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Monthly Informative Application Guidelines, with respect to *Motors & Drives* to keep you better INFORMED.

APPLICATION GUIDELINE #19

(EFFICIENCY – NEMA PREMIUM – COMMON QUESTIONS)

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NEMA PREMIUM ENERGY EFFICIENCY MOTOR PROGRAM

NEMA's Motor and Generator Section announced in early October 2000 that it will establish a PREMIUM MOTOR ENERGY EFFICIENCY PROGRAM. There are four main reasons for this:

1) Electric motors have a significant impact on the total energy operating cost for industrial, institutional and commercial buildings.
2) Electric motors vary in terms of energy efficiency. The NEMA PREMIUM MOTOR PROGRAM will assist purchasers to identify higher efficiency motors that will save them money and improve system reliability.
3) NEMA PREMIUM labeled electric motors will assist users to optimize motor systems efficiency in light of power supply and utility deregulation issues. Utility rates have been known to double.
4) NEMA PREMIUM MOTORS **and** optimized systems will reduce electrical consumption thereby reducing pollution associated with electrical power generation.

Traditionally, there has been no industry consensus specification defining high efficiency or premium efficiency motors. Recent power supply issues and utility deregulation have brought attention to the need to help motor users optimize motor systems efficiency. The Energy Policy Act of 1992 imposed energy efficiency standards on many classes of motors. Since then, many users and motor repair shops have become confused over the lack of consistency in terms of describing INTEGRAL MOTOR PREMIUM EFFICIENCY PERFORMANCE. By agreeing on a North American Premium Motor program, NEMA motor manufacturers expect this confusion to be greatly reduced.

Only partnering manufacturers may use the NEMA PREMIUM LABEL. The LABEL may be used with those products that meet or exceed the NEMA PREMIUM EFFICIENCY GUIDELINES. The label makes it possible for purchasers to identify with ease and confidence those products that are premium efficiency. This program is still under review and no date of implication is currently known. See below table for suggested efficiencies for 1800 rpm motors.

HP	EPACT	NEMA Premium	Difference
1.0	82.5	85.5	3
1.5	84	86.5	2.5
2.0	84	86.5	2.5
3.0	87.5	89.5	2
5.0	87.5	89.5	2
7.5	89.5	91.7	2.2
10	89.5	91.7	2.2
15	91	92.4	1.4
20	91	93	2
25	92.4	93.6	1.2

HP	EPACT	NEMA Premium	Difference
30	92.4	93.6	1.2
40	93	94.1	1.1
50	93	94.5	1.5
60	93.8	95	1.2
75	94.1	95.4	1.3
100	94.5	95.4	0.9
125	94.5	95.4	0.9
150	95	95.8	0.8
200	95	96.2	1.2

Average Difference=1.64%

WHEN IS AN ENERGY EFFICIENT MOTOR COST EFFECTIVE?
The extra cost of an energy efficient motor is often quickly repaid in energy savings.
Annual energy savings = Hp x Load x 0.746 x annual.hrs. x Energycost x [100/std Eff – 100/Premium Eff]

The **annual value of a one point efficiency gain** (based on 8,760 hours of use at full load)

Horsepower	Annual Savings $0.05/KWh	Annual Savings $0.06/KWh	Annual Savings $0.07KWh
5	$23	$28	$33
10	$44	$53	$61
20	$83	$100	$117
50	$194	$233	$272
100	$381	$457	$533
200	$735	$882	$1,029

WHEN SHOULD I CONSIDER BUYING AN ENERGY EFFICIENT MOTOR?
1) For all new installations
2) When purchasing equipment packages, such as compressors, HVAC systems, and pumps
3) When major modifications are made to facilities or processes
4) Instead of rewinding older, standard efficiency units, it is recommended to select a NEW energy efficient motor under any of the following conditions:
   - The motor is less than 40hp
   - The cost of the rewind exceeds 65% of the price of a new motor
   - The motor was rewound before 1980
5) To replace oversized and under loaded motors
6) As part of a preventive maintenance or energy conservation program

SHOULD I REWIND A FAILED MOTOR?
Although failed motors can usually be rewound, it is often worthwhile to replace a damaged motor with a new energy-efficient model to save energy and improve reliability. When calculating operating costs of rewound motors, deduct one efficiency point for motors exceeding 40hp and two points for smaller motors. Have motors rewound only at reliable repair shops that use low temperature (under 700°F) bakeout ovens, high quality materials, and a quality assurance program based on EASA-Q or ISO-9000. Ask the repair shop to conduct a core loss or loop test as part of their rewind procedures.

