

**SPECIFICATION GUIDE**  
**Horizontal NEMA® Frame Motors**  
**Totally Enclosed Fan Cooled - TEFC**

Standards Referenced: NEMA® MG-1-2011, IEEE Std 112™-2004, ASTM B117-97

1. General Requirements

- a. Scope – This specification covers NEMA frame horizontally mounted, T/TS Shaft, 3-phase, squirrel cage, AC induction motors. That are totally enclosed fan cooled 1 HP and above, and under 600 volts.
- b. Standard 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 – Ambient greater than 40°C. 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. Totally enclosed fan cooled NEMA horizontal motors can be certified for use in a Division 2 location by either the motor manufacturer in accordance with the National Electric Code Article 500 (NFPA-70) or by CSA in accordance with the Canadian Electrical Code.

2. Electrical Requirements

a. Voltage and Frequency

i. Standard low 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. 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. 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 – 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.

- 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-hygroscopic Class F (155°C), suitable for a TEFC motor with moderate exposure to moisture. One dip and bake in polyester resin.
    - 1. Insulife 2000 insulation system 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. Standard on CORRO-DUTY® motors.
    - 2. Vacuum Pressure Impregnation using 100% solid epoxy resins is available on 280 frames and larger
      - a. Insulife VPI 1000 – Single cycle of VPI
      - b. Insulife VPI 2000 – Two cycles of VPI 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. INVERTER GRADE® insulation meets NEMA MG1, Parts 31. This includes additional phase paper between coils, extra bracing on end turns and Insulife 2000 insulation treatment 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 140 - 447 frame sizes.
- b. Enclosures
  - i. Motors shall be totally enclosed fan cooled (TEFC).
  - ii. Material - Motor frame and end shields shall be cast iron, steel or aluminum construction. Fan covers will be constructed of plastic, steel, or cast iron depending on requested construction and/or frame size.

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

c. Bearings

i. Motors shall be supplied with grease lubricated anti-friction ball bearings. If application is belted, a drive end roller bearing may be required.

d. Ventilating Fans - shall be corrosion resistant, non-sparking material.

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 requirements and diagonally split and rotatable in 90 degree increments except on aluminum frames. Conduit boxes will be steel. 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 - 1045 Hot rolled Steel

h. External Paint - shall be mill and chemical duty paint, capable of passing a 500 hours salt spray test in accordance with ASTM B117 test method.

i. Nameplate - shall be of stainless steel and stamped per NEMA Standard MG1 Part 12, Part 20, Part 30 and Part 31 (on Inverter Duty).

j. Motor Vibration

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

**VIBRATION LEVEL**

	Velocity (IPS-PEAK)	Velocity (IPS-PEAK)
Poles	STANDARD	SPECIAL
2	0.15	0.08
4	0.15	0.08
6	0.15	0.08
8	0.12	0.06
10	0.12	0.06
12	0.12	0.06

**3.j.i . -1.**

4. Optional Features

a. Accessory Conduit Box

- 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
- b. Ingress Protection
- i. Standard TEFC motors at minimum meet the requirements of IP44.
  - ii. Shaft Slinger(s) – For IP54 bearing protection on drive end bearing and/or the opposite drive end bearing.
  - iii. INPRO/SEAL® – For IP55 bearing protection on both ends.
- c. Grounding Provisions
- i. Grounding lug available in main conduit box
  - ii. Shaft grounding ring
    - 1. Inpro-CDR® for shaft grounding.
    - 2. Inpro-MGS® for shaft grounding and IP55 bearing protection.
    - 3. Suggest use of insulated short end bearing with drive end shaft grounding device. Shaft ground rings are for use in unclassified areas.
  - iii. Grounding on frame
    - 1. Grounding pad 400 frame and larger
    - 2. Grounding terminal on frame
- d. Insulated bearings – Ceramic bearings or 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.

- e. 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.
- f. Shaft Material - Stainless steel 303 or 304
- g. Foot Flatness - 0.005" foot flatness on cast iron frame from mounting hole to mounting hole.
- h. Stainless Steel Hardware
- i. Thermal Protection
  - i. Bearings - Bearing protective devices are available on 320 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 winding) – 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. THERMA 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 320 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.i.ii.4. -1.
- a. Available 320 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 a time of order.  
(2) TCR rating .00392  
(3) TCR rating of .00385 (DIN & IEC STD.)

**Table 4.i.ii.4. - 1.**

j. Vibration Detectors

- i. Standard vibration switch is ROBERTSHAW® 366A8 type.
- ii. Ability to arrange to accommodate vibration sensor or switch on 320 frame and larger.
- iii. Other sensors or switches must be approved for application and/or area classification.

## 5. Tests

- a. All motors shall be tested to ensure 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. Vibration test - This test consists of vibration measurements (inches/second peak) at three points on the drive end and three points on the opposite drive end in accordance with NEMA MG-1 Part 7.
  - iii. 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.
  - iv. Calibration Test - Same as a Complete Initial Test, but curves based on test data are provided.
  - v. 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 motors and inverter duty motors 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. Special warranty applies for premium efficient and energy efficient motors used with Variable Frequency Drives.