## Correct HVAC Operations Schedules

### Author

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### Description

This energy efficiency measure (EEM) modifies the availability schedules of HVAC fans, pumps, chillers, and zone thermostats to represent a movement to an occupancy based scheduling of HVAC equipment, allowing the building to coast towards its unoccupied state while it is still partially occupied. An AirLoop occupancy threshold value of lower than 5 percent of peak occupancy is considered to define when HVAC equipment should not operate. Energy can be saved by shutting down cooling equipment when it is not needed, as soon as occupants leave the building and prior to their arrival. While this measure may save energy, unmet hours and occupant thermal comfort conditions during transient startup periods should be closely monitored. The measure also adds heating and cooling unmet hours and Simplified ASHRAE Standard 55 Thermal Comfort warning reporting variable to each thermal zone.

### Modeler Description

The measure loops through the AirLoops associated with the model, and determines an occupancy weighted schedule with values of 1 or 0 based on the percent of peak occupancy at the timestep being above or below a set threshold value of 5 percent. The resulting occupancy schedule is applied to the airloop attribute for the availability schedule. The measure then loops through all thermal zones, examining if there are zone equipment objects attached. If there are one or more zone equipment object attached to the zone, a thermal zone occupancy weighted schedule with values of 1 or 0 based on the percent of peak occupancy at the timestep being above or below a set threshold value of 5 percent is generated. The schedule is then assigned to the availability schedule of the associated zone equipment. To prevent energy use by any corresponding plant loops, the pump control type attribute of Constant or Variable speed pump objects in the model are set to intermittent. The measure them adds heating and cooling unmet hours and Simplified ASHRAE Standard 55 warning reporting variable to each thermal zone.

### Use Case Types

Retrofit EE

### Arguments

No arguments

### Initial Condition Message

The initial model contained {W} applicable airloop and {X} Zone Equipment, {Y} Constant Speed Pump and {Z} Variable Speed Pump objects for which this measure is applicable.

### Final Condition Message

The availability schedules for {W} airloops and {X} Zone Equipment objects were modified by this measure. The pump control type attribute for {Y} Constant Speed Pump and {Z} Variable Speed Pump objects were modified by this measure.

### Not Applicable Messages

The model contains no Airloops or Zone Equipment for which this measure is applicable.

### Warning Messages

N/A

### Information Messages

Any time an object’s properties are changed, an info message will be generated indicating the object name, old value and new value.

### Error Messages

### None

### Code Outline

1. Loop through each AirLoop
   1. Call the method that creates a schedule where the value is zero when the overall occupancy for all zones on the airloop is below the specified threshold of 5%, and one when the overall occupancy is greater than or equal to the threshold of 5%. This method is designed to use the total number of people on the airloop, so if there is a zone that is continuously occupied by a few people, but other zones that are intermittently occupied by many people, the first zone doesn't drive the entire system.
   2. Apply the newly generated schedule representing air loop occupancy patterns to the Availability schedule attribute of the airloop.
   3. Write info messages
2. Loop through each Thermal Zone object:
   1. Call the method that creates a schedule where the value is zero when the overall occupancy for all zones on the airloop is below the specified threshold of 5%, and one when the overall occupancy is greater than or equal to the threshold of 5%. This method is designed to use the total number of people on the airloop, so if there is a zone that is continuously occupied by a few people, but other zones that are intermittently occupied by many people, the first zone doesn't drive the entire system.
   2. Assign the occupoancy driven schedule to the availability schedule attribute of each Zone Equipment object associated with the thermal zone
   3. Write info messages
3. Loop through all pump objects (constant speed, variable speed, constant speed headered, variable speed headered) in the model:
   * 1. Set the pump object control type attribute to ‘intermittent’.
     2. Write info messages
4. Add diagnostic reporting variables to the model
   1. Simplified ASHRAE Standard 55
   2. Zone Thermostat Heating Setpoint Temperature
   3. Zone Thermostat Cooling Setpoint Temperature
   4. Zone Air Temperature [C]

### Tests

**This measure applies to:**

1. Secondary School
2. Primary School
3. Outpatient Healthcare
4. Large Office
5. Warehouse
6. Midrise Apartment
7. Small Office
8. Medium Office
9. Stand-Alone Retail
10. Strip Mall
11. Supermarket
12. Quick Service Restaurant
13. Full Service Restaurant
14. Small Hotel
15. Hospital
16. Large Hotel

**Engineering Notes:**