

Equipment operates during unoccupied hours

Introduction

In most buildings with office-function occupancies (including hospitals with office areas), HVAC systems are scheduled to operate only at certain times. This includes a morning warm-up or cool-down period, plus normal occupancy. The systems are shut down after occupants leave the building at night. The occupancy schedule is usually dictated in the space lease agreement.

As you investigate this symptom, remember that each facility has its own unique HVAC system schedule. Some facilities have occupancy schedules that vary for each floor if they have floor-by-floor air handlers.

Buildings with large central systems tend to have strict occupancy schedules for all tenants to conserve energy. Otherwise, a system with several hundred horsepower worth of motors may operate for as few as 5 to 10 tenants who are working late.

Many tenants have terms in their leases that specify charges for using air conditioning after hours. This tends to minimize after-hours energy use because it affects the tenant's bottom line directly.

How This Wastes Energy

Operating HVAC systems in normal occupied mode when the facility is really unoccupied can waste energy in several ways. Electrical energy is wasted running fans and possibly central plant equipment. Also, the building can become overcooled or overheated to the point where the HVAC system must run more than necessary in the morning to compensate.

Possible Causes of This Problem

The table below shows some of the possible causes of this symptom. The cause of a symptom can be an energy-performance problem that can be fixed, or it may be explained by an unavoidable aspect of your current system that would probably require a capital project to change. Follow the steps described after the table to determine the possible cause of this symptom. If you find a problem, perform the suggested trend logging to confirm that the problem exists and, later, that you have solved the problem.

Checked	Inspection Step	Type	Description
	1	Explanation	Equipment controls are overridden to allow or force operation after hours.
	2	Explanation	Equipment is operating to prevent system damage.
	3	Problem	Clock has not been reset after a power outage.
	4	Problem	System placed in manual mode at local starter.
	5	Problem	DDC system has a frozen contact that prevents equipment from being shut down at scheduled times.
	6	Problem	Setback temperatures for unoccupied hours are the same as, or close to, setpoints for occupied hours.

How to Find the Problem(s) by Inspection

Walk the entire facility both before and after normal occupancy hours to create a list of affected equipment.

Inspection Step 1

Examine the direct-digital-control (DDC) system to see if the HVAC-system control has been overridden to run after hours. A log should be kept to notify staff which tenants have requested after-hours HVAC and for how long, and to make sure they are properly billed for it. If equipment is operating with no after-hours requests, continue the inspection.

Inspection Step 2

Some conditions rightfully cause equipment to operate after hours. For example:

- Some heating-water systems operate constantly to prevent the piping system from cooling down and springing leaks.
- Some chilled-water pumps are activated to circulate water through coils to prevent freezing.

Inspection Step 3

Make sure the clock is set properly, whether you have a complex DDC system or simple time clocks. Check the status of the UPS or battery backup regularly.

Inspection Step 4

Make sure the local starters for each piece of equipment are in the automatic position. If not, find out who overrode them and why before resetting the starter.

Inspection Step 5

Command the equipment off via the DDC system to see if it shuts down. If it does not, a contact may be frozen, or a communications link is down. Have your DDC system technician investigate and replace any damaged parts.

Inspection Step 6

Make sure the setpoints for the unoccupied mode are properly entered. Sometimes the unoccupied setpoints are mistakenly set up as the occupied setpoints, or the two setpoints are very close. Therefore, the system can enter unoccupied mode and still need to operate to maintain that mode's setpoints. The end result is that the system seems to run continuously. Make sure realistic setback temperatures are programmed.

