The Small Motor Rule, How Will This Affect You?

New Federal Regulations Take Effect in March 2015

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According to the Department of Energy (DOE), more than half of all electrical energy consumed in the U.S. is used by electric motors. To address this, several years ago, the DOE conducted a technical study as to what could be done to raise the efficiency levels of "small" motors. After years of study and litigation, the Small Motor Rule (SMR) was passed that covers two-digit NEMA frame single- and three-phase ¼ through 3 horsepower motors in open enclosures.

Facility managers are increasingly under pressure to reduce energy costs, increase productivity and reduce greenhouse gas emissions. To that end, this mandate is anticipated to have significant positive effects for products shipped from 2016–2045:

- Save approximately seven quads of energy (one quad is equivalent to the annual energy consumption of ten million U.S. households)
- Reduce $41.4 billion in energy costs
- Cut 395 million metric tons of carbon dioxide emissions
- Eliminate the need for approximately eight new 250-megawatt (MW) power plants (Ref. 1)

The purchase price for an average motor makes up approximately three percent of the total lifecycle cost to own and operate. Energy costs make up the rest (Ref. 2). Managing motors could pay big dividends in reducing energy costs and increasing process reliability.

But how will this mandate affect OEMs and end-users? Let's examine the various aspects needed for complying with the new legislation taking effect March 9, 2015. Motors requiring outside agency approval, such as UL or CSA, have a two year extension and need to comply by March 9, 2017.

Motor Designs

One unique aspect about small electric motors is there are many design possibilities. Some motors' designs employ magnets to assist with rotation and increase efficiency, while other designs, such as switch reluctance, are being improved with controls, making significant increases in efficiency. Older existing designs, such as shaded pole motors, may be phased out over time as they exhibit efficiencies much lower than new designs and products available. New motors require electronic control, increasing costs, but they have tremendous energy saving benefits (Ref. 3).

Tables 1 and 2 show the new minimum efficiency standard levels, which apply to all small electric motors manufactured for sale in the United States, or imported into the U.S. either as standalone items or as a part of a system (Ref. 4).

> **"Now, rising energy costs and the new legislation are moving efficiency to the top of everyone's checklist."**

Who Is Affected?

Prior to this legislation, from an OEM designer's point of view, motor choice focused primarily, in descending order, on price, size, noise-level, and weight. Until the Energy Independence and Security ACT (EISA) legislation, neither the OEMs nor their customers considered efficiency important enough to factor into a machine's overall design. Now, rising energy costs and the new legislation are moving efficiency to the top of everyone's checklist (Ref. 2).

End users will not have to replace machinery currently in use, but if they want to replace a motor in an existing machine, they may have to call the OEM to supply them with a motor that meets the most current regulations.

OEMs considering replacement of shaded pole or capacitor type motors with these new emerging designs will need to re-engineer their products and validate their motors. OEMs will incur costs to redesign their products to accommodate larger, more efficient motors, or to purchase a stockpile of replacement motors of the correct size.

Table 1 Standard levels for polyphase small electric motors

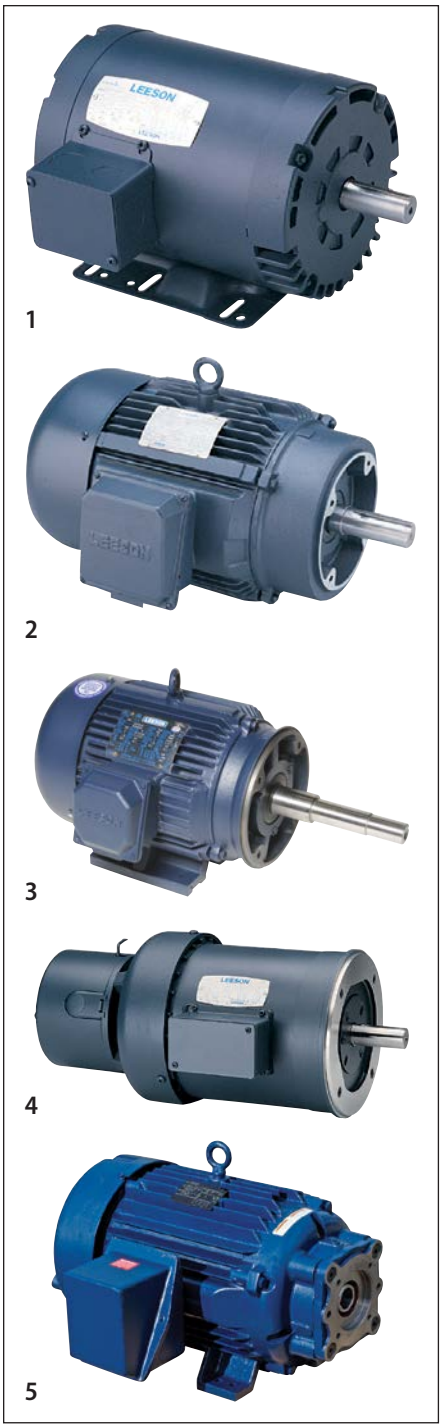
Motor Output Power	Six Poles	Four Poles	Two Poles
0.25 hp/0.18 kW	67.5	69.5	65.6
0.33 hp/0.25 kW	71.4	73.4	69.5
0.5 hp/0.37 kW	75.3	78.2	73.4
0.75 hp/0.55 kW	81.7	81.1	76.8
1 hp/0.75 kW	82.5	83.5	77.0
1.5 hp/1.1 kW	83.8	86.5	84.0
2 hp/1.5 kW	N/A	86.5	85.5
3 hp/2.2 kW	N/A	86.9	85.5

*Standard levels are expressed in terms of full-load efficiency

Table 2 Standard levels for capacitor-start induction-run and capacitor-start capacitor-run small electric motors.

