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Optimizing Your Heating, Ventilating and Air Conditioning Systems

Risk Solutions

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Many modern buildings are designed with a forced-air heating, ventilating and air conditioning (HVAC) systems. While different types of designs may be found, the HVAC system has two critical functions:

– Control temperature and humidity for occupant comfort
– Control indoor air quality for a healthy environment

One type of modern HVAC system achieves this by delivering a variable air volume (VAV) to a space. A VAV system provides many separate units, usually hung above the ceiling, to controls the various space conditions in defined zones of the building. Each zone has its own control sensor mounted in the individual space being controlled. This helps control energy costs by allowing the users to customize the space condition depending on the hours or use. In some systems this can be done for every room in the building. Most modern HVAC systems have a distributed control system that is accessible through the internet for setpoint adjustments or for remote monitoring.

Many older systems still use room-unit ventilators. These are units that are installed against an outside wall of the room and are able to pull in fresh ventilation air through a small duct installed through the outside wall of each room. The heating function controls the space temperature in the winter but also preheats the cold outside ventilation air in the cold days of winter. Most of these systems are “heating only” units, but still provide uncomfortably warm, but ventilated rooms, during the warmer seasons.

Many older control systems use pneumatic controls. A pneumatic control system uses air pressure signals rather than electrical signals to relay control messages from the rooms to the HVAC equipment. Pneumatic control systems require a noisy air compressor usually in the equipment room. Other larger area spaces are designed with constant air volume HVAC systems. Limited control capabilities contribute to energy waste. This occurs when large horsepower motors run while rooms are unoccupied. Any HVAC system that operates when it is not needed wastes energy.

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While heating and cooling are seasonal, the ventilation systems need to function whenever the building is occupied. Enforceable building and mechanical codes specify the ventilation options available for HVAC systems designers. Ventilation systems, like all HVAC systems, require frequent maintenance to keep the system working efficiently and effectively. Failing to keep ventilation systems maintained and controlled properly has the potential to waste huge amounts of energy. Bringing in too much cold air in the winter, or too much hot, muggy air in the summer, forces a great energy load on the boiler or the air conditioning systems. A disproportionately high amount of energy is needed to temper hot or cold ventilation air requirements for the rooms while occupied.

There are many ways that facilities personnel can help to reduce energy waste and redirect saved energy dollars. Some of the best, simplest and lowest cost options for increasing the efficiency of the HVAC systems are:

Inspect and maintain all air duct systems

Periodically inspect supply and return ducts for air leaking into or out of the duct seams. Also look for open ducts that may be disconnected and open above false ceilings. Seal all leaking duct seams with seam sealer and cap or repair unused or abandoned branch taps dumping air into the ceiling cavities. By repairing leaks the air will go where it was designed to go and energy will not be wasted.

Verify the integrity of the insulation on insulated ducts. This is especially true for ducts that are made out of rigid insulation board. It is common for duct sealing tape on rigid ductboard to fall off allowing the seams to discharge air out of the ducts. Good integrity of the insulation and vapor barrier are especially important for ducts supplying cold air. Cold air ducts operating in an unconditioned air space will sweat and condense water out of the hot muggy air. This moisture can cause mold problems in concealed locations above false ceilings.

Remove any cardboard or “stuffing” installed by the occupants due to annoying or drafty air discharges on people. Blocking off the intended air flow by uncomfortable occupants forces more air to be delivered to the remaining rooms on the system. Verify that the duct systems are open to all the original design rooms and properly balanced to prevent occupants from taking matters into their own hands.

Clean heating and cooling coils

Dirt and dust are great insulators on coil surfaces. Even a fine coating of dust on a coil can result in a reduced heat exchange, causing the system to run longer to meet heating or cooling needs. Keep the coils clean throughout the changing seasons.

