SPECIFICATION GUIDE
Vertical Hollow and Solid Shaft High Thrust NEMA® Frame Motors
Totally Enclosed Fan Cooled – TEFC

Standards Referenced: NEMA® MG-1-2011, IEEE Std 112™-2004, IEEE Std 841™-2009

1. General Requirements

    a. Scope – This specification covers NEMA frame vertically mounted, P-base, 3-phase, squirrel cage, AC induction motors. That are totally enclose fan cooled 3 HP and above, and under 600 volts.

    b. Service Conditions – Unless otherwise specified, motors conforming to this specification shall be suitable for operation in accordance with their rating under the following service conditions.

        i. Ambient temperature in a range of -29°C to 40°C (-20°F to 104°F).

        ii. Maximum altitude of 1000 meters (3300 feet) above sea level.

        iii. Indoor or outdoor installations.

        iv. Full voltage, across-the-line starting.

    c. Special Service Conditions

        i. Arctic Duty - Available on motors applied in ambient of -30°C (-22°F) to -56°C (-70°F). This feature has special electrical, lubrication and mechanical features (CORRO-DUTY® features are included).

        ii. High Ambient – Special engineering is required on motors in an ambient over 65°C.

        iii. High Altitude – Applications with altitudes above the standard service conditions require special design considerations.

        iv. Use with Variable Frequency Drive (VFD)

        v. Hazardous Location

            1. This is a special requirement and shall not be covered in this specification.

    d. Standards - All motors shall be in accordance with NEMA Standard MG1-2011, or the latest revision in so far as it is applicable.

2. Electrical Requirements

    a. Voltage and Frequency

        i. Standard voltages

            1. 60 cycle, 3 phase: 200, 230, 230/460, 460 and 575 volts are considered standard for ratings of 100 H.P. and below in maximum frame size of 405.

                a. 460 and 575 volts are standard above 100 HP and up to and including 447 frame

            2. 50 cycle, 3 phase: 190, 220, 190/380, 380 and 415 volts are all considered standard for ratings of 100 H.P. and below and in a maximum frame size of 405.

                a. 380 and 415 volts are standard above 100 HP and up to and including 447 frame.

        ii. Motors shall operate successfully under running conditions at rated load with variation in the voltage or the frequency not exceeding the following conditions:

            1. +/-10% rated voltage at rated constant volts/hertz ratio except for specific torque boost situations.

            2. Motors shall operate successfully under running conditions at rated load and volts/hertz ratio when the voltage unbalance at the motor terminals does not exceed one percent.

    b. Operating Characteristics - With rated volts/hertz ratio applied under standard service conditions, motor performance shall be as follows for critical operating characteristics:

        i. Torques - Motors shall meet or exceed the minimum locked rotor (starting) and breakdown torques specified in NEMA Standard MG1 Part 12 for Design B for the rating specified when on sine wave power.

        ii. Currents - Locked rotor (starting) currents shall not exceed NEMA Design B values.

        iii. Efficiency – Vertical motor efficiency will be determined according to NEMA standard MG1 Part 12, IEEE Test Procedure 112 Method B, using accuracy improvement by segregated loss determination including stray load loss measurements. Efficiency calculations include friction losses due to high thrust bearings.

        iv. Temperature Rise - The temperature rise, by resistance, shall meet Class B requirements at 1.0 service factor and standard conditions and Class F requirements at 1.15 service factor.

    c. Service Factor and Ambient - Standard motors shall be rated for a 1.15 service factor on sine wave power in a 40°C ambient.

d. Insulation

i. Standard motors shall utilize the U.S. Electrical Motors Insulife 1000 insulation system which consists of at a minimum Class F or better insulation materials. This utilizes 100% solid polyester resins completely impregnating slot and end turns. The standard insulation material is non-hypogrospic Class F (155°C), suitable for a TEFC motor with moderate exposure to moisture. One dip and bake in polyester resin.

1. CORRO-DUTY® motors will have Insulife 2000 which includes an additional treatment of polyester varnish ideal for applications with high moisture content, such as tropical environments for fungus resistance. Two dips and bakes.

2. Vacuum Pressure Impregnation using 100% solid epoxy resins is available on 320 frames and larger

a. Insulife VPI 1000 – Single cycle

b. Insulife VPI 2000 – Double cycle that meets NEMA definition of moisture-resistant winding per NEMA MG1-1.27.1.

3. If inverter duty is specified special INVERTER GRADE® insulation is required.

a. INVERTER GRADE® insulation meets NEMA MG1, Parts 30 and 31. This includes additional phase paper between coils, extra bracing on end turns, and additional insulation treatments to protect motor winding from damaging effects that could occur when motor is used with a variable frequency drive.

