

# EnergyPlus Exercise HVAC 1

## *Unitary System and VAV using HVACTemplate Inputs*

*This exercise is similar to Tutorial 2 in "Getting Started with EnergyPlus"*

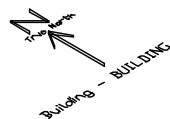
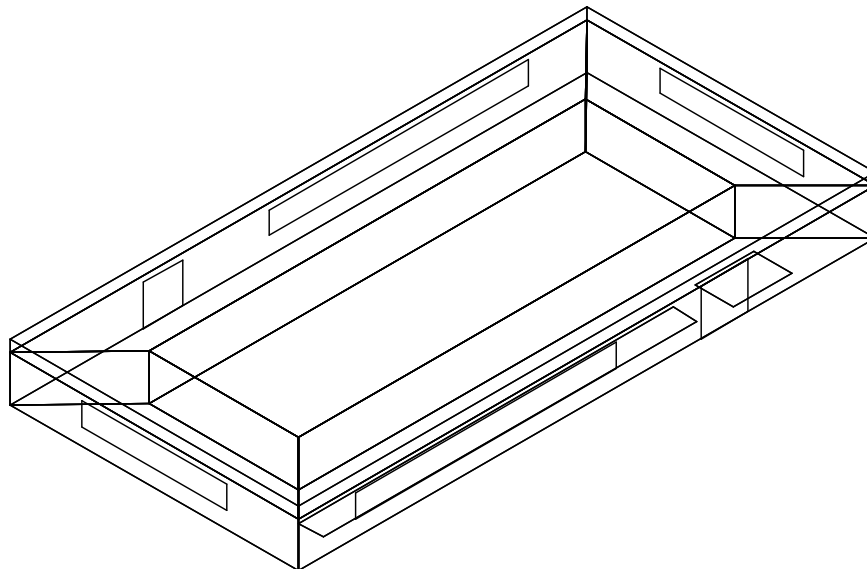
*Last revised November 2012 for EnergyPlus v7.2.0.006*

## General Description

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### Overview

- Rectangular single story building with 5 occupied zones and a ceiling plenum
- Packaged DX cooling with gas heat serving one zone
- VAV with reheat and return plenum serving the other 4 zones
- All equipment autosized using summer and winter design days



## Details

### Building Description

- Single floor rectangular building 30.5 m (100 ft) by 15.2 m (50 ft) by 3m (10 ft) high.
- Building is oriented with the long axis running east-west.
- Floor Area 463.6 m<sup>2</sup> (5000 ft<sup>2</sup>).
- 5 occupied zones - 4 exterior, 1 interior, zone height 2.4 m (8 ft). Exterior zone depth is 3.7 m (12 ft).
- 1 plenum zone 0.6 m (2 ft) high.
- Windows on all 4 facades
- South and north facades have glass doors.
- South facing glass is shaded by overhangs.
- Walls are wood shingle over plywood, insulation, and gypsum board.
- Roof is gravel built up roof with mineral board insulation and plywood sheathing.
- Floor slab is 0.1 m (4 in) heavy concrete.
- Windows and glass doors are double pane Low-e clear glass with argon gap.
- Window to wall ratio is approximately 0.3.
- Lighting is 16 W/m<sup>2</sup> (1.5 W/ft<sup>2</sup>).
- Office electric equipment is 10.8 W/m<sup>2</sup> (1.0 W/ft<sup>2</sup>).
- 1 occupant per 9.3 m<sup>2</sup> (100 ft<sup>2</sup>) of floor area.
- Infiltration is 0.25 air changes per hour (always on, proportional to wind speed).
  - \* Refers to specific glass type included in the EnergyPlus datasets directory (WindowGlassMaterials.idf)

### Space Conditioning

Heating setpoints: 21.1C (70F) occupied, 12.8C (55F) unoccupied

Cooling setpoints: 23.9C (75F) occupied, 40.0C (104F, system off) unoccupied

Plenum zone not controlled

### Environment

Location: Chicago, Illinois, USA

Design Days: Summer

Winter

Annual Simulation Period: Jan 1 – Dec 31

Ground Temperatures: from Slab preprocessor (20.4 to 23.0 C)

## Instructions

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### Exercise HVAC 1A – Add Unitary System with DX Cooling and Gas Heating (Furnace) Serving a Single Zone

*Objective: Learn how to describe a thermostat and unitary equipment using HVACTemplate objects.*

