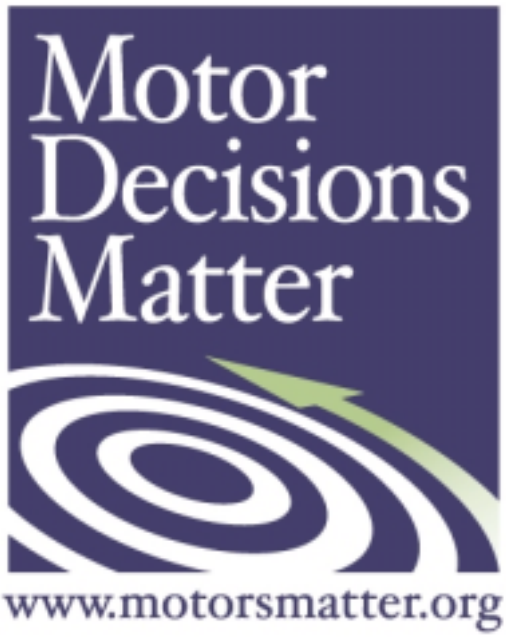
MOTOR PLANNING KIT

Tools, Internet links and procedures for organizing a comprehensive motor management plan



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See the Motor Decisions Matter[SM] web site for more information on the campaign at www.motorsmatter.org.

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Motor Manufacturers
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(17 motor manufacturers)

MOTOR DECISIONS MATTER

MOTOR PLANNING KIT

Table of Contents

Introduction

Welcome to the Motor Planning Kit section of the web site. This area will assist you in developing a Motor Plan – an effective tool for dramatically cutting motor energy costs and conserving energy. With a proactive Motor Plan in place, you will be better prepared to make efficient and thoughtful decisions in the event of motor failure. You benefit from reduced downtime and energy costs, and ensure motor availability by making your decisions through planning – rather than panic.

The Motor Planning Kit includes helpful tips to start a motor plan, links to pertinent online resources and general information about the campaign.

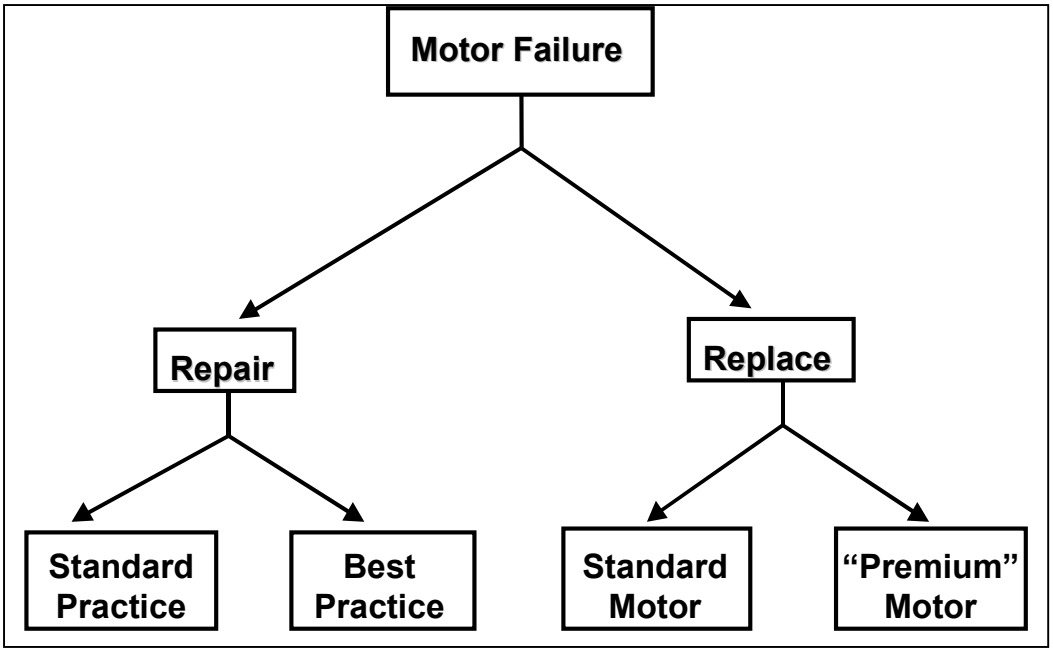
Remember, even a simple motor management plan is better than no plan at all because without a plan you are left with fewer choices.