How to Confirm the Problem(s) by Trend Logging

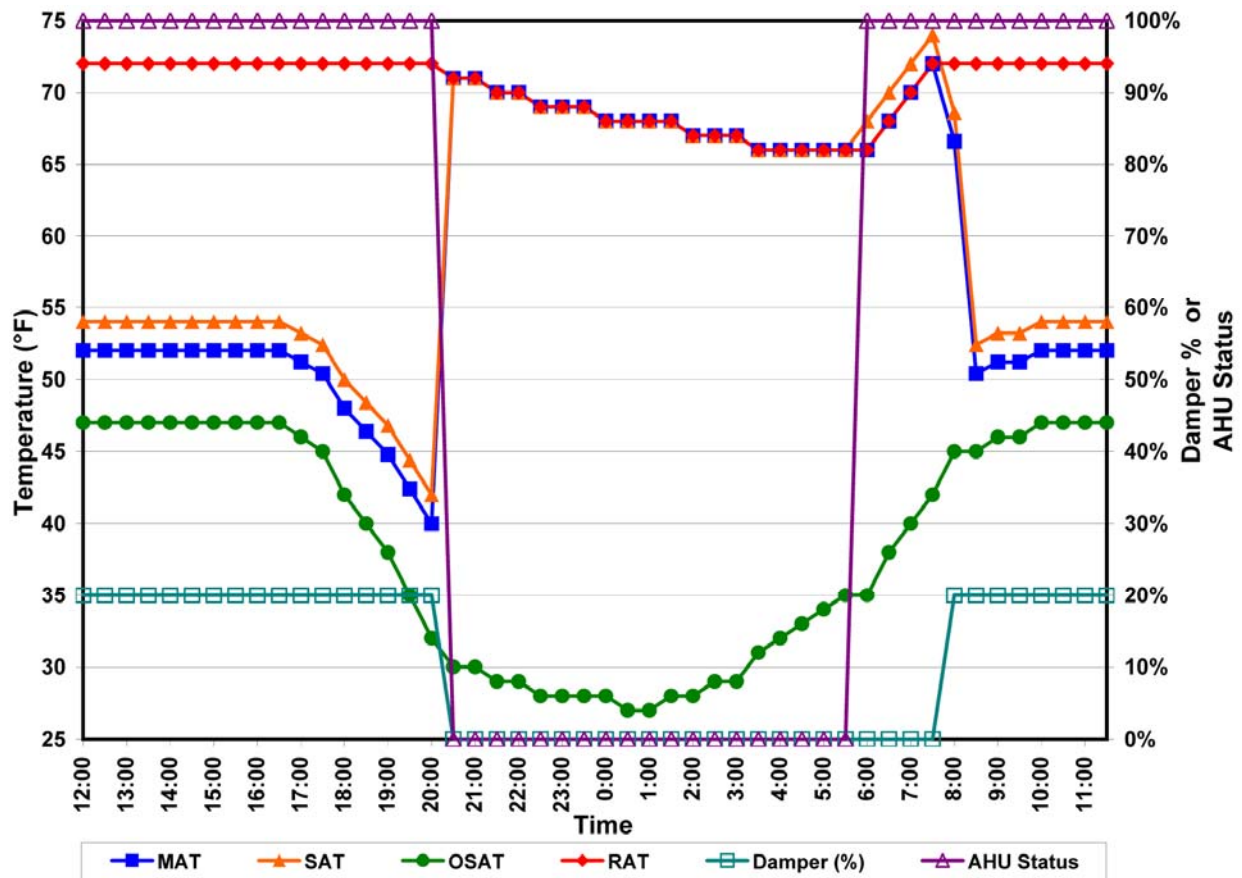
Trend log the following:

- Status of any suspect equipment noted during the inspection process. It may not be feasible to trend log every piece of equipment.
- Space temperatures where unoccupied setback temperatures are suspect.
- For air handling units (AHU), trend the following:
 - Mixed-air temperature (MAT)
 - Supply-air temperature (SAT)
 - Outside-air temperature (OSAT)
 - Return-air temperature (RAT)
 - Damper position
 - AHU status
- Any other relevant parameters such as the status of restroom exhaust fans.

Graph the trends for the suspect equipment and see how the equipment status varies as the system passes between occupied and unoccupied modes. Note that sometimes equipment runs for a while after it has been commanded to shut down. For example, chiller and boiler pumps typically operate for 15–30 minutes after they “shut down” to allow the temperature of the heat-transfer surfaces to equalize to prevent possible damage.

Example of Normal Operation

If your graph for an AHU looks like the figure below, your system is probably operating properly. (Note the noon-to-noon time scale.) The unit comes online in morning-warm-up mode at 6:00 with OSA at 0%. The space warms up from 66 to 72 during this period. The OSA damper opens at 8:00 when normal occupancy starts. MAT and SAT are controlled by the OSA damper at minimum position, with terminal units providing reheat as required. The unit shuts down at 20:00 with the OSA damper closing tight. The building temperature drifts down overnight gradually from 72 to 66 degrees.



