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GENERAL ENERGY SAVING RECOMMENDATIONS

The Kentucky Pollution Prevention Center (KPPC) has compiled a list of General Energy Saving Recommendations for office, commercial and industrial facilities. These are examples of the types of opportunities you and/or KPPC could discover during an Energy Efficiency (E2) Assessment. Recommendations are provided for the following systems: Lighting, Heating and Cooling, Boilers, Motors and Compressed Air.

LIGHTING

- **Switch to Energy Efficient Lighting** - Older lamps and magnetic ballasts should be replaced with energy efficient lamps and/or electronic ballasts. Lamps manufactured today have superior performance compared to lamps of five to ten years ago. Traditionally, T-12 fluorescent tube lamps (tube diameter of twelve eighths of an inch, or 1.5 inches) were used. Smaller T-8 lamps (tube diameter of one inch) are now available and provide greater light output (typically measured in lumens) per watt of electricity. T-8 fluorescent lamps consume as little as 50% less energy as T-12 lamps while maintaining 89% of the light output over their lifetime. Thus, improved technology of the T-8 lamp results in greater energy efficiency than the traditional T-12 lamp. The most common lighting installed today in office spaces is 32W T-8 electronic ballast fixtures.

Another form of energy efficient lighting is the compact fluorescent lamp (CFL), which is used to replace the standard incandescent lamp. For a typical 60-watt incandescent light bulb, the replacement CFL is approximately 13 watts, which is less than 25% of the power used.

- **Install Occupancy Sensors for Restrooms, Offices, etc.** - By installing occupancy sensors into some area lighting and exhaust fan circuits, both lighting and exhaust fan operation could be eliminated during unoccupied periods. Energy savings will result from reduced heating load (due to reduced ventilation losses) and reduced electrical usage for cooling, lighting and exhaust fan motor operation. Determining which lights are most appropriate candidates for an occupancy sensor depends on how much electricity the light uses, the traffic of the area, and how often lights are left on. Occupancy sensors can conserve more than 20% of the annual energy usage of an individual lighting system, depending upon the area.

The following table shows the EPA's average predicted savings for installing occupancy sensors in the specified areas:

U.S. EPA Average Percentages	
Type of room	Percentage
Private office	13 to 50%
Open-plan office	20 to 28%
Classroom	40 to 46%
Conference room	22 to 65%
Restroom	30 to 90%
Corridors	30 to 80%
Storage area	45 to 80%

- **Use Light Timers and Photosensors** - Install photosensor devices to allow control of artificial (electrical) lighting during periods when natural sunlight from exterior windows (or skylights) is adequate. Savings are due to reduced consumption by the fixtures being controlled.

A photosensor is a device that measures the presence of visible light. One photosensor can control several lights and it can be programmed to turn lights on and off when a chosen light level in the area is detected. Lights can also be controlled by a timer, but this control method may turn lights on too early or late in the morning or evenings, resulting in lights being used when there is sufficient natural light or not being used when there is not enough natural light available.

The photocell is mounted outdoors, typically on a roof facing the northern sky. In addition to receiving input from the photocell, the controller module may also be connected, via a dry contact input, to a system clock, time switch, or building management system that signals occupied/unoccupied (business hours/after hours) status of the facility.

- **Install LED Exit Signs** - Several manufacturers produce exit sign lamp kits which can reduce the power consumed by the signs by as much as 80% and last about 200 times as long.

It is estimated that 80% of all exit signs in the USA are still illuminated with incandescent bulbs, and new fixtures using this antiquated technology are still manufactured and sold. The reason for this is that they are cheap to manufacture and thus the initial cost to the consumer is relatively low. In the long term they wind up costing hundreds and thousands of dollars in energy and maintenance expenditures, but many consumers simply do not understand these "hidden" costs.

Replacing the bulbs in every fixture (not to mention purchasing and storing the replacement bulbs) requires frequent maintenance which can cost over \$30 per year per fixture.