1. Open ExerciseHVAC1.idf in IDF Editor and save it as ExerciseHVAC1A.idf. (ExerciseHVAC1.idf contains the building envelope, internal loads, and some extra schedules to support the HVAC system descriptions which will be added in this Exercise.)
2. Add an HVACTemplate:Thermostat object to define the thermostat setpoints for this simulation. (Note: HVACTemplate objects are near the end of the class list, just before the Economics and Report groups. <ctl-f> "HVACTemp" will find it.)
  - a. Choose a name for the thermostat. This name will be referenced in the next step.
  - b. For heating setpoints, use pre-defined schedule named "Office Heating Setpoints".
  - c. For cooling setpoints, use pre-defined schedule named "Office Cooling Setpoints".
3. Add an HVACTemplate:System:Unitary object. Specify a name for this system, such as "Office HVAC". Retain the defaults for all fields except the following:
  - a. System Availability Schedule = Office HVAC (predefined)
  - b. Control Zone Name or Thermostat Location = NORTH PERIMETER
  - c. Supply Fan Operating Mode Schedule Name = Constant
  - d. Heating Coil Type = Gas
  - e. Minimum Outdoor Air Schedule Name = Office Minimum OA (predefined)
  - f. Economizer Type = DifferentialDryBulb
  - g. Economizer Lockout = LockoutWithCompressor
4. Add an HVACTemplate:Zone:Unitary object serving the "NORTH PERIMETER" zone. Retain the defaults for all fields except the following:
  - a. Template Unitary System Name, select the system name created in step 3. This name should appear in the drop down list for this field.
  - b. Template Thermostat Name, select the thermostat name created in step 2. This name should appear in the drop down list for this field.

5. Add a Sizing:Parameters object and set the heating and cooling sizing factors to 1.2 (for 20% oversizing). Leave Timesteps in Averaging Window blank to default to a 1-hour peak load window.
6. Edit the SimulationControl object and set all "Do ... sizing" fields to "Yes".
7. Run the simulation and review output files, especially:
  - a. Errors, there will be some warnings about meters that do not exist and about plant sizing objects. These will go away as more features are added in the next part.
  - b. SVG, block diagram of the HVAC system components. (HINT: right-click in the drawing and read the Help to learn how to navigate in the SVG viewer. If the SVG output will not open in EP-Launch, you may need to set the correct application in View → Options → Diagramming)
  - c. Variables (csv) and Meters (Meter.csv).
  - d. EIO, zone and system sizing results
8. Add Output:Variable objects to report operation of the system (furnace) fan, heating coil, and cooling coil. Reference the RDD output file for variable names.
9. Re-run the simulation and review results again.

## **Exercise HVAC 1B – Add VAV System with Reheat Serving Four Zones with Chiller and Boiler Plant**

*Objective: Learn how to describe a VAV system with central plant using HVACTemplate objects.*

1. Save ExerciseHVAC1A.idf as ExerciseHVAC1B.idf.
2. Add an HVACTemplate:System:VAV object. Retain the defaults for all fields except the following:
  - a. Name = <assign a name>
  - b. System Availability Schedule = Office HVAC (predefined)
  - c. Cooling Coil Design Setpoint= 13C (55.4F)
  - d. Minimum Outdoor Air Schedule Name = Office Minimum OA (predefined)
  - e. Economizer Type = DifferentialDryBulb
  - f. Return Plenum Name = PLENUM
3. Add four HVACTemplate:Zone:VAV objects serving the four remaining zones (South Perimeter, East Perimeter, West Perimeter, and Core). Retain the defaults for all fields except the following:
  - a. Specify the same air handler name added in Step 2 (use the dropdown list)