During the cooling season, moisture collecting on the cooling coils is collected by drain pans and drained out of the air handler. Drain lines can accumulate dirt or become plugged, causing moisture carryover into the discharge side of the coil. Plugged drains can also cause the drain pan to overflow and damage ceiling or floor tiles. Keeping condensate drains open and clean will reduce the chance for unhealthy microbiological growth in the dark, damp air handling units.

Inspect for aging or deteriorated coils in units and replace if necessary. Rusting coil frames and flaking aluminum fins on the coils will be hard to keep clean due to the corroded surfaces. Steel that has lost its protective galvanizing coating could promote unhealthy mold or slime growth within the air handling units.

Inspect and maintain fans and blowers

Establish a periodic or seasonal maintenance plan for all fans and blowers. Document the many types and location of the fans. Be sure to include all lavatory exhaust fans. These are typically overlooked and can create unhealthy air in the lavatories. Keep the blower wheel or fan blades clean to maximize the efficiency of the equipment. Centrifugal blower wheels frequently collect enough dirt on the bladed to reverse the designed curvature of the blade.

Establish a documented service plan for any kitchen and food services fans and blowers. Fans used in cooking hoods are critical to keep cleaned of grease residue to prevent a fire in the kitchen or the exhaust duct. The kitchen hoods and fans should be serviced by a professional cleaning company familiar with the fire codes related to proper and safe system functioning.

Inspect and replace worn or loose V-belts on belt driven fans and blowers. A loose belt on a blower can slip, squeal and waste motor horsepower in addition to burning up the belts. Friction between the loose

belt and the sheave can generate enough heat to burn the belt and trip the fire alarm causing a building evacuation. Make sure the belts are properly aligned and tracking properly to prevent premature belt and bearing wear. Keep all motor bearings and driven equipment shaft bearings lubricated at the scheduled frequency provided by the manufacturer.

Maintain and properly control all motors

Verify that all fractional horsepower motors are functioning properly. Although they do not consume a large amount of energy when they run, they all perform a necessary HVAC function. The smaller motors used in small room unit ventilators, heat pumps or stand-alone room air-conditioners have a shorter rated life than a large equipment room motor. These smaller motors usually fail from seized motor bearings and then the motor shaft locks up. When this happens, the motor will continue to draw energy but do no useful work. If left unchecked, these motors can get very hot and possibly cause a fire or release unpleasant smelling smoke into the building.

Keep motors clean and the bearings properly greased to extend the life of the motors. Dirt accumulation or grease on a motor housing or air ventilation openings can trap heat in the motor and cause it to trip the thermal overloads causing an unexpected equipment shutdown.

If a motor requires replacement, consider replacing it with a premium efficiency rated motor. It can save up to 8 percent energy compared to a standard efficiency motor. Also, check with the HVAC service provider to see if any motors in the building could be retrofitted with variable frequency drives for energy savings. Make sure all motors are only operated when performing a needed task. Motors are typically large loads and can quickly waste a lot of money if left on when everyone goes home for the night. Invest in a simple, economically installed controller for the largest uncontrolled motors in the building.

Maintain all belts and sheaves

Inspect the motor and driven equipment pulleys or sheaves to make sure the V-grove sides are not worn into a concave shape. A worn sheave will not transmit the rated mechanical horsepower from the motor to the driven equipment. Worn sheaves will cause new belts to be noisy, wear out quickly and perform poorly.

Verify that all installed V-belt types are used in a matching sheave type. There are many V-belt cross-sectional shapes on the market. The V-belt designated type must be specified in addition to the belt length for proper application. Installing a belt based on length only will cause operational problems for the equipment.

Align and properly tension all V-belt drive systems. Check with the equipment manufacturer to determine the proper method for tensioning the belts. Belts that are too tight will overload bearings, causing premature belt and bearing failure. Misaligned belts increase belt and sheave wear and waste energy.

Verify that the number of belt grooves in the sheaves match the number of V-belts installed. Multiple grooved sheaves require the same number of belts to transfer the required horsepower from the motor shaft to the driven equipment shaft.