HEATING AND COOLING

- **Change Interior Temperature by 1 or 2°F or Use Temperature Setback while Unoccupied** - As a rule of thumb, the potential savings from changing or adjusting the temperature settings on heating and air-conditioning units, commonly referred to as roof top units (RTUs), is that each °F results in a 1.5% change in energy usage. Thus, if the normal temperature setting for a space is 70°F and the air conditioning setback temperature is 78°F, the energy usage is reduced (8 x 1.5% =) 12% during the setback period, which is the non operating hours. There are minimal operating/maintenance and implementation costs; therefore, payback would be immediate.
- **Install Programmable Thermostats** - Install automatic time clock thermostats to reduce space temperatures during unoccupied periods and thus reduce gas energy consumption for space heating. The thermostats could also shut off the cooling system during unoccupied periods of the cooling season, thereby reducing energy usage by the air conditioning system. With programmable thermostats, a 10% energy savings for heating and cooling is possible. A programmable thermostat is inexpensive and costs about \$100. On average, thermostats should be able to be installed in about one hour each.
- **Install Demand Control on Building Cooling System** - The power demand controller automatically regulates or limits operation in order to prevent set maximum demands from being exceeded. The role of such a power demand controller has been widely recognized. Operation and maintenance costs for this recommendation may include some labor to adjust control algorithms to fine-tune the demand control strategy. However, cost for this labor should be minimal.

BOILERS

- **Keep to a Regular Maintenance Schedule** - It is very important to keep a regular maintenance schedule on your machines to maximize efficiency and life. Particular equipment components to inspect and clean include: fireside surfaces, waterside surfaces, the burner assembly, and the stack. Other items to inspect include the refractory, seals, feed water pumps and operation of safety valves.
- **Install Boiler Reset Control** - A boiler sequence control works by estimating load conditions in real time and match load with the most efficient combination of boilers in a group of multiple boilers. Most boilers operate most efficiently at full load; however, not all suffer part-load efficiency reductions. Load response and start-up times are also factors. The controller also needs to be programmed to decide whether to run two boilers at half load in order to better match rapidly changing loads, or one boiler at full load for peak efficiency.

The benefits for installing a boiler sequence control include:

- Complete automation for startup and shutdown of the boilers and control of the main steam header pressure or header temperature.
 - The steam or hot water supply for a facility is controlled precisely. Without the controller, each boiler operates at its pressure or temperature - not the main header pressure or temperature.
 - Boiler life is improved since each boiler can operate as the lead boiler for equal hours of operation. The lead/lag sequencer will change the lead boiler based on operating hours or date and time.
 - Fuel savings by eliminating idle time at low fire.
- **Boiler Blowdown Management and Heat Control** - Blowdown represents thermal energy loss which can be recovered either by flashing the blowdown to low pressure steam or with a heat exchanger. The amount of flash steam increases as the pressure difference between the boiler pressure and flash pressure increases. The blowdown is reduced in pressure and passed through a pressure vessel or a flash tank. The flash tank acts as a separator allowing the remaining liquid blowdown to separate from flash steam. The low pressure steam can then be used for process applications.

A heat exchanger can be used to transfer thermal energy from the blowdown to makeup water, but a limiting factor is the higher potential of fouling in the heat exchanger attributed to quality of blowdown.

- **Duct Warmest Air into Combustion Intake** - The temperature of intake air into the boiler affects the efficiency of the boiler. If the intake air is preheated or drawn from a warmer area, energy and cost savings can be substantial. As a rule of thumb, an increase in boiler efficiency of approximately 1% is possible for each 40°F increase in intake combustion air temperature.

In industries, generally the area just below the roof will be warmer due to temperature stratification of air. It would therefore be beneficial to draw air from near the ceiling. Initial cost is incurred from installing ductwork to the ceiling.

- **Recover Stack Loss** - Stack loss is the major loss associated with the boiler operation. The energy loss through the stack is a function of flue gas temperature and the excess air. Typically this contributes to about 15% loss. Energy from stack can be recovered for various other useful purposes, such as preheating combustion intake air or preheating water.
- **Install Condensing Economizers** - Condensing economizers improve the effectiveness of reclaiming flue gas heat. By cooling the flue gas below the dew point, they recover both sensible heat from the flue gas and latent heat from the moisture which condenses. Condensing economizers may reach efficiencies as high as 85% in very low velocity stacks. A condensate breech elbow and drain is required in condensing applications.

- **Adjust Air to Fuel Ratio** - Many factors including environmental considerations, cleanliness, quality of fuel, etc. contribute to the efficient combustion of fuels in boilers. It is therefore necessary to carefully monitor the performance of boilers and tune the air/fuel ratio often, at least quarterly for a year-round system. Best performance is obtained by the installation of an automatic oxygen trim system that will automatically adjust the combustion ratio to changing conditions.
- **Eliminate Steam Leaks** - Significant savings can be realized by locating and repairing leaks in live steam lines and in condensate return lines. Leaks in the steam lines allow steam to be wasted, resulting in higher steam production requirements from the boiler to meet the system needs. Additional feed water is required to make up for condensate losses and more energy would be expended to heat the cooler feed water than to heat the warmer condensate. Water treatment would also increase as the make-up water quantity increased. Leaks most often occur at the fittings in the steam and condensate pipe systems. Savings for this measure depend on the boiler efficiency, the annual hours during which the leaks occur, the boiler operating pressure, and the enthalpies of the steam and boiler feed water (where enthalpy is a measure of the energy content the steam and feed water).