- b. Specify the same thermostat name added in Exercise HVAC 1A Step 2 (again, use the dropdown list).
  - c. Reheat Coil Type = HotWater
  - d. *HINT: Define one HVACTemplate:Zone:VAV object, make the above changes to defaults, then press "Dup Obj" three times to duplicate the object, then edit the remaining three zone names.*
4. Add an HVACTemplate:Plant:ChilledWaterLoop object and assign a name. Retain the defaults for all fields except the following:
  - a. Condenser Water Temperature Control Type = SpecifiedSetpoint
5. Add an HVACTemplate:Plant:Chiller object, type = ElectricReciprocatingChiller with a nominal COP of 3.6, WaterCooled.
6. Add an HVACTemplate:Plant:Tower object, type = TwoSpeed.
7. Add an HVACTemplate:Plant:Hot Water Loop object and assign a name. Retain the defaults for all fields.
8. Add a natural gas fired hot water boiler using HVACTemplate:Plant:Boiler.
9. Run the simulation, add desired report variables, and re-run the simulation. Review results and compare with results from Exercise HVAC 1A:
  - a. Note how the heating and cooling rates for the NORTH PERIMETER zone are smaller than before. Why?
  - b. Review the SVG drawing to see the components of the VAV system and water loops.
  - c. Browse the EXPIDF file in a text editor (or open in IDF Editor from File, Open, setting file type to expidf) to see the full detailed description of the HVAC systems using native EnergyPlus objects (the expanded result of the HVACTemplate preprocessor).

## Exercise HVAC 1C – Annual Simulation

*Objective: Learn how to schedule report variables and create a monthly table report.*

1. Save ExerciseHVAC1B.idf as ExerciseHVAC1C.idf.
2. Edit the SimulationControl object to turn off the sizing period simulations and turn on the weather file (annual) simulation.
3. Edit existing Output:Variable and Output:Meter:MeterFileOnly objects and change the reporting frequency from Hourly to Monthly as needed.
4. Locate the Output:Variable object for "Zone/Sys Air Temp" and duplicate it. Edit the new object and add a schedule "Office Occupancy 2". This object will report zone temperatures averaged only during occupied periods (when "Office Occupancy 2" is greater than zero). The original instance of this report variable will average the zone temperatures over all hours.

5. Add a new Output:Table:Monthly object:  
*Note: Output:Table:Monthly builds custom monthly output tables*
  - a. Name = Zone Temperature Report
  - b. Open the RDD output file for ExerciseHVAC1B in the text editor and find the following report variable names to copy and paste into the fields of the Output:Table:Monthly object in IDF Editor. Variable name and aggregation type are listed in pairs.
  - c. Zone Mean Air Temperature, SumOrAverage
  - d. Zone Mean Air Temperature, Maximum
  - e. Zone Mean Air Temperature, Minimum
6. Edit Output:Table:SummaryReports changing from "AnnualBuildingUtilityPerformanceSummary" to "AllSummary" report.  
*Note: This activates all predefined reports.*
7. Select Chicago TMY3 weather file and run the simulation.
8. Review outputs. (Note the AnnualBuildingUtilityPerformanceSummary report in the HTML file will now show a full year of results.) Especially review the Zone Temperatures table report in the HTML file.

## List of New Objects

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This is a listing of new objects added in this Exercise.