Motor Planning Overview

With each motor failure, commercial and industrial managers have the opportunity to choose premium-efficiency motors and best practice repair services that can make a real difference to their company's operations – and bottom line. It also creates a potential opportunity to replace a motor with one of more appropriate type and size, or one with a higher efficiency.

By contrast, most motor decisions are made at the time of motor failure, when the immediate costs of the downtime loom large, while future operating costs are only vaguely understood. As a result, the quickest option to get a working motor is chosen with little regard to the short- or long-term cost.

The first step in reducing motor operating costs and increasing reliability is to establish a motor management plan. The planning process gives facility managers the opportunity to work with suppliers to ensure that products and services are available when needed, either by purchasing a spare motor or having the supplier stock a replacement. A motor plan enables decisions to be made in advance of motor failure, and increases the available options.



Reaping the Benefits
Establishing a motor management plan opens up opportunities for significant energy savings and increases in the reliability of your whole operation. The motor management plan allows you to think your motor decisions through before they become critical – when a motor fails.

Just as motors are critical to your operation, a motor management plan should be a critical part of your overall business plan. The process of developing the motor management plan saves time in the long run, evaluates the value of higher-efficiency motors and repair services, and notifies your local motor professional about your future needs.

Remember, Motor Planning …

- is strategic for your company, recognizing a critical link between capital and operating budgets
- helps capture savings you don't normally have time to think about
- enables managers to make better decisions, more quickly
- reduces equipment downtime by allowing motor suppliers/repair facilities to respond more quickly
- results in less downtime, and greater reliability, in addition to energy savings

Why Motor Planning Makes $ense

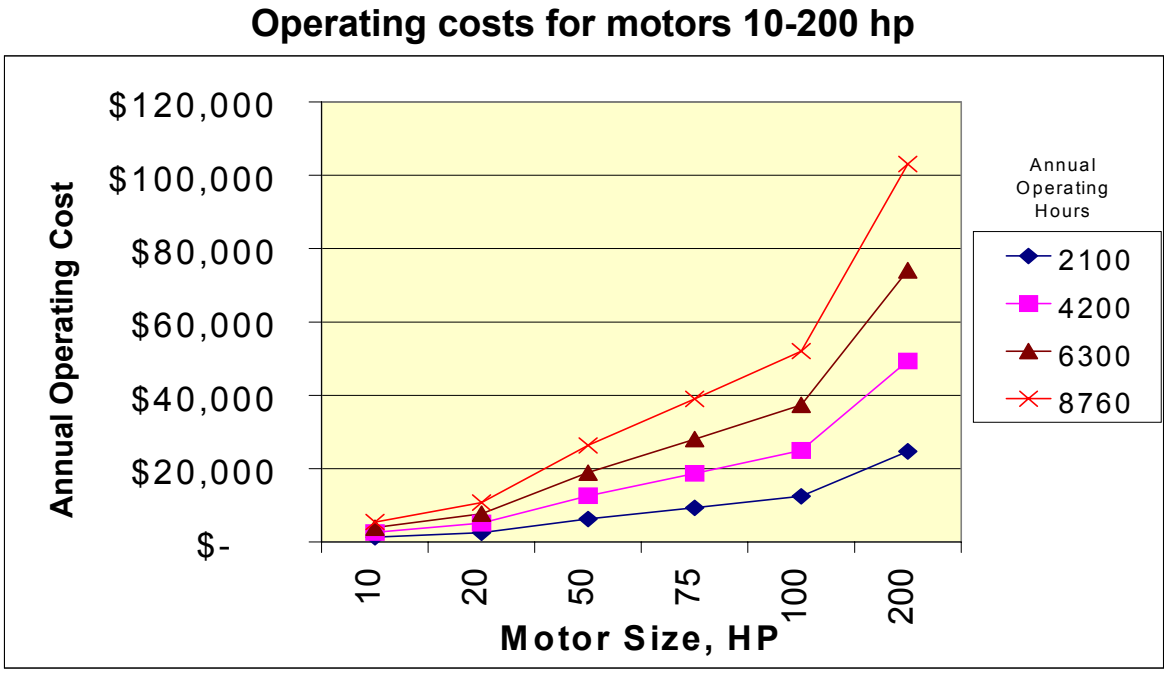
There is never a good time for a motor to fail. However, when motor failures do occur, critical decisions must be made about whether to repair or replace them. These decisions warrant serious consideration, not snap judgements.

