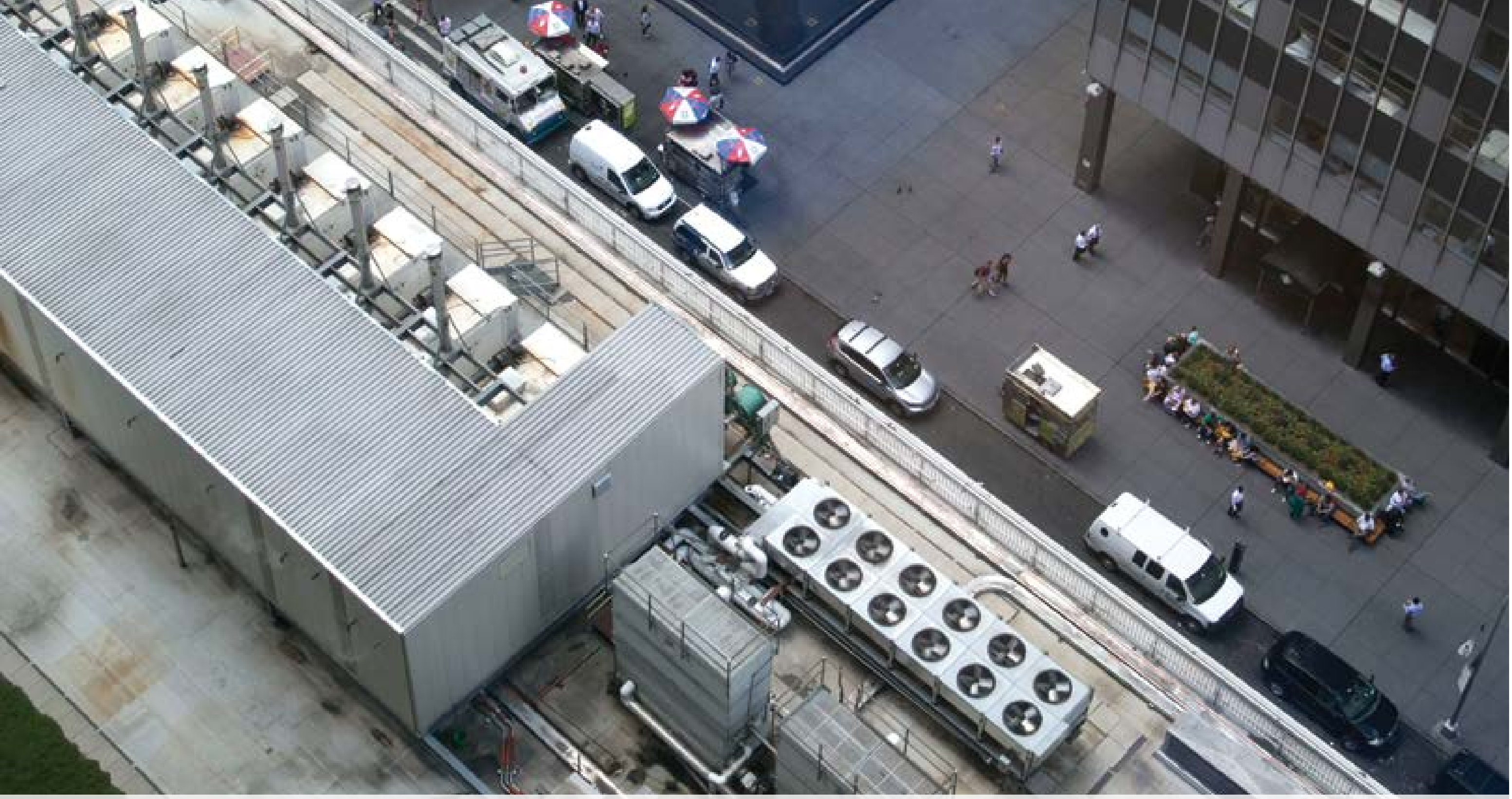

Developing a Commercial HVAC Motor Program

Expanding on last month's commercial HVAC motor feature, this article explains how adopting a system approach, facility managers and building owners can ensure systems are understood and upgraded to reach maximum efficiency.

BY DON SULLIVAN AND DARRYL ROBERSON

Images courtesy of Regal-Beloit Corporation.

In the December 2016 edition of *RSES Journal*, the article "Commercial HVAC Motors" focused on commercial building age, and motor energy efficiency was also explored. In addition, readers were informed of starting points for conducting site audits and what to do with initial audit findings.

This month's article expands on that topic and highlights the process for developing a commercial HVAC motor program based on total system efficiency. The first step in developing a commercial HVAC motor program and maximizing system efficiency is to perform a system audit. In order to secure approval or budget commitments, it is critical to be able to articulate and quantify what maximizing motor and system efficiency potentially means to the organization or company responsible for paying the energy bill. In many organizations, decisions for budgeting or replacing in-service equipment, motors or components can involve multiple stakeholders for signing off on efficiency retro-commissioning projects.

On the surface

A typical site audit only reveals what commercial motors you have and does not identify improperly sized motors. On the surface it might appear that simply replacing standard efficiency motors with NEMA premium efficiency motors would result in a several-point efficiency gain and would have a two- to four-year payback window, depending on usage dynamics and energy rates. That alone would be cause to consider initiating a retro-commissioning/replacement effort. However, understanding actual motor load and system efficiency can help maximize energy savings.

