

*Additional capabilities for this system:*

- 1) To enable an exhaust fan add the keywords EXHAUST-CFM = Value (CFM) and EXHAUST-KW = Value (.0001 is typical) to the ZONE keyword list. [16]
- 2) To enable a humidifier which requires heat to evaporate water into the air add MIN-HUMIDITY = Value (25% is typical) to the SYSTEM keyword list. [17]
- 3) To enable heat recovery to exchange relief air heat with outside air heat add RECOVERY-EFF = Value (0.6 is typical) to the SYSTEM keyword list. [18]
- 4) To disable the economizer change OA-CONTROL = TEMP to OA-CONTROL = FIXED. [19]
- 5) To reset the supply air as a function of outside air temperature see an example of this control in the *Sample Run Book (2.1E)*, 31-Story Office Building, Run 1.
- 6) To enable control of maximum humidity whenever the supply air temperature is reset, insert MAXIMUM-HUMIDITY = Value (60% is allowed in the new ASHRAE 90.1 Standard) in the SYSTEM keyword list. [20]
- 7) Simulating baseboard heat in lieu of or in addition to reheat coils is demonstrated in the *Sample Run Book (2.1E)*, 31-Story Office Building, Runs 2 and 3.
- 8) To enable variable speed control of the fan motor, insert FAN-CONTROL = SPEED in the SYSTEM keyword list. [21]

### Two-Pipe Fan Coil System (TPFC)

The TPFC system provides both heating and cooling to individually controlled zones. However, all zones served by the TPFC must be operating in the same mode (i.e., either heating or cooling) at any given time.

TPFC consists of a filter (not shown), combination heating/cooling coil, and fan. The coil is connected to a piping system that provides either hot or cold water, according to the prevailing mode of operation as defined by the HEATING-SCHEDULE and COOLING-SCHEDULE. The unit provides a fixed quantity of outside air ventilation or merely recirculates conditioned air. Exhaust fans are optional for any or all zones.

Temperature control is achieved by throttling the flow of water through the heating/cooling coil. The control thermostat commonly used for this type of system has separate heating and cooling setpoints.

The pumping energy associated with this system is accounted for in the PLANT program, rather than in the SYSTEMS program.

The fan coil units, particularly the smaller direct-drive units, may not be available with a fan capacity that matches the calculated value. Therefore, assignment of the fan capacity for a specific, commercially available unit is recommended for improved simulation accuracy.

