Understanding NEMA Motor Nameplates
Mission Statement

**Baldor** is to be the best (as determined by our customers) marketers, designers and manufacturers of industrial electric motors, mechanical power transmission products, drives and generators.
Who is NEMA?

- The National Electrical Manufacturers Association (NEMA) was founded in 1926 to develop and promote electrical manufacturing standards.
NEMA states that the motor nameplate must show:

- Manufacturer type
- Time rating
- Service Factor
- Efficiency
- Frame Size
- Design Code
- Rated horsepower
- Rated voltage and amps
- Rated full-load amps for each voltage level
- Rated full-load speed
- Frequency
- Phase
- Insulation class
- Rated ambient temperature
- Locked-rotor code letter
Measurement of work done per unit of time
Volts

- Voltage rating at which the motor is designed to operate most efficiently
- Motors are designed to operate at plus or minus a 10% tolerance of this value
- A motor with a 460V rating could operate effectively at around 414V to 506V
- Motors run in this 10% range will not perform optimally, but will perform effectively
Nameplate amps, also called “Full Load Amps” is the amount of current the motor can be expected to draw under full load conditions.
The speed at which full-load torque is delivered for the rated voltage and frequency

The difference of the full load speed and the synchronous speed is called “slip”. The motor’s “slip” is determined by its design

For most induction motors, full load speed can be between 96% and 99% of the no load speed
Motor dimension standardization is reflected by the “frame” size number.

This number reflects the same mounting and shaft information between different manufacturers in order to be consistent.
Hertz

- The frequency for which the motor is designed
- Hertz is measured in cycles per second
- The most common frequency in the US is 60 Hz
- The most common frequency outside the US is 50 Hz
Phase

- The indication of the type of power supply for which the motor is designed
- The two main categories are single phase and three phase
Service Factor

Service Factor is an indicator of the amount of overload a motor can be expected to handle.

For example, a motor with a 1.0 service factor cannot be expected to handle more than its nameplate hp on a continuous basis. A motor with a 1.15 service factor can be expected to safely handle infrequent loads to 15% past it’s rated horsepower. A 10 hp motor could run at 11.5hp.

A downside is a hot motor with a shorter expected life.
When AC motors are started with full voltage (Across-the-Line Starting), they draw line amperage 300% to 600% greater than their full load running current.

The magnitude of the “inrush current” (also called locked rotor amps or LRA) is determined by motor horsepower and design characteristics.
## Torque speed curve

- The design letter indicates the shape of the torque speed curve

<table>
<thead>
<tr>
<th>CAT. NO.</th>
<th>EM3615T</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEC.</td>
<td>36G271S268G1</td>
</tr>
<tr>
<td>HP</td>
<td>5</td>
</tr>
<tr>
<td>VOLTS</td>
<td>208–230/460</td>
</tr>
<tr>
<td>AMPS</td>
<td>13.9–13.4/6.7</td>
</tr>
<tr>
<td>R.P.M.</td>
<td>1750</td>
</tr>
<tr>
<td>FRAME</td>
<td>184T</td>
</tr>
<tr>
<td>HZ</td>
<td>60</td>
</tr>
<tr>
<td>PH</td>
<td>3</td>
</tr>
<tr>
<td>SER. F.</td>
<td>1.15</td>
</tr>
<tr>
<td>CODE</td>
<td>J</td>
</tr>
<tr>
<td>B</td>
<td>DES</td>
</tr>
<tr>
<td>CLASS</td>
<td>F</td>
</tr>
<tr>
<td>NEMA NOM. EFF.</td>
<td>89.5 %</td>
</tr>
<tr>
<td>P.F.</td>
<td>78 %</td>
</tr>
<tr>
<td>RATING</td>
<td>40C AMB–CONT</td>
</tr>
<tr>
<td>CC</td>
<td>010A</td>
</tr>
<tr>
<td>BEARINGS</td>
<td>DE 6206</td>
</tr>
<tr>
<td>ENCL.</td>
<td>TEFC</td>
</tr>
<tr>
<td></td>
<td>SN</td>
</tr>
</tbody>
</table>
Insulation codes are designated in order of their thermal capabilities by A, B, F, and H.