3. Mechanical Requirements

a. Frame Size

i. Motors covered by this specification are 180 - 447 frame sizes.

b. Enclosure

i. Motors shall be totally enclosed fan cooled (TEFC)

ii. Material - Motor frame, endshields and inner bearing caps shall be cast iron construction. Fan cover will be constructed of plastic, steel, aluminum, or cast iron depending on exact frame size. Frames will be aluminum construction 180-280 frames.

iii. CORRO-DUTY® may be specified if all cast iron construction is required.

c. Bearings

i. Standard high thrust motor shall be supplied with an angular contact thrust bearing and ball type guide bearing.

ii. Optional Bearing Arrangements:

1. 175% extra high thrust bearings. Which are two angular contact bearings in tandem are available on 324 frames and above.

2. Back-to-back bearings are available on 324 frames and larger for up-thrust protection and to meet API 610 endplay requirements of max 0.005". This arrangement consists of two angular contact bearings mounted in opposite directions (back-to-back).

3. Up-thrust – 30% momentary up-thrust protection (of standard high-thrust value -- NOT extra-high thrust value) is provided as standard. When up-thrust protection is supplied on vertical HOLLOSHAFT® motors, the drive couplings must be bolted together and the self release feature will not apply; however, the non-reverse ratchet can be furnished.

   a. Continuous up-thrust protection can be accommodated for the same thrust ratings as standard down thrust by using back-to-back bearing arrangement.

iii. See Table 3.c - 1 for standard bearing arrangement and lubrication.

STANDARD BEARING LUBRICATION

FRAME	UPPER BEARING	LOWER BEARING	THRUST CAPACITY
180 – 360	GREASE	GREASE **	HIGH
400 – 440	OIL	GREASE	HIGH

** Thrust bearing located in lower bearing

Table 3.c – 1

d. Ventilating Fans - shall be corrosion resistant, non-sparking material. Some 2 pole fans may be unidirectional.

e. Conduit Box - shall be gasketed between the conduit box halves and between conduit box and motor frame. The conduit box shall be oversize as compared to NEMA type 4 requirements and diagonally split and rotatable in 90 degree increments except on aluminum frames. Conduit boxes will be aluminum on frames 180-280, steel for frames 320 and greater. Cast iron conduit boxes are available with CORRO-DUTY® features.

f. External screws and bolts - shall be grade five, hex heads and be plated to resist corrosion.

g. Motor Shaft – shall be 1045 Hot rolled Steel. Available with solid shaft or HOLLOSHAFT®

h. External Paint - shall be corrosion resistant - mill and chemical duty paint.

i. Nameplate - shall be of stainless steel and stamped per NEMA Standard MG1 Part 10 and Part 31.

j. Motor Vibration

i. Standard and refined vibration per table 3.j – 1.

VIBRATION LEVEL

	STANDARD	REFINED
Number of Poles	Velocity (IPS-PEAK)	Velocity (IPS-PEAK)
2	0.15	0.10
4	0.15	0.08
6	0.15	0.08
8	0.12	0.06
10	0.09	0.05
12	0.08	0.04

Table 3.j - 1

4. Optional Features

a. Non-Reversing Ratchet – BALLOMATIC® type

i. Standard direction is counter clockwise as viewed from opposite drive end.

ii. Clock wise rotation ratchets may also be requested on 4 – pole and slower 400 frame and larger.

b. Accessory Conduit Boxes

i. NEMA type 4 enclosure to terminate leads of accessories such as space heaters, thermostats, etc.

ii. Cast iron construction

1. Larger boxes will have steel covers.

iii. Multiple opening sizes and positions

c. Ingress Protection

i. INPRO/SEAL® – For IP55 ingress protection on pulley end bearing.

ii. Shaft Slinger – For IP54 ingress protection on both ends.

d. Meet Intent of IEEE 841 - Motor will be designed & built in accordance with NEMA MG1, but built with typical features & testing of IEEE 841, so to meet the intent of IEEE 841. Motor will not be rated or nameplated IEEE 841.

i. Available on vertical solid shaft high thrust motors. Vertical HOLLOSHAFT® motors require special consideration.

ii. Features of “Meet Intent of IEEE 841” shall be:

1. Inpro Seal – Pulley End
2. Corro-Duty (All Cast Iron Construction)
3. 1.15 Service Factor
4. Ground Lug In Conduit Box
5. Ground Terminal On Frame
6. Class F Insulation
7. Special Balance
8. Special Shaft Runout
9. “B” Rise at 1.0 S.F. by Resistance Method
10. Oversized Main Conduit Box
11. NEMA Design B
12. “MEETS INTENT IEEE841” Nameplate
13. N.W. IEEE 841 Enhanced No Load Test

e. Gate Valve Oil Drain – Gate type oil drains for oil lubricated upper thrust bearing is available on 447 frame.

f. Grounding Provisions

   i. Grounding lug available in main conduit box

   ii. Shaft grounding ring on lower bearing cap

      1. Inpro-MGS for shaft grounding and IP55 ingress protection.
      2. Suggest use of insulated upper bearing on upper bracket with shaft grounding device.

   iii. Grounding on frame

      1. Grounding pad 400 frame and larger
      2. Grounding terminal

g. Insulated bearings – BELZONA® type insulation

   i. Either one or both bearings can be insulated.

