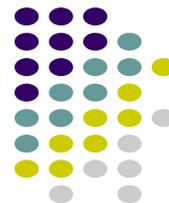


The Triangle Papers

EPA Headquarters, Federal Triangle, Washington, DC



Volume 1, Issue 2
April, 2005

The purpose of The Triangle Papers is to facilitate improved Preventative Maintenance (PM) programs. Issues that are considered timely or critical are presented for informative purposes, discussion, action and as a catalyst for improvement.

The Systems Connection: - Manual vs Automatic

Interaction of System Components

All of the components of the Heating, Ventilation and Air Conditioning Systems (HVAC) are interconnected with each other to form a complete and workable operating system. The performance of each unit of the HVAC systems is dependant on the proper operation of all of the individual components. This applies also to the Temperature Control System.

If just one component of the System fails to do its job due to poor maintenance, the entire System can fail to perform as intended.

The following are descriptions of Automatic and Manual Temperature Control systems. The effects of poor, inadequate or improper maintenance procedures on system control operations is described in this paper. Included in the discussion are the effects on the System as a whole and on other individual components.

You Pick It! Manual or Automatic

There are many buildings using either manual or automatic control systems that are being operated with excellent indoor comfort. These buildings also experience minimal equipment operating problems. Any building can be equally successful whether operated manually or automatically.

The reverse is also true. There are many manual and automated buildings with poor performance. There are successes and failures in both categories.

There are some common factors, besides the issue of manual or automatic operation, that affect the conditions within a building. In other words, successful buildings, whether manual or automated, have many things in common.

So you want Manual?

Manual operation is just what the name implies. Almost all functions are controlled manually.

For instance, Start/Stop functions may be accomplished by simple time clocks. The times for turning equipment on or off must be set manually. Changes such as for Daylight Savings Time may have to be done twice a year. Any changes in schedule must be manually set and may require changes to multiple time clocks. Changes to the schedules such as after hours use or weekend use must be manually set to accommodate the short term changes in schedule.



Temperature controls must be set manually to the desired set point for each point of control. Any changes in set point must be done manually. Need for changes are usually in response to requests from tenants. Some changes are done intuitively by experienced operators based on changes in weather. Types of controls requiring set point changes include space thermostats, chilled and hot water controllers and supply air temperature.

Optimization strategies can be accomplished

but are cumbersome and not as efficient as automated systems. Optimized Start/Stop can be done manually based on predictions of next day weather conditions. Manual optimization, at best, is done based on experienced operators who know how the building responds to various conditions. Staging heating and cooling equipment on and off is done based on changing building load or weather conditions.

How About Automatic?

Automated building control is usually accomplished with computerized Automated Direct Digital Control (DDC) Systems. Newer buildings incorporate DDC systems into the original design. In older buildings some DDC systems are integrated into the existing building pneumatic control systems. This strategy can be successful if the original pneumatic system is operating efficiently and in accordance with the design control parameters.



Siemen's Building Controller

With an automated DDC system all control functions are programmed into the computer according to the control design strategies. All functions can be programmed or set from one or more central work stations, so changing parameters or set points does not require visiting each controller that must be changed.

Pros and Cons

There are advantages and disadvantages to both Manual and Automated control systems. Some of the major differences are described below.

Manual Control – Advantages

The main advantages are:

- No sudden and system wide failure of the entire system.
- Most failures are localized and are normally limited to a single controller or piece of equipment.
- There can be intuitive response making adjustments to the systems by seasoned and experienced operators.
- Personnel can offer quick response to observed changes in conditions or to system failure.

Manual Control – Disadvantages

- System operation relies on human ability and availability.
- Operation of systems requires a high percentage of operating hours devoted to manual manipulation of the systems to achieve optimum performance. This restricts time available for routine maintenance and repairs.
- Manual operation can require additional manpower.

Automatic Control – Advantages

- Control functions are reliable and repeatable.
- There is greater flexibility.
- Changes in strategies or set points are easier.
- Changes can be done at a central work station without physically going to each point of control.
- Optimization strategy options are greater and more flexible.
- Energy efficiency is improved.



Automated control systems do not take vacations, go on sick leave, quit for more money or move to another city.

Operator's Workstation

Automatic Control – Disadvantages

- Equipment becomes obsolete more quickly.
- Requires frequent upgrades.
- Replacement components are expensive.
- Operators tend to be more computer oriented with limited experience in operation of mechanical systems.
- There is normally a heavy dependence on outside vendors for support. This often involves expensive maintenance contracts.
- Requires extensive and expensive training for O&M people.
- Control system may be subject to sudden failure.

The Right Stuff

There are three basic requirements that are common to both manually operated and automated buildings. All three components are required to create a successful environment within the occupied

space.

1. HVAC equipment

The HVAC equipment consists of such items as chillers, pumps, cooling towers, condensers, heat exchangers, boilers, air handling units, fan coil units, VAV boxes, motors or other equipment used to provide heating and cooling to the occupied spaces.



