## Add Hot Water Pump Differential Pressure Reset Controls

### Description

This energy efficiency measure (EEM) configures all pumps identified as secondary heating loop pumps. Pumps identified are then either replaced (in the case of a constant speed pump) or reconfigured (in the case of a variable speed pump) to operate as a variable speed pump with an aggressive Part Load Performance Curve representing operation of a functional hot water differential pressure reset control with a wide range of zone valve deviation. Energy savings will be generated by operating the secondary heating pump motor for longer periods of time at lower energy consumptive levels.

### Modeler Description

This measure identifies all OS Pump objects attached to the inlet side of the demand loop of a plant loop having both OS:Sizing:Plant Loop type = “Heating” and OS:PlantLoop Common Pipe Simulation setting = “TwoWayCommonPipe”, indicating that a secondary hot water pump is present on the inlet side of the hot water demand loop. If the existing secondary heating pump is an OS:Pump:ConstantSpeed object, it will be replaced with a new OS:PumpVariableSpeed object configured with the same Rated Flow Rate, Rated Pump Head, Rated Power Consumption, Motor Efficiency and Fraction of Motor Inefficiencies to Fluid Stream as the original pump and a Part Load Performance Curve will be added. If the existing secondary heating pump is an OS:PumpVariableSpeed object, a new Part Load Performance Curve will be added.

If the Rated Flow Rate of the existing OS:Pump:ConstantSpeed or OS:Pump:VariableSpeed is specified, the Minimum Flow Rate of the modified pump will be set to a value representing 30% of the specified Rated Flow Rate. If the Rated Flow Rate of the OS:Pump:ConstantSpeed or OS:Pump:VariableSpeed is Autosized, a sizing run will need to be fired off and the pump design gpm retrieved to accurately set the Minimum Flow Rate of the modified pump to a value representing 30% of the Autosized design flow rate.

### Use Case Types

Model Articulation, Retrofit EE, New Construction EE

### Arguments

No arguments

### Initial Condition Message

The initial model contained {X} applicable OS:Pump:ConstantSpeed and {y} applicable OS:Pump:Variable Speed objects for which this measure is applicable.

### Final Condition Message

{Z} OS:Pump:Variable Speed objects were configured to replace {X} OS:Pump:ConstantSpeed and {Y} applicable OS:Pump:Variable Speed objects in the model.

OS:Pump:ConstantSpeed objects affected were {OS:Pump:ConstantSpeed name1 }, { OS:Pump:ConstantSpeed name2}, etc.

OS:Pump:VariableSpeed objects affected were { OS:Pump:VariableSpeed name1 }, {OS:Pump:VariableSpeed name2}, etc.

### Not Applicable Messages

The model contains OS:Pump:ConstantSpeed and OS:Pump:Variable Speed objects for which this measure is applicable.

### Warning Messages

If Rated Pump Head = 60’ write warning message that it appears the E+ default pump head is being used.

### Information Messages

Did something to object 1. Etc.

### Error Messages

If no secondary pump object exist in a qualified pump loop, write an error message describing the plant loop name and that the secondary pump does not exist on the demand inlet side of the loop.

### Code Outline

Loop through all Plant Loops having OS:Sizing:PlantLoop.LoopType = “Heating” and OS:PlantLoop. CommonPipeSimulation setting = “TwoWayCommonPipe”

1. Read the first component on the demand inlet branch to determine the type of pump object – will be either OS:Pump:ConstantSpeed or OS:Pump:Variable Speed
2. If component = OS:Pump:ConstantSpeed object then
   1. read and store OS:Pump:ConstantSpeed attributes:
      1. Name
      2. Rated Flow Rate
      3. Rated Pump Head
      4. Rated Power Consumption
      5. Motor Efficiency
      6. Fraction of Motor Inefficiencies to Fluid Stream
      7. Pump Control Type
   2. Remove OS:Pump:ConstantSpeed object
   3. Add and configure new OS:Pump:VariableSpeed object (\*persist existing values)
      1. New Name
      2. \*Set Rated Flow Rate
      3. \*Set Rated Pump Head
      4. \*Set Rated Power Consumption
      5. \*Set Motor Efficiency
      6. \* Set Fraction of Motor Inefficiencies to Fluid Stream
      7. Create and set new Part Load Performance Curve Coefficients
         1. Coefficient C1 =0
         2. Coefficient C2 =0.0205
         3. Coefficient C3 =0.4101
         4. Coefficient C4 =0.5753

* + 1. Minimum Flow Rate
       1. If Rated Flow Rate <> Autosized then
          1. Set Minimum Flow Rate = (Rated Flow Rate x 0.30)
       2. If Rated Flow Rate == Autosized then set execute an OS sizing run.
          1. Retrieve pump Rated Flow Rate from SQL output table.
          2. Set Minimum Flow Rate = (Rated Flow Rate x 0.30)
    2. \* Set Pump Control Type

1. If component = OS:Pump:VariableSpeed object then
   1. read and store OS:Pump:VariableSpeed attributes:
      1. Name
      2. Rated Flow Rate
      3. Rated Pump Head
      4. Rated Power Consumption
      5. Motor Efficiency
      6. Fraction of Motor Inefficiencies to Fluid Stream
      7. Minimum Flow Rate
      8. Pump Control Type
   2. Remove OS:Pump:VariableSpeed object
   3. Add and configure new OS:Pump:VariableSpeed object (\*persist existing values)
      1. New Name
      2. \*Set Rated Flow Rate
      3. \*Set Rated Pump Head
      4. \*Set Rated Power Consumption
      5. \*Set Motor Efficiency
      6. \* Set Fraction of Motor Inefficiencies to Fluid Stream
      7. Create and set new Part Load Performance Curve Coefficients
         1. Coefficient C1 =0
         2. Coefficient C2 =0.0205
         3. Coefficient C3 =0.4101
         4. Coefficient C4 =0.5753
      8. \*Minimum Flow Rate
         1. If Minimum Flow Rate <> 0 then
            1. \* Set Minimum FlowRate = Minimum Flow Rate
         2. If Rated Flow Rate <> Autosized then
            1. Set Minimum Flow Rate = (Rated Flow Rate x 0.30)
         3. If Rated Flow Rate == Autosized then set execute an OS sizing run.
            1. Retrieve pump Rated Flow Rate from SQL output table.
            2. Set Minimum Flow Rate = (Rated Flow Rate x 0.30)
      9. \* Set Pump Control Type

### Tests

**This measure applies to:**

1. Secondary School
2. Primary School
3. Outpatient Healthcare
4. Large Office
5. Hospital
6. Large Hotel

**This measure does not apply to:**

1. Warehouse
2. Midrise Apartment
3. Small Office
4. Medium Office
5. Stand-Alone Retail
6. Strip Mall
7. Supermarket
8. Quick Service Restaurant
9. Full Service Restaurant
10. Small Hotel

**Test results:**

Run the simulation using prototype .osm files, examine the results, cut and paste some before/after screenshots/evidence that makes you think that the measure is working correctly, including generating messages.

Engineering Notes

The Part Load Performance Curve used by this measure to represent secondary hot water differential pressure reset were referenced in both

1. Table 51 on Page 5-186 of the 2013 Nonresidential Alternative Calculation Manual (ACM) - REFERENCE MANUALFOR THE 2013 BUILDING ENERGY EFFICIENCY STANDARDS
2. Table 5 on Page 29 of PNNL-21569 – “Energy Savings Modeling of Standard Commercial Building Re-tuningMeasures: Large Office Buildings”