MOTORS

- **Use Proper Lubrication** - Excessive motor wear can be caused by high temperatures, which are friction induced. Proper lubrication prolongs the life of the motor, and keeps the motor running close to, if not at, its optimum efficiency.

It is important to maintain motors according to manufacturers' instructions. Although energy-efficient motors with higher temperature-rated insulation may be able to handle higher temperatures and other abuse, there is no reason to reduce maintenance. Motors should have good ventilation and be periodically inspected for increased vibration or power supply problems.

- **Size Motor Properly for its Application** - A motor which does not run at its full rated load, commonly measured in revolutions per minute (RPM), does not operate as efficiently as a motor that does run at its full rated RPM. So it is important that the motor is not too large for its application. Conversely, if the motor is too small it will not be able to handle the stress of overloading, and will fail.

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. Of course, some situations may require oversizing for peak loads, but in such cases alternative strategies should be considered, such as a correctly sized motor backed up with a pony motor.

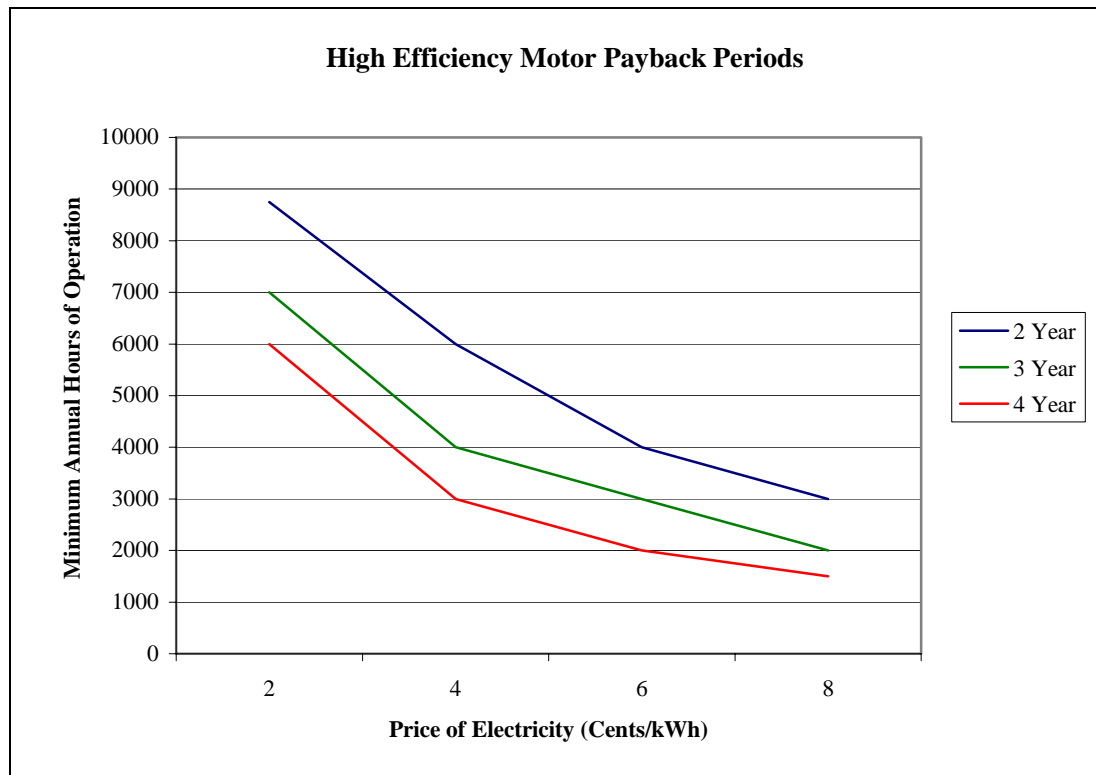
- **Rewind Motor Vs Motor Replacement** - Rewinding generally is not cost effective in motors 75 hp or smaller. For a major rebuild to be justified, the original stator and rotor must be in serviceable or reasonably-repairable condition. Repair of significant rotor or stator core damage is generally only cost effective on larger motors. In most cases, rewinding costs about 60% of new motor costs and results in 1% decrease in efficiency, but can be as high as 3%, depending on the rewind procedure of the rebuild shop.