Normal equipment schedule (noon-to-noon time scale)

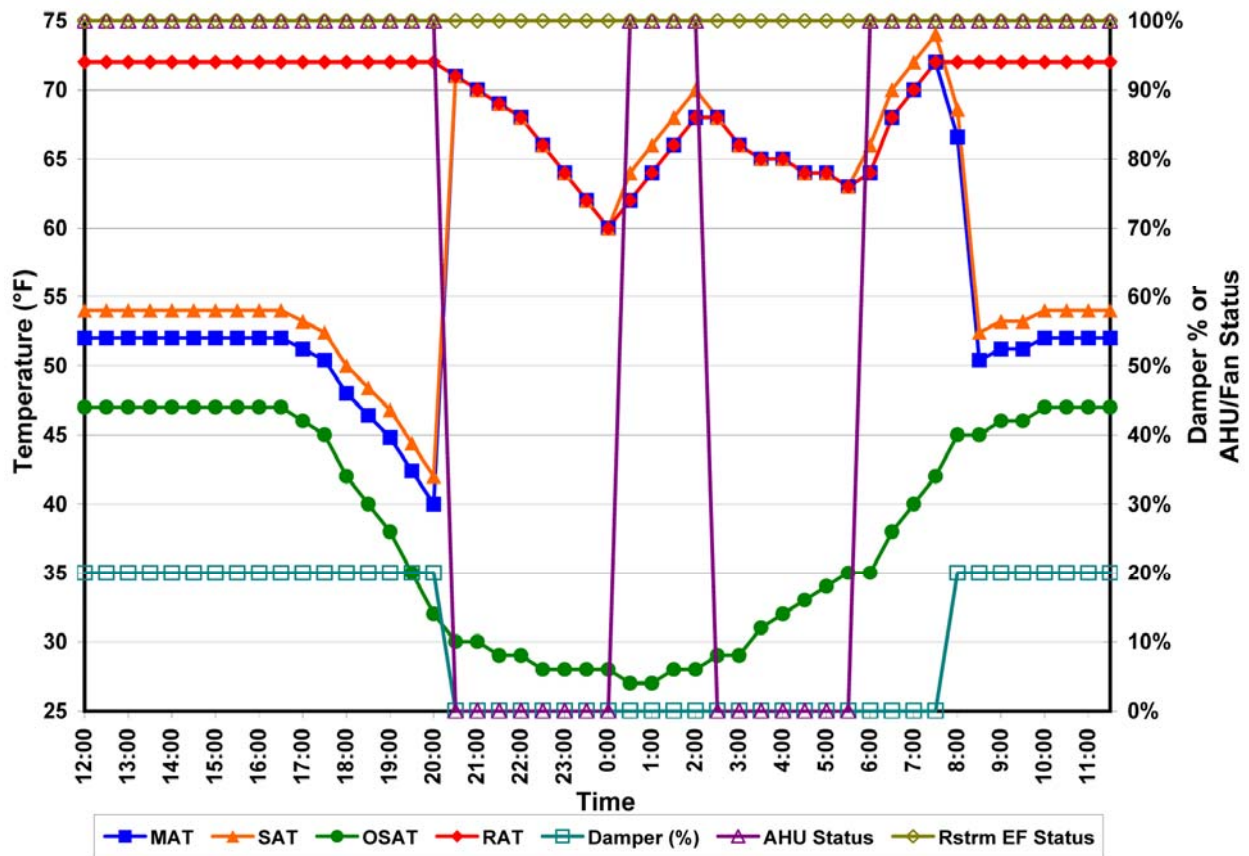
Example of Abnormal Operation

If your graph for an AHU looks like the figure below (again, note the noon-to-noon time scale), something is causing the building to cool off rapidly enough that the setback-temperature setpoint has been reached and the AHU comes online to warm the building back up. Starting at 20:00, the building temperature drops rapidly from 72 to 60 degrees, which is the lower setpoint for heating during the unoccupied period. The AHU comes on at midnight for about two hours to warm the building back up to the upper limit of 68 degrees. Note that the OSA damper remains closed.

This condition could indicate a failure in the building envelope integrity (in which case your system is probably operating as intended, but in response to an abnormal load) or an exhaust fan is operating when it shouldn't. All building exhaust fans should be interlocked to shut down at the same time as the AHUs

providing make-up air. In this case, the exhaust fan in the central restroom was not interlocked, so it created negative pressure in the building and bring in unconditioned air through any leaks in the building envelope. The lack of a motorized damper on the exhaust outlet can produce the same effect in buildings with more the three or four floors.

The rate of temperature decline in a tight building will depend on the envelope's thermal mass and insulation level.



Night setback activated due to an exhaust fan not being shut down (noon-to-noon time scale)

Labor Skills Required to Find and Resolve the Problem

- DDC system operator/programmer
- Service mechanic
- Electrician