel plate with a nominal thickness of 3 mm ($^1/_8$ in.). The main terminal box shall be Type II as specified by NEMA MG 1 Part 20 with porcelain or cycloaliphatic standoff-insulator supported terminations. Bus bars shall be copper and shall be silver-plated at the connection points, except when tin-plating is specified. Bus bars, except for field connection points, shall be insulated.

5.1.2 As a minimum, the main terminal box shall meet the requirements of IP55. The auxiliary equipment enclosures shall meet the requirements of IP55 or NEMA 250, Type 4. Enclosures shall be suitable for the area classification shown on the datasheets. All vertical gasketed surfaces shall be provided with a drip shield at the top. The gasket material shall be impervious to oil attack. Type test and or design information shall be supplied when requested on identical gasket material to verify that this requirement has been satisfied.

5.1.3 The main terminal box shall be supplied with adequate space for cable bending limitations, termination of shielded cables, minimum ground plane clearances, and connection and accessibility of accessories. The box shall include the following items:

a) drains;

b) breathers;

• c) neutral bus when 2300/4000 V is specified (unless otherwise specified, dual voltage motor leads shall be connected for 4000 V);

• d) space heaters supplied in accordance with 5.4, when specified; and

• e) other requirements as specified on the datasheet.

• **5.1.4** Unless otherwise specified, the main terminal box shall have a removable plate to allow cable entry from the bottom. All auxiliary terminal boxes shall have provisions for cable entry from the bottom. All terminal boxes shall have their internal access available from the front of the terminal box.

• **5.1.5** When specified, the terminal box for the main power lead terminations shall be capable of withstanding the pressure build-up resulting from a three phase fault of the specified value (one-half cycle after fault inception) for a duration of 0.1 sec. If a rupture disc is used to relieve pressure build-up, it shall not compromise the environmental rating of the box and the discharge from the pressure release shall be directed away from locations where personnel may be normally present. For motors fed from fused motor starters, the terminal box withstand capability shall be coordinated with the I^2t (ampere-squared sec.) let-through energy specified on the datasheet.

5.1.6 Wiring and terminal blocks in all terminal boxes shall be clearly identified and permanently labeled. Stator leads shall be identified in accordance with NEMA MG 1 or IEC 60034-8. All wiring markings shall agree with the notations on the special nameplates required by 4.4.11.3.

5.1.7 Grounding for field wiring shall be provided inside all terminal boxes and conform to the requirements of NEMA MG 1 Part 4 or IEC 60034-1. When a ground bus is supplied, it shall be copper.

5.1.8 Accessory leads shall terminate in a box or boxes separate from the main terminal box. All auxiliary device wires shall be terminated on 600 V (or higher if required) rated terminal blocks. All wiring shall have insulation that is impervious to attack by mineral oil.

• **5.1.9** When specified, auxiliary terminal boxes shall be AISI 300 series stainless steel (or EN equivalent). Where the motor will be installed offshore, AISI 316 materials (or EN equivalent) shall be supplied.

5.2 Winding Temperature Detectors

5.2.1 Stator winding resistance temperature detectors (RTDs) shall be supplied.

5.2.1.1 RTD elements shall be platinum, three-wire elements with a resistance of 100 ohms at 0 °C (32 °F). These elements shall have tetrafluoroethylene-insulated, stranded, tinned copper wire leads with cross sections at least equal to 0.326 mm^2 (22 AWG). The leads shall meet the requirements of NFPA 70 or IEC 60079.

5.2.1.2 A minimum of two sensing elements per phase shall be installed and distributed around the circumference in the stator winding slots.

5.3 Bearing Temperature Detectors

Bearing RTDs shall be provided in motors with hydrodynamic bearings. These RTDs shall be installed so that they measure bearing metal temperature in such a way that they do not violate the integrity of the bearing insulation. RTD elements shall be platinum, three-wire elements with a resistance of 100 ohms at 0 °C (32 °F). These elements shall have tetrafluoroethylene-insulated, stranded, tinned copper wire leads with cross sections at least equal to 0.326 mm^2 (22 AWG). The leads shall meet the requirements of NFPA 70 or IEC 60079.

5.4 Space Heaters

• **5.4.1** Space heaters shall be provided for the stator/frame, and when specified, for the main terminal box.

• **5.4.1.1** Unless otherwise specified, the surface temperature of an unlabeled heating element shall not exceed 160 °C (320 °F). Unless otherwise specified, labeled heating elements shall be identified with a temperature code of T3 or lower temperature.

5.4.1.2 Space heaters shall be wired using high temperature insulation lead material which is rated at 200 °C (392 °F) or higher and is compatible with mineral oil based lubricants. The wiring shall be brought out to a separate terminal box.

• **5.4.1.3** Space heaters shall have all energized or heated parts protected against contact. Unless otherwise specified, space heaters shall be 120 V nominal single phase.

5.4.1.4 Space heaters shall be installed inside the enclosure in a location suitable for easy removal and replacement. Heaters shall be located and insulated so that they do not damage components or finish. Direct contact of the space heater elements with the surface of the stator winding is not acceptable, except flexible silicone rubber insulated heaters specifically designed for the purpose shall be allowed to touch the winding on TEFC motors.

5.5 Ground Connectors

Visible and readily accessible ground pads, made from corrosion resistant material, shall be provided at opposite corners of the motor frame. A ground connection point shall be provided by drilling and tapping the pad for a 12 mm ($^1/_2$ in. UNC thread) bolt.

5.6 Auxiliary Device Installation

All auxiliary devices shall be applied and installed per IEEE 303, where applicable.

6 Inspection, Testing, and Preparation for Shipment

6.1 Final Testing

6.1.1 General

6.1.1.1 Tests shall be made on the fully assembled motor, using contract components, instrumentation, and accessories. Terminal boxes may be excluded, except when observed or witnessed tests are specified.

6.1.1.2 All detection, protective, and control devices (except differential current transformers, surge capacitors, and surge arresters) shall be tested to verify acceptable performance in accordance with the device specifications. Devices not tested by the motor vendor as permitted in this clause shall have satisfactory test reports available from the device supplier.

6.1.1.3 Vertical motors shall be tested in the vertical position for no load testing.

NOTE Spherical roller bearings often have springs designed to compress with the down thrust. If the thrust is less than design, the rotor rides higher than normal and there will be increased vibration during no load testing.

6.1.2 Routine Test

Each motor shall be given a routine test to demonstrate that it is free from mechanical and electrical defects. These tests shall be conducted in accordance with the applicable portions of NEMA MG 1 and IEEE 112, or IEC 60034-2. The test shall include the following items.

a) Measurement of no-load current (each phase).

b) A determination of locked-rotor current.

c) A high-potential test on the stator windings, space heaters, and RTDs.

d) An insulation resistance test by megohmmeter and polarization index per IEEE 43. The insulation resistance measurement and polarization index shall be performed at 2500 V DC, or at 5000 V DC for rated motor voltages of 4000 V and above. (The polarization index is the ratio of the 10-minute resistance value to the 1-minute resistance value.) The minimum acceptable value for the stator winding polarization index is 2.0.

e) Measurement of stator winding resistance using a digital low resistance meter.

f) Measurement of vibration. Vibration levels shall be in compliance with 6.1.3.1 and 6.1.3.2.

g) A test of the bearing insulation.

h) A test of the bearing temperature rise. The motor shall be operated at no load for at least one hour after the bearing temperatures have stabilized. Stable temperature is defined as a change of not more than 1 °C (1.8 °F) in 30 minutes. The no load run shall demonstrate that bearing operation is without excessive noise, heating, or vibration. There shall be no oil leaks during the test. For antifriction bearings, when bearing RTDs are not provided, bearing temperature rise may be measured by inserting a probe through the grease inlet or drain and measuring the grease temperature.

6.1.3 Vibration Tests

6.1.3.1 All fully assembled motors shall have vibration levels that do not exceed 2.5 mm per second zero-to-peak (0.10 in. per second zero-to-peak) for both filtered and unfiltered measurements when tested at no load and full voltage and bolted to a massive, flat base. Measurements shall be made in three orthogonal directions on both bearing housings. For TEFC motors where the non-drive end bearing housing is not accessible, the non-drive end axial measurement may be omitted. Frequency spectrum sweeps ranging from 25 % of running speed to four times line frequency, as a minimum, shall be made.

6.1.3.2 When equipped with non-contacting eddy current probes or provisions for probes, the shaft vibration limits are the same as those identified in API 541.

6.1.3.3 Unfiltered and filtered radial and axial vibration, electrical input, and temperature data shall be recorded at 30 minute intervals or less during all mechanical running tests. If equipped with shaft probes per 4.4.5.1.2 and 6.1.3.2, shaft vibration shall also be recorded. If the vibration pulsates, the high and low values shall be recorded.

6.1.3.4 All purchased vibration probes, transducers, oscillator-demodulators, and accelerometers shall be in use during the test. If only provisions for vibration devices are furnished by the equipment vendor or if the purchased devices are not compatible with shop readout facilities, then shop devices and readouts that meet the accuracy requirements of API 670 shall be used. Where shaft non-contacting probes or provisions for these probes are not specified, only bearing-housing vibration measurements are required.

6.1.4 Stator Surge Tests

Surge comparison tests shall be made of the turn insulation of every coil in the fully wound stator just before the coil-to-coil connections are made, at test voltage levels and methods in accordance with Figure 1 of IEEE 522 or IEC 60034-15. Reduced testing voltages for uncured coils may be used, as permitted by IEEE 522 or IEC 60034-15.

• 6.1.5 Special Tests

When special tests are specified, they shall be performed in accordance with the requirements of API 541 where applicable, i.e.:

a) routine and complete tests;

b) rated rotor temperature vibration; and

c) sealed winding conformance test.

6.2 Preparation for Shipment

6.2.1 Preparation for shipment shall be performed after all testing and inspection have been completed and the purchaser has released the equipment for shipment. The preparation shall make the equipment suitable for at least six months of outdoor storage from the time of shipment and shall include items (a) through (i) of 6.2.2 (as required). The vendor shall provide the purchaser with the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and before start-up. One copy of the manufacturer's standard installation instructions shall be packed and shipped with the equipment.

6.2.2 The motor shall be prepared for shipment in accordance with the following.

- a) Exterior surfaces, except for machined surfaces or corrosion resistant material, shall be coated with the manufacturer's standard paint for the service conditions defined in 1.2 c), unless otherwise specified. Exposed machined surfaces of shafts, shaft couplings, and mounting plates shall be protected with an easily removed waterproof coating or wrapping. Bearing assemblies shall be fully protected from the entry of moisture and dirt.

b) After thorough cleaning, internal areas of bearings and carbon steel oil system auxiliary equipment shall be coated with a suitable oil-soluble rust preventive.

c) For shipping purposes, threaded openings shall be provided with steel caps or solid-shank steel plugs. Nonmetallic plugs shall only be used for terminal box openings.

d) The equipment shall be mounted on a rigid skid or base suitable for handling by forklift, truck or crane. The skid or base shall extend beyond all surfaces of the motor.

e) Lifting points and lifting lugs shall be clearly marked. The recommended lifting arrangement shall be identified on boxed equipment.

f) Each motor shall be properly identified with item and serial numbers. Material shipped in separate crates shall be suitably identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. Any small loose parts (shims, bolts, etc.) shall be safely packaged and secured inside the main terminal box. If vapor phase inhibitor crystals in bags are used to absorb moisture, the bags shall be attached in an accessible area for ease of removal. The bags shall be secured to avoid movement and shall have their locations identified with corrosion resistant durable tags. These bags shall not be located inside the motor with the exception of the main terminal box.

g) Motors that are disassembled for shipment or storage shall be provided with marine type plywood over all openings and be sloped for proper watershed when protected with exterior covering.

h) The rotor shall be blocked to prevent axial and radial movement.

i) Space heater leads shall be accessible without disturbing the shipping package and shall be suitably tagged for easy identification.

7 Guarantee and Warranty

The details of the guarantee and warranty will be developed jointly by the purchaser and the vendor during the proposal period.

8 Vendor Data

8.1 Proposals

8.1.1 The vendor shall complete the "PROPOSAL" pages of the datasheets in Annex B.

8.1.2 The vendor shall provide curves and data to fully define the performance of the motor, including the following items:

a) average torque versus speed during starting at rated voltage and at 80 % voltage;

b) current versus speed during starting at rated voltage and at 80 % voltage;

c) when load curves and inertia are supplied with the request for proposal, the estimated times for acceleration at rated voltage and at 80 % voltage;

d) the locked-rotor withstand time, with the motor at ambient temperature and at its maximum rated operating temperature, at rated voltage and at 80 % voltage; and

e) the expected and guaranteed efficiencies in accordance with 8.2.3 g).

8.1.3 The vendor shall provide net mass and maximum erection mass with identification of the item. This data shall be stated individually where separate shipments, packages, or assemblies are involved and shall be entered on the datasheets.

8.1.4 The vendor shall provide a preliminary dimensional outline drawing showing the direction of rotation when viewed from the non-drive end.

8.1.5 The vendor shall provide a separate price for each test and a packaged price for all the tests that are specified on the datasheets.