Why? Because motors cost more than you think. Many plant and facility managers are surprised to learn that a motor running even one shift has annual operating costs that are far above the motor's initial purchase price. In fact, the average standard efficiency motor easily consumes 40 to 60 times its initial purchase price in electricity during a typical 10-year operating period (see below).

Motor Energy Savings Can Be Lucrative

A typical 75 hp motor running at full load for 6,000 hours per year consumes about $22,000 worth of electricity at $0.075 per kilowatt-hour (kWh). A typical purchase price for such a motor is about $4,000. Over the motor's 10-year life, the purchase price represents just 2 percent of the lifetime costs, while the cost of electricity accounts for 98 percent. And just a 1 percent increase in motor efficiency translates into $2,800 in energy savings over that time – nearly the cost of the motor.

The chart on the next page demonstrates how annual motor operating costs change across horsepower ranges and motor operating hours. Other critical factors in motor operating costs are load levels, motor efficiency and electricity prices. Electricity rates vary by type of organization and region of the country. Check with your local electric utility account representative to better understand how much your motors cost to operate.



Note: Assumes $.075 per kWh at 75 percent load. The operating costs depicted in the chart are a simple illustration, your annual costs will likely be different from those above.

Failed motors are expensive, too
The cost of replacing or repairing motors is often minor compared to the following associated costs of extended downtime due to motor failure:

- Idle workers
- Reduced productivity
- Disrupted schedule
- Late delivery, angry customers
- Overtime pay for mechanics
- Priority shipping charges
- Spoiled product clean-up and disposal
- Damage to driven equipment from seizure

Do You Know What Your Motor Operating Costs Are?

The electric bill for most commercial and industrial customers is a little more complicated than that of a residential customer. Besides the actual cost of power consumed (in kilowatt-hours), there is usually an additional charge called a "demand charge" that reflects the maximum rate at which a customer consumes power. This maximum rate is also known as peak demand.

The added charge is justified because the electric utility has to provide and maintain equipment (such as substations and distribution lines) that is capable of handling the peak electrical current required by its customers. Power factor and other charges have a similar reasoning behind them. Because these factors can lead to an electric rate schedule that can be difficult to understand. Below are two approaches to determine what your motor operating costs are.

1) Check with your local electric utility account representative to make sure that you are using an electric utility rate that closely matches your true cost of power.

2) Calculate the Aggregate Cost of Power. This rate can be calculated by dividing the grand total cost of electricity by the number of kilowatt hours (kWh) consumed in a standard billing period. This information should be clearly printed on your monthly utility bill. The aggregate cost of power is useful in estimating the overall impact of energy savings measures.

For Example: From the simplified electric bill below, the aggregate cost of power is:

1,489.20/(27,600+14,00) = 1489.20/41,600 = **$0.0358 per kWh**

Sample Electric Bill			
On-Peak kWh	27,600	Cost	$634.80
On-Peak Demand kW	407	Cost	307.00
Off-Peak kWh	14,000	Cost	266.00
Off-Peak Demand kW	311	Cost	126.60
Power Factor	0.84	Cost	155.00
Please Remit (Total)			$1,489.20

Tools for Estimating Annual Motor Operating Costs

DOE BestPractices Clearinghouse – 1-800-862-2086

MotorMaster+3.0 Software. U.S. Department of Energy, Office of Industrial Technologies. An energy-efficient motor selection and management tool developed by the Department of Energy (DOE), MotorMaster+ 3.0 software includes a catalog of over 20,000 AC motors. Available through the U.S. Department of Energy's BestPractices Clearinghouse, 1-800-862-2086, an on-line version is available to make quick calculations and comparisons at www.energy.wsu.edu/cfdocs/mmplus/menu.cfm
You can download the complete software program at
http://mm3.energy.wsu.edu/mmplus/

Your local electric utility account representative can provide you with rate calculators to assess the economic benefit of reducing both peak demand and consumption.

Motor Systems Operating Cost Calculator – Productive Energy Solutions, LLC.
www.productiveenergy.com/

Developing a Motor Plan

A motor management plan does not have to be complicated or comprehensive to be effective. Even a simple plan can help you identify the best motor for your particular application and save time and money when motors fail. Consult with your motor service professional to determine the right motor management approach for your facility's particular needs.

The three sample motor management plans below range from simple to complex. Rather than three discrete strategies, these approaches represent points on a continuum from simple decision rules to a comprehensive inventory. Simple decision rules are less precise and take less time to develop. While more complete plans take more time and resources to develop, they also tend to offer more savings.