      1. If both bearings are insulated, a grounding ring is required to be installed to dissipate shaft currents.

h. Space heaters – Silicone rubber “strip – type” low-watt, density-type space heaters. Space heaters are wrapped around and bonded to the end turns on drive end.

i. Shaft Material – 4140 or 17-4PH High tensile strength steel

j. API 610 Flange Tolerances – Max shaft runout = 0.001”, max face runout = 0.001”, max register runout = 0.004”(See back-to-back bearing arrangement above).

k. Stainless Steel Hardware

l. Thermal Protection

   i. Bearings - One bearing protective device is available on the upper bracket only on 444 frame and above

      1. RTD type – 10 ohm copper, 120 ohm nickel, 100 ohm platinum, 100 ohm precision platinum

      2. Thermocouple – Type J, T, E, and K.

   ii. Windings

      1. Thermostats – Snap action, bimetallic, temperature actuated switches installed in the connection end-turns of the motor winding. Their purpose is to activate a warning device (N.O.) or shut down the motor (N.C.) upon excessive winding temperatures. Leads are normally brought out to the main conduit box on 460 volt motors. They are available with normally closed contacts for automatic reset. Overheat protectors with normally open contacts, for use in alarm or warning circuits, are available upon request.

      2. Thermistors (embedded in winging) – Winding thermistors are a nonlinear resistance temperature detector made of semiconductor material and embedded in the end turns of the motor winding, one per phase. They are a PTC type device (Positive Temperature Coefficient).

         a. Standard thermistors are SIEMENS® type B59155. Three thermistors are installed in the winding with 6 leads brought to the main conduit box. Control module is supplied by others.

         b. This accessory provides NEMA Type 1 (winding - running and locked rotor over temperature) protection for motors in the 182 through 447 frame size.

         c. THERMAL SENTRY® system is a PTC type thermistor that includes the control module.

            i. Available on 400 frame and larger

ii. Control must be separately excited by a 24 to 240 AC/DC voltage source.

3. Thermocouples - A thermocouple consists of two dissimilar conductors welded together into a junction. This is inserted into the motor winding -- 2 per phase / 6 per motor. Thermocouple leads are brought out to terminal strip connections in an accessory conduit box, which is included in its price. These accessory signal wires leads are connected to an input instrument (supplied by others) to form a reference junction. Heating of the thermocouple imbedded in the winding generates a thermoelectric potential (EMF) proportional to the temperature difference between the two points, indicating the temperature of the embedded thermocouple.

    a. Available 324 frame and larger.

4. Resistance Temperature Detectors (RTDs) - An RTD is a sensing element consisting of a precision wound wire coil of pure metal. Recognized for their accuracy, the RTD's resistance increases with temperature rise in a known and highly repeatable manner. Two RTDs per phase/6 per motor are our standard offering. Accessory lead (signal) wires are connected to terminal strip connectors in an accessory conduit box. When connected to an input instrument or monitor (supplied by others), RTD temperature can be monitored. A variety of RTDs are offered to industry standard curves as shown in table 4.L.ii.4 – 1.

    a. Available 324 frame and larger.

RTD ELEMENT	NO. OF WIRES	RESISTANCE
NICKEL (1)	2	120 OHMS @ 0°C
COPPER	3	10 OHMS @ 25°C
PLATINUM (2)	3	100 OHMS @ 0°C
PRECISION PLATINUM (3)	3	100 OHMS @ 0°C
NICKEL / IRON	2	676 OHMS @ 25°C

(1) USEM standard supply if not specified at time of order.
(2) TCR rating .00392
(3) TCR rating of .00385 (DIN & IEC STD.)

4.L.ii.4 - 1

m. Vibration Detectors

1. Standard vibration switch is ROBERTSHAW® 366A8 type.

2. Ability to arrange to accommodate one vibration sensor or switch on upper bracket of 324 frame and larger.

3. Other sensors or switches must be approved for application.

5. Tests

    a. All motors shall be tested to insure correct operation. More extensive testing is available but is not standard.

    b. Common additional testing:

        i. Short commercial test – This test consists of no-load current, locked rotor current, winding resistance, and high potential tests.

        ii. Complete initial test - Tested per IEEE Standard 112, method B, dynamometer test. This test consists of full-load heat run, percent slip, no-load current, full-load current, locked rotor current, lock rotor torque, breakdown torque (calculated), efficiency and power factor at 100%, 75%, and 50% full load, insulation resistance per IEEE Standard 43, winding resistance and high potential.

        iii. Sound Test -- This is a no-load test performed in accordance with ANSI S12.51 and NEMA MG-1.

6. Warranty

    a. Standard warranty on sine wave power for a premium efficient motor shall be 36 months from date installed or 42 months from manufactured date whichever comes first.

    b. Standard warranty on sine wave power for an energy efficient motor shall be 24 months from date installed or 30 months from manufactured date whichever comes first.

    c. Standard warranty on sine wave power for a standard efficient motor shall be 12 months from date installed or 18 months from manufactured date whichever comes first.

    d. Special warranty applies for motors used with Variable Frequency Drives.