8.2 Contract Data

8.2.1 General

The vendor shall provide electronic files in an agreed-upon format for all submitted data, drawings, and instruction manuals. In addition, a paper copy of these documents shall be attached to the motor in a sealed waterproof envelope, including the "AS-BUILT" version of the datasheets.

8.2.2 Drawings

The drawings furnished shall contain enough information so that when they are combined with the manuals specified in 8.2.4, the purchaser will be able to properly install, operate, and maintain the ordered equipment. As a minimum, the following details shall be provided:

a) overall dimensions and mass for each separately installed piece;

b) the direction of rotation when viewed from the non-drive end;

c) identification and location of all wiring terminations for purchaser connections, including power, control, instrument wiring, etc.;

d) shaft end details and, when applicable, the make, size, and type of couplings;

e) a list of any special weather protection and climatization features supplied by the vendor and required by the purchaser;

f) a list of auxiliary equipment or loose parts furnished by the vendor for mounting by the purchaser;

g) rigging provisions for removal of (maintenance) parts with a mass in excess of 20 kg (45 lb);

h) size and location of all connections for conduit, piping, and any other type of connection (openings plugged by the vendor shall be identified);

i) maintenance clearances required for erection and maintenance;

j) name and location of all auxiliary equipment installed or having provisions for installation;

k) dimensions, hole locations, and other features (e.g. horizontal jackscrews) for sole plates or base plates included with the equipment;

l) foundation loading information (including the location of the center of gravity); and

m) when applicable, lubrication flow diagram.

8.2.3 Data

After order placement, the vendor shall provide complete performance curves and data to fully define the operating range of the equipment, including the following items.

a) Completed “AS-DESIGNED” version of the datasheets in Annex B along with other data supplied after order placement, followed by the “AS-BUILT” version of the datasheets at the time of shipment.

b) Average torque versus speed during starting at rated voltage and at 80 % voltage.

c) Current versus speed during starting at rated voltage and at 80 % voltage.

d) Power factor versus speed, including locked-rotor, at rated voltage and at 80 % voltage.

e) When load curves and inertia are supplied with the purchaser’s order, the estimated times for acceleration at rated voltage and at 80 % voltage.

f) The locked-rotor withstand time (with the motor at ambient temperature and at its maximum rated operating temperature) and thermal limit curves per IEEE 620, at rated voltage and at 80 % voltage.

g) Expected and guaranteed efficiencies as determined in accordance with IEEE 112 or IEC 60034-2. Efficiency shall be determined by IEEE 112 Method B (input-output with segregation of losses) or the equivalent method from IEC 60034-2. If testing limitations prevent the use of the above methods, use of another method, such as IEEE 112 Method E (segregated losses) or Method F (equivalent circuit) or similar methods from IEC 60034-2 are acceptable, and the vendor shall specify on the datasheet the efficiency test method to be used.

h) Certified copies of test data.

i) If applicable, lateral critical speed response calculations.

j) If applicable, rotor mass-elastic data (to allow for a torsional analysis to be performed).

k) Motor equivalent circuit parameters and time constants for:

   1) stator DC resistance per phase at operating temperature (R_1);

   2) rotor resistance per phase at rated speed and operating temperature (R_2);

   3) stator leakage reactance per phase at rated current (X_1);

   4) rotor leakage reactance per phase at rated speed and rated current (X_2);

   5) total starting reactance per phase at zero speed and locked-rotor (X_S);

6) magnetizing reactance per phase (X_M);

7) fundamental-frequency component of stray-load loss at rated current (LL_S);

8) open circuit AC time constant (T''_{do}); and

9) the base kVA for the above parameters, if given in per-unit.

NOTE 1 The above parameters are required to determine the short circuit AC and DC time constants and the X/R ratio of the motor. See NEMA MG 1, Section 1, Part 1 for information on induction motor time constants and the significance of the items listed.

NOTE 2 IEEE 112 test methods and IEC 60034-2 test methods and results will differ. Therefore, comparisons of expected and guaranteed efficiencies should recognize that efficiency values may be different between the different methods and standards.

8.2.4 Instruction Manuals

The vendor shall provide an Installation, Operations and Maintenance Instruction Manual containing as a minimum:

a) written instructions, including diagrams or photographs, for initial installation, startup, normal operation, and maintenance; and

b) recommended spare parts list for startup and normal maintenance.

Annex A
(informative)

Use of API Monogram by Licensees

A.1 Scope

The API Monogram® is a registered certification mark owned by the American Petroleum Institute (API) and authorized for licensing by the API Board of Directors. Through the API Monogram Program, API licenses product manufacturers to apply the API Monogram to new products which comply with product specifications and have been manufactured under a quality management system that meets the requirements of API Q1. API maintains a complete, searchable list of all Monogram licensees on the API Composite List website (www.api.org/compositelist).

The application of the API Monogram and license number on products constitutes a representation and warranty by the licensee to API and to purchasers of the products that, as of the date indicated, the products were manufactured under a quality management system conforming to the requirements of API Q1 and that the product conforms in every detail with the applicable standard(s) or product specification(s). API Monogram program licenses are issued only after an on-site audit has verified that an organization has implemented and continually maintained a quality management system that meets the requirements of API Q1 and that the resulting products satisfy the requirements of the applicable API product specification(s) and/or standard(s). Although any manufacturer may claim that its products meet API product requirements without monogramming them, only manufacturers with a license from API can apply the API Monogram to their products.

Together with the requirements of the API Monogram license agreement, this annex establishes the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products that satisfy the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program requirements.

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8145 or by email at certification@api.org.

A.2 Normative References

API Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

A.3 Terms and Definitions

For purposes of this annex, the following terms and definitions apply.

A.3.1
API monogrammable product
Product that has been newly manufactured by an API licensee utilizing a fully implemented API Q1 compliant quality management system and that meets all the API specified requirements of the applicable API product specification(s) and/or standard(s).

A.3.2
API specified requirements
Requirements, including performance and licensee-specified requirements, set forth in API Q1 and the applicable API product specification(s) and or standard(s).

NOTE Licensee-specified requirements include those activities necessary to satisfy API specified requirements.

A.3.3
API product specification
Prescribed set of rules, conditions, or requirements attributed to a specified product which address the definition of terms; classification of components; delineation of procedures; specified dimensions; manufacturing criteria; material requirements, performance testing, design of activities; and the measurement of quality and quantity with respect to materials; products, processes, services, and/or practices.

A.3.4
licensee
Organization that has successfully completed the application and audit process and has been issued a license by API.

A.3.5
design package
Records and documents required to provide evidence that the applicable product has been designed in accordance with API Q1 and the requirements of the applicable product specification(s) and/or standard(s).

A.4 Quality Management System Requirements

An organization applying the API Monogram to products shall develop, maintain, and operate at all times a quality management system conforming to API Q1.

A.5 Control of the Application and Removal of the API Monogram

Each licensee shall control the application and removal of the API Monogram in accordance with the following.

a) Products that do not conform to API specified requirements shall not bear the API Monogram.

b) Each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/ monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:

   1) define the authority responsible for application and removal of the API Monogram;

   2) define the method(s) used to apply the Monogram;

   3) identify the location on the product where the API Monogram is to be applied;

   4) require the application of the licensee's license number and date of manufacture of the product in conjunction with the use of the API Monogram;

   5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and

   6) require application of the additional API product specification(s) and/or standard(s) marking requirements.

c) Only an API licensee may apply the API Monogram and its designated license number to API monogrammable products.

d) The API Monogram license, when issued, is site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location.

e) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Requirements for alternative API Monogram marking are detailed in the API Policy, *API Monogram Program Alternative Marking of Products License Agreement*, available on the API Monogram Program website at http://www.api.org/alternative-marking.

A.6 Design Package Requirements

Each licensee and/or applicant for licensing must maintain a current design package for all of the applicable products that fall under the scope of each Monogram license. The design package information must provide objective evidence that the product design meets the requirements of the applicable and most current API product specification(s). The design package(s) must be made available during API audits of the facility.

In specific instances, the exclusion of design activities is allowed under the Monogram Program, as detailed in *Advisory # 6*, available on API Monogram Program website at http://www.api.org/advisories.

A.7 Manufacturing Capability

The API Monogram Program is designed to identify facilities that have demonstrated the ability to manufacture equipment that conforms to API specifications and/or standards. API may refuse initial licensing or suspend current licensing based on a facility's level of manufacturing capability. If API determines that additional review is warranted, API may perform additional audits (at the organization's expense) of any subcontractors to ensure their compliance with the requirements of the applicable API product specification(s) and/or standard(s).

A.8 API Monogram Program: Nonconformance Reporting

API solicits information on products that are found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API specified requirements. Customers are requested to report to API all problems with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at http://compositelist.api.org/ncr.asp.

Annex B
(normative)

Datasheets

API 547 2nd Edition -- DATASHEETS
INDUCTION MOTORS

1 **HOW TO USE THIS DATASHEET:**

2 Refer to Annex C - Datasheet Guide for comprehensive guidance on all content within this datasheet, which has many revisions from the first edition of API 547. The purchaser and/or their representative is responsible for completing Pages 1-3.

3 The motor supplier (a.k.a. vendor or manufacturer) is responsible for completing pages 4-5 when requested during the pre-order phase using the PROPOSAL DATA symbol. During execution of an order the supplier is to complete these pages with current design data and use the AS-DESIGNED symbol for initial transmittal of the datasheet to the purchaser after order placement. Following motor shipment to the purchaser, the supplier is to update these pages with any applicable changes and change the AS-DESIGNED symbol to the AS-BUILT symbol for final transmittal to the purchaser.

4 This datasheet can be used for either U.S. / North American standards and units of measure (ANSI/NEMA) or International / SI standards and units of measure (IEC/metric). Select the applicable bullets on page 1.

5 To minimize duplication, a single datasheet and set of requirements should be utilized for each common (same power, voltage, enclosure, etc.) rating intended for the same application, service or load, regardless of the number of units. If there is even a single different requirement within a service (e.g. T-Box locations, direction of rotation), a separate datasheet should be used for each unique set of requirements or service.

6 Some items may have an option for "Supplier Decision." This is intended to give clear guidance and direction to the supplier when the purchaser has no other preference.

7 Each item on each page can be referred to by it's page number (in the header in the upper right of each page), line number (down the left side of each page), and/or Rev. number (in header and down the right side of each page).

8 **Instructions on how to use datasheet symbols to make selections**

9 Some of the paragraphs in the standard require a purchaser decision or are optional. These are indicated by a solid round bullet next to the paragraph in the standard. This datasheet uses open bullets to identify those items that fit this convention. Changing the bullet to a solid bullet on the datasheet indicates the purchaser requires an item or that the item applies to the purchaser's requirements for the motor.

10	Page 1	On line 5, select the applicable bullet to indicate the status of the datasheet. The initial state is "Proposal," and it should be changed to "Purchase" to indicate a final revision and purchase of the motor is underway.
11	Pages 1 - 3	Throughout these pages, select and change to solid the bullets that apply to the purchaser's requirements.
12	Page 3	Select and change to solid the bullets that apply to the purchaser's requirements for analysis, inspection and testing as described above. Additionally, change the triangle bullet to a solid triangle only when the purchaser requires all units of a multi unit order to receive the applicable inspection or test. Leaving the triangle bullet open indicates the inspection or test applies only to one unit of a multi-unit order.
13	Page 4	The supplier is to complete this page, using the bullets to indicate items applicable to their offer.
14	Page 4	The supplier is to select the applicable bullet to indicate the status of the "Motor Supplier Proposal and Order Data" section after an order has been placed. Above line 1, the "As-Designed" bullet is selected when pages 4-5 have been completed and are returned to the purchaser during the initial transmittal of documentation. The "As-Built" bullet is selected to indicate the final configuration of the motor(s) including any changes made since the "As-Designed" version of the datasheet was transmitted. This final version of the datasheet is transmitted to the purchaser after the applicable motor(s) have been shipped. The supplier uses the other bullets throughout pages 4-5 to indicate items applicable to either the "As-Designed" or "As-Built" configuration of the motor.

15 **BULLET ITEMS NOT SELECTED ARE CONSIDERED NOT APPLICABLE,**
OR WILL FOLLOW THE DEFAULT CONDITION WHERE IT EXISTS

16 **Instructions on how to change datasheet symbols to make selections**

17 1) Select (click on) symbol

18 2) Type listed letter on keyboard

19 3) Press enter or click onto next item

	To change:			Use your keyboard and enter:	Description
20					
21	❍	to	●	lower case " l "	Changes an item from default or not required to an item that is required
22	●	to	❍	lower case " m "	Changes an item from being required to the default or not required
23	◁	to	◀	lower case " t "	Changes an inspection or test from applying to one unit only to applying to ALL motors of a multi-unit order.
24	◀	to	◁	lower case " v "	Changes an Inspection or Test from applying to ALL motors of a multi-unit order to applying to only one unit of a multi-unit order.