WHAT DESIGN FACTORS SHOULD I CONSIDER WHEN CHOOSING A NEW MOTOR?
Motor Size:
Size motors for efficiency. Motors should be sized to operate with a load factor between 65% and 100%. The common practice of oversizing results in less efficient motor operation. For example, a motor operating at a 35% load is less efficient than a smaller motor that is matched to the same load. This emphasizes the importance of a properly designed motor for premium efficiency, without the compromise of high locked rotor torques and high break down torques to allow operation without stalling on momentary overloads. Toshiba motor design factors which achieve this include rotor length, surplus back iron, and high tooth density on stator slots.

Operating Speed:
Select replacement energy-efficient motors with a comparable full-load speed for centrifugal load applications (pumps and fans). Induction motors have an operating speed that is slightly lower than their rated synchronous speed. For example, a motor with a synchronous speed of 1800rpm will typically operate under full load at about 1750rpm. Operating speed (full load rpm) is stamped on motor nameplates. The difference between the synchronous speed and the operating speed is called slip. Slip varies with load and the particular motor model/design.

Every pump and fan has a design speed. Centrifugal pump and fan loads are extremely sensitive to speed variations; an increase of just 5rpm can significantly affect the pump or fan operation, leading to slightly increased flow, reduced efficiency, and increased energy consumption. Whenever a pump or fan motor is replaced, be sure to select a model with a full load rpm rating equal to or as close to that of the motor being replaced.

Toshiba has created a tool to help perform efficiency calculations at a given operating load while also considering the effect of decrease slip. Note - Motors with higher operating speeds (i.e. lower slips) will provide increased flow or volume. The extra flow should be taken into account when evaluating the overall system. For example, if the extra flow created by using a lower slip motor provides increased profits, this should be factored into the evaluation. If, however the extra flow is of no value or will be compensated for by partially closing a valve or damper, the comparison below is valid without any further compensation.

Motor and System Efficiency Calculator

Load Type	1	Enter 1 for VT, 2 for CT
Actual Load HP	38	(At full Speed)
Nominal Speed	1800	(RPM)
Usage	8000	(Hrs / Year)
Power Cost	7	(cents / KWHr)

Payback to Replace Existing Motor versus Rewind

HP	Full Load RPM	Operat'g Speed (RPM)	Eff'y 100% Load	Eff'y 75% Load	Eff'y 50% Load	Calc. Eff'y at load	Actual Load (KW)	Actual Load (HP)	Power Cost per Year	Repair or New Cost	Simple Payback (Years)	Volume or Flow Increase	Savings /yr after Payback
50	1759	1769	91.0%	91.9%	90.9%	91.9%	30.9	38.0	$17,281	$900	(EXISTING Toshiba Std Eff'y)		
50	1771	1778	94.0%	94.3%	93.9%	94.3%	30.5	38.6	$17,098	$1,700	4.4	0.52%	$182
50	1785	1789	94.0%	94.3%	93.9%	94.3%	31.1	39.3	$17,407	$1,400	Costs More	1.12%	-$126
50	1763	1772	93.2%	93.5%	93.5%	93.5%	30.5	38.2	$17,068	$1,600	3.3	0.17%	$212
40	1780	1781	94.0%	94.4%	94.1%	94.1%	30.8	38.8	$17,224	$1,400	8.8	0.69%	$57
60	1777	1785	95.1%	95.2%	94.6%	95.2%	30.6	39.1	$17,141	$2,500	11.4	0.94%	$140
40	1763	1765	93.0%	93.4%	93.1%	93.1%	30.2	37.7	$16,940	$1,350	1.3	-0.23%	$341

In the above analysis:

Existing Motor : Is a 50HP, Toshiba Standard efficiency motor
Option #1 : Is a 50HP, EQPIII
Option #2 : Is a 50HP, Hypothetical, premium efficiency, low slip motor
Option #3 : Is a 50HP, Toshiba EPACT
Option #4 : Is a 40HP EQPIII
Option #5 : Is a 60HP EQPIII
Option #6 : Is a 40HP, Toshiba EPACT
Estimated Pricing is based on US dollars

In this case, Options #3 and #6 turn out to have the best paybacks on this VT application, due to the fact that their design slips are least reduced. The worst scenario is that of option #2, that of a typical, hypothetical low slip design motor, this change despite the higher efficiency ends up costing more.