Commercial three-phase induction motors are typically designed to run between 50% and 100% of full (nameplate) load. This means a 50-hp three-phase motor has an acceptable load range of 25 hp to 50 hp. These motors run most efficiently at about 80% of the full rated load. Therefore, a 50-hp motor runs most efficiently when delivering approximately 40 hp. Underloaded motors are less efficient and, as mentioned, not designed for loads less than 50% of rating. In addition, they also have a shortened life expectancy. When encountered, these are generally considered candidates for downsizing.

Performing/analyzing the system audit

Auditing motor inventory and nameplate information is easy. One can then compare existing motor efficiency to premium efficiency motor ratings and justify replacement. While upgrading to premium efficiency motors will provide great energy savings, evaluating the entire system can result in significant additional savings.

The U.S. Department of Energy (DOE) stated: "While motor efficiency is certainly of importance, it is a relatively small contributor to overall system efficiency. System efficiency is the efficiency of converting electrical input energy into useful mechanical work." The DOE estimates system losses can be: up to 5% for electrical distribution; up to 5% for controllers; 3.5% to less than 10% for motors; 10% or

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more for coupling losses; and 30% to 50% driven load losses for pumps and fans. The DOE also wrote: "To maximize system efficiency, one must optimize the entire drive train. By increasing the driven equipment efficiency, improving modulation efficiency, and upgrading the power transmission efficiency, you will reduce the driven equipment shaft horsepower requirements and may be able to supply the useful work with a smaller motor." Simply put, everything connected to the motor should be evaluated for system performance and improvement opportunity.

⌃Other efficiency improvements can be discovered in a thorough system audit, however, this takes a high level of technical skill and an understanding of monitoring equipment.

At a minimum, a system audit should also evaluate:

→Repairing or replacing any components restricting air flow (e.g., inoperable dampers, etc.);

→Replacement or repair of any worn or damaged drive components. Sheaves/Pulleys with greater than 1/32-in. wear typically need replacement. Assuming proper installation and alignment, a sheave/pulley will typically last five to seven years in a commercial HVAC application;

→Replacement of wrapped-style V-belts with notched-/cogged-style V-belts; and

→Ensure proper belt tension and install spring-loaded, self-adjusting/automatic motor bases that minimize belt tension loss.

Other efficiency improvement opportunities can be discovered in a thorough system audit. However, properly performing, analyzing and interpreting system performance takes a high level of technical skill and an understanding of monitoring equipment. The DOE acknowledges this skill set: "Taking field measurements requires plant staff or a consultant to be familiar with the use of such equipment as power loggers, recording pressure transducers, thermocouples, steam vortex shedding meters, orifice and Venturi differential pressure meters, non-intrusive ultrasonic Doppler or transit time liquid flow meters, and Pitot tubes or annubars."

Often maintenance personnel and technicians lack the necessary skills and equipment to thoroughly evaluate system performance. It is advantageous to seek guidance from a motor or belt drive vendor, a motor manufacturer or an energy consultant familiar with commercial HVAC systems.

Most facility managers and building owners are interested in total cost of ownership (TCO), as it considers the initial purchase cost of a motor and drive components as well as the operational costs throughout the life of the system. The DOE published a very sobering comment in their *Continuous Energy Improvement in Motor Driven System* publication. They stated: "One of the major goals of a plant manager is to reduce the 'total cost of ownership' of plant assets. Many plant managers, however, do not realize that electrical energy costs can account for over 97% of a motor's lifetime cost. Significant savings can be achieved through increasing motor and driven-equipment efficiency, resulting in a reduction in the amount of energy required per unit of production. The motor management team should examine energy usage and operating costs for each plant process and piece of motor-driven equipment. They should then determine how purchasing and installing premium efficient motors can reduce these costs."

A deeper and more thorough system audit leading to an ongoing motor and maintenance program should also include:

→Development of an in-house motor/system team or selection of a vendor to install and manage;

→Development of a repair/upgrade priority list;

→Creation of a motor specification;

→Creation of a motor database (e.g., location, application, nameplate information, age if known, etc.);

→Evaluation of required air flow or cfm by application. Selecting sheave/pulley combinations that create the desired driven rpm can easily be done with manufacturer input or online software;

« Many plant managers do not realize that electrical energy costs can account for over 97% of a motor's lifetime cost. Significant savings can be achieved through increasing motor and driven-equipment efficiency, resulting in a reduction in the amount of energy required per unit of production.

→Development of spare motor and drive component inventory matching any upgraded equipment;

→Evaluation and possible installation of a variable-frequency drive (VFD); and

→Short or long-term energy monitoring to gather data for internal or external usage. Proven energy reduction may qualify for building certifications or provide results for any qualifying rebates.

Translating this into real dollars

A $1,500 premium efficiency motor will typically cost $48,500 to operate over its lifetime. That is, the motor cost is insignificant compared to its operating cost. By adopting a system approach, facility managers and building owners can ensure systems are understood and upgraded to reach maximum efficiency. Partnering with a knowledgeable vendor or motor manufacturer is often a great way to identify and implement commercial HVAC total system efficiency improvement opportunities.

References/Resources:

- *Audit information and resource library. U.S. Department of Energy – Office of Energy Efficiency & Renewable Energy. www.energy.gov/eere/amo/information-resources*
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- *U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey – www.eia.gov/consumption/commercial.*

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