advanced energy

Implementing improvements in motor efficiency can significantly benefit energy savings and motor operating costs.

An industrial facility may have hundreds or thousands of motors in use. Typically, most of these motors are never inventoried, and little is known about their operating costs. Motors normally receive attention when they fail, which often requires stopping an entire operation and can be costly. This is why decisions to repair or replace motors are usually made quickly and with little consideration of economic justification.

Sound motor management identifies the critical motors in your operation and helps to determine the repair or replace decision before they fail. Other key policies to a solid motor management program include:

- Developing a facility-wide horsepower breakpoint
- Following a written motor purchase specification
- Following a written motor repair specification
- Incorporating preventive and predictive maintenance
- Preparing for special cases (drives)

Advanced Energy's Motor Survey can help you actively manage your motors, identify your current motor inventory and formulate a Motor Action Plan. A Motor Action Plan creates a tracking system that leads to better motor management decisions and continual improvement.

This guide will help you collect the proper motor information to make sound economic decisions more easily and accurately. Once you have the data, you can send it to Advanced Energy for unbiased processing to determine if you should repair or replace your motors. You will also receive a customized Motor Action Plan.

MOTOR SURVEY

Solutions for Industry

WHY SURVEY YOUR MOTORS?

The data gathered in your plant can become the basis for a continually updated motor inventory. This inventory will allow you to track the history of your motors and make better motor management decisions. At the same time, Advanced Energy can use this inventory to create an economic analysis for your facility that will assist in making the best decisions concerning your motors. In some cases, the economics of replacing an operating motor with a new, more efficient one are favorable enough that it is advisable to replace it before failure occurs. Any small increase in motor efficiency is beneficial, especially when considering the life-cycle costs to operate a motor throughout a projected 10 years.

50-HP Motor Efficiency Comparison

	Premium Efficiency	EPCA Efficiency	Standard Efficiency
Purchase Cost	$2,724	$2,150	Existing
Repair Cost	$1,477	$1,477	$1,477
Annual Use	8,000 Hours	8,000 Hours	8,000 Hours
Efficiency	94.5%	93.0%	91.6%
Energy Cost	$0.07/kWh	$0.07/kWh	$0.07/kWh
Annual Operating Cost	$22,104	$22,460	$22,804
Annual Savings with Premium Efficiency Motor	N/A	$357	$700
Premium Efficiency Motor Payback	N/A	3.5 Years	1.78 Years
Projected Life-cycle Savings	N/A	$3,565	$6,998

The table above shows the possible savings when replacing an existing 50-HP motor with a NEMA Premium® motor. It is evident that relatively small gains in efficiency can result in substantial savings throughout a year of operation. The savings are dramatic for a single motor throughout its expected 10-year life cycle. When a motor fails, the decision to repair or replace must be made after considering all factors.

If the existing motor operates at Energy Policy and Conservation Act of 1992 (EPCA) levels, known as being an energy-efficient motor, the savings from replacing it at failure with a NEMA Premium motor rather than repairing it result in a payback of approximately 3.5 years. To some, this figure is not justifiable, but since a typical motor has a 10-year life span, the energy cost savings alone will surpass the purchase price of the motor after 7.6 years in operation. If the existing motor is operating below EPCA levels, known as being a standard-efficiency motor, the cost savings look even better. If this motor is replaced at failure with a NEMA Premium motor, the payback will be less than two years. Additionally, the energy cost savings alone will net a gain after only 3.9 years.

It is clear that gains in efficiency can result in significant energy and cost savings, especially when applied throughout an entire facility. Conducting a motor survey with Advanced Energy will make a difficult repair or replace decision straightforward and justified.

WHAT IF THE BEST CHOICE IS REPAIR?

First, develop and use a motor repair specification. Some companies have customized specifications to meet their specific needs and ensure their savings. The ANSI/EASA AR100-2015 and the IEEE 1068 are great resources to help you get started if you do not already have a specification. You can obtain copies of these specifications by visiting http://www.easa.com/resources/booklet/ANSI-EASA-AR100-2015 and https://ieeexplore.ieee.org/document/7482635.

Second, you should certify your motor repair vendors through Advanced Energy's Proven Efficiency Verification (PEV) program. More important than having a motor repair specification is knowing that your motor repair vendor can return a motor to its original efficiency level during the repair process. Find additional helpful hints on motor repair here: www.advancedenergy.org/motorsanddrives.

WHAT IF THE BEST CHOICE IS REPLACE?