Chiller

The Heating, Ventilation and Air Conditioning systems (HVAC) must be properly designed to provide the desired comfort conditions within the occupied spaces. This includes careful selection of system components that will produce the desired conditions within the space. The primary areas of concern are sufficient capacity and types of systems that will produce:

- Uniform temperature control
- Acceptable humidity levels
- Adequate ventilation
- Proper filtration to insure acceptable Indoor Air Quality (IAQ)
- Adequate air circulation
- Reasonable energy efficiency

2. Temperature Control System (TCS)

The Temperature Control System has only one function: Provide comfort to the occupants of the space.



Local Zone Controller

There are controls to regulate chilled water, hot water, condenser water, supply air or any other component where conditions must be maintained at a desired level. The controls can also be used to maintain humidity levels.

The TCS also may be used to Start or Stop any or all components of the HVAC system on any desired schedule

Whether manual or automated, the TCS must be designed to:

- Maintain accurate control of the space conditions.
- Be reliable and provide consistent repeatability.
- Be easily maintained by the O&M staff
- Be supported by the manufacturer at reasonable costs with rapid response in emergencies

The TCS can be used to optimize the operation of the HVAC systems. Such optimizing strategies may include optimized start/stop, supply air temperature reset, chilled or hot water reset, optimized ventilation, free cooling, and humidity control.

3. Operating and Maintenance Program

The operating and maintenance department must provide adequate numbers of trained, experienced and motivated people to successfully operate the HVAC and TCS systems in the manner in which they were designed.

The O&M staff must perform preventive maintenance in accordance with the manufacturer's recommendations or within industry accepted practice or governmental guidelines. Prescribed safety standards must be maintained at all times.

The O&M staff provides repairs to the equipment when systems or components fail.

Even the best and most reliable HVAC or Temperature Control Systems will fail without proper maintenance and repair.

A violation in the integrity of any one of the above three components will result in inferior operation of the systems. Excessive repairs and comfort complaints will occur. Early and repeated failure of the equipment is assured.

No Maintenance; No Operation

The best designed HVAC systems or the most expensive and sophisticated TCS will fail to perform if they are not operated and maintained adequately. This is true for both Manual or Automatic controlled buildings. All components of the building HVAC systems, including the machinery and controls, are interconnected and dependant on each other for suc-

successful operation.

If the TCS is not designed, installed, maintained and operated properly, none of the machinery will function to provide comfort to the space.

Just as the Water Treatment Program has far reaching effects on the entire system, so does the TCS. Some of the major areas of concern are described in more detail.

SET POINT CONTROL

Set Point Control is pretty much what the name implies. It is the *point* at which the control is *set* to maintain conditions at the desired levels. For instance, a thermostat is **set at a point** to maintain space conditions at a comfortable level.

A discharge air controller is **set at a point** to maintain the supply air temperature of an air handler at the point that will allow the space to be cooled or heated to a comfortable level,

There are many other controls in the TCS that require set points to maintain specific conditions.

If the *set point* is not set properly, the conditions that are being controlled will not be maintained at the desired condition. This is not the same as adjustment but refers to actually setting the control at an improper point such as too high or too low.

ADJUSTMENT

One of the most common problems found is controls that are not properly adjusted. This prevents dampers from fully opening or closing, or cooling and heating valves from fully opening or closing.

Improper adjustment can cause over heating or cooling, inadequate heating or cooling, improper ventilation (too much or too little) and wasted energy.

CALIBRATION

Another prevalent problem is controls that are not properly calibrated. This means that a control is trying to maintain a condition that is different than the *set point*. A room thermostat may have a set point of 70 °F. but is controlling a higher or lower temperature depending on how far out of calibration it is.

Improper calibration can affect all controls but the most common place that is noticed is space temperature. This is the source of a large number of

occupant comfort complaints.

DISJOINTED

Often, controls that have been physically disconnected. The most common controls that are disconnected are heating and cooling valves and damper actuators. This results in total loss of control of the desired conditions. A single disconnected controller can affect a large area or segment of the HVAC system.

OIL & WATER DO NOT MIX

Many TCS use pneumatic controls whether they are manual or automatic. The heart of the pneumatic controls is the pneumatic air compressor. The purpose of the air compressor is to provide a clean, dry supply of air to operate the controls.



Air compressor

PSI reports water is passing into the East/West building systems. They have requested approval from GSA to install a larger air drier. The North-South buildings have evidence of both oil and water in the pneumatic system.

Water or oil in a pneumatic control system can be fatal. Cleanup and repair is very costly and time consuming.

KEYS TO SUCCESS

The primary objective of the HVAC systems is to provide acceptable comfort to the occupants of the building. The key to success in reaching that objective is an excellent Preventive Maintenance Program.

The PM program must be designed so that all recommended tasks are performed at the necessary intervals. These tasks include routine inspections, calibrations, adjustments and repairs.

The PM staff must be of sufficient numbers to be able to perform all the required duties. They must be highly trained and motivated. There must be an adequate Quality Control Program to ensure performance levels are maintained.