*Try not to look at this section until you have completed the Exercise.*

## Exercise HVAC 1A

```
HVACTemplate:Thermostat,
  Office Thermostat,      !- Name
  Office Heating Setpoints,!- Heating Setpoint Schedule Name
  ,                       !- Constant Heating Setpoint {C}
  Office Cooling Setpoints,!- Cooling Setpoint Schedule Name
  ;                       !- Constant Cooling Setpoint {C}

HVACTemplate:System:Unitary,
  North Zone Unitary,     !- Name
  Office HVAC,            !- System Availability Schedule Name
  NORTH PERIMETER,       !- Control Zone or Thermostat Location Name
  autosize,              !- Supply Fan Maximum Flow Rate {m3/s}
  Constant,              !- Supply Fan Operating Mode Schedule Name
  0.7,                   !- Supply Fan Total Efficiency
  600,                   !- Supply Fan Delta Pressure {Pa}
  0.9,                   !- Supply Fan Motor Efficiency
  1,                     !- Supply Fan Motor in Air Stream Fraction
  SingleSpeedDX,         !- Cooling Coil Type
  ,                      !- Cooling Coil Availability Schedule Name
  ,                      !- Cooling Design Supply Air Temperature {C}
  autosize,              !- Cooling Coil Capacity {W}
  autosize,              !- Cooling Coil Rated Sensible Heat Ratio
  3,                    !- Cooling Coil Rated COP {W/W}
  Gas,                   !- Heating Coil Type
```

```

,               !- Heating Coil Availability Schedule Name
,               !- Heating Design Supply Air Temperature {C}
autosize,       !- Heating Coil Capacity {W}
0.8,           !- Gas Heating Coil Efficiency
,               !- Gas Heating Coil Parasitic Electric Load {W}
autosize,       !- Maximum Outdoor Air Flow Rate {m3/s}
autosize,       !- Minimum Outdoor Air Flow Rate {m3/s}
Office Minimum OA, !- Minimum Outdoor Air Schedule Name
DifferentialDryBulb, !- Economizer Type
LockoutWithCompressor, !- Economizer Lockout
,               !- Economizer Upper Temperature Limit {C}
,               !- Economizer Lower Temperature Limit {C}
,               !- Economizer Upper Enthalpy Limit {J/kg}
,               !- Economizer Maximum Limit Dewpoint Temperature {C}
,               !- Supply Plenum Name
,               !- Return Plenum Name
BlowThrough,    !- Supply Fan Placement
StayOff,        !- Night Cycle Control
,               !- Night Cycle Control Zone Name
None,           !- Heat Recovery Type
0.7,           !- Sensible Heat Recovery Effectiveness
0.65,          !- Latent Heat Recovery Effectiveness
None,          !- Dehumidification Control Type
,               !- Dehumidification Control Zone Name
60,            !- Dehumidification Setpoint {percent}
None,          !- Humidifier Type
,               !- Humidifier Availability Schedule Name
0.000001,      !- Humidifier Rated Capacity {m3/s}
2690,          !- Humidifier Rated Electric Power {W}
,               !- Humidifier Control Zone Name
30;            !- Humidifier Setpoint {percent}

HVACTemplate:Zone:Unitary,
  NORTH PERIMETER, !- Zone Name
  North Zone Unitary, !- Template Unitary System Name
  Office Thermostat, !- Template Thermostat Name
  autosize, !- Supply Air Maximum Flow Rate {m3/s}
  , !- Zone Heating Sizing Factor
  , !- Zone Cooling Sizing Factor
  Flow/Person, !- Outdoor Air Method
  0.00944, !- Outdoor Air Flow Rate per Person {m3/s}
  0.0, !- Outdoor Air Flow Rate per Zone Floor Area {m3/s-m2}
  0.0, !- Outdoor Air Flow Rate per Zone {m3/s}
  , !- Supply Plenum Name
  , !- Return Plenum Name
  None, !- Baseboard Heating Type
  , !- Baseboard Heating Availability Schedule Name
  autosize, !- Baseboard Heating Capacity {W}
  SystemSupplyAirTemperature, !- Zone Cooling Design Supply Air Temperature Input
  Method
  , !- Zone Cooling Design Supply Air Temperature {C}
  , !- Zone Cooling Design Supply Air Temperature Difference
{deltaC}
  SystemSupplyAirTemperature, !- Zone Heating Design Supply Air Temperature Input
  Method
  , !- Zone Heating Design Supply Air Temperature {C}
  , !- Zone Heating Design Supply Air Temperature Difference
{deltaC}
  Sizing:Parameters,
  1.2, !- Heating Sizing Factor
  1.2; !- Cooling Sizing Factor

```

```

Output:Variable,
*,                               !- Key Value
Furnace Fan Part-Load Ratio,    !- Variable Name
Hourly;                         !- Reporting Frequency

Output:Variable,
*,                               !- Key Value
DX Cooling Coil Runtime Fraction, !- Variable Name
Hourly;                         !- Reporting Frequency

Output:Variable,
*,                               !- Key Value
Heating Coil Runtime Fraction,  !- Variable Name
Hourly;                         !- Reporting Frequency