Similar to motor repair, you should first have a specification for new motor purchases. Second, you should ensure that your purchasing policies negotiate for efficiency and not initial price. It is important to remember that the initial purchase price typically represents 3 to 5 percent of the total life-cycle costs to own and operate the motor. The energy required to run the motor throughout an expected 10-year life span represents 95 percent of its total operating cost. We recommend purchasing the most efficient motor you can find that fits the application well. Keep in mind that NEMA Premium efficiency levels are required for all new covered motors. The U.S. Department of Energy's (DOE's) Advanced Manufacturing Office (AMO) has a guide on the application of premium efficiency motors here: https://energy.gov/sites/prod/files/2014/04/f15/amo_motors_handbook_web.pdf. Industrial facilities should consider customizing a new motor purchase policy that is specific to their needs and achievable with selected motor vendors.

Some large paper and chemical industrial facilities reduce new motor costs further by negotiating single source contracts directly with motor manufacturers. They typically review these contracts every three years and use Advanced Energy's National Voluntary Laboratory Accreditation Program (NVLAP) lab to test for efficiency and other performance factors to make decisions. These companies have formal programs involving all key departments in motor management, from maintenance to purchasing.

GETTING STARTED

It is impossible to manage your motors if you do not know anything about them. The first step is to determine your motor inventory. Though possibly a large task, it is beneficial to count every motor in your facility. Equally important is determining your facility's horsepower breakpoint in order to collect the data that will lead to the most economically informed decisions. The information on page three of Advanced Energy's Horsepower Bulletin can help you determine your facility's breakpoint. Noncritical motors well below the horsepower breakpoint can be replaced as a matter of policy, simplifying the motor inventory task. Motors above or just below the horsepower breakpoint should be surveyed using this tool. Smaller motors should also be considered for survey when many of the same type are in operation. Some industrial facilities have applications that employ hundreds of similar small motors. Building a motor inventory will better prepare a facility in the event that a motor fails, reducing downtime and improving operating costs. The motor inventory will help you create a tracking database and provide you with the necessary tools to manage your motors successfully.

ASSIGNING RESPONSIBILITY

The next step is to identify the employees or contractors responsible for completing these tasks. Collecting motor data should be assigned to at least two people who have a good feel for the layout of the facility and are able to identify the equipment. These individuals should also be well trained in the dangers of energized electrical circuits and rotating machinery as well as in the proper procedures to safely and accurately gather the required information. When obtaining load information using the procedures found in the Electric Motor Survey Information form, follow all safety precautions, including wearing insulated gloves and face shields and taking arc protection seriously. Personnel should also understand the measurements taken and ensure their data is accurate.

Although desirable, surveying every motor in a facility may not always be possible or necessary. Two important goals of the survey are to identify the most critical motors to the active processes and those with the best opportunity for savings. In general, large motors that run for long periods of time have the most energy- and cost-savings potential. However, large numbers of small motors of the same type that run for long periods can add up to the same, or more, energy usage. Therefore, they can provide a greater opportunity for cost and energy savings. It is up to the people responsible for the motor management policy to determine the best candidates for the Motor Survey.

PERFORMING THE SURVEY

The Electric Motor Survey Information form provided by Advanced Energy lists the required data fields pertaining to facility, motor application, nameplate and motor load information. All of these factors are important, but there

are a few items that are absolutely necessary to provide accurate information. These items are noted in bold on the survey form in this how-to guide.

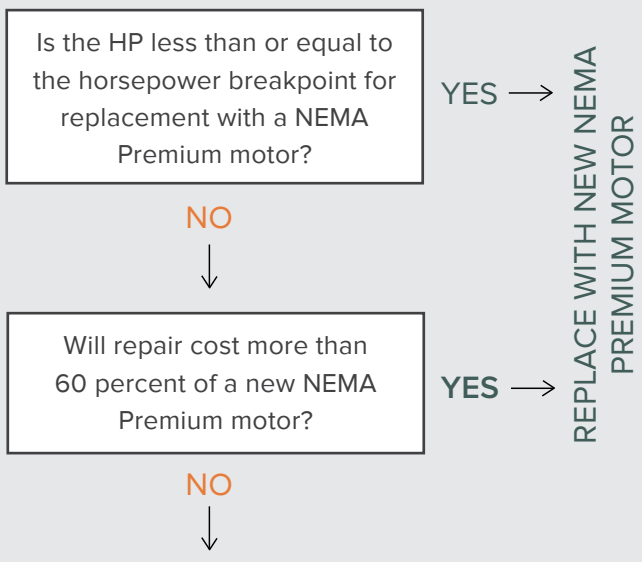
The first section contains General Information about the facility, such as its name, location, and contact names and numbers. **Electricity Cost ($/kWh)** and **New Motor Discount Factor** are the most important values. You can find the electricity cost on past bills, which should include energy and demand charges. The New Motor Discount Factor is the percentage of list price that the facility pays when buying new motors. Actual pricing can be obtained from existing vendors the facility uses to make new motor purchases and will be more accurate than a New Motor Discount Factor. These two items are important for Advanced Energy to make an accurate economic analysis. Since this information will be the same for all motors surveyed at a facility, it is convenient to fill out this section before making copies of the form for surveying.