Motor Output Power	Six Poles	Four Poles	Two Poles
0.25 hp/0.18 kW	62.2	68.5	66.6
0.33 hp/0.25 kW	66.6	72.4	70.5
0.5 hp/0.37 kW	76.2	76.2	72.4
0.75 hp/0.55 kW	80.2	81.8	76.2
1 hp/0.75 kW	81.1	82.6	80.4
1.5 hp/1.1 kW	N/A	83.8	81.5
2 hp/1.5 kW	N/A	84.5	82.9
3 hp/2.2 kW	N/A	N/A	84.1

*Standard levels are expressed in terms of full-load efficiency



Do you use motors like these? You may soon be affected by the Small Motor Rule, which goes into effect March 9, 2015. Shown here are just some of the motor types that will be affected, including: 1) three-phase ODP motors, designed for air compressor, pump, fan and blower duty applications; 2) three-phase C-Face motors used on pumps, compressors, blowers, fans and other industrial applications; 3) NEMA JP pump motors, used in continuous-duty applications where the pump impeller is mounted directly on the motor shaft; 4) brake motors, used in conveyors, hoists and packaging equipment; and 5) hydraulic SAE pump motors, used in oilfield applications and the hydraulic pump industry.

The proposed rules cover capacitor design motors as described, which impact many different types of OEMs, such as appliance manufacturers, pool pumps, and residential and commercial HVAC equipment.

To comply with the new regulations, motor manufacturers will need to change original motor designs significantly. Since additional active materials, like copper and steel, will be needed in motor designs to increase efficiency, the overall cost of motors will likely increase. Additionally, manufacturers will face the tooling cost for each separate design at each incremental efficiency level. Besides these capital expenditures, manufacturers will incur equipment conversion expenses such as research and development, testing, and product literature development associated with the new energy conservation standards. The DOE admits that the rule "may require expenditures of $100 million or more on the private sector..." (Ref. 5).

> "To comply with the new regulations, motor manufacturers will need to change original motor designs significantly."

The good news for end users at all levels is these regulations will result in reduced energy consumption. End users have no direct compliance requirements with the DOE like motor manufacturers and OEMs. They do not need to concern themselves with equipment design issues related to motor changes nor do they need to submit compliance paperwork to the DOE.

A Change in Topology

To meet these higher efficiency levels, many motors will change in topology. Based on meeting higher efficiency levels there may be potential impact on the mounting and alignment.

The Nuts and Bolts (SMR & EISA Expansion)

In May 2014, the DOE released communications with required expansions of three-phase, single-speed, low voltage, integral HP motors, 1-500 HP to meet NEMA Premium efficiency levels, excluding some exceptions. This ruling, which goes into effect on June 1, 2016, expands current motor regulation for motors that were not previously covered in the EISA 2010 regulations. These families of motors are also listed below.

For the SMR, the motors that are in scope include:

- 2-digit frame numbers – 42, 48 and 56 frame motors and their IEC equivalent frame size motors
- The Speed or Poles of the motors would include 2, 4 and 6 pole designs from 1/4 to 3 HP
- Open construction motors that are either 3 phase (Polyphase), Cap Start- Induction Run or Cap Start/ Cap Run designs
- Continuous duty rated and also meet NEMA Service Factor

Exemptions to this rule include:

- Definite or Special Purpose OPEN construction design motors
- Motor speeds that are outside of the 2, 4 and 6-pole speeds
- Enclosed motors
- Motor types that are not classified as being three-phase, cap start-induction run or cap start/cap run
- Intermittent duty motors as well as designs outside the HP and frame size listing as described above
- Motors that are already covered by other efficiency legislation are also not covered by this rule

The Energy Independence and Security Act (EISA) expansion and compliance rule, sometimes referred to as the EISA Expansion Rule, expands the following list of motor designs to meet NEMA Premium efficiency. 1 – 500 HP, NEMA Design A, B & C (1-200 HP only today for Design A & B motors); IEC Design N, H, 8 Pole designs, enclosed

56 Frame IHP (1 HP and larger) that are either of General Purpose, Special or Definite Purpose design electric motors.

The Efficiency levels must meet NEMA Premium levels as listed in Table 12-12 (IE3 – 60Hz).

Motors that are now affected by this Expansion Rule include:

- NEMA Design A & B motors from 201 to 500HP
- NEMA Design C motors from 1 to 500 HP
- All voltages ≤ 600 volts
- 8-pole motors
- Electric motors with non-standard endshields, flanges or shafts
- Motors with moisture resistant windings, like encapsulated or sealed windings
- Motors that use any non-standard mounting like a base or cradle
- Motors that do not have a base or cradle – footless designs
- Partial designed electric motors - but not rotor and stator sets
- Vertical hollow shaft motors
- TENV designed motors
- JM and JP Pump motors
- Electric motors having thrust or roller bearings
- Integral brake motors
- Motors with separately cooled blowers on them
- Enclosed 56 frame 1HP and larger – 56 Open motors are covered by the SMR
- Gearmotors if the motor can be removed from the reducer and work as independent motor

Exempt Motors from the 2010 Expansion Rule include:

- Fire Pump motors
- Liquid cooled motors
- Submersible motors
- Air over design motors
- Component sets (stator, rotor sets)
- Small electric motors below 56 frame – See SMR Rules
- Advanced Motor Technology motors which include PMAC, ECM, Brushless DC, etc.
- Inverter Duty only motors

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Conclusion

The electric motor is a critical component in many plant applications and in most equipment and is used in a wide range of equipment in almost every sector of the economy. Given this, the impact of this regulation will be significant for overall energy consumption in the United States. **PTE**

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