```

## Exercise HVAC 1B

```

HVACTemplate:System:VAV,
VAV with Reheat,                !- Name
Office HVAC,                    !- System Availability Schedule Name
autosize,                       !- Supply Fan Maximum Flow Rate {m3/s}
autosize,                       !- Supply Fan Minimum Flow Rate {m3/s}
0.7,                            !- Supply Fan Total Efficiency
1000,                           !- Supply Fan Delta Pressure {Pa}
0.9,                            !- Supply Fan Motor Efficiency
1,                               !- Supply Fan Motor in Air Stream Fraction
ChilledWater,                   !- Cooling Coil Type
,                                !- Cooling Coil Availability Schedule Name
,                                !- Cooling Coil Setpoint Schedule Name
13,                             !- Cooling Coil Design Setpoint {C}
None,                           !- Heating Coil Type
,                                !- Heating Coil Availability Schedule Name
,                                !- Heating Coil Setpoint Schedule Name
,                                !- Heating Coil Design Setpoint {C}
0.8,                            !- Gas Heating Coil Efficiency
,                                !- Gas Heating Coil Parasitic Electric Load {W}
None,                           !- Preheat Coil Type
,                                !- Preheat Coil Availability Schedule Name
,                                !- Preheat Coil Setpoint Schedule Name
,                                !- Preheat Coil Design Setpoint {C}
0.8,                            !- Gas Preheat Coil Efficiency
,                                !- Gas Preheat Coil Parasitic Electric Load {W}
autosize,                       !- Maximum Outdoor Air Flow Rate {m3/s}
autosize,                       !- Minimum Outdoor Air Flow Rate {m3/s}
ProportionalMinimum,           !- Minimum Outdoor Air Control Type
Office Minimum OA,              !- Minimum Outdoor Air Schedule Name
DifferentialDryBulb,            !- Economizer Type
NoLockout,                     !- Economizer Lockout
,                                !- Economizer Upper Temperature Limit {C}
,                                !- Economizer Lower Temperature Limit {C}
,                                !- Economizer Upper Enthalpy Limit {J/kg}
,                                !- Economizer Maximum Limit Dewpoint Temperature {C}
,                                !- Supply Plenum Name
PLENUM,                         !- Return Plenum Name
DrawThrough,                    !- Supply Fan Placement
InletVaneDampers,               !- Supply Fan Part-Load Power Coefficients
StayOff,                        !- Night Cycle Control
,                                !- Night Cycle Control Zone Name
None,                           !- Heat Recovery Type
0.7,                            !- Sensible Heat Recovery Effectiveness
0.65,                           !- Latent Heat Recovery Effectiveness
None,                           !- Cooling Coil Setpoint Reset Type

```



```

None,                !- Heating Coil Setpoint Reset Type
None,                !- Dehumidification Control Type
,                    !- Dehumidification Control Zone Name
60,                  !- Dehumidification Setpoint {percent}
None,                !- Humidifier Type
,                    !- Humidifier Availability Schedule Name
0.000001,            !- Humidifier Rated Capacity {m3/s}
2690,                !- Humidifier Rated Electric Power {W}
,                    !- Humidifier Control Zone Name
30,                  !- Humidifier Setpoint {percent}
NonCoincident;       !- Sizing OptionHVACTemplate:Zone:VAV,
SOUTH PERIMETER,     !- Zone Name
VAV with Reheat,     !- Template VAV System Name
Office Thermostat,   !- Template Thermostat Name
autosize,             !- Supply Air Maximum Flow Rate {m3/s}
,                    !- Zone Heating Sizing Factor
,                    !- Zone Cooling Sizing Factor
Constant,            !- Zone Minimum Air Flow Input Method
0.2,                 !- Constant Minimum Air Flow Fraction
,                    !- Fixed Minimum Air Flow Rate {m3/s}
,                    !- Minimum Air Flow Fraction Schedule Name
Flow/Person,         !- Outdoor Air Method
0.00944,             !- Outdoor Air Flow Rate per Person {m3/s}
0.0,                 !- Outdoor Air Flow Rate per Zone Floor Area {m3/s-m2}
0.0,                 !- Outdoor Air Flow Rate per Zone {m3/s}
HotWater,            !- Reheat Coil Type
,                    !- Reheat Coil Availability Schedule Name
Reverse,             !- Damper Heating Action
,                    !- Maximum Flow per Zone Floor Area During Reheat {m3/s-m2}
,                    !- Maximum Flow Fraction During Reheat
,                    !- Maximum Reheat Air Temperature {C}
,                    !- Design Specification Outdoor Air Object Name
,                    !- Supply Plenum Name
,                    !- Return Plenum Name
None,                !- Baseboard Heating Type
,                    !- Baseboard Heating Availability Schedule Name
autosize;            !- Baseboard Heating Capacity {W}

HVACTemplate:Zone:VAV,
SOUTH PERIMETER,     !- Zone Name
VAV with Reheat,     !- Template VAV System Name
Office Thermostat,   !- Template Thermostat Name
autosize,             !- Supply Air Maximum Flow Rate {m3/s}
,                    !- Zone Heating Sizing Factor
,                    !- Zone Cooling Sizing Factor
Constant,            !- Zone Minimum Air Flow Input Method
0.2,                 !- Constant Minimum Air Flow Fraction
,                    !- Fixed Minimum Air Flow Rate {m3/s}
,                    !- Minimum Air Flow Fraction Schedule Name
Flow/Person,         !- Outdoor Air Method
0.00944,             !- Outdoor Air Flow Rate per Person {m3/s}
0.0,                 !- Outdoor Air Flow Rate per Zone Floor Area {m3/s-m2}
0.0,                 !- Outdoor Air Flow Rate per Zone {m3/s}
HotWater,            !- Reheat Coil Type
,                    !- Reheat Coil Availability Schedule Name
Reverse,             !- Damper Heating Action
,                    !- Maximum Flow per Zone Floor Area During Reheat {m3/s-
m2}
,                    !- Maximum Flow Fraction During Reheat
,                    !- Maximum Reheat Air Temperature {C}
,                    !- Design Specification Outdoor Air Object Name
,                    !- Supply Plenum Name
,                    !- Return Plenum Name