INDUCTION MOTOR
API 547 2nd Edition -- DATASHEET
General Purpose Motors 185 kW (250 hp) to 2240 kW (3000 hp)

PURCHASER'S SELECTIONS

Bold Italics = Indicate Default Selection of Standard

JOB NO. ______ ITEM / TAG NO. ______
PURCHASE ORDER NO. ______
REQ. / SPEC. NO. ______
REVISION NO. ______ DATE ______
REV. DATE ______ PAGE 1 5 Rev

1 USER ______ APPLICATION ______
2 LOCATION ______ SUPPLIER ______
3 PROJECT NAME ______ SUPPLIER REF. No. ______
4 SITE / PLANT ______ NUMBER of UNITS REQUIRED ______
5 Applicable to: ❍ Proposal ❍ Purchase ❍ As Designed ❍ As Built MOTOR TAG No.(s) ______

REFER TO THE DATASHEET GUIDE IN ANNEX C OF API 547 FOR DETAILED SUPPORT IN USING THIS DATASHEET

GENERAL

6 Applicable Standards (1.4.2): ***North American (i.e., ANSI, NEMA)*** ❍ IEC ❍ Local Standards (Purchaser to identify and provide)
7 System of Units for Hardware (1.4.1): ❍ Supplier Decision ❍ U.S. / North American Customary ❍ SI (Metric)
8 **Enclosure / Nameplate Power:** See Datasheet Guide and paragraphs 1.1.1; 4.1.2; 4.2.2. Lines 10-12 utilize drop-down lists in data fields of native file.
9 IP ______ kW hp RPM IP***W 24*** kW hp RPM
10 ❍ TEFC, 2-Pole (1.1.1 b) ______ or ______ ______ ❍ WP-II, 2-Pole (1.1.1 c) ______ or ______ ______
11 ❍ TEFC, 4- or 6- or 8-Pole (1.1.1 a) ______ or ______ ______ ❍ WP-II, 4- or, 6- or 8-Pole (1.1.1 a) ______ or ______ ______
12 Voltage & Frequency Rating (4.2.2): ***3*** Phase ❍ 60 Hertz ______ Volts ❍ 50 Hertz ______ Volts
13 For 2300/4000 Volt Requirements, Connect Terminals for (5.1.3 c) ***4000 Volts*** ❍ 2300 Volts
14 Max. Sound Pressure Level (at 1 meter at no-load, full voltage/frequency on sine wave power) (4.1.3): ***85 dBA*** ❍ Other: ______ dBA
15 **Usual Conditions (1.2):** ***40° C*** Nameplate Ambient Temp. Rating (1.2 a) ❍ Other: ______ °C Min. Amb. ***-18° C*** ❍ Other: ______ °C
16 Site Elevation (1.2 b): ***Maximum 1000 m (3300 ft.)*** ❍ Other: ______ ❍ m ❍ ft.
17 Motor Location (1.2 c; 4.4.4): ***Severe Duty, Humid, Corrosive, or Salty Atmosphere*** ❍ ***Indoor or*** ❍ ***Outdoor*** ❍ Offshore (4.4.4; 5.1.9)
18 Motor Mounting (1.2 d): ***Horizontal Foot Mounted*** (if vertical mounting is required, see line 31 below)
19 Mounting Plates (4.4.2.3) ❍ Soleplates ❍ Baseplate Provided by: ❍ Driven Equipment Supplier ❍ Motor Supplier
20 Motor Power Source (1.2 f): ***Constant Frequency Sine Wave Power (direct on line starting)*** ❍ Other (page 2 lines 1-7 &/or below lines 26-30)
21 Connection to Load (1.2 h): ***Direct Coupled*** ❍ Other ______
22 Area Classification (1.2 e; 4.1.4): ❍ ***Class I, Divison 2,*** Group ______ Temp. Code (T-Code): ______ Autoignition Temp (AIT): ______ °C
23 ❍ Nonclassified ❍ ***Class I, Zone 2,*** Group ______ Temp. Code (T-Code): ______
24 ❍ Other (4.1.4): Class ______ ❍ Division ______ or ❍ Zone ______ Group ______ T-Code ______
25 ❍ Ex (detail Ex requirements if applicable) ______
26 **Unusual Conditions (1.3)** ❍ Adjustable Speed Drive (ASD) (1.3 d-e); if applicable, complete below (read note under para. 4.2.2 of API 547):
27 ❍ ASD Only Operation ❍ ASD+DOL Start Capability[1] ❍ ASD Start Only, w-Bypass to Utility Power ❍ ASD w-DOL Start & Bypass to Utility[1]
28 ❍ Variable Torque Speed Range: Min RPM: ______ @ ______ ❍ Nm ❍ lb-ft Max RPM: ______ @ ______ ❍ Nm ❍ lb-ft
29 ❍ Constant Torque Speed Range: Min RPM: ______ @ ______ ❍ Nm ❍ lb-ft Max RPM: ______ @ ______ ❍ Nm ❍ lb-ft
30 ❍ Constant Power Speed Range: Max RPM: ______ @ ______ ❍ Nm ❍ lb-ft **Note 1**: For DOL Start Capability, complete pg. 2 lines 1-7 + 11-13
31 ❍ Vertical Shaft Down, Flange Mount, Solid Shaft less than 375 kW (500 hp) (1.1.1 d; 1.3 h; 4.5) ❍ Non-reverse Ratchet (4.5.3)
32 ❍ Other Unusual Conditions (1.3): ______
33 **Bearings (4.4.7.1):** ***Hydrodynamic (4.4.7.1.1)*** ❍ Antifriction (4.4.7.1.6)
34 ❍ Vertical Motors (4.4.7.1.7): Continuous Bearing Thrust Load: Downthrust ______ Upthrust ______ ❍ kg ❍ lb ❍ No Ext. Thrust Load
35 **Lubrication (4.4.8):** ***Ring Type Self Lubrication*** ❍ Pressurized Lubrication ❍ Common with Driven Equipment
36 ❍ Grease (for A/F bearings) Grease Type (4.4.8.3) ***Polyurea Compatible*** ❍ Other Grease Requirements: ______
37 Thrust Bearing Lubrication (4.4.7.1.7 e-h): ❍ Supplier Decision ❍ Oil Lubricated ❍ Grease Lubricated

Other Requirements, Notes: ______
38 ______
39 ______

INDUCTION MOTOR API 547 2nd Edition -- DATASHEET General Purpose Motors 185 kW (250 hp) to 2240 kW (3000 hp)	JOB NO. ______ ITEM / TAG NO. ______
PURCHASER'S SELECTIONS	PURCHASE ORDER NO. ______ REQ. / SPEC. NO. ______ REVISION NO. ______ DATE ______ BY ______
Bold Italics = Indicate Default Selection of Standard	REV. DATE ______ PAGE 2 OF 5 Rev

1 **Motor Design and Starting Characteristics (4.2.3)** Starting Voltage: (4.2.3.3) ***80% Rated Volts*** ○ Other: ______ % Rated Volts

2 Starting Method: ***Direct On Line (DOL)*** ○ Reduced Voltage Starter ○ Auto-Transformer ○ ASD (complete ASD section pg. 1)

3 ○ Solid State Soft Starter; Define percent Locked Rotor Current (LRC) limit during acceleration: ______ % LRC

4 Motor Load Starting Capability (4.2.3.3): ***Load curve torque varies w/ square of speed; full load torque < / = motor rated full load torque***

5 ○ Other (4.2.3.5): Provide Load Curve No. here and Load Intertia on line 13: ______

6 Design Condition: ○ Unloaded (e.g. closed valve or damper) ○ Loaded (e.g. open valve or damper) ○ Partially Loaded (e.g. min.flow)

7 ○ Other: ______

8 **Driven Equipment:** Tag No.(s): ______ Description ______ Location ______

9 Driven Equipment Mfgr.: ______ Type / Model No. ______ RPM ______

10 Driven Equip. Rotation ***Viewed from Non-drive End of Motor*** **:** ○ Clockwise ○ Counterclockwise ○ Bi-directional

11 Required Motor Rotation ***Viewed from Non-drive End of Motor*** **:** ○ Clockwise ○ Counterclockwise ○ Bi-directional (Re.: 4.4.3 Fans)

12 Type of Load (1.1.1 e): ***Centrifugal:*** ○ Pump ○ Compressor ○ Fan ○ Other: ______

13 Load Inertia (4.2.3.3, 4.2.3.5): ______ ○ $kg\text{-}m^2$ ○ $lb\text{-}ft^2$ at: ______ RPM ○ GD^2: ○ WK^2:

14 Coupling (4.4.9.2): Supplied By: ○ Purchaser ○ Driven Equipment Supplier ○ Motor Supplier ○ Other: ______

15 Mounted By: ○ Purchaser ○ Driven Equipment Supplier ○ Motor Supplier ○ Other: ______

16 **Main Terminal Box (5.1.1):** ***NEMA MG 1-20 Type II with Standoff Insulators and Insulated Silver Plated Copper Bus Bar*** ○ Tin Plated Bus Bar

17 ○ Other: ______ ○ Supply Neutral Bus

18 ○ Main T-Box Pressure Withstand Capability (5.1.5) (complete applicable items below) ○ Ground Provision in Main Terminal Box

19 3-Phase Fault Current at Motor Terminals: (5.1.5): ______ MVA Let-Through Energy from Fused Starters (5.1.5): ______ I^2t (ampere-squared seconds)

20 Box Location Facing Non-Drive End: ○ ***Supplier Decision*** ○ Left Side ○ Right Side ○ Other: ______

21 Main T-Box Cable Entry (5.1.4): ***Removeable Plate on Bottom*** ○ Other: ______

22 ○ Main T-Box Space Heaters (5.1.3 d; 5.4.1) Voltage (5.4.1.3): ***Single Phase, 120V Nominal*** ○ Other Phase/Volts: ______

23 ○ Other Main T-Box Accessories, if required detail here (5.1.3 e): ______

24 ______

25 **Winding Temperature Detectors (5.2)** ***Required - Platinum, 3 Wire, 100 Ohms at 0 °C, 2 / Phase*** ○ Ground RTD Common Leads in T-Box

26 Other: ______

27 **Bearing Temperature Detectors (5.3)** ***Required - Platinum, 3 Wire, 100 Ohms at 0 °C*** ○ Ground RTD Common Leads in T-Box

28 Other: ______

29 Location for Bearing Temp. Det. Terminations: ***Supplier Decision*** ○ Terminal Head ○ Separate T-Box ○ T-Box with Winding Temp. Det.

30 **Stator Space Heaters (5.4)** ***Required*** Voltage (5.4.1.3): ***Single Phase, 120V Nominal*** ○ Other Phase/Volts: ______

31 Unlabeled Heater Max. Surface Temp. (5.4.1.1): ***160 °C*** ______ °C 160°C default for unlabeled heaters if AIT not specified; must be < 80% of AIT

32 Labeled Heater Temp. Code (from pg.1) (5.4.1.1): ***T3*** ______ T3 default for labeled heaters unless specified otherwise here and/or on page 1

33 **Location of Aux. Boxes Facing Non-drive End:** ***Supplier Decision*** ○ Left Side ○ Right Side ○ Other: ______

34 ○ Stainless Steel Aux. Boxes/Encl. (5.1.9) Aux. T-Boxes Cond./Cable Entry 5.1.4): ***Bottom*** ○ Other: ______

35 **Air Filters:** ***Required for WP-II*** **(4.4.1.3 c)** Filter Capability (4.4.1.3 d): ***90% of Particles ≥ 10 Micron*** ○ Other: ______

36 **Differential Pressure Device (4.4.1.3 f):** ***Provisions Required for WP-II*** ○ Differential Pressure Switch (4.4.1.3 f)

37 ○ Differential Pressure Gauge (4.4.1.3 f) ○ Combination Switch / Gauge ○ Differential Pressure Transmitter (4.4.1.3 f) ○ Not Required

38 **Vibration Probes (4.4.5.1.2; ref. API 541 para. 5.8):** Non-contact Shaft Probes: ○ Provisions Only ○ Installed ○ Not Required

39 Phase Reference Probe: ○ Provisions Only ○ Installed ○ Not Required

40 Bearing Housing Seismic Sensors: ○ Provisions Only ○ Installed Mounting / Hole Size: ______ ○ Not Required

41 Bearing Housing Vibration Switch: ○ Provisions Only ○ Installed Switch Type: ○ Manual Reset ○ Electric Reset ○ Not Required

42 Bearing Housing Sensor Locations: ○ D.E. Bearing Qty.: ______ Position(s): ○ Horizontal ○ Vertical ○ Axial

43 ○ N.D.E. Bearing Qty.: ______ Position(s): ○ Horizontal ○ Vertical ○ Axial

INDUCTION MOTOR API 547 2nd Edition -- DATASHEET General Purpose Motors 185 kW (250 hp) to 2240 kW (3000 hp)	JOB NO. ______ ITEM / TAG NO. ______
	PURCHASE ORDER NO. ______
	REQ. / SPEC. NO. ______
PURCHASER'S SELECTIONS	REVISION NO. ______ DATE ______ BY ______
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INSPECTION & TESTING

○ (m) Indicates line item is not required ◁ (v) Indicates line item applies to only one motor in a multiple motor application/order

● (l) Indicates Purchaser required line item ◀ (t) Indicates line item applies to all motors in a multiple motor application/order