- Develop a set of criteria for repair/replace decisions.

- Make repair/replace decisions in advance on specific critical application motors.

- Develop a comprehensive motor inventory, a repair/replace decision for each motor in the inventory, and a list of all spares available.

Getting Started: What You Need to Know

Regardless of which motor planning approach you take, each facility must develop motor decisions that fit its unique situation based on factors, including those listed below.

- Motor type (size, speed, enclosure, efficiency)
- Motor operating hours
- Motor load (constant or variable),
- Electricity prices (vary by region)
- Motor repair costs (vary by region)
- New motor prices/discounts (vary by region)

Simple Repair/Replace Decision Rules

One way to approach motor management is to develop a written set of criteria for all repair/replacement decisions. This approach must be approached with caution because it does not consider the factors above on a case-by-case basis. The advantage of these rules is that they are relatively easy to explain and implement. Be sure to discuss these decision rules with your motor service professional before adoption.

EXAMPLES OF DECISION RULES

- Replace all failed standard-efficiency, general purpose motors under a pre-determined horsepower with the highest efficiency new motor available.
- Repair all failed motors above a pre-determined horsepower.
- Replace a failed motor when the repair cost exceeds a pre-determined percentage of the new motor; for example, 60 percent. (**Note:** Check with your motor distributor/dealer to make sure that the motor is available.)
- Stock replacements for all critical motors.
- Establish a motor purchasing policy. When purchasing new motors, purchase the highest efficiency model available, particularly for those applications where the motor runs longer than a pre-determined length of time.
- If it makes economic sense for your operation, consider replacing standard-efficiency, general purpose motors that are still in service (but operate continuously) with the highest efficiency new motors available.

TOOLS

Horsepower Breakpoint Charts – Horsepower Breakpoint Charts are a simple but useful tool to help make repair/replace decisions. As described in the Horsepower Bulletin, these charts use electricity prices, annual operating hours, motor enclosure type and motor speed to determine a motor horsepower breakpoint. Motors above the breakpoint are repaired, those below the breakpoint are replaced. Horsepower Breakpoint Charts are available for two motor enclosure types (Totally Enclosed Fan Cooled and Open Drip Proof Motors) and three speeds (1200 RPM, 1800, 3600 RPM) (**Note:** Horsepower Breakpoint Charts assume 2-year or less payback, average motor loads of 75 percent, and 40 percent average discount rates off new motor list price.)

Horsepower Bulletin – This eight-page bulletin outlines a policy for cost-effective management of motor purchases and repairs. The information is based on feedback from industrial customers, electric utilities, motor suppliers, and repair shops as well as test results from more than 100 new and repaired motors for measured efficiency. Available through DOE's BestPractices Clearinghouse – 1-800-862-2086, www.oit.doe.gov/catalog/cfm/page.cfm?ID=158&type=single or through Advanced Energy – 1-800-869-8001, www.advancedenergy.org/industrial/publications

For further information about making repair/replace decisions, see *Choosing a Replacement Motor* (below) and *Specifying Best Practice Motor Repair Services* (page 9).

Choosing a Replacement Motor

There are a variety of factors to consider when buying a replacement motor, including motor size, speed, design, enclosure type, voltage, in-rush, frame, etc. Recent agreements among motor manufacturers and utilities have made finding and choosing high-efficiency motors a lot easier. Basically, there are two types of motor efficiencies to be aware of:

> **Standard-Efficiency Motors** – Many general purpose motors manufactured or imported in the United States must meet minimum energy-efficiency standards established under the Energy Policy Act of 1992. These standards went into effect in 1997. Most failed motors are **less efficient** than the new standard and **much less efficient** than the so-called "premium-efficiency" motors that are offered by most motor manufacturers. For more information, see *The Impacts of the Energy Policy Act of 1992 on Industrial End Users of Electric Motor-Driven Systems*, available through the U.S. Department of Energy's BestPractices Clearinghouse, 1-800-862-2086, or www.oit.doe.gov/bestpractices/explore_library/pdfs/e-pact92.pdf
>
> **NEMA PREMIUM™ –** Motor manufacturers (through NEMA) and utility and state motor programs (through CEE) endorse a common specification and label for premium-efficiency motors. The NEMA PREMIUM™ label assures high quality and performance, designed with easy replacement of failed motors in mind. If you want a premium-efficiency motor, look for NEMA PREMIUM™. For further information about NEMA PREMIUM™, see www.nema.org/premiummotors/

Motor Purchase Policy. For many companies, it makes sense to establish a motor purchasing policy because it indicates management approval and simplifies the paperwork needed to purchase a new premium-efficiency motor. Motor purchasing policies commonly incorporate the results of Horsepower Breakpoint analysis by requiring the purchase of premium-efficiency motors above a defined horsepower.