The higher the designated Code letter, the greater the heat capability.
Efficiency

- The percentage of the input power that is actually converted to work output from the motor shaft
Power Factor

- Percent power factor is a measure of a particular motors requirements for magnetizing amperage.
Ambient and Time rating

- The rating of the motor is the ambient (room) temperature vs. the time it can operate at that temperature.

- Most motors are rated for continuous duty.

- The most common rating is 40C AMB-CONT.
Enclosure

- The enclosure, or housing/cooling method, for which the motor is designed.
Safety and standards groups

- Nema Premium®
- Canadian Standards Association
- UL Recognized
**Additional Nameplate Information**

- **Catalog Number** – if blank, the motor is custom. May have unique OEM part or modification # also.

- **Spec Number** – VERY IMPORTANT. This number will provide bill of materials to locate parts.

- **CC** – Certified Compliant #. This number appears on all motors that require compliance with US energy law.

- **DE** – Drive End (output shaft end)

- **ODE** = Opposite Drive End (fan end or rear of motor)
• **NEMA** design A
• maximum 5% **slip**
• high to medium starting current
• normal **locked rotor torque**
• normal breakdown torque
• suited for a broad variety of applications - as fans and pumps
• NEMA design B
• maximum 5% slip
• low starting current
• high locked rotor torque
• normal breakdown torque
• suited for a broad variety of applications, normal starting torque - common in HVAC application with fans, blowers and pumps
• **NEMA** design C
• maximum 5% **slip**
• low starting current
• high **locked rotor torque**
• normal breakdown torque
• suited for equipment with high inertia starts - as **positive displacement pumps**
• NEMA design D
• maximum 5-13% slip
• low starting current
• very high locked rotor torque
• suited for equipment with very high inertia starts - as cranes, hoists etc.
Typical motor failures

- 51% Unknown
- 16% Bearings
- 16% Rotor Bar
- 10% Shaft/Coupling
- 5% External Factors
- 2% Windings
Typical motor failures

- 67% Other Factors
- 33% Bearings/Windings
# Motor failures by component

<table>
<thead>
<tr>
<th>Component</th>
<th>% Failures</th>
<th>Potential Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearings</td>
<td>51%</td>
<td>Lubrication, mechanical, shaft currents, contamination</td>
</tr>
<tr>
<td>Windings</td>
<td>16%</td>
<td>Overvoltage, water, overload, undervoltage, environment</td>
</tr>
<tr>
<td>External Factors</td>
<td>16%</td>
<td>Environmental or load related</td>
</tr>
<tr>
<td>Rotor Bar</td>
<td>5%</td>
<td>Overload, locked rotor, vibration</td>
</tr>
<tr>
<td>Shaft/Coupling</td>
<td>2%</td>
<td>Mechanical, overload</td>
</tr>
<tr>
<td>Unknown</td>
<td>10%</td>
<td>No root cause determined</td>
</tr>
</tbody>
</table>
Causes of bearing damage

- Inadequate lubrication
- Mechanical issues
- Heat
- Bearing currents (or electric discharge machining)
- End user mixed lubrication – two incompatible greases
Causes of bearing damage

- Overload
- Misalignment
- Belt tension & pulley issues
- Condensation
- Misapplication
External / environmental failures (15%)

- Motors like to breathe...