Make selections in only one column for each item	Required		Witnessed		Observed	
Stator Surge Tests - ***Required for All Motors*** (6.1.4)	●	◀	○	◁	○	◁
Routine & Vibration Tests - ***Required for All Motors*** (6.1.2, 6.1.3)	●	◀	○	◁	○	◁
Special Tests:						
API 541 Routine & Complete Tests (6.1.5 a; ref. API 541 para. 6.3.2, 6.3.5.1)	○	◁	○	◁	○	◁
Rated Rotor Temperature-Vibration Test (6.1.5 b; ref. API 541 para. 6.3.5.2)	○	◁	○	◁	○	◁
(Rated Rotor Temperature Test option is an alternate to a Complete Test, both are usually not necessary)						
Sealed Winding Conformance Test (6.1.5 c; ref. API 541 para. 6.3.4.4)	○	◁	○	◁	○	◁
Other (define): ______	○	◁	○	◁	○	◁
Other (define): ______	○	◁	○	◁	○	◁

MISCELLANEOUS

○ Separate Nameplate with Purchaser's Information (4.4.11.4) (define/attach info): ______

Paint/Paint System (6.2.2 a) ***Supplier's Decision*** ○ Other Paint System (define/attach info): ______

○ Supply API Monogram Nameplate (no deviations from API 547 requirements, see Annex A) ○ Electronic Document Format ______

Other Requirements, Notes: ______

INDUCTION MOTOR
API 547 2nd Edition -- DATASHEET
General Purpose Motors 185 kW (250 hp) to 2240 kW (3000 hp)
Motor Supplier Proposal - Order Data
Bold Italics = Indicate Default Selection of Standard

JOB NO. ______ ITEM / TAG NO. ______
PURCHASE ORDER NO. ______
REQ. / SPEC. NO. ______
REVISION NO. ______ DATE ______ BY ______
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❍ **PROPOSAL** ❍ **AS-DESIGNED** ❍ **AS-BUILT**

1 USER ______ LOCATION ______ PROJECT NAME ______
2 APPLICATION ______ SITE / PLANT ______ NUMBER of UNITS REQUIRED ______
3 SUPPLIER REF. No. ______ MOTOR TAG No.(s) ______
4 **Manufacturer:** ______ Type/Model: ______ Frame Size/Designation: ______
5 Enclosure: ❍ TEFC IP ______ ❍ WP-II IP***W 24*** ______
6 Power: ______ ❍ kW ❍ hp ***1.0 SF*** Insulation Class ***F***: ______ Temperature Rise Class ***B:*** ______
7 Speed: ______ RPM (synch) ______ Poles Voltage: ______ V ______ Phase ______ Hz
8 Base Standard (1.4.2): ❍ NEMA ❍ IEC Hardware System of Units (1.4.1): ❍ U.S. / N. A. Customary ❍ SI (Metric)
9 Max. Sound Pressure Level (4.1.3) ***85*** dBA @ 1 m., No-load ❍ Other: ______ dBA @ 1 m., No-load
10 Motor Rotation ***Viewed from Non-drive End of Motor***: ❍ Clockwise ❍ Counterclockwise
11 Motor Fan Rotation ***Viewed from Non-drive End of Motor*** (4.4.3): ❍ Bi-directional ❍ Uni-directional
12 **Motor Mass:** ❍ kg ❍ lb Motor Net: ______ Stator/Frame: ______ Rotor/Shaft: ______ Shipping: ______
13 **Performance Data:**
14 Full-load Torque (FLT): ______ ❍ Nm ❍ lb-ft Speed-torque Curve No.: ______
15 Locked-rotor % of FLT (LRT) ______ % Speed-current Curve No.: ______
16 Pull-up (PUT) ______ % Speed-power Factor Curve No.: ______
17 Breakdown (BDT) ______ % Thermal Capacity / Limit Curve No.: ______
18 Rotor Inertia: GD^2: ______ $kg\text{-}m^2$ or WK^2: ______ $lb\text{-}ft^2$
19 Load Point: Locked-rotor 50% 75% 100% Other: ______ %
20 Efficiency: ______ % ______ % ______ % ______ %
21 Power Factor: ______ % ______ % ______ % ______ % ______ %
22 Current: ______ Amps ______ Amps ______ Amps ______ Amps ______ Amps
23 Locked-rotor Withstand Time, Cold: at 100% Voltage ______ Sec at 80% Voltage ______ Sec Locked-rotor Current at 80%V:
24 Locked-rotor Withstand Time, Hot: at 100% Voltage ______ Sec at 80% Voltage ______ Sec ______ Amps
25 Guaranteed Efficiency (8.2.3 g): ______ % Efficiency at ______ % Load per Test Method (8.2.3 g): ______
26 **Induction Motor Equivalent Circuit Data** (8.2.3 k)**:** ______ kVA Base at Rated Voltage at 25°C (77°F)
27 At Rated Load at Rated Voltage & Temperature: ______ At Locked-rotor at Rated Voltage (Zero Speed): ______
28 Stator R_1 ______ Stator X_1 ______ Stator R_1 ______ Stator X_1 ______
29 Rotor R_2 ______ Rotor X_2 ______ Rotor R_2 ______ Rotor X_2 ______
30 Magn R_M ______ Magn X_M ______ Magn R_M ______ Magn X_M ______
31 Subtransient Reactance $X_S = X''_{do}$ ______
32 Fundamental Frequency Component of Stray Load Loss at Rated Current (LL_S): ______ kW
33 Residual Voltage Open Circuit Time Constant T''_{do}: Motor Only ______ Sec With Surge Capacitors ______ Sec
34 Phase-to-Phase Resistance ______ Ohms, @ ______ °C Total Winding Capacitance to Ground ______ uF
35 **Bearings (4.4.7.1):** ***Hydrodynamic (4.4.7.1.1)*** ❍ Antifriction (4.4.7.1.6)
36 ❍ Vertical Motors (4.5): Rated Continuous Bearing Thrust Load (4.4.7.1.7): Downthrust ______ Upthrust ______ ❍ kg ❍ lb
37 Hydrodynamic Bearing Part Number(s): ______
38 Antifriction Bearing AFBMA Number(s): Drive End: ______ Non-drive End: ______
39 **Lubrication:** ***Ring Type Self Lubrication (4.4.7.1.1)*** Oil Type, Viscosity: ______
40 ❍ Pressurized Lube Heat Loss per Bearing: ______ kW Oil Requirements: Flow: ______ ❍ LPS ❍ LPM ❍ GPM
41 Pressure: ______ ❍ kPa ❍ PSI
42 Lubrication Horizontal Antifriction Bearings: ❍ Grease Grease Type: ______
43 ❍ Oil Oil Type, Viscosity: ______
44 Lubrication Vertical Motor Thrust Bearing: ❍ Grease Grease Type: ______
45 ❍ Oil Oil Type, Viscosity: ______
46 ❍ Thrust Bearing External Bearing Oil Cooler Required (4.4.7.1.7 g) Heat Loss ______ kW Cooling Water Inlet Temp. ______ °C
47 Flow ______ ❍ LPS ❍ LPM ❍ GPM Pressure ______ ❍ kPa ❍ PSI
48 Lubrication Vertical Motor Guide Bearing: ❍ Grease Grease Type: ______

INDUCTION MOTOR
API 547 2nd Edition -- DATASHEET
General Purpose Motors 185 kW (250 hp) to 2240 kW (3000 hp)

Motor Supplier Proposal - Order Data

Bold Italics = Indicate Default Selection of Standard

JOB NO. ______ ITEM / TAG NO. ______
PURCHASE ORDER NO. ______
REQ. / SPEC. NO. ______
REVISION NO. ______ DATE ______ BY ______
REV. DATE ______ PAGE 5 OF 5 Rev

○ **PROPOSAL** ○ **AS-DESIGNED** ○ **AS-BUILT**

Enclosure Accessories for WP-II: ***Air Filters:*** Filter Type, Size: ______
Differential Pressure Device (4.4.1.3 f) ***Provisions*** ○ Provisions Only Supplied ○ Differential Pressure Switch
○ Differential Pressure Gauge ○ Combination Switch / Gauge ○ Differential Pressure Transmitter
Recommended Settings: Alarm: ______ Shutdown: ______
Winding Temperature Detectors (5.2): ***RTD - Platinum, 3 Wire, 100 Ohms at 0°C*** No. per Phase (5.2.1.2): ***Two*** ○ Other ______
○ Other Type Detector: ______ Wires: ______ Resistance: ______
Recommended Settings: Alarm: ______ Shutdown: ______
Bearing Temperature Detectors (5.3): ***RTD - Platinum, 3 Wire, 100 Ohms at 0°C*** No. per Bearing: ______ ○ Dual Element
○ Other Type Detector: ______ Wires: ______ Resistance: ______
Recommended Settings: Alarm: ______ Shutdown: ______

Space Heaters (5.4):	Operating Voltages	kW	Phase	Sheath Material
○ Frame Heaters	______ / ______	______	______	______
○ Main T-Box Heaters:	______ / ______	______	______	______
○ Bearing Heaters	______ / ______	______	______	______

Vibration Detectors:
Non-contact Shaft Probes (4.4.5.1.2, ref. API 541 para. 5.8): ○ Not required ○ Provisions Only ○ Installed
Phase Reference Probe: ○ Not required ○ Provisions Only ○ Installed
Bearing Housing Seismic Sensors: ○ Not required ○ Provisions Only ○ Installed Sensor Mtg. Hole Size: ______
Bearing Housing Vibration Switch: ○ Not required ○ Provisions Only ○ Installed Type: ○ Manual Reset ○ Electric Reset
Bearing Housing Sensor Locations: ○ D.E. Bearing ○ N.D.E. Bearing ○ Horizontal ○ Vertical ○ Axial
Recommended Settings: Alarm: ______ Shutdown: ______

Type of Stator Slot Wedge used (4.3.8): ○ Non-magnetic ○ Magnetic ○ Years Experience with Specific Wedge System Provided _____
○ API 547 Monogram Nameplate Installed (Annex A)

Other Features, Notes: ______

Annex C
(informative)

Datasheet Guide

Purpose

This datasheet guide provides instructions for completing the API 547 2nd Edition datasheet in Annex B. It is not necessary to utilize the datasheet for pre-configured or catalog based motors. However, in order to properly apply this standard, a datasheet is required to specify motor requirements for a specific application and/or with options and features beyond the description per paragraph 1.1.2. This datasheet guide presumes the specifying engineer:

1. is familiar with the process of procuring motors,
2. is familiar with the basic components and construction of form-wound squirrel cage induction motors, and
3. is familiar with API 547 2nd Edition and the purpose, format and use of datasheets.

This guide does not cover all possible applications. The specifying engineer should consider the specific installation when filling out the datasheet. Each page and line of the datasheet is referenced in this guide by the respective page number - line number, i.e. page 1, line 12 is 1 - 12, etc.

Scope

The datasheet covers squirrel cage induction motors in TEFC or WP-II enclosures, subject to the power ranges defined in the standard. They are:

TEFC enclosure, two-pole – 185 kW (250 hp) to 530 kW (700 hp)
WP-II enclosure, two-pole – 185 kW (250 hp) to 750 kW (1000 hp)
TEFC or WP-II enclosure, four-, six-, and eight-pole – 185 kW (250 hp) to 2240 kW (3000 hp)

A single version of the datasheet covers both US customary units and SI (metric) units. Paragraph numbers corresponding to API 547 are indicated in parentheses on the datasheet where applicable. Features that are defined in the standard as the default for that particular item are shown in the datasheets as ***bold italics***. The default for the item will be assumed by the supplier unless an alternate selection is identified. Items for which the standard defines specific requirements and there are no alternatives (e.g. stainless steel nameplates) are not shown on the datasheets. If an option not presented in the datasheet is desired, it should be listed under "Other."

Symbol Explanatory Page

The initial page of the datasheet explains how to insert or change the symbols used to mark selections in the digital form datasheet. The symbols are based on "Wingdings" font and are helpful when filling out the datasheets for digital transmission.

Datasheet Criticality

Whenever a datasheet is used, it is important that the datasheet be supplied to the motor supplier if compliance to API 547 is expected. The more thoroughly it is completed, the higher the probability of achieving a satisfactory outcome and compliance. Additionally, if the purchaser expects the motor supplier to provide a completed motor proposal datasheet page, the driven equipment section on page 2 must be completed thoroughly.

Page 1 Header

1 **Job No.** – For the user / purchaser project reference number

1 **Item / Tag No.** – For the driven equipment identification and / or tag number

1 **Purchase Order No.** – For the user / purchaser purchase order number

1 **Req. / Spec. No.** – For the user / purchaser project requisition or specification number

1 **Revision No.** – Identify the current revision of the datasheet here and change each time the datasheet is re-issued.