TOOLS

Energy-Efficient Motor Selection Handbook (McCoy, Litman & Douglass, 1993) Available through DOE's Clearinghouse – 1-800-862-2086.

Efficient Motors: Selection and Application Considerations. (Consortium for Energy Efficiency, 1999). This brochure provides a brief guide to understanding and selecting efficient motors. It contains several examples that help plant engineers determine when use of a premium-efficiency motor is appropriate. www.ceeformt.org/ind/motrs/motr-broch.pdf

MotorMaster+3.0. U.S. Department of Energy, Office of Industrial Technologies. An energy-efficient motor selection and management tool developed by the Department of Energy (DOE), MotorMaster+ 3.0 software includes a catalog of over 20,000 AC motors.

Available through the U.S. Department of Energy's BestPractices Clearinghouse, 1-800-862-2086, or http://mm3.energy.wsu.edu/mmplus/

Specifying Best Practice Motor Repair Services

Motor repair quality is an important consideration when analyzing the costs associated with repair/replacement decisions. Proper evaluation requires comparing motor energy use after repair versus a new NEMA PREMIUM™ replacement in order to determine which option will achieve the greatest energy savings possible. In general, the benefits of repairing an existing motor can be realized only if the repair achieves little or no deviation from its original specifications. The resources below can help ensure that you are getting the highest quality motor services possible.

DOE Motor Repair Tech Brief and Model Repair Specifications for Low Voltage
Available through DOE's BestPractices Clearinghouse – 1-800-862-2086, or on the web, www.oit.doe.gov/bestpractices/explore_library/technical_publications.shtml#repair

Guidelines for a Good Motor Repair – developed by the California Motor Initiative
www.ceeformt.org/ind/mot-rep/mot-rep-guide.pdf

EASA Standards for the Repair of Electrical Apparatus (ANSI/EASA ARI 100)
EASA established guidelines for motor repair service shops, discussing in detail expected practices that motor service centers should follow. For more information, contact the Electrical Apparatus and Service Association at 314-993-2220, or by e-mail at easainfo@easa.com. A publications list is also available on EASA's web site: www.EASA.com

EASA Guidelines for Maintaining Motor Efficiency during Rebuilding (Tech Note No. 16) For more information contact the Electrical Apparatus and Service Association - 314-993-2220, or email at easainfo@easa.com.

Guide to AC Motor Repair and Replacement – For more information contact the Electrical Apparatus and Service Association at 314-993-2220, or by e-mail at easainfo@easa.com. A publications list is also available on EASA's web site: www.EASA.com

SELECTING A MOTOR REPAIR AND SERVICE PROVIDER
In addition to specifying repair services, you can also look for a motor service provider that meets one of the certifications below. These certifications can provide a good indication of a service center's quality, however, there is no substitute for a strong working relationship with your local service center. Remember, the best way to ensure that you will always get the best repair/replacement advice is to **KNOW YOUR MOTOR SERVICE CENTER.**

DOE Service Center Evaluation Guide – provides useful information to customers on service center quality. Available through the U.S. Department of Energy's BestPractices Clearinghouse, 1-800-862-2086, or www.oit.doe.gov/bestpractices/explore_library/technical_publications.shtml#repair

EASA Q – a service center certification program paralleling ISO 9000 for management practices with respect to motor repair quality assurance. For more information contact the Electrical Apparatus and Service Association at 314-993-2220, or by e-mail at easainfo@easa.com.

Proven Excellence Verification (PEV) – A service center certification program that includes independent on-site assessment as well as before-and-after repair testing in a nationally accredited motor laboratory. Available through Advanced Energy – 1-800-869-8001 or www.advancedenergy.org/industrial/consulting/pev.html

ISO 9000 – The ISO 9000 family of international quality management standards and guidelines that has earned a global reputation as the basis for establishing quality management systems. For more information, see the International Standards Organization's web site: www.iso.ch

Repair/Replace Decisions for Critical Motors

A more focused approach to planning motor decisions is to identify the most important motors in the facility, such as the largest and most critical application motors, by collecting motor data. Collecting motor information can be as simple as spray painting a "yellow dot" on motors with high operating hours for which energy-efficient motors offer good paybacks (see Carolina Power and Light example on next page), or a more thorough motor survey.