```

```

None,                !- Baseboard Heating Type
,                    !- Baseboard Heating Availability Schedule Name
autosize,            !- Baseboard Heating Capacity {W}
SystemSupplyAirTemperature, !- Zone Cooling Design Supply Air Temperature Input
Method
,                    !- Zone Cooling Design Supply Air Temperature {C}
,                    !- Zone Cooling Design Supply Air Temperature Difference
{deltaC}
  SupplyAirTemperature, !- Zone Heating Design Supply Air Temperature Input
Method
  50.0,              !- Zone Heating Design Supply Air Temperature {C}
;                    !- Zone Heating Design Supply Air Temperature Difference
{deltaC}

HVACTemplate:Zone:VAV,
  EAST PERIMETER,    !- Zone Name
  VAV with Reheat,   !- Template VAV System Name
  Office Thermostat, !- Template Thermostat Name
  autosize,          !- Supply Air Maximum Flow Rate {m3/s}
,                    !- Zone Heating Sizing Factor
,                    !- Zone Cooling Sizing Factor
Constant,            !- Zone Minimum Air Flow Input Method
0.2,                 !- Constant Minimum Air Flow Fraction
,                    !- Fixed Minimum Air Flow Rate {m3/s}
,                    !- Minimum Air Flow Fraction Schedule Name
Flow/Person,         !- Outdoor Air Method
0.00944,             !- Outdoor Air Flow Rate per Person {m3/s}
0.0,                 !- Outdoor Air Flow Rate per Zone Floor Area {m3/s-m2}
0.0,                 !- Outdoor Air Flow Rate per Zone {m3/s}
HotWater,            !- Reheat Coil Type
,                    !- Reheat Coil Availability Schedule Name
Reverse,             !- Damper Heating Action
,                    !- Maximum Flow per Zone Floor Area During Reheat {m3/s-
m2}
,                    !- Maximum Flow Fraction During Reheat
,                    !- Maximum Reheat Air Temperature {C}
,                    !- Design Specification Outdoor Air Object Name
,                    !- Supply Plenum Name
,                    !- Return Plenum Name
None,                !- Baseboard Heating Type
,                    !- Baseboard Heating Availability Schedule Name
autosize,            !- Baseboard Heating Capacity {W}
SystemSupplyAirTemperature, !- Zone Cooling Design Supply Air Temperature Input
Method
,                    !- Zone Cooling Design Supply Air Temperature {C}
,                    !- Zone Cooling Design Supply Air Temperature Difference
{deltaC}
  SupplyAirTemperature, !- Zone Heating Design Supply Air Temperature Input
Method
  50.0,              !- Zone Heating Design Supply Air Temperature {C}
;                    !- Zone Heating Design Supply Air Temperature Difference
{deltaC}

HVACTemplate:Zone:VAV,
  WEST PERIMETER,    !- Zone Name
  VAV with Reheat,   !- Template VAV System Name
  Office Thermostat, !- Template Thermostat Name
  autosize,          !- Supply Air Maximum Flow Rate {m3/s}
,                    !- Zone Heating Sizing Factor
,                    !- Zone Cooling Sizing Factor
Constant,            !- Zone Minimum Air Flow Input Method
0.2,                 !- Constant Minimum Air Flow Fraction
,                    !- Fixed Minimum Air Flow Rate {m3/s}