1 **Date** – For the date the datasheet is originally issued

1 **By** – Name or initials of the person who is responsible for completing the purchaser's selections

1 **Rev. Date** – For the date a revision of the datasheet is issued

1 – 1 **User** – Enter the end user's company name

1 – 1 **Application** – Enter the type of the motor application (e.g. "Pump," "Compressor," "Fan")

1 – 2 **Location** – Enter the geographical location (e.g. city, state)

1 – 2 **Supplier** – Enter the name of the party the purchaser will hold responsible for supplying the motor and, if known, the name of the motor supplier. For example, if a pump OEM (original equipment manufacturer) will procure and supply the motor and the motor supplier is known, the entry would be "ABC Pumps / XYZ Motor Company." Anyone who knows this information could enter this, but the motor supplier should ensure it is completed at the time they issue the as-built version of the datasheet.

1 – 3 **Project Name** – Enter the purchaser's name for the project for which the motor is being purchased.

1 – 3 **Supplier Ref. No.** – For capturing any motor supplier reference number (e.g. a purchase order and sales order number). Generally the motor supplier would fill in this data when they issue the as-built version of the datasheet.

1 – 4 **Site / Plant** – Indicates the name of the plant (e.g. Plant 18) or the equipment-train identification.

1 – 4 **Number of Units Required** – Enter the quantity of identical motors required. Create a separate datasheet for a motor with any different selection, requirement, or configuration.

1 – 5 **Applicable To** – Select "Proposal" when the datasheet is sent out for quotation (purchaser); "Purchase" when a final document is complete for order placement (purchaser); "As Designed" when the motor supplier order data is issued for the first time (motor supplier); and "As Built" to reflect the final completed datasheet after all design details inclusive of any changes during manufacturing and/or testing have been completed (motor supplier).

1 – 5 **Motor Tag No.(s)** – List all individual motor identification numbers on this line.

General, Miscellaneous

1 – 6 **Applicable Standards** – North American standards are the default. If international standards apply, the purchaser may select the IEC bullet to indicate the use of international standards as being applicable.

1 – 7 **System of Units for Hardware** – This standard allows for the use of U.S. customary and SI (metric) hardware and fasteners. Both are in use by manufacturers broadly. It may be difficult for a supplier to meet 100 % compliance to either system. It may be unlikely that a supplier can offer the choice of either system without added cost. If there is no preference, select the "Supplier Decision" bullet provided, and the supplier will provide their normal hardware. If there is a preference, select the applicable bullet, and discuss this with the supplier.

1 – 8-11 **Enclosure / Nameplate Power** – This standard is limited to the TEFC and WP-II type of enclosures. Additionally, the standard limits the two-pole power ratings in each type of enclosure to a range of power ratings that are readily available as stiff-shaft motors so as to limit the scope of this standard to stiff-shaft motors and not engage with the issues that accompany flexible shaft motors. A stiff-shaft motor is one with a maximum operating speed less than 85 % of the first lateral critical speed. Should the purchaser require a motor that the supplier identifies as a flexible shaft motor, API 541 should be used instead of API 547.

There are four bullets to choose from that correlate to the scope of ratings described in the Scope section above and found in the standard under paragraph 1.1. Select one of these four bullets.
Next, using the drop-down lists, select the desired power rating from either the kW or hp column. The defined standard IEC and NEMA power ratings are listed below in Table C.1. Non-standard power ratings may be entered but are not recommended as this will steer the motor design into a special category and restrict potential interchangeability. Then select applicable motor speed from the RPM column based on the frequency of the required electrical power system. Available speeds on 60 Hz power systems include 3600, 1800, 1200, and 900 RPM; for 50 Hz power systems, 3000, 1500, 1000, and 750 RPM speeds are available. Synchronous speed is calculated using the formula: Speed in RPM = 120f/p, where "f" is the electrical frequency and "p" is the number of poles in the motor (2, 4, 6, or 8).

Table C.1—Standard IEC and NEMA Power Ratings

IEC Kilowatt (kW)	**NEMA** Horsepower (hp)
185	250
220	300
250	350
300	400
335	450
375	500
450	600
530	700
600	800
670	900
750	1000
950	1250

Table C.1—Standard IEC and NEMA Power Ratings (Continued)

IEC Kilowatt (kW)	**NEMA** Horsepower (hp)
1120	1500
1250	1750
1400	2000
1600	2250
1800	2500
2240	3000

The standard requires motors to have a 1.0 service factor rating. Applying a motor such that it will operate at greater than its rated power (that is, using a service factor higher than 1.0) shortens the life of the motor. All motors that are rated for Class B rise have the inherent capacity to operate above rated power by utilizing the higher temperature capability of Class F insulation (that is, they will run hotter at the higher power). This higher temperature operation negatively impacts the life of the insulation and other components of the motor (such as motor lead insulation, bearings, oil, sealing materials, gaskets, and noise abatement materials). Therefore, motors should only be sized and selected based upon a standard 1.0 service factor rating. If output beyond the 1.0 service factor rating is required, the next higher motor rating should be chosen. This is primarily done to assure adequate torque margin for the motor (accelerating, pull-up, and breakdown torques) and to ensure long insulation life when applied to a Class F winding insulation system. Also note that IEC standards do not provide for service factor above 1.0, and ISO standards for hazardous (classified) motors do not allow the employment of service factors above 1.0.

Description of Enclosures within the Scope of API 547:

TEFC – The TEFC enclosure (totally enclosed fan-cooled / IC411 as defined by NEMA) is a construction where free exchange of air is prevented between the inside and outside of the motor. The motor is cooled by a shrouded shaft-mounted fan external to the main frame or enclosure which forces air axially over and along the outside of the frame. This design is typically characterized by the body or frame of the enclosure having external fins that act as a heat exchanger. TEFC motors are relatively simple and are recommended for severe environments. There are other variations of the TEFC enclosure, such as one that utilizes a blower mounted on the motor to replace the shaft mounted fan and deliver a constant flow of cooling air, which may be found in ASD applications where shaft mounted fans do not provide adequate cooling at lower speeds. TEFC enclosures are typically available up to approximately 1500 kW (2000 hp) and are very common in sizes under 600 kW (800 hp). Note that neither the TEAAC (IC611) nor the TEWAC (IC8A1W) type of totally enclosed motors are included within the scope of this standard. It is not necessary to specify the IP code for TEFC motors, but space is provided on line 9 for the purchaser to do so if desired.

WP-II – The WP-II (weather-protected Type II as defined by NEMA) is a common enclosure. Air from outside the motor is drawn into and passed through its interior for cooling. The WP-II enclosure is intended for outdoor applications. It is constructed so that high-velocity air and dirt blown into the air inlet or outlet can be discharged without entering the internal air passages to the electric parts of the motor. It may not be an appropriate choice where adhering dust is present or if the area does not have free air exchange. The hot air discharged from the motor can cause a closed-in area to become excessively hot.

WP-II motors with a rated voltage over 4000 Volts may have a shorter insulation life due to contamination and the related tracking. The IP code for WP-II is shown on line 9 for reference.

1 – 12 **Voltage and Frequency Rating** – There are two bullets to select from, one for 60 hertz and one for 50 hertz. After selecting one of these, voltage may be selected from the drop-down lists found in the spaces after "60 Hertz" or "50 Hertz." The available nameplate voltages defined by the standard for fixed speed North American applications are 2300, 4000, 2300/4000, or 6600, supplied by 60 Hz, three-phase power systems of 2400, 4160, and 6900 V, respectively. For 50 hertz systems, voltages of 3000, 3300, 6000, and 6600 V are available. Occasionally, a motor voltage of 460 V or 575 V might be specified for a motor of "form-wound" winding construction supplied by a 480 V or a 600 V power system. Motors for use on adjustable speed drives sometimes have non-standard voltages and frequencies, as required by the drive and the application. Note that the "nameplate" voltage value that is intended to appear on the motor nameplate is not necessarily the "system" voltage. Non-standard voltages may be entered into this data field when necessary.

1 – 12 **Phase** – Three phase power systems are almost always applicable; therefore "3" has been applied in the space provided for phase. If the power system has a different arrangement, identify it here and explain further in the notes section.

1 – 13 **For 2300/4000 Volt Requirements, Connect Terminals for** – The standard requires that a motor specified with a 2300/4000 volt design will have the terminals in the main terminal box connected for 4000 volts by default. This clarifies how the supplier should make the connection for this dual voltage configuration. This is done to ensure the winding will not be damaged if the motor was connected to 4000 volt power while the internal connections were connected for 2300 volts. If the purchaser wants the motor to be connected for 2300 volts, select the bullet provided to indicate this and be sure this selection is correct. A mistake could be costly.

1 – 14 **Max Sound Pressure Level** – The standard requires a maximum sound pressure level of 85 dBA at a distance of one meter (3 feet), at no load, at full voltage, and on sine wave power. This is consistent with OSHA rules so that hearing protection is not required while the motor is in operation. Remote, unattended equipment may not require 85 dBA. Lower sound levels may be desired but may be difficult and expensive to achieve. Certain rare installations near noise sensitive areas (e.g. residential dwellings) may require reduced noise levels of 80 dBA or 75 dBA. The noise level of the equipment train is affected by each individual machine's contribution to the total sound level and other external effects (e.g. nearby equipment, walls or other reflective surfaces). Motor noise levels are based upon a free-field measurement at no-load conditions when tested at the supplier's facility and may be different under loaded or installed conditions. Consider the alternative of accepting supplier standard noise levels and enclosing the entire drive train in a sound enclosure that does not affect cooling air flow. Consult a local safety engineer for more guidance. If lower sound levels are required from the motor, document it here.

1 – 15-25 **Usual Service Conditions** – API 547 has been developed for "General Purpose" motor applications driving centrifugal loads, with the essential requirements of API 541 but without the breadth of detailed requirements and options found in API 541. Accordingly, there are a minimum number of optional purchaser decisions provided for in the datasheets as compared to API 541. The following section captures most of the usual condition variables.

1 – 15 **Nameplate Ambient Temperature** – The ambient temperature to be used in defining the motor ratings given on the motor nameplate should be specified here. This is a critical starting point for motor design. Typically, the base or rated ambient for motors is 40 ˚C, and this is the default found in most standards. It is

often the same as the site ambient but not always the same as the maximum ambient specified for the site, which may only be realized for short periods. If it is determined that the site ambient is higher than 40 °C, the higher value should be used for the motor nameplate ambient as well. If the maximum site ambient is lower than 40 °C, the purchaser may agree to use the lower value for the nameplate ambient, otherwise 40 °C should be used. If the motor is to be used in a heated indoor location where the site ambient is lower than 40 °C, the purchaser may also elect to utilize the 40 °C for the nameplate ambient instead of the lower outdoor site ambient. Also note that this standard's minimum ambient temperature is –18 °C (0 °F). If a lower minimum ambient temperature is required, use the bullet and space at the end of this line to identify it. The rated ambient temperature range affects the design of the motor's physical size, stator windings, bearings, lubrication, and other characteristics.

1 – 16 **Site Elevation** – Enter the applicable elevation for the site where the motor will be operating. This is significant if over 1000 m (3300 ft) above sea level. Due to the decreased air density of higher elevations, motors are normally derated by approximately 1 % per 100 m (330 ft) above 1000 m (3300 ft). The supplier should be consulted for elevations above 2000 m (6600 ft) as other factors may affect this estimation. For new equipment, the supplier can take the elevation into consideration during the design stage and offer a motor fully rated for the conditions without derating.

1 – 17 **Motor Location** – The standard recognizes that the motor is to be suitable for severe duty, humid, corrosive, or salty atmospheres, either indoors or outdoors. Select one of the available bullets to convey the location to the supplier, which may also be an offshore location that will require use of 316 series stainless steel hardware.

1 – 18 **Mounting** – The scope of this standard applies to horizontal foot mounted motors and vertical shaft down flange mounted motors less than 375kW (500 hp) down to 185kW (250 hp). Vertical motors 375kW (500 hp) and larger are to utilize the requirements of API 541. The vast majority of applications make use of horizontally mounted (i.e. feet and shaft are parallel with the ground) motors that have four feet for use in bolting the motor to the base or foundation. If a vertical motor fitting the above description is required, select the bullet for this selection on line 31.

1 – 19 **Mounting Plates** – When a driven equipment OEM will purchase the motor within their scope of supply, they will normally handle the supply of any necessary mounting plates. In other situations where a baseplate or soleplates are required, the bullets on this line can be used to specify them. Use these bullets only when the driven equipment OEM is not providing a mounting plate or base.

1 – 20 **Motor Power Source** – Sine wave power is the fixed frequency utility supply. This is the usual source of power for an API 547 motor. Other types of power supply, such as an ASD (adjustable speed drive), are considered an unusual condition. If another type of power source is to be used, use the bullet and space provided to define it.

1 – 21 **Connection to Load** – The default condition is "Direct Coupled" where the motor is directly coupled to the driven load to operate at the same speed (i.e. not coupled through gears, belts, etc.); If another condition is required, such as "Gearbox" or "V / Cog Belt," use the bullet for "Other" and define the applicable type of load connection.