The second section records Motor Application Information. Each motor should be given a number to ensure that the results of the survey can be applied to the specific unit and that its history can be tracked. Extra information like Location and Drive makes identification easier. The critical piece of data here is **Operating Hours per Year**. The number of operating hours will determine the total annual operating cost and is important to ensure accurate results. Other useful information for the survey includes New Motor or Rewind Motor. If a motor has been rewound by a motor service center without a repair specification or is not PEV certified, the motor may experience a drop in efficiency. Information such as **Cost of Rewind** and Were Bearings Replaced can also be helpful.

The third section is for Motor Nameplate Information, which can be used in conjunction with the Motor Load Information to determine whether the motor is loaded properly. The Manufacturer and Model Number can be used to obtain additional information if necessary. The most important pieces of data are **Horsepower, Nominal Efficiency, Voltage, Speed (RPM), Current (Amps) and Enclosure Type**. This data is the backbone of the survey and must be recorded correctly. Other useful information includes Frame, Insulation Class and NEMA Design. Nameplate data can vary from manufacturer to manufacturer, and some of the data requested may not be available. Also, different notations may be used for certain items. Please record any other data that may be pertinent under Other Information.

The final section is Motor Load Information. This data can be used to determine the actual motor load during operation. Data should be taken only by licensed electricians and personnel specifically trained to access power panels using all necessary safety measures under extreme caution. **Line Current (Amps)** and **Voltage (Vrms)** are the easiest numbers to obtain. Input Power (kW), using True-RMS Watts, can more accurately convey how much the motor is loaded. If the motor load data is taken and recorded, it is very important to determine and note whether the motor is operating at its typical load condition. Many motors experience varying load with process changes and output requirements. Therefore, when considering load, it is best to measure over a longer period to capture all of the variations the motor may experience. This is not necessary for the survey but should always be considered when downsizing a motor. Load does not have to be measured to conduct this survey. The Advanced Energy tool assumes 75 percent when load is not provided.

REPAIR OR REPLACE A MOTOR WHEN IT FAILS?



ELECTRIC MOTOR SURVEY INFORMATION

General Information (record on form before making copies)

COMPANY:

PLANT/LOCATION:

CONTACT PERSON: TELEPHONE NUMBER:

*ELECTRICITY COST IN $/kWh:

*NEW MOTOR DISCOUNT FACTOR:

Motor Application Information

MOTOR ID NUMBER: LOCATION:

*DRIVE (FAN, PUMP, ETC.):

*OPERATING HOURS PER YEAR:

*NEW MOTOR: ○ REWIND MOTOR: ○
If rewind, **cost of rewind:**

WERE BEARINGS REPLACED? YES: ○ NO: ○

Motor Nameplate Information

MANUFACTURER: MODEL NUMBER:

*HORSEPOWER (HP): *VOLTAGE (V, Vrms):

*SPEED (RPM): *AMPS (A, FLA):

SERVICE FACTOR (SF): FRAME:

*ENCLOSURE TYPE (ENCL):

*NOMINAL EFFICIENCY (NEMA NOM EFF, FULL LOAD EFF):

INSULATION CLASS (INS, CL): B: ○ F: ○ H: ○

*NEMA DESIGNATOR OR DESIGN (DES): A: ○ B: ○ C: ○ D: ○

OTHER INFORMATION:

Motor Load Information (optional)

LINE CURRENT (AMPS) THREE PHASES A: B: C:

LINE VOLTAGE (Vrms) THREE PHASES A-B: A-C: B-C: kW:

IS THE MOTOR OPERATING AT ITS TYPICAL LOAD CONDITION? YES: ○ NO: ○

CAUTION

PLEASE READ AND REVIEW PRIOR TO COLLECTING MOTOR LOAD DATA

PROCEDURE FOR COLLECTING MOTOR LOAD DATA

Follow all safety precautions in meter instruction manual. Measurements will be taken on energized electrical circuits. These procedures should be carried out only by trained personnel using proper equipment and precautions.

1. Determine the full-load amperage and nameplate voltage of the motor from the nameplate information. Ensure that the instrument ranges are set to appropriate levels for the motor being measured.

2. Find a location where the motor leads are exposed so the voltage leads can be attached to a bare conductor and the ammeter can be clamped around each phase. A starter cabinet or fuse box is a good location.

3. If using a multimeter, measure input voltage by connecting the voltage leads to two phases at a time, recording results (e.g., A-B, A-C, B-C).

4. If using a clamp-on ammeter, measure motor current by clamping the ammeter around each individual conductor, recording results (e.g., A, B, C).

5. If using an RMS wattmeter, follow all instructions in the instrument manual to connect to the system. Set instrument to read kW and record results. This is the most accurate method for measuring consumed energy.

6. Determine if the data collected reflects the motor operating at its typical load condition. If so, record result. If not, collect data when the motor is at its typical load condition.

For more information, contact or send your surveys to:

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