```

```

,                                     !- Minimum Air Flow Fraction Schedule Name
Flow/Person,                         !- Outdoor Air Method
0.00944,                             !- Outdoor Air Flow Rate per Person {m3/s}
0.0,                                 !- Outdoor Air Flow Rate per Zone Floor Area {m3/s-m2}
0.0,                                 !- Outdoor Air Flow Rate per Zone {m3/s}
HotWater,                             !- Reheat Coil Type
,                                     !- Reheat Coil Availability Schedule Name
Reverse,                             !- Damper Heating Action
,                                     !- Maximum Flow per Zone Floor Area During Reheat {m3/s-
m2}
,                                     !- Maximum Flow Fraction During Reheat
,                                     !- Maximum Reheat Air Temperature {C}
,                                     !- Design Specification Outdoor Air Object Name
,                                     !- Supply Plenum Name
,                                     !- Return Plenum Name
None,                                 !- Baseboard Heating Type
,                                     !- Baseboard Heating Availability Schedule Name
autosize,                             !- Baseboard Heating Capacity {W}
SystemSupplyAirTemperature,          !- Zone Cooling Design Supply Air Temperature Input
Method
,                                     !- Zone Cooling Design Supply Air Temperature {C}
,                                     !- Zone Cooling Design Supply Air Temperature Difference
{deltaC}
SupplyAirTemperature,                !- Zone Heating Design Supply Air Temperature Input
Method
50.0,                                !- Zone Heating Design Supply Air Temperature {C}
;                                     !- Zone Heating Design Supply Air Temperature Difference
{deltaC}

HVACTemplate:Zone:VAV,
CORE,                                 !- Zone Name
VAV with Reheat,                     !- Template VAV System Name
Office Thermostat,                   !- Template Thermostat Name
autosize,                             !- Supply Air Maximum Flow Rate {m3/s}
,                                     !- Zone Heating Sizing Factor
,                                     !- Zone Cooling Sizing Factor
Constant,                             !- Zone Minimum Air Flow Input Method
0.2,                                  !- Constant Minimum Air Flow Fraction
,                                     !- Fixed Minimum Air Flow Rate {m3/s}
,                                     !- Minimum Air Flow Fraction Schedule Name
Flow/Person,                         !- Outdoor Air Method
0.00944,                             !- Outdoor Air Flow Rate per Person {m3/s}
0.0,                                 !- Outdoor Air Flow Rate per Zone Floor Area {m3/s-m2}
0.0,                                 !- Outdoor Air Flow Rate per Zone {m3/s}
HotWater,                             !- Reheat Coil Type
,                                     !- Reheat Coil Availability Schedule Name
Reverse,                             !- Damper Heating Action
,                                     !- Maximum Flow per Zone Floor Area During Reheat {m3/s-
m2}
,                                     !- Maximum Flow Fraction During Reheat
,                                     !- Maximum Reheat Air Temperature {C}
,                                     !- Design Specification Outdoor Air Object Name
,                                     !- Supply Plenum Name
,                                     !- Return Plenum Name
None,                                 !- Baseboard Heating Type
,                                     !- Baseboard Heating Availability Schedule Name
autosize,                             !- Baseboard Heating Capacity {W}
SystemSupplyAirTemperature,          !- Zone Cooling Design Supply Air Temperature Input
Method
,                                     !- Zone Cooling Design Supply Air Temperature {C}
,                                     !- Zone Cooling Design Supply Air Temperature Difference
{deltaC}