1 – 22-25 **Area Classification** – As the majority of API 547 motors are presumed to be intended for use in an area classified as Class I, in either a Division 2 or Zone 2 area, these are shown as the default requirement. Separate spaces are given to identify a Division or Zone based area with space provided to define the applicable Group, Temperature Code and/or Autoignition Temperature. If the application for the motor is

in an unclassified area, select Nonclassified, or if another classification (such as a Class II combustible dust area) is necessary, use the space provided on line 24. If it is in a Class I, Division or Zone classified area, fill in all the applicable data required on lines 22 or 23. If the motor is to be applied in an area that uses the Ex system of hazardous area classification, space is provided on line 25 to define and detail the specific Ex requirements. The motor supplier requires all this information to properly configure a motor for a classified area.

Classified areas are normally defined for existing plants and/or new plants or projects. Refer to API 500 or API 505 and the U.S. National Electrical Code (NEC) in NFPA 70, Chapter 5, Article 500, or the Canadian Electric Code CSA 22.1, Part 1, Section 18. The definitions of Class, Group, and Division and alternatively Class, Group, and Zone are found there. IEC 60079-10 may also be referenced, where applicable, in addition to local codes or regulations.

Almost all areas in petrochemical facilities are “Division 2” or “Zone 2.” The most commonly specified area classifications for process areas are Class I, Division 2, Group D or Class I, Zone 2, Group IIA. “Class I” covers a flammable gas or liquid; “Division 2” applies where gas, vapor, or liquid is present only during abnormal conditions; and “Group D or Group IIA” covers a category of materials including gasoline. Motors used in Division 2 or Zone 2 areas are not required to be explosion-proof, but they cannot have any component that in normal operation may generate a spark (e.g. a contact type switch) unless that component is in a certified enclosure. While Division 2 and Zone 2 areas in North America do not require special motor enclosures, Zone 2 areas outside of North America do require special motor enclosures (e.g. non-sparking type) so precautions should be used for applications outside North America.

A “Division 1” area means that flammable gas or vapor is often present and special enclosures or provisions for ventilation must be used. A “Zone 1” area is one where the gas or vapor is likely to exist under normal conditions or that is adjacent to a “Zone 0” area and also requires motors with special enclosures. A “Zone 0” area is one where the gas or vapor is present continuously (**no motors are allowed in a Zone 0 location**). In the Zone system, Group IIA is similar to Group D in the Division system, Group IIB is similar to Group C in the Division system, and Group IIC is similar to Groups A and B in the Division system. However, not all chemicals retain this relationship. Some materials change group designations depending upon the evaluating authority. API 505 discusses the Zone system in more detail. Care should be exercised when using the Zone system to avoid confusion with the Division system.

Ex labeled motors are not commonly used in North America but may be required in other regions of the world. For installation in many non-North American Zone 2 locations, a certification of Ex n is often required. Some jurisdictions may require a more severe Ex designation for Zone 2. Care should be exercised to ensure clear understanding of any Ex requirement and the various options and nomenclature for defining an Ex requirement. Assumptions should be rigorously avoided. Refer to the following IEC standards for further definitions: IEC 60079-15, non-sparking, Ex n; IEC 60079-7, increased safety, Ex e; IEC 60079-1, flameproof, Ex d; and IEC 60079-2, pressurized, Ex p.

1 – 22-23 **Temperature Code and Autoignition Temperature** – If the application is in a Class I classified area**,** enter the applicable temperature code (T-Code) here, and/or enter the applicable autoignition temperature (AIT). The T-Code represents a temperature class applied to equipment and must be less than the minimum AIT for a group of gases, vapors, or liquids defined to apply for the Division or Zone area classification for a given site. See NFPA 70, Table 500.8 (C) for a listing of T-Codes and temperatures. Note that space heaters have additional requirements in classified areas, as they are required to either have sheath temperatures that do not exceed 80 % of the applicable AIT or be identified for a Class I, Division 2 or Zone 2 location and listed with a T-Code that is suitable for the

applicable AIT. Refer to NFPA 70, 501.125 (B). If the "Nonclassified" bullet is not selected and nothing is entered onto the datasheet for T-Code or AIT in classified areas, the motor supplier will not have enough information to confirm the motor design. Therefore, when this information is not provided by the purchaser, this standard requires use of a space heater labeled with a T3 T-Code or otherwise having a maximum surface temperature of 160 °C, which infers 200 °C as the applicable AIT for the purpose of selecting and sizing space heaters. However, some liquids have ignition temperatures lower than 200 °C, and the purchaser should list the applicable AIT here. Refer to the below table of selected flammable gases, vapors, or liquids having an AIT of less than 200 °C. NOTE: this table is NOT applicable to gases and vapors tested to European standards. There are a few, but significant, differences between the two reporting systems. See the current edition of NFPA 497 for a complete listing of flammable liquid, gases, or vapors (ref. NFPA 499 for Class II combustible dusts). For installations to IEC standards, see IEC 60079-20-1, "Explosive atmospheres – Part 20-1: Material characteristics for gas and vapor classification – Test methods and data." The purchaser is strongly urged to identify and enter the required T-Code and/or AIT into the datasheet in the spaces provided on these lines.

Table C.2—List of Liquids with an Autoignition Temperature (AIT) of Less Than 200 °C, Requiring Space Heaters with Heater Element Surface Temperature Less Than 160 °C (Extracted from NFPA 497-2008)

Material	Cl 1 (Div.) Group	AIT °C	80% of AIT °C
Acetaldehyde	C[d]	175	140
Allyl Glycidyl Ether	B(C)[e]	57	45
Carbon Disulfide	-[d,h]	90	72
Diethyl Ether (Ethyl Ether)	C[d]	160	128
Hyrdrazine	C	23	—
Dimethyl Sulfate **	D	188	150
1,4-Dioxane	C	180	144
2-Ethylhexaldehyde *	C	191	152
Isobutyraldehyde	C – gas	196	156
Iso-octyl Aldehyde *	C	197	157
Monomethyl Hydrazine	C	194	155
Propyl Nitrate	B[d]	175	140

Notes:

* Flash point of these materials is between 100 °F (37.8 °C) and 140 °F (60 °C). Special electrical equipment is required only if these materials are stored or handled above their flash points.

** Flash point of these materials is between 140 °F (60 °C) and 200 °F (93.3 °C). Special electrical equipment is required only if these materials are stored or handled above their flash points.

d. Material has been classified by test.

e. Where all conduit runs into explosion proof equipment are provided with explosion proof seals installed within 450 mm (18 in.) of the enclosure, equipment for the group classification shown in parentheses is permitted.

h. Certain chemicals have characteristics that require safeguards beyond those required for any of the above groups. Carbon disulfide is one of these chemicals because of its low autoignition temperature and the small joint clearance necessary to arrest its flame propagation.

1 - 23 **Nonclassified** – Although it is within the "Usual" scope of this standard for motors to be applied in hazardous areas, there may be sites or areas that do not require this consideration. In this case, select this bullet to communicate to the supplier that the motor(s) will not be installed into an environment that is classified as hazardous, versus leaving the area classification options in this section incomplete. This will avoid unnecessary configuration of the motor for a classified application.

1-26-32 **Unusual Service Conditions** – The standard recognizes there may be required conditions that are considered unusual for the scope of a typical general purpose motor. This section allows for the purchaser to provide details on use of an ASD or to select a requirement for a vertical flange mounted motor within the scope of API 547. If any other unusual conditions apply, use line 32 to define them.

1 – 26 **Adjustable Speed Drive** – If an ASD will be used, select this bullet and complete the section that follows.

1 – 27 **ASD Only, ASD+DOL Start, ASD Start Only w-Bypass, ASD w-DOL Start & Bypass** – Motor design is affected when operation from an ASD is required, and changes may be needed compared to a motor intended to operate only on constant frequency sine-wave power, particularly the magnetics, insulation and the cooling system. A motor may be intended to be started and operated on ASD power only. Alternatively, it could be started on either ASD power or utility power or switched to utility power after starting on ASD power. If starting on utility power is a requirement, load inertia and torque versus speed characteristics as well as the voltage dip expected at that time are required by the motor designer. Select which of these conditions apply on line 27.

1 – 28 **Variable Torque Speed Range** – A variable torque load is one where the load torque varies with the square of the speed. Most centrifugal pumps and compressors are variable torque loads, and this is the most usual load type for petrochemical applications. Select this line if this is the case and give the minimum and maximum speeds that are required and the torque at those points if known. A typical speed range for a pump is a 2:1 (e.g. 3600-1800) range. If there is a requirement for continuous or temporary operation above the motor's rated speed, give details in the notes section.

1 – 29 **Constant Torque Speed Range** – A constant torque load is one where the load torque remains essentially the same (constant) as the full-load rated torque condition as the speed varies. This is not very common in petrochemical applications and not typical of driven equipment with a centrifugal load profile that is within the scope of this standard. Note that some compressors and pumps (such as reciprocating compressors or positive displacement pumps) have constant torque characteristics when operated on ASDs. These applications may be more appropriately specified using API 541. However, if required, select this line and give the minimum and maximum speeds that are required and the torque at those points if known. Motor size and cooling are much more affected by constant torque loads than variable torque loads.

1 – 30 **Constant Power Speed Range** – When a motor is to operate above its rated speed, it is entering the constant power range. In this range, the power demand remains the same, but the proportional torque requirement reduces at some rate. Again, this is not common in petrochemical applications but might need to be addressed whenever the application requires either continuous or temporary operation above rated speed. Give the maximum speed and torque at that speed.

1 – 31 **Vertical Shaft Down, Flange Mount, Solid Shaft** – The standard can be applied to vertical, shaft down, solid shaft motors within the range of 185 kW (250 hp) to less than 375 kW (500 hp). Motors smaller than this range may be specified using IEEE 841, and motors larger than this range may be specified using API 541. If the user or purchaser has other application requirements for vertical motors (e.g. API 610), detail them on line 32 or on page 3 in the "Additional Requirements…" section.

1 – 32 **Other Unusual Conditions** – If there are any other application conditions outside the "Usual Conditions" defined by the standard, detail them here.

1 – 33 **Bearings** – The default bearing construction required by this standard is the hydrodynamic or sleeve type. This is due to their long life expectancy and relative ease of maintenance without removal and dismantling of the motor. These may be the supplier's normal choice on large motors due to the size of the shaft or speed-diameter considerations. Although most API 547 horizontal motors have hydrodynamic bearings, antifriction bearings are an acceptable option within the standard but are required to meet the parameters defined within it. There are limitations where antifriction bearings can be applied, and each supplier has their own set of limits or capabilities. For motors covered by the scope of this standard, a typical limit of motor size where antifriction bearings may be considered is up to 600 kW (800 hp). If antifriction bearings are required, use the bullet provided to select this feature.

1 – 34 **Vertical Motors** – Certain requirements are found in the standard in relation to thrust bearing load capability. If thrust is to be applied to the motor bearings, use this line to provide the maximum continuous thrust that the pump application will impose on the motor. The motor supplier will require a definition of the applied external thrust loads in order to properly size the bearings to meet these requirements. The driven equipment OEM (typically this application is for a pump) should be able to provide this information. Vertical motor thrust bearing size, lubrication, and life cannot be confirmed without this information. Provide this data in the space provided; if the application is known not to apply any external thrust to the motor, select the "No Ext. Thrust Load" bullet.

1 – 35 **Lubrication, Ring Type** – The default lubrication scheme for the default hydrodynamic bearing construction is self-lubricating oil ring type. If a pressurized (forced, pressure fed or flood-lubed) system is required, use the bullets that follow to indicate this and whether the lubrication system is common with the driven equipment. The motor supplier will need to supply data and fittings for the lube system to attach to the motor bearing housings. Note that shared systems may pose a risk of gases from the driven equipment entering the motor through the lube system. This possibility should be considered and any necessary precautions taken. Consult IEEE 1349 for more information on this subject.

1 – 36 **Lubrication, Grease** – If antifriction bearings are selected, grease is the most common method of lubrication. Select this bullet if antifriction bearings are required. If there are specific grease preferences or requirements, select the next bullet and describe the grease requirements in the space provided.

1 – 37 **Thrust Bearing Lubrication** – The thrust bearing is required by the standard to be located at the non-drive end or top of the motor. The standard also has requirements related to the lubrication of thrust bearings. This line provides the purchaser the opportunity to indicate which type of lubrication is preferable. If there is no preference, select the "Supplier Decision" bullet so the supplier may supply their standard arrangement suitable for the thrust load specified. Note that oil lubrication is often required for applications with higher thrust values, and in some cases an external oil cooler may be required. Space is provided on page 4 of the datasheet for the supplier to document oil cooler requirements. The drive end or bottom bearing is usually considered a guide bearing and is typically grease lubricated.

1 – 38 **Separate Nameplate with Purchaser's Information** – Frequently, the purchaser has established an identifying number for the subject motor(s). The motor supplier can provide a separate nameplate on the motor with this information, commonly called the Tag No. It is usually quite similar to the driven equipment number, so care should be applied to ensure the correct number is identified in the space provided on line 38 and the Tag No.'s match any entry in line 5. Attach additional documentation if more space is needed.

1 – 39 **Paint/Paint System** – As the standard does not specify a paint system, the supplier's paint system is the default. If a special paint system is required (such as for offshore environments), select the applicable bullet, identify the relevant paint system specification and surface preparation requirements, and supply copies to the motor supplier for quotation. In addition, the supplier's paint color is the default, unless the purchaser specifies a paint color. If a particular color is desired, provide the applicable color name and code. Sometimes a sample paint chip will be required if the color cannot be readily identified by a code.