During a motor survey, a determination is made and recorded about which motors should be replaced immediately, repaired at failure and which should be replaced on failure. A fairly simple motor management program requires a minimum amount of data collection. Data can be collected on **nameplate characteristics**, such as:

- motor horsepower
- design & code letter (to define inrush current and torque, respectively)
- enclosure
- frame size and special mounting features (e.g, C-face)
- full-load efficiency
- full-load speed
- voltage

and **operational data**, such as

- where the motor is located
- motor application
- when the motor was placed in service
- when the motor was last repaired
- who last repaired the motor
- how many times the motor has been repaired and/or rewound (and why)
- motor loading and operating hours

Some electric utilities offer this service for a nominal charge. More and more, consultants, motor suppliers and some state energy-efficiency programs are also offering this service.

"Yellow Dot" Motor Management

Carolina Power and Light (CP&L) administered a simple program in the 1980s where the utility assisted customers in identifying, through audits, which motors should be repaired and which replaced with energy-efficient motors upon failure. Auditors identified motors with high operating hours for which energy-efficient motors offered good payback at time of motor replacement. Customers were then encouraged to mark these motors with a large yellow dot, and maintenance crews were instructed to install a new efficient motor when a yellow dot motor fails. (Source: *American Council for an Energy Efficient Economy (ACEEE), "Guide to Energy-Efficient Commercial Equipment, 2nd edition")*

TOOLS

Motor Master+ – (on-line version)
www.energy.wsu.edu/cfdocs/mmplus/menu.cfm
or download at http://mm3.energy.wsu.edu/mmplus/

Motor Systems Operating Cost Calculator – Productive Energy Solutions, LLC.
www.productiveenergy.com/motor.asp

Motor Survey How-To Guide – Provides industrial and commercial facility managers with a method to identify motors in a single facility or on a company-wide basis. The guide helps explain how to gather necessary data including motor load and nameplate information. A form for documenting this information is provided. This resource is available from Advanced Energy at 1-800-869-8001 or on the web at www.advancedenergy.org/industrial/publications

DOE Clearinghouse – 1-800-862-2086.

Contact your local electric utility account representative or motor sales or service professional.

Case Study: Disney World Benefits from Motor Planning

According to the Department of Energy's BestPractices program, the Reedy Creek Improvement District sends chilled water to Walt Disney World facilities and has over 20,000 horsepower worth of motors. Using DOE's MotorMaster+ (MM+) software, the University of Florida Energy Extension Service surveyed 120 motors at the North Service Area Chiller Plant, ranging from 25 to 700 HP. Applications included all aspects of water pumping – chilled, condenser, hot, and municipal water – as well as compressors and cooling tower fans. Using data from MM+, the University of Florida identified areas where motor system upgrades would reduce energy usage. The motor survey resulted in the replacement of seven critical motors at the chiller plant and one at the Magic Kingdom totaling 1,425 HP. Energy savings exceeded 300,000 kWh per year and 60 kW in demand worth some $30,000 annually. For more information, see www.oit.doe.gov/bestpractices/explore_library/energymatters/nov1999_partnering.shtml

Comprehensive Motor Inventory

The most comprehensive approach to planning motor decisions requires developing an inventory, or listing of motors at the facility. This approach requires documenting a repair/replace decision for each motor in the inventory, and a list of spares that can be used for different applications.

An overview of setting up a motor inventory program is available from DOE's BestPractices Motor Systems program, as well as from many utilities and motor suppliers. Since many facilities have numerous motors, it is often attractive to use a computer program to maintain a motor inventory. There are a variety of inventory tools available from private parties, government and utilities. MotorMaster software allows motor selection as well as advance planning for motor repair/replace decisions and tracks individual motor operations as part of a predictive maintenance program. A repair or replacement suggestion is made for each motor in the inventory based on the user's particular conditions.