```

```

    SupplyAirTemperature,    !- Zone Heating Design Supply Air Temperature Input
Method
    50.0,                    !- Zone Heating Design Supply Air Temperature {C}
    ;                        !- Zone Heating Design Supply Air Temperature Difference
{deltaC}

HVACTemplate:Plant:ChilledWaterLoop,
    Chilled Water Plant,    !- Name
    ,                       !- Pump Schedule Name
    Intermittent,           !- Pump Control Type
    Default,                !- Chiller Plant Operation Scheme Type
    ,                       !- Chiller Plant Equipment Operation Schemes Name
    ,                       !- Chilled Water Setpoint Schedule Name
    7.22,                   !- Chilled Water Design Setpoint {C}
    ConstantPrimaryNoSecondary, !- Chilled Water Pump Configuration
    179352,                 !- Primary Chilled Water Pump Rated Head {Pa}
    179352,                 !- Secondary Chilled Water Pump Rated Head {Pa}
    Default,                !- Condenser Plant Operation Scheme Type
    ,                       !- Condenser Equipment Operation Schemes Name
    SpecifiedSetpoint,      !- Condenser Water Temperature Control Type
    ,                       !- Condenser Water Setpoint Schedule Name
    29.4,                   !- Condenser Water Design Setpoint {C}
    179352,                 !- Condenser Water Pump Rated Head {Pa}
    None,                   !- Chilled Water Setpoint Reset Type
    12.2,                   !- Chilled Water Setpoint at Outdoor Dry-Bulb Low {C}
    15.6,                   !- Chilled Water Reset Outdoor Dry-Bulb Low {C}
    6.7,                    !- Chilled Water Setpoint at Outdoor Dry-Bulb High {C}
    26.7;                   !- Chilled Water Reset Outdoor Dry-Bulb High {C}

HVACTemplate:Plant:Chiller,
    Chiller 1,              !- Name
    ElectricReciprocatingChiller, !- Chiller Type
    autosize,               !- Capacity {W}
    3.6,                    !- Nominal COP {W/W}
    WaterCooled,            !- Condenser Type
    ,                       !- Priority
    1.0;                    !- Sizing Factor

HVACTemplate:Plant:Tower,
    Tower 1,                !- Name
    TwoSpeed,               !- Tower Type
    autosize,               !- High Speed Nominal Capacity {W}
    autosize,               !- High Speed Fan Power {W}
    autosize,               !- Low Speed Nominal Capacity {W}
    autosize,               !- Low Speed Fan Power {W}
    autosize,               !- Free Convection Capacity {W}
    ,                       !- Priority
    1.0;                    !- Sizing Factor

HVACTemplate:Plant:HotWaterLoop,
    Hot Water Plant,        !- Name
    ,                       !- Pump Schedule Name
    Intermittent,           !- Pump Control Type
    Default,                !- Plant Operation Scheme Type
    ,                       !- PlantEquipmentOperationSchemes Name
    ,                       !- Setpoint Schedule Name
    82,                     !- Design Setpoint {C}
    ConstantFlow,           !- Pump Configuration
    179352,                 !- Pump Rated Head {Pa}
    None,                   !- Setpoint Reset Type
    82.2,                   !- Setpoint at Outdoor Dry-Bulb Low {C}
    -6.7,                   !- Reset Outdoor Dry-Bulb Low {C}
    65.6,                   !- Setpoint at Outdoor Dry-Bulb High {C}

```

```

10;                                !- Reset Outdoor Dry-Bulb High {C}

HVACTemplate:Plant:Boiler,
  Boiler 1,                        !- Name
  HotWaterBoiler,                  !- Boiler Type
  autosize,                        !- Capacity {W}
  0.8,                             !- Efficiency
  NaturalGas,                      !- Fuel Type
  ,                                !- Priority
  1.0;                             !- Sizing Factor

Output:Variable,
  *,                               !- Key Value
  VAV Terminal Damper Position,    !- Variable Name
  Hourly;                          !- Reporting Frequency

Output:Variable,
  *,                               !- Key Value
  Chiller Evap Heat Trans Rate,    !- Variable Name
  Hourly;                          !- Reporting Frequency

Output:Variable,
  *,                               !- Key Value
  Chiller COP,                    !- Variable Name
  Hourly;                          !- Reporting Frequency

Output:Variable,
  *,                               !- Key Value
  Boiler Heating Output Rate,      !- Variable Name
  Hourly;                          !- Reporting Frequency

Output:Variable,
  *,                               !- Key Value
  Tower Heat Transfer,             !- Variable Name
  Hourly;                          !- Reporting Frequency

```

## Exercise HVAC 1C

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Output:Variable,
  *,                               !- Key Value
  Zone/Sys Air Temperature,        !- Variable Name
  Monthly,                         !- Reporting Frequency
  Office Occupancy 2;              !- Schedule Name

Output:Table:Monthly,
  Zone Temperature Report,         !- Name
  2,                               !- Digits After Decimal
  Zone Mean Air Temperature,       !- Variable or Meter 1 Name
  SumOrAverage,                   !- Aggregation Type for Variable or Meter 1
  Zone Mean Air Temperature,       !- Variable or Meter 2 Name
  Maximum,                        !- Aggregation Type for Variable or Meter 2
  Zone Mean Air Temperature,       !- Variable or Meter 3 Name
  Minimum;                        !- Aggregation Type for Variable or Meter 3

Output:Table:SummaryReports,
  AllSummary; !- Name

```

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