1 – 40 **Supply API Monogram Nameplate** – As explained in Annex A, manufacturers of API 547 motors have the option to request and receive an inspection from the API Monogram Program. If the manufacturer passes the inspection and the motor is fully compliant with API 547, the manufacturer can apply the API quality monogram on the motor's nameplate. This serves to identify that the manufacturer's motor design and quality system provide the ability to manufacture a motor that is fully compliant to API 547. Use the bullet on this line to request this feature.

1 – 41 **Other** – Use the space provided to add other requirements or identify where other applicable requirements and information may be found.

Page 2 Starting, Driven Equipment, Terminal Boxes, Accessories

2 – 1-7 **Motor Design and Starting Characteristics** – This section is for the purchaser to specify the conditions under which the motor will be started.

2 – 1 **Starting Voltage** – The default motor starting condition is for Direct On Line (DOL) starting at 80 % of rated voltage. Under this condition, the motor starter or circuit breaker is closed to start the motor with nothing intentionally inserted in the circuit to reduce the voltage to the motor, i.e. full voltage is applied to start the motor. This is typically called full voltage starting. However, when large motors are started DOL, a voltage drop is expected at the motor terminals during starting. Typically, this voltage drop is less than 20 %. Therefore, this standard requires that the motor should be able to accelerate the load with 80 % voltage at its terminals to allow for typical maximum voltage drop in the system feeding it.

2 – 1 **Other** – In some instances, excessive voltage drop may be experienced on soft power systems, such that the voltage available during starting is less than 80 %. Where the purchaser knows this to be applicable, the purchaser is expected to specify the minimum percentage of rated voltage that the motor will be subjected to during starting in the space provided. This may have a significant effect on motor size, inrush, and selection of starting equipment, starting time, equipment protection, and overall system cost.

2 – 2 **Starting Method** – Other starting methods may intentionally be used to adjust starting voltage as a means of reducing inrush current and burden on the power system during a DOL start. These may include, a captive transformer (a single transformer feeding only the motor), an adjustable speed drive (ASD), reduced voltage (soft-start) starter, shunt capacitor (switched in during starting), series reactor and shunt capacitor, or autotransformer starting methods. For example, the voltage would typically be reduced to either 80 % or 65 % with an autotransformer starter. Where the starting voltage is intentionally reduced by use of one of these or any other method, make the applicable selection. Note that any of these methods may affect motor size and cost.

2 – 3 **Solid State Soft Starter** – When a solid state soft starter is used to start the motor, it is important to coordinate starting criteria with the motor supplier. If this is applicable, fill in the expected current limit to be used so the supplier can qualify the motor's ability to start the load without incurring damage. Changes to the soft start limits or motor size may be necessary.

2 – 4-5 **Motor Load Starting Capability** – The standard requires motors to be capable of starting and accelerating a centrifugal load. A centrifugal load is one in which the load torque varies with the square of the speed and the full-load torque requirement is equal to or less than the rated full-load torque of the motor. Whereas NEMA MG 1 Part 20.10.1 requires motor torque to be at least 10 % higher than the above defined load curve up to the speed that breakdown torque occurs with 90 % of the nameplate voltage rating, the standard requires the same torque margin with 80 % of nameplate voltage rating. This should be sufficient for most pump applications whose load inertia is within the limits defined by the standard. Some applications, such as fans or compressors with higher than defined load inertia reflected to the motor, may require special motor designs to safely accelerate the driven equipment. In addition, the purchaser and supplier may want to check the load characteristics and confirm a motor design that provides adequate torque margin for the specific driven equipment with the 80 % starting voltage condition. To apply the specific load characteristics of the driven equipment under consideration, select the "Other" bullet, supply the "Load Speed-Torque Curve No." in the space provided, and provide this curve to the motor supplier. Also supply the load inertia data in the space provided on line 13. All of this information will be used along with the data and selections made in the Motor Starting section on this page in order to comply with the requirements of this standard.

2 – 6 **Design Condition** – When a load curve is available and supplied for the driven equipment, it may include two curves. One of the curves is usually considered "Loaded." It is the worst case load condition, sometimes referred to as open valve or damper condition. The other may be for "Unloaded" or "Partially Loaded," sometimes referred to as closed valve, closed damper, or minimum flow condition. The purchaser may direct the motor supplier to use any one of these options to correspond to the load curve by selecting the applicable bullet. The unloaded and partially loaded curves typically present lower torque requirements. If these conditions are specified, the motor supplier will use the applicable curve to design the motor's starting capability. Use of these lower torque conditions may avoid added cost, increased size, and/or higher inrush current which can result from designs for higher load torques and/or reduced starting voltage conditions. Conversely, it may be difficult to define the intended starting condition of the driven equipment, and/or the actual conditions used in daily operations of this equipment may not match the intended conditions. For these situations, the conservative approach is to use the loaded curve to define starting conditions. In either case, clear definition and understanding of the trade-offs in defining load requirements will expedite the process of specifying, quoting, and designing the motor.

2 – 7 **Other** – Use this line to add any additional information related to motor starting requirements or load profile.

2 – 8 **Driven Equipment Tag. No.; Description; Location** – It is essential that the motor supplier be given all the necessary application data for the driven equipment. This data will come from OEM data, either directly or indirectly. It is the responsibility of the purchaser to ensure this data is entered for this entire section or that the OEM is tasked with and completes this action prior to the datasheet being sent to the motor supplier. Enter the identification number of the driven equipment, its description (e.g. Amine Pump), and its location. As "Motor Tag No.'s" are quite similar and usually based on the "Driven Equipment Tag. No.," care should be taken to differentiate between them accurately where applicable.

2 – 9 **Driven Equipment Mfgr.; Type/Model; RPM** – Enter the name of the driven equipment supplier, the type and model of the driven equipment if known, and its rated operating speed in RPM. This will be different from the motor speed if a gearbox is being used.

2 – 10 **Driven Equipment Rotation** – Identify the direction of rotation of the driven equipment here, as viewed from the non-drive end (NDE) of the motor (a.k.a. opposite-drive end – ODE, outboard, or non-coupling end). Indicate which direction of rotation the equipment is intended to operate - clockwise or counterclockwise. This information should be considered for reference only, as the required motor rotation will be specified in the next line. In most cases, the direction of rotation for the motor and driven equipment is the same. However, where a gear box is inserted between the motor and the driven equipment, the direction of rotation is likely to change. If the equipment will be expected to rotate in either direction, select the direction to be used for primary operation and also select "Bi-directional." This is not normally the case, although many motor designs can rotate bi-directionally.

2 – 11 **Required Motor Rotation** – To be certain the motor supplier provides a motor that will operate in the direction required by the driven equipment, identify what is required by selecting the applicable bullet, using the same point of view as described above (from the NDE of the motor). The direction of rotation relative to the proper identification of each phase of the motor should be confirmed by the supplier at the final test, and the motor power lead wires should be labeled properly to give the specified direction of rotation. This information is also important to the motor supplier because some designs use a uni-directional fan, and these fans must be installed for the specified direction of rotation. Changes to correct the direction of rotation in the field for uni-directional motors may not be easy to do without major rework. If the motor will be expected to operate in either direction, select the direction to be used for primary operation and also select "Bi-directional," or just select "Bi-directional." Also select "Bi-directional" if this capability is the preferred direction of rotation. NOTE: If there are two or more units being specified for the same service, the motor direction of rotation should be the same for all motors specified with one datasheet. If a different direction of rotation is required for any of the units, a separate datasheet should be considered to avoid confusion.

2 – 12 **Type of Load - Centrifugal** – This standard is intended to be used primarily for driven equipment whose load is of the centrifugal type. A centrifugal load is one in which the torque of the load varies with the square of its speed. Select one of the applicable types of load (driven equipment) given on this line.

2 – 13 **Load Inertia** – This data is used to verify that the motor has sufficient capability to start and accelerate the driven equipment satisfactorily. Provide the total inertia reflected to the motor shaft in this space. This should be inclusive of the load, coupling, and any effect from a gearbox if applicable. The polar moment of mass inertia is often called Wk^2 (or Wr^2 or Mr^2) where k (or r) is defined as the radius of gyration. Normal units are lb-ft^2 in the imperial/US system and kg-m^2 in SI units. In some cases, be aware a different equation for mass inertia may be used - GD^2, where D is the diameter rather than the radius, thus resulting in a value that will differ by a factor of four. Provide this value in the available space, and identify it as either lb-ft squared or kilograms-meters squared. Also give the RPM at which the total inertia is calculated, and select the applicable term of inertia, either Wk^2 or GD^2.

2 – 14 **Coupling: Supplied By** – Use this line to define who is responsible to supply the coupling. This is frequently the driven equipment supplier, who in turn will have to supply the motor half-coupling to the motor supplier if the purchaser desires it to be mounted by the motor supplier.

2 – 15 **Coupling: Mounted By** – For new equipment installations, the most typical arrangement is for the driven-equipment supplier to provide the coupling and mount it at their works. For other cases, such as when testing with the coupling half at the motor factory is required, coordination for shipping the motor half-coupling to the motor supplier is necessary. Make the applicable selections in the spaces provided.

2 – 16-17 **Main Terminal Box** – The standard requires the minimum size and volume of the main terminal box to not be less than that specified for a Type II box per NEMA MG 1 Part 20. It further requires the use of copper bus bar mounted on insulated standoff insulators (as defined by NEMA for a Type II box) and silver plating at the lead terminal connection (landing) points. Tin plating is recognized as an alternative in some areas, so an option to specify tin plating is provided on the datasheet as well. The standard also requires the bus bar to be insulated except for connection areas. If another size or type of box is required, space is provided in line 17 for the purchaser to define it.

2 – 17 **Supply Neutral Bus** – This bullet is provided to allow the purchaser the option to specify that the supplier bring the neutral ends of each phase of star connected windings to a common bus inside the main terminal box. Doing so gives the purchaser the opportunity to perform phase to neutral testing for troubleshooting and maintenance purposes if desired. This feature is a requirement for motors specified for a dual voltage 2300/4000 volt nameplate rating.

2 – 18-19 **Main T-Box Pressure Withstand Capability** – This is an option for the purchaser to specify. When required, additional information can be provided on line 19 for electrical system data that may assist the supplier with design and supply of a device to relieve any pressure build up inside the terminal box.

2 – 20 **Box Location** – If the main terminal box location is not specified, the supplier will use their standard arrangement to install it. The purchaser may select the “Supplier Decision” bullet if the required location is not known. However, it is important for the purchaser to identify which side of the motor the main terminal box is to be mounted (with reference to the non-drive end of the motor) at the time the motor is ordered. Changing the location from one side or location to another after order placement may result in additional delivery time and cost and is usually not possible after the motor is installed.

2 – 21 **Main T-Box Cable Entry** – The default is for the supplier to provide a removable plate on the bottom of the box which covers a hole giving entry into the box. A hole of required size can be punched into this plate to accommodate the cable or conduit size needed. If the purchaser requires a different entry type or location, use the bullet and space provided to identify it. Top entry of cables is not recommended and should be avoided if at all possible due to the difficulty of maintaining a leak-proof installation.

2 – 22 **Main T-Box Space Heaters** – Space heaters for the main terminal box should be specified if the motor is intended to operate in an outdoor or humid environment, especially when the terminal box has other accessories in it (e.g. surge capacitors, lightning arrestors, current transformers). These heaters should be energized at the same time as motor (frame) space heaters and/or when the motor is expected to be inoperative for extended periods of time. The default configuration is for single phase heaters connectable at 120 volts, which is the same as for stator space heaters on line 30. If another arrangement is required, use the bullet and space provided to define it. These space heaters should always be energized when the motor is not in operation.

2 – 23-24 **Other Main T-Box Accessories** – The standard does not include terminal box accessories within its scope but recognizes that some devices may be required. Use the bullet and space provided to detail any terminal box accessories beyond those listed above.

2 – 25-26 **Winding Temperature Detectors** – The standard requires that winding temperature detectors be installed. The default sensor is a platinum three-wire 100Ω at 0 °C resistance temperature detector (RTD). Other types are nickel, 120Ω at 0 °C and copper, 10Ω at 25 °C.These detectors are installed in intimate contact with the winding insulation and give an accurate measurement of the operating temperature of the winding. They provide better protection for the motor than current-sensitive overload

relays. They also improve protection against clogged air filters, which can cause high winding temperatures in WP-II (weather-protected Type II) enclosures. Should the purchaser require a different type of detector, use the space provided to specify the details.

2 – 27-28 **Bearing Temperature Devices** – The standard requires that one bearing temperature detector is installed per bearing. They can provide early warning of lube oil loss or impending bearing failure. The default sensor is a platinum three-wire 100Ω at 0 °C resistance temperature detector (RTD). Other types are nickel, 120Ω at 0 °C and copper, 10Ω at 25 °C. Should the purchaser require a different type of detector, use the space provided to specify the details. These detectors should be selected and applied consistently within the entire equipment train.