Establish an air filters maintenance program

Apply a consistently executed filter maintenance program to help minimize dirt and dust deposits on fans and coils. In addition, keeping the filters changed at the proper frequencies will help to improve the indoor air quality.

Determine the optimal frequency for changing the filters based on regular inspections of the filter material. Not all filters need to be replaced at the same frequency. For example, for a ventilator unit with an outside air filter and a recirculated-air filter, the outside air filter many need to be replaced half as many times as the recirculated-air filter. Filter change frequencies are a function of many variables such as dusty areas near air intake grilles or units operating during high pollen counts in the air, etc.

If the structure has an automated building management system, consider connecting a differential pressure sensor across the filter section of the air handler. This control input device can automatically notify the computer system when the preset pressure drop across the filter is reached. If this method is used, be sure to include periodic calibrations of the pressure switches in the maintenance program to keep the sensor working accurately.

Use filters with a Minimum Efficiency Reporting Value (MERV) rating of 7 or higher to adequately control indoor air quality. Improved

filter design and materials are available allowing cleaner air delivery without significantly restricting air flow and increasing energy consumption.

Inspect and maintain all dampers and diffusers

Over time, building space usage may change or the dampers, actuators or control devices may wear out or fail. When this stage is reached, the HVAC systems may need to be re-commissioned to reset the HVAC system designs to the new or modified use of the building occupants. Dampers control the air flow through the duct systems. During initial installation, the dampers, actuators and controls were set up to deliver the correct amount of air to a space based on the needs at that time. Dampers also control the amount of fresh ventilation air drawn into the building to meet mechanical code requirements. Verifying that all of the input and output control devices perform as designed is the art of commissioning.

For systems that have been in operation for a number of years or have seen considerable changes in occupancy and use, a complete Testing Adjusting and Balancing (TAB) may be advisable.

Verify that dampers are not leaking excessive air when they are in the closed position. This is especially important on outside air dampers. If an outside air damper fails to close tightly in the winter and if the building has a negative pressure within, cold outside air can be pulled into the unit and freeze coils or pipes in the area.

Inspect outside air intake louvers to make sure they have bird screens to prevent small animals from entering the system. Also, check that the bird screens are clear of lint and paper debris. Intake air louvers do not usually have filters at the wall penetrations and can be a forgotten item on the maintenance rounds.

Maintain chillers for optimal efficiency

Perform the scheduled manufacturer's recommended service on large chillers. Chillers produce chilled water used for space comfort cooling and can be the single largest electrical energy user in a facility.

Keep the chiller condenser tubes clean and monitor the water quality to the cooling towers. Clean condenser tubes have a direct impact on the chillers operating efficiency. Condenser tubes are also subject to internal fouling and corrosion problems. Routine condenser water testing is normally required by a qualified water treatment service company.

Verify all safety and operating control devices. Running the system at excessively low or high setpoints will waste energy. Test the system for refrigerant leaks to be sure the system capacity will remain at design values throughout the season.

If multiple chillers are available, determine the most efficient staging routines to use to optimize the part-load performances of the different available chillers in the group. The staging routines may vary based on the changing seasonal building heat gains or losses.

Control Costs Related To Air Conditioning Units

Keep the condensers clean on small through-the-wall or mini-split air-conditioning systems. These systems are often run with stand-alone local controls and are harder to integrate in the central building automation control system. Try to develop an automated control scheme for these smaller units even if it is a simple local time clock controller.

If rooftop air conditioning units are used, make sure all of the access covers are properly screwed on tightly and are not pulling in unconditioned outside air into the ductwork. If this occurs, the unit capacity will be exceeded and the space conditions will be uncontrolled and uncomfortable. Remember to change the air filter in these less accessible locations through the filter maintenance program.

When it is time to replace a unit, select a replacement unit with at least a 13 SEER energy efficiency rating. Determine if the existing or new central HVAC system can accommodate the loads previously supplied by smaller air conditioning units. This option could be available if older HVAC systems were updated with new equipment after smaller units were purchased for temporary HVAC "work-around" solutions.