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COST-EFFECTIVE CUTS

HOW LITTLE O&M ENERGY USE ADJUSTMENTS CAN YIELD BIG SAVINGS

For the past decade or two, the latest and greatest advances in design methodologies and sustainable products have garnered much of the attention and headlines. However, many FMs may be continually perplexed by the millions of dollars expended on technologically advanced energy conservation projects while ripe, low-hanging green fruit dangled untouched from the operations and maintenance branches. Couple this befuddlement with the fact that facility departments generally have direct control or responsibility for approximately 75 percent of a building's energy use. It is high-time we plucked those overripe fruit, claim the savings and use them to drive facility programs forward.

PRIORITIZE & COMPLETE PMS

First things first, it is imperative that preventive maintenance (PM) work orders are scheduled, managed and completed. PMs are the easiest and most cost-effective means to ensure equipment is performing efficiently and optimally. For example, changing air filters is the simplest HVAC maintenance, however, many FMs have relegated such activity to a "'round2it" philosophy — meaning they will change them when they get around to it.

Dirty air filters drop efficiency by 20 to 25 percent or more and put additional strain on fan motors. Consequently, heating and cooling coils get clogged, which causes another 30 to 40 percent energy loss. Not to mention, dirty coils and filters will cause the equipment to short cycle, burn out compressors or crack heat exchangers, and the diminished indoor air quality and hampered thermal comfort will significantly impact worker productivity to the tune of 10 percent or more. That is big money.

Expand this same perspective to all other facility systems and the impact the facility team has to the bottom line cannot be understated. A Computerized Maintenance Management System (CMMS) is a necessary tool to aid in this endeavor, including coordinating day-to-day operations, tracking asset history and costs, budget forecasting and monitoring customer satisfaction. It is also of upmost importance to prioritize PMs against service requests (SR) and corrective maintenance (CM) to ensure PMs are completed as scheduled.

Otherwise, PMs will get skipped, furthering the department's downward spiral into reactive firefighting. Facility managers and directors leverage key performance indicators (KPIs) and reports to ensure completion and sufficient operations.

INCORPORATE PDM

As a longtime proponent of predictive maintenance (PdM), it is discouraging to see the use of these technologies still underutilized. They are a key way to assist us with working smarter, not harder, to promote asset function and reduce operating costs.

Vibration analysis can be used to discern a number of easily resolvable issues before they truly become a problem and it plays a key role in driving equipment performance and efficiency. For example, misalignment, which attributes to roughly 50 percent of all vibrations in rotating equipment, consumes an additional 15 percent in electricity.

Thus, if vibration is present, perhaps the first step should be to double-check unit alignment. Imbalance is the cause for approximately 45 percent of vibration issues. Unfortunately, the reasons for imbalance are not as easily discernable. Dirty or bent fan blades, bowed shaft and broken impellers can present themselves as out of balance. Belt vibrations and slippage, which often show up as white noise in the lower frequencies, can also account for 15 percent energy loss.

Let us not forget the subsequent wear and tear and increased downtime such issues create. There are many different vibration analysis tools available ranging from US$1500 for simple "red/yellow/green" tools to US$10,000+ for full-spectrum analyzers. The quantity and complexity of equipment and staff capability will partly determine whether an FM can collect and analyze data in-house or contract with a provider. Additionally, if the team changes belts or installs motors or pumps, adding a laser alignment tool to the team's toolbox is strongly recommended.

There are a number of PdM technologies, but to be succinct we will only take a moment to explore the use of infrared thermography (IR) to assess primarily electrical systems, such as panels and transformers.

Infrared thermography, also known as thermal imaging, is a predictive maintenance tool that visually represents temperature differentials and identifies areas of concern and needed resolution. Note, IR has a wide range of applications, including envelope testing and steam system evaluation.

QUICK TIP

Before implementing any potential energy saving changes, measure the relevant operating parameters (i.e. amperage, run-time, etc.) and allow enough time to capture comprehensive data and cycle times, such as one to two weeks. Also, check with the utility provider to determine if any applicable incentives are available. Trends can be set up in the building management system to gather such data.

20 to 25 percent
Average drop in efficiency from dirty air filters

30 to 40 percent
Average energy loss from clogged heating and cooling coils

Anywhere heat and vibration are detected, energy is being lost — not to mention increased risk of failures, downtime and potentially fires. Thankfully, the cost of infrared cameras has decreased significantly from the six-figure amounts of 20 years ago to a minimal investment of US$3000 to US$5000. However, it is strongly recommended that only certified thermographers, who do such on a regular basis, conduct the thermal scans as the craft is a mixture of art and science. In addition to circuit panels, switchgear, motor control centers, disconnects, transformers and switches should be included in the periodic inspection.

LEVERAGE TECHNOLOGY

As the operations and maintenance program matures, Condition-Based Maintenance (CBM) should play a larger role in deployed maintenance strategies, which allows the FM team to perform the right maintenance at the right time. CBM differs from preventive maintenance in that PMs are calendar or run-time based — equipment is taken offline, opened and PM completed whether needed or not.