2 – 29 **Location for Bearing Temperature Detector Terminations** – A common practice for motor suppliers is to place the terminations of the bearing temperature detectors in conduit heads on or near the bearing housings. Some users prefer these devices to have their terminations in the same terminal box as the winding temperature detectors or in a separate terminal box. If the purchaser has no preference, the “Supplier Standard” arrangement will be supplied. Otherwise, use the bullets provided to define the location of these terminations.

2 – 30 **Stator Space Heaters** – It is highly recommended that all motors have space heaters installed. Their primary purpose is to prevent condensation on the motor stator windings when the motor is not in operation. Normally, the supplier’s standard bar type space heater is acceptable; these are sometimes referred to as frame space heaters. Flexible silicone insulated belt type space heaters that contact the surface of the motor winding (end turns) are only permitted by the standard in TEFC motors. Single phase heaters connectable at 120 volts are the default. In Division 2 or Zone 2 applications, the motor supplier must supply heaters whose surface temperature at operating voltage complies with the temperature limits defined by the standard (160 °C or T3 T-Code) or those defined by the purchaser in the space provided for temperature code or AIT. (See more information about this in the discussion of Temperature Code for page 1, lines 22 & 23.) If another arrangement is required, use the bullet and space provided to define it. Space heaters should always be energized when the motor is not in operation.

2 – 31-32 **Temp. Code / Max. Surface Temp.** – Refer to the discussion of this topic for datasheet page 1, line 22 & 23 found previously in this guide. The temperature code (T-Code) represents a temperature class applied to equipment and must be less than the minimum autoignition temperature (AIT) for a group of gases, vapors or liquids defined to apply for the division or zone area classification for a given site. NFPA 70, Table 500.8 (C) and CSA C22.1, Section 18 contains a listing of T-Code temperatures. Space is provided on these lines for the applicable T-Code.

For Division 2 classified locations, either an unlabeled or a labeled space heater can be used. The surface temperature of unlabeled heater elements is limited by NFPA-70, 501.125 (B) to a maximum of 80 % of the defined minimum AIT, otherwise the space heater must be labeled with a suitable T-Code. Using an example of a 204 °C AIT for the classified area, the maximum surface temperature for an unlabeled space heater must not exceed 80 % of this value, which is 163 °C. If a labeled space heater is used, it is not necessary to multiply the minimum AIT of the classified area by 80 % to establish the maximum temperature for selecting a T-Code, as is required for the unlabeled space heater. It is only necessary to choose a T-Code that has a temperature rating lower than the AIT, although a lower than required temperature T-Code can still be used if preferred. In the example, a listed space heater labeled with a T-Code of T3 (maximum temperature of 200 °C) or lower temperature T-Code can be used.

For Zone 2 classified areas, space heaters must be labeled with a T-Code per NFPA 70, 505.20 (C). An unlabeled space heater is not permitted. The T-Code is selected in the same manner as described above.

Local codes or regulations may require additional considerations for space heater temperature requirements. Refer to IEEE 303 for additional guidance.

Enter the appropriate T-Code or the maximum space heater surface temperature in the space provided. If the maximum surface temperature or the T-Code is not specified, the standard requires that an unlabeled heating element must not exceed 160 °C (320 °F) and a labeled heating element must be identified with a temperature code of T3 or lower temperature code. Unless otherwise noted, the T-Code specified on page 1 of the datasheet should be specified in this space. See the information for datasheet page 1, lines 22 & 23 in this guide for a table listing AIT's for various gases and liquids.

2 – 33 **Location of Auxiliary Boxes** – Some suppliers locate auxiliary device terminal boxes (such as temperature detectors) on the side of the motor opposite the main terminal box as a standard practice. If the purchaser has no preference, the "Supplier Standard" arrangement will be supplied. Otherwise, use the bullets provided to define. The location of the cable entry into these boxes can be defined on line 34. The default entry is from the bottom. If another entry location is required, use the bullet and space provided to define it. In all cases, the location and cable entry location are directed or limited by the box size, motor arrangement, and other physical considerations

2 – 34 **Stainless Steel Auxiliary Boxes/Encl**. – In applications (e.g. offshore or other corrosive environments) where the purchaser requires the use of stainless steel construction of the auxiliary terminal boxes, select the bullet provided. The grade of stainless steel should also be noted on line 44 "Other" or in the "Additional Requirements …" section on page 3 of the datasheet.

2 – 35 **Air Filters** – Air filters are required for WP-II motors by the standard. It is highly recommended that either an air filter differential pressure switch (or transmitter), winding temperature detectors, or both be used and wired to the control system as a means to annunciate and alarm operators when the filters become dirty. When filters are specified, it is wise to order a set of spares so they can be exchanged from the motor and cleaned.

2 – 35 **Filter Capability** – The default requirement of the standard is for filters that capture 90 % of 10 micron dust particles. If a different capability is required, use the "Other" option provided.

2 – 36-37 **Differential Pressure Device** – The supplier is to include provisions for the installation of an air filter differential pressure device as a default requirement of the standard. The device itself is optional but is recommended for any motor with air filters. There are a variety of devices available that will detect the pressure differential across the air filters, which will increase as they become clogged with dust and retard cooling air flow into the motor. Select one of the options provided on line 37. Local practice at the site usually dictates if a gauge or switch or both are supplied. Note that if the motor is to be used in a Division 2 or Zone 2 area and the differential pressure device that is supplied has contact type switches, the device must be housed in a certified enclosure. If a device using transmitters is required, provide further detail on line 44 "Other" or in the "Additional Requirements …" section on page 3 of the datasheet.

2 – 38 **Vibration Probes** – Use this area to specify one or more of the typical types of vibration measurement equipment used for API motors. These devices should be selected and applied consistent with API 541 and the entire equipment train.

2 – 38 **Non-Contact Shaft Probes** – Non-contact (X-Y) shaft vibration probes are commonly used to monitor the mechanical vibration of large motors operating at synchronous speeds of 1200 RPM or higher. Typically, they are specified to be consistent with the driven equipment. If probes are not used for the driven equipment, they are generally not required for the motor. Provisions for the future installation of shaft probes and a phase reference probe may also be specified. If this equipment is to be installed or provisions are supplied, the requirements of API 541 govern the application and installation of the devices. Typically, two probes are required per bearing. If shaft probes are required, use the bullets on line 38 to specify installation or provisions. If shaft probes are specified, the phase reference probe or provisions for it are commonly required. The bullets on line 39 can be used to select this probe or to select provisions only. Note that the phase reference probe may be installed in other locations on the equipment train and typically is only required in one location of the train (unless there is a need for an installed spare phase reference probe). However, since the motor can be run uncoupled from the driven equipment during commissioning or troubleshooting, the most appropriate location for the phase reference probe is usually on the motor to provide for complete vibration monitoring when running uncoupled.

2 – 40 **Bearing Housing Seismic Sensors** – Seismic vibration sensors may be used on sleeve bearing motors and on motors with antifriction bearings. Typically, they are specified to be consistent with the driven equipment. If vibration sensors are not used for the driven equipment, they are generally not required for the motor. There is a wide variety of vibration sensors designed to mount on bearing housings. Accelerometers are common, and velocity transducers (pickups) may also be specified. When defining specific devices, the purchaser may select models that are configured for acceleration, velocity, or displacement transducer output and are compatible with the equipment train vibration monitoring system. Velocity transducer output is recommended for accelerometers, and velocity or displacement transducer output is recommended for velocity pickups. If required, use the bullets on line 40 to specify provisions only or the installation of these devices. If provisions only are required, the purchaser should define the mounting hole / thread size for the required devices on line 40 and the locations and quantities of devices on lines 42-43. In this case, it is recognized that the purchaser will arrange to supply and install them at site.

2 – 41 **Bearing Housing Vibration Switch** – These devices are not normally recommended for motors of the size range covered by this specification, since they typically do not offer the ability to monitor vibration. Their function is simply to annunciate a warning when a pre-defined vibration level has been reached. However, if specified, the same details as for the seismic sensors should be supplied on lines 42 and 43, and the type of reset associated with the vibration switch should be identified on line 41.

2 – 42-43 **Bearing Housing Sensor Locations: D.E. Bearing, N.D.E. Bearing** – Here the purchaser should specify the location of the sensors – "H" horizontal, "V" vertical and/or "A" axial. All positions are not necessarily required or possible. Often just one is specified. Indicate the total number of devices required and in what position they should be provided. This also applies when only provisions are to be supplied – the number and location of the provisions are needed by the motor supplier. It is also necessary to define if the sensors are required for both bearings or just for one end of the motor.

2 – 44 **Other** – Use the space provided to add other requirements or identify where other applicable requirements and information may be found.

Page 3 Inspection & Tests

3 – 1-2 **Inspection & Tests** – These two lines offer guidance on how to use the bullets to select the tests that follow. Leaving an item with an open bullet indicates it is not required. Also, select the triangle bullets to indicate when a selected item applies to all units when there is more than one unit being ordered for the same application based on the same datasheet. If the item is only to apply to one unit of a multi-motor order, leave the triangle open. Generally, the first machine of any design receives complete tests as “design qualification,” depending on previous experience with a given design. Once the design is qualified on the first motor, other motors covered by this standard may receive routine and quality testing only.

3 – 3 **Make Selections in Only One Column for Each Item** – Choose from only one of the “Required,” “Witnessed,” or “Observed” columns. The number of procedures that are required may have a significant impact on the price and quality of the final motor. Tests may be “Witnessed” or “Observed.” For definitions of these terms, refer to Section 3 of this standard.

3 – 4 **Stator Surge Test** – This testing is not optional, and it applies to all units of a multi-unit order. It is performed on the uncured stator coils before stator VPI. The risk of not doing the test is that marginal turn-to-turn insulation in the winding may not fail during the factory tests but may fail in operation when subjected to mild power system surges. The purchaser may elect to witness or observe one or all the units by selecting the applicable bullet(s) under the Witness or Observed columns.

3 – 5 **Routine Test & Vibration Test** – These tests are not optional and are required for all motors. The API 547 routine test is more extensive than the standard routine test required by NEMA, and it includes vibration and bearing temperature rise. There are slight differences between the API 541 routine test and the routine test required by API 547. The purchaser may elect to witness or observe one or all the units by selecting the applicable bullet(s) under the Witness or Observed columns. The vibration test is a no load test to verify that the motor’s vibration levels do not exceed the requirements of the standard. The purchaser may elect to witness or observe these tests on one or all the units by selecting the applicable bullet(s) under the Witness or Observed columns.

3 – 6 **Special Tests** – The tests that follow are optional.

3 – 7 **API 541 Routine & Complete Test** – This optional test applies the API 541 “Complete Test” requirements, including the more detailed “Routine Test” requirements of API 541. Specify this when the purchaser requires a tested validation of efficiency and temperature rise. The standard requires the purchaser, in consultation with the supplier, to specify which method given in IEEE 112 or IEC 60034-2 is to be used to determine efficiency and performance data. The heat run is used to determine rated temperature rise of the motor. It is also valuable to confirm rotor thermal stability, which includes vibration with the rotor at rated temperature. The complete test may be specified for at least one (generally the first) of each motor rating when multiple units are ordered at the same time. The complete test should also be specified where the evaluation factor justifies the test cost to prove the efficiency.

3 – 8 **Rated Rotor Temperature-Vibration Test** – The purchaser may specify this test if the motor is not going to have an API 541 “Complete Test,” but it is still important to know that the rotor is thermally stable. Although this test is less comprehensive than a complete test, it may require most of the set-up and cost for a complete test. It is recommended to discuss this test with the supplier and consider use of a complete test, which includes this test plus much more.

3 – 9 **Sealed Winding Conformance Test** – This test involves submerging the motor winding or spraying it with a wetting solution to verify the seal of the insulation system. This test may be applied to motors whose windings will be exposed to weather or wash-down conditions and/or when purchasing from an unfamiliar supplier. Consideration should be given to define this test as witnessed because corrective measures, in the event of a failure, require purchaser involvement.

3 – 10-11 **Other** – Use the bullets and space provided to add other inspection or testing requirements. Note that the addition of other tests may increase the scope outside of the intended general purpose nature of API 547 and into API 541.

3 – 12-40 **Additional Requirements, Comments, Notes** – This space is available to be used in any way for further information, etc.

Pages 4 & 5 Motor Supplier Proposal & Order Data

This section is to be used by the motor supplier to supply motor proposal data. The motor supplier may provide the proposal in another format. When a proposal request includes a request for datasheets to be completed at the proposal stage, this is the applicable section for the API 547 datasheet and should have the "Proposal" bullet selected. Upon becoming applicable to the purchase of the motor(s), this page then becomes the "Order Data" page of the datasheet. It is to be completed by the motor supplier during the order engineering process and then returned to the purchaser with the "As-Designed" bullet selected. After motor shipment, the supplier is to re-issue the datasheet with this section modified if necessary to capture any changes since the "As-Designed" release of the document. The final release will have the "As-Built" bullet selected.

Bibliography

[1] IEEE 1349, *IEEE Guide for the Application of Electric Motors in Class I, Division 2 and Class I, Zone 2 Hazardous (Classified) Locations*

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