...and are designed to dissipate heat, not store it!
Life Cycle Costs

- Energy 97.3%
- One Rewind 0.7%
- Initial Purchase 2%
## Life Cycle Cost Energy Savings

<table>
<thead>
<tr>
<th>200 HP 4 pole operating costs</th>
<th>DOE average efficiency</th>
<th>High efficiency motor</th>
<th>NEMA Premium® efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>93.5</td>
<td>95.0</td>
<td>96.2</td>
</tr>
<tr>
<td>Electrical cost / year</td>
<td>$139,785</td>
<td>$137,578</td>
<td>$135,862</td>
</tr>
<tr>
<td>Annual savings</td>
<td>$2207</td>
<td></td>
<td>$3923 X 20 years</td>
</tr>
</tbody>
</table>

Continuous operation at $0.10/kWh

$78,460 total savings
“Right-size” the Motor

- Choose the correct rating for the application
  - Oversized motors have lower efficiency and power factor
  - Highest efficiency 75 - 100% of rated load
  - Service factor is for short-term operation
The App allows you to calculate the energy savings you can achieve on a typical pump or fan load by replacing direct-on-line control with a variable-speed drive. Simply select your industry and the operating duty profile; the voltage, phase and motor power rating; running hours; and electricity cost. The App then estimates how much CO₂, energy and money you can save by installing an ABB drive to control the application. Download for iPad, iPhone, Blackberry.

The Baldor Energy Savings Tool is used to determine the annual operating costs and kilowatt hour (kWh) usage of an electric motor. The program compares the efficiency of an existing motor to a comparable Baldor Super-E NEMA Premium® efficient motor, shows the results and suggests a replacement Baldor motor.

Best for North America

Best outside North America
Identifying Energy Savings

• Component Savings
  – Easier to identify
  – Smaller returns

• System / Variable Speed Application
  – Harder to qualify but most effective
  – Largest return investment
# Improving Component Efficiency

## Motors:

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Efficiency</th>
<th>Reducer Type</th>
<th>Efficiency</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Efficient</td>
<td></td>
<td>Worm Gearing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premium Efficient</td>
<td></td>
<td>Helical Gearing</td>
<td>10 to 30%</td>
<td></td>
</tr>
<tr>
<td>NEMA Premium</td>
<td></td>
<td>Synchronous Belt</td>
<td>5 to 7%</td>
<td></td>
</tr>
</tbody>
</table>

## Reducers:

- **Worm Gearing**: Efficiency 10 to 30%
- **Helical Gearing**: Efficiency 5 to 7%
- **Synchronous Belt**: Efficiency 2 to 3%

## Belt Drive:

- **V-Belt Drives**: Efficiency 3%
- **Permanent Magnet**: Efficiency 3%
## Affinity Laws for Centrifugal Loads

<table>
<thead>
<tr>
<th>Speed</th>
<th>Volume</th>
<th>Pressure/Head</th>
<th>Horsepower Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>90%</td>
<td>90%</td>
<td>81%</td>
<td>73%</td>
</tr>
<tr>
<td>80%</td>
<td>80%</td>
<td>64%</td>
<td>51%</td>
</tr>
<tr>
<td>70%</td>
<td>70%</td>
<td>49%</td>
<td>34%</td>
</tr>
<tr>
<td>60%</td>
<td>60%</td>
<td>36%</td>
<td>22%</td>
</tr>
<tr>
<td>50%</td>
<td>50%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>40%</td>
<td>40%</td>
<td>16%</td>
<td>6%</td>
</tr>
<tr>
<td>30%</td>
<td>30%</td>
<td>9%</td>
<td>3%</td>
</tr>
</tbody>
</table>
ABB drives and motors help solve the energy challenge

More than 90 percent of industrial motors either cannot adjust their power consumption or use very crude methods to do so. Many always run at full speed, regardless of the actual output needed. In many applications, energy use can be cut to one-eighth just by reducing the motor speed by half. The most immediate, cost-effective and practical way to address the energy challenge is to grasp the opportunities for energy reduction that come from using energy more efficiently with available and proven technology. ABB’s drives, motors and other technologies can help lower energy use, either by reducing power consumption and losses, improving productivity or through better management of equipment.

Drives adjust the speed of electric motors to match the actual demand of the application thereby reducing motor energy consumption by typically 20 to 50 percent.
Need more information?
Please stop by our website
RockyMountainBaldor.Com
or email us
Info@RockyMountainBaldor.Com