Ask the repair shop to conduct a core loss or loop test as part of their rewind procedures. 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.

Select a new energy-efficient motor under any of the following conditions:

- The motor is less than 40 hp.
- An energy-efficient motor is recommended.
- The cost of the rewind exceeds 65% of the price of a new motor.

The following graph provides payback periods for replacing an existing motor with a new energy-efficient model. Payback periods are based upon the annual hours of operation and price of electricity. As shown, the payback period improves as annual hours of operation and price of electricity increase.



- **Install Variable Frequency Drives (VFDs) on All Eligible Air Handlers** - Typical annual savings from installing VFDs can range as high as 20 to 40%. With the VFDs, an operation and maintenance (O&M) savings of approximately 10% could be realized as well.

Benefits will also include: maintenance savings arising from running the motor at reduced speed that lowers the load torque and lessens mechanical stress on belts and bearings; environmental comfort increased as a result of reduced air velocity - less drafts; and lower background noise levels.

- **Use Energy Efficient V-Belts** - Around one-third of all electric motors in use in industry use belt drives. Belt drives are used for their flexibility, reliability, relatively high efficiency, and relatively low cost. The most commonly used belt is a V-belt. V-belts have a trapezoidal cross section to create a wedging action on pulleys to increase friction and power transfer capacity. V-belt drives can reach a peak efficiency of 95% to 98% immediately after installation, with a nominal efficiency of 93%.

COMPRESSED AIR

- **Repair Compressed Air Leaks** - A proactive leak detection and repair program can reduce leaks to about 10% of compressor air demand. Leaks are a significant source of wasted energy in an industrial compressed air system. Compressed air is considered a third utility and is very expensive.

Compressed air systems consist of a supply side that includes compressors and air treatment, and a demand side that includes storage, distribution and end-use equipment. Air leaks occur mainly in the following areas:

- Couplings, hoses, tubes, and fittings.
- Pressure regulators.
- Open condensate traps and shut-off valves.
- Pipe joints and thread sealants.

In a typical industrial facility without a leak detection and repair program, air leaks contribute to about 25%- 40% of the air demand. A proactive leak detection and repair program can typically reduce leaks to about 10% of the average air demand. Thus about 15% of peak air demand can be saved by repairing leaks and ensuring periodic maintenance on the air lines. A good leak reduction program will include the following:

- Identification of air leaks and tagging
 - Repair
 - Tracking
- **Recover Waste Heat from Air Compressors** - For an air compressor, as a rule of thumb, about 80% of the input power is wasted as heat. Air-cooled, packaged, rotary

screw compressors are very amenable to heat recovery for space heating. (From Improving Compressed Air System Performance- A Sourcebook for Industry)

This recommendation involves installing air to air heat exchangers and duct work to enable recovering heat during winter and rejecting it to the outside during summer. Paybacks within a year for this recommendation are not unusual.

- **Reduce Line Pressure to Minimum Required** - The capacity (volume of the intake air flow compressed) and the pressure (amount of stored power, psig) determine the basic horsepower required by a compressor. It is recommended to change the compressor air pressure set point to reduce energy usage in air compressors. As a rule of thumb, 1% savings can be achieved with every 2 psig reduction in pressure for screw compressors. Reducing pressure in the air lines also results in reduction in air loss from leaks and other unregulated uses. Assuming that the operating pressure can be decreased without having to make any other modifications to the existing compressor system, the implementation cost associated with this recommendation is considered minimal, resulting in an immediate payback.
- **Use Blowers/Fans Instead of Compressed Air for Cooling, Drying, or Blow-Off Operations** - Compressed air is considered a third utility and is very expensive. It is cost-intensive to use compressed air for cooling, drying, or blow-off operations because it uses much more energy than a fan would use to accomplish the same job. Facility personnel should consider other cost-effective forms of power to accomplish the required tasks and eliminate replaceable demands.
- **Use Outside Air for Compressor Intake** - Compressors require less energy to compress cooler, denser air. Installing ductwork to provide the inlet of the compressors with cooler outside air will result in energy savings, since less compressor work will be required for the same output. Following this recommendation will also result in savings from reduced energy usage in HVAC equipment. Typical results are savings of about 5%, with payback periods of less than a year for compressors with continuous operation.