The effort and cost of developing a comprehensive inventory can be quite high. One approach is to build the inventory gradually, starting with key motors (large and critical applications) as repairs or maintenance are performed. Alternatively, many consultants and motor suppliers are beginning to offer this service. Check with your local motor service professional about the availability of motor survey services in your area.
Tools:

MotorMaster+3.0. U.S. Department of Energy, Office of Industrial Technologies. An energy-efficient motor selection and management tool developed by the Department of

Energy (DOE), MotorMaster+ 3.0 software includes a catalog of over 20,000 AC motors. Available through the U.S. Department of Energy's BestPractices Clearinghouse, 1-800-862-2086, or http://mm3.energy.wsu.edu/mmplus/

Motor Survey How-To Guide – Provides industrial and commercial facility managers with a method to identify motors in a single facility or on a company-wide basis. The guide helps explain how to gather necessary data, including motor load and nameplate information. A form for documenting this information is provided. This resource is available from Advanced Energy at 1-800-869-8001 or on the web at www.advancedenergy.org/industrial/publications

Case Study: Woodgrain Millwork Inc. Begins Plant-Wide Motor Inventory

Woodgrain Millwork of Fruitland, Idaho, makes wood molding for doors and windows. After saving over $600 per year on a high-efficiency, 250-horsepower motor, Mark Rawlings, Woodgrain Millwork's plant maintenance manager, committed his department to develop a motor inventory for its 500 motors in the coming year. Without an inventory that provides good data – such as rewind and repair history, hours of operation, nameplate data, and more – available motor analysis tools won't be of much help. Rawlings reasoned that since it takes time to do the analysis, doing it in advance of a motor failure can prevent a hasty decision that costs more in the long run.

Once established, Woodgrain Millwork's motor inventory will track spares on hand, rewind history, and be used for repair/replace decision-making about energy-efficient motors. He is working with a motor management field consultant to streamline the process by collecting the most important data, and focussing on one set of motors in the plant at a time. Rawlings plans to use the inventory data collected to date to generate reports that demonstrate savings opportunities. He expects these to be convincing enough to change the way the company makes repair/replace decisions. He knows, after all, when utility costs rival labor costs, his management takes notice.

For more information contact the Electric Motor Management Program, 425-646-4727, (888-720-6823 in the Northwest), or http://www.drivesandmotors.com/.

Additional Issues for Motor Management Plans

Spares

Determine how easily each motor can be replaced by consulting your spare motor inventory. Also talk with your motor distributor to determine what stocked motors will fit your motor applications. Incorporate your results into your motor management plan. Periodically (once a month) rotate the shafts of your spares inventory to avoid lubrication losses in bearings.

Get To Know Your Motor Service Professional

Your motor repair/supplier can be a valuable partner to your operation and an important part of your total motor management plan. Develop a good working relationship with your motor repair/supplier. The motor repair/supplier is in excellent position to advise you about the availability of spares and determine when a motor is beyond repair and should be replaced. He/she can also complete the repair in a timely manner. The more the motor repair/supplier learns about your operation and needs, the better he/she can serve you.

Pre-Packaged Motors (OEMs)

Purchasing a new motor affords you an ideal opportunity to specify a premium-efficiency motor, especially if the motor will run for long periods of time. However, since many motors in new applications are purchased as part of another piece of equipment (such as a pump, fan or compressor), be sure to specify a premium-efficiency motor when you place your equipment order.

While some original equipment manufacturers can supply premium motors as an option, they generally will offer a lower efficiency motor unless your motor management plan specifies the premium model. When soliciting bids on new equipment, ask the bidders to submit their offers based on equipment containing premium-efficiency motors. Since you will be paying the electric bills to operate this motor for years to come, remember these ***motor decisions matter*** to your bottom line.

SUMMARY

WHAT TO INCLUDE IN YOUR MOTOR MANAGEMENT PLAN

1. Establish a motor purchase policy to simplify the process of buying a premium-efficiency motor, when appropriate, so that the paperwork needed to purchase a new motor does not create an unnecessary impediment.
2. Identify your company's "Horsepower Breakpoint" and make repair/replace decisions based on it, or another decision rule determined ahead of motor failure.
3. Replace motors that make economic sense right away with the best spares available.
4. Get to know your local motor expert (consultant, vendor or service center)
5. Develop you own motor repair specification for each of the motor repair facilities you work with.
6. Establish an inventory of all motors operating in the plant with special attention on motors critical to the process for your product/service.
7. Track motor performance every time a motor is taken out of service and keep good records in your inventory system.

Remember even a simple motor management plan is better than no plan at all, because without a plan you are left with fewer choices.