CBM takes a key step beyond PdM to include data from PdM technologies and other sources such as the building controls system, rounds and readings. This includes meter based (not calendar based) PMs and maintenance that is performed when operating parameters stray outside optimum (e.g. changes in temperature, pressure, amperage, etc.).

On-Going Commissioning (OCx)

Building upon the use of technology

If the desired sensors are not available, data loggers (e.g. HOBO and Fluke) can be deployed; they are relatively inexpensive and fairly flexible. Once the enhancements are made, measure again and estimate the savings, and then market the effect the team has made to the bottom line. Such efforts can be used to justify more desired improvements and budgets. Note, if a large-scale implementation is not feasible or funded, then identify a sample set upon which a study can be performed. Show the sample is successful to solidify support for expanding across the portfolio.

explored with CBM, facility operations should leverage technology (such as building controls systems) to identify sub-optimal performance of facility equipment. Do not limit the capabilities of these powerful systems to identifying high and low alarms and firefighting. Some examples are defined below.

Comparing MAT/SAT/RAT/OAT

Monitor temperatures within an air handler to verify that sensors, dampers and the overall air handler unit (AHU) are functioning correctly. The return air temperature (RAT) is the air returning from the conditioned space, which should typically be in the mid- to upper-70s (F). The supply air temperature (SAT) is the desired temperature of the air leaving the air handler to satisfy the conditioned space's demand. Building code requires a minimum amount of outside air, measured in CFM (cubic feet per minute), be provided to a building (see ASHRAE Standard 62); thus, the incoming outside air temperature (OAT) significantly impacts a building's efficiency and is a key parameter to monitor. The mixed air temperature (MAT) measures the resultant air temperature of combining return air with outside air. This air is then sent through the cooling coil and/or possibly heating coil (depending upon design) to create the desired SAT. The relative differences between these various air temperatures can tell us a lot about the function of the AHU.

Economizer Mode

Most rooftop package units (RTU) and air handlers (AHU) are equipped with economizer dampers that allow for outside air to efficiently cool a building when the OAT is lower than the desired SAT during cooling season. However, studies have found that over half of the economizers surveyed were not functioning correctly with one-third of them not working at all. Economizers can provide substantial savings when properly functioning — or they can cost a lot of money when they are not. Virtual points can be used to compare OAT, MAT, SAT setpoint, damper positions and percent (or stage of) cooling.

Lockouts

Depending upon outside conditions and the desired SAT (and other design requirements), systems should be turned off or "locked out" to ensure that systems are not cooling and heating simultaneously or running equipment and wasting energy unnecessarily. For example, if the OAT is a percentage or certain degree above the SAT setpoint, then the boiler(s) should be disabled, unless the boilers are required for process purposes. The lockout can be verified by evaluating the hot water supply temperature. Additionally, the hot water pumps should be off. Lockout of the chiller and chilled water system could be setup and monitored in a similar fashion.

Schedules and Setbacks

Many building management systems have a smart start capability where the BMS learns when to turn the building systems on so that the space is at the desired temperature by the specified occupied time. For example, based upon outside air temperature, space temperatures and occupied setpoint, the BMS will determine the optimum time to start up the boiler(s) so that it does not fire up too early or too late. This can significantly reduce energy use and equipment run-time.

WELL-BALANCED

In addition to the building envelope losses mentioned above, another related key source of thermal comfort and energy loss is building pressurization. It is imperative that primary sensors are calibrated on a regular basis and a qualified Test/Adjust/Balance (TAB) contractor be employed when any tenant improvements or projects touch HVAC, zone layout or space use. In fact, it is advisable to conduct spot TAB tests periodically, especially if the number of hot or cold calls increases.

COMMISSIONING

On a similar note to TAB, Retro-Commissioning/Re-Commissioning (RCx) should be performed on all existing buildings at least once every three to five years. According to a Lawrence Berkeley National Laboratory study, energy savings should exceed 15 percent. Plus, occupants will realize increased comfort and productivity.

NOT LIKE FOR LIKE

Lastly, when updating or replacing equipment, do not simply replace like-for-like. Explore opportunities to increase performance, efficiency, controllability, maintainability and reliability. Examples include replacing the typical large air handler fan with a fan wall unit, upgrade chillers with the amazingly efficient and quiet magnetic bearing compressors, explore the possibilities of condensing boilers, employ economizers and free-cooling, where applicable. And, of course, install high-efficiency motors and variable frequency drives (VFD).

These simple, incremental advances allow us to harvest the low-hanging green fruit, drive value to the bottom line and increase occupant productivity. FMJ

REFERENCES

1. Making Green Equal Green: https://fm360consulting.com/making-green-equal-green-selling-sustainability-projects-when-the-dollars-do-not-pencil/
2. Electrical Systems: Don't Get Burned: https://fm360consulting.com/electrical-systems-dont-get-burned/
3. IFMA webinar (recording): Smart Tools for Smarter Maintenance: https://fm360consulting.com/smart-tools-for-smarter-maintenance-leveraging-predictive-technologies-to-optimize-facility-om/
4. Commissioning and Retro-commissioning: https://fm360consulting.com/commissioning-retro-commissioning-as-published-in-ifmas-fmj/

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