*Note: On the schematic, items shown in dashed boxes are optional components.*

BM016

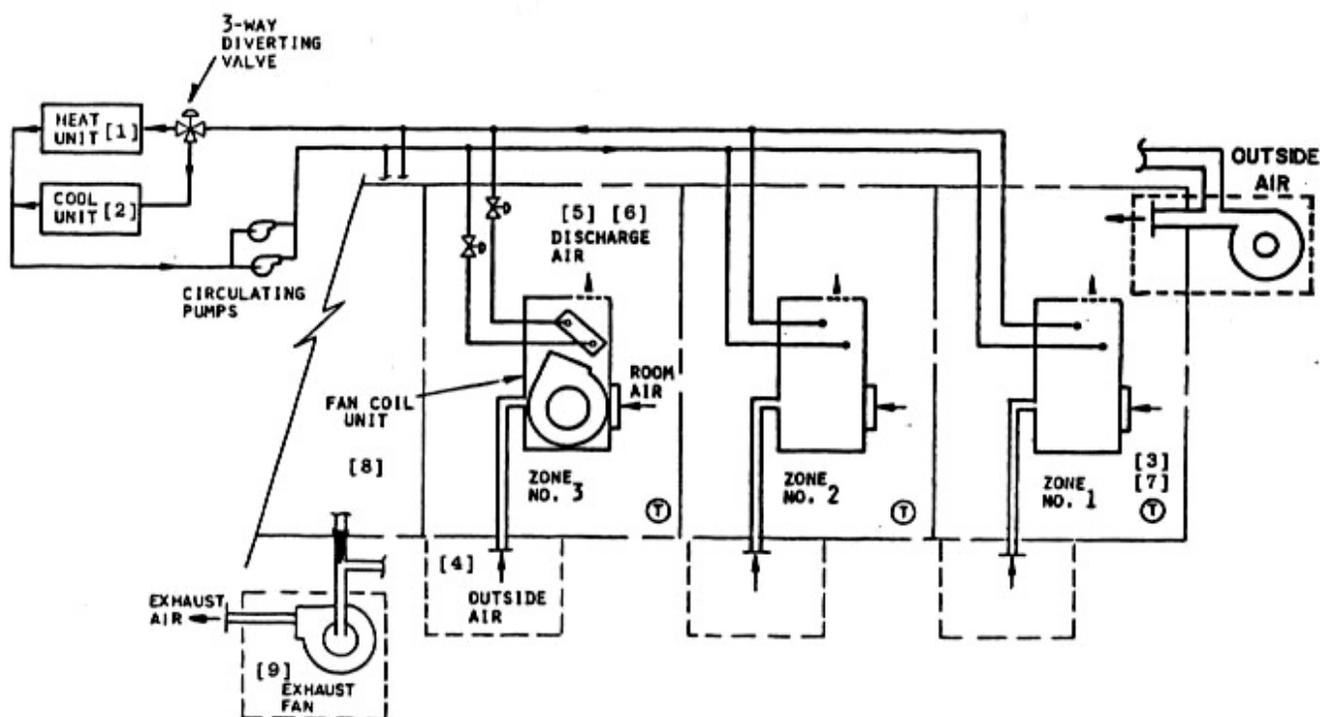


Figure 3.13: Two-Pipe Fan Coil System (TPFC)

*Suggested minimal input for TPFC system:*

INPUT SYSTEMS ..

SYSTEMS-REPORT SUMMARY=(SS-A,SS-O) ..

\$ SYSTEMS SCHEDULES

FANS-ON = SCHEDULE THRU DEC 31 (WD) (1,7)(0) (8,18)(1)  
 (19,24)(0)  
 (WEH) (1,24)(0) ..

COOLSETPT = SCHEDULE THRU DEC 31 (WD) (1,7)(99) (8,18)(76)  
 (19,24)(99)  
 (WEH) (1,24)(99) ..

HEATSETPT = SCHEDULE THRU DEC 31 (WD) (1,7)(55) (8,18)(72)  
 (19,24)(55)  
 (WEH) (1,24)(55) ..

DHW = SCHEDULE THRU DEC 31 (WD) (1,7)(0)  
 (8,18)(1.0) (19,24)(0)  
 (WEH) (1,24)(0) ..

HEAT-ON = SCHEDULE THRU MAY 15 (ALL) (1,24) (1)  
 [1] THRU SEP 15 (ALL) (1,24) (0)  
 THRU DEC 31 (ALL) (1,24) (1) ..

COOL-ON = SCHEDULE THRU MAY 15 (ALL) (1,24) (1)  
 [2] THRU SEP 15 (ALL) (1,24) (0)  
 THRU DEC 31 (ALL) (1,24) (1) ..

OFFICE = ZONE DESIGN-HEAT-T = 72  
 DESIGN-COOL-T = 74  
 HEAT-TEMP-SCH = HEATSETPT [3]  
 COOL-TEMP-SCH = COOLSETPT [3]  
 OA-CFM/PER = 15 .. [4]

AC-SYST = SYSTEM SYSTEM-TYPE = TPFC  
 HEATING-SCHEDULE = HEAT-ON [1]  
 COOLING-SCHEDULE = COOL-ON [2]  
 MAX-SUPPLY-T = 110 [5]  
 MIN-SUPPLY-T = 55 [6]  
 NIGHT-CYCLE-CTRL = CYCLE-ON-ANY [7]  
 FAN-SCHEDULE = FANS-ON [8]  
 ZONE-NAMES = (OFFICE) ..



### Four-Pipe Fan Coil System (FPFC)

The FPFC system is identical to the TPFC with the following exceptions:

- 1) instead of an a combined heating/cooling coil, the fan coil units have separate heating and cooling coils;
- 2) each coil is connected to a separate piping system, one circulating cooled fluid and one circulating heated fluid. Thus, the fan coil(s) in one zone can cool at the same time that those in another zone are heating; changeover energy losses are minimal. Exhaust fans are optional for any or all zones. Except as noted above, the discussion of system design features, options, and DOE-2 input for TPFC applies to FPFC.

*Note: On the schematic, items shown in dashed boxes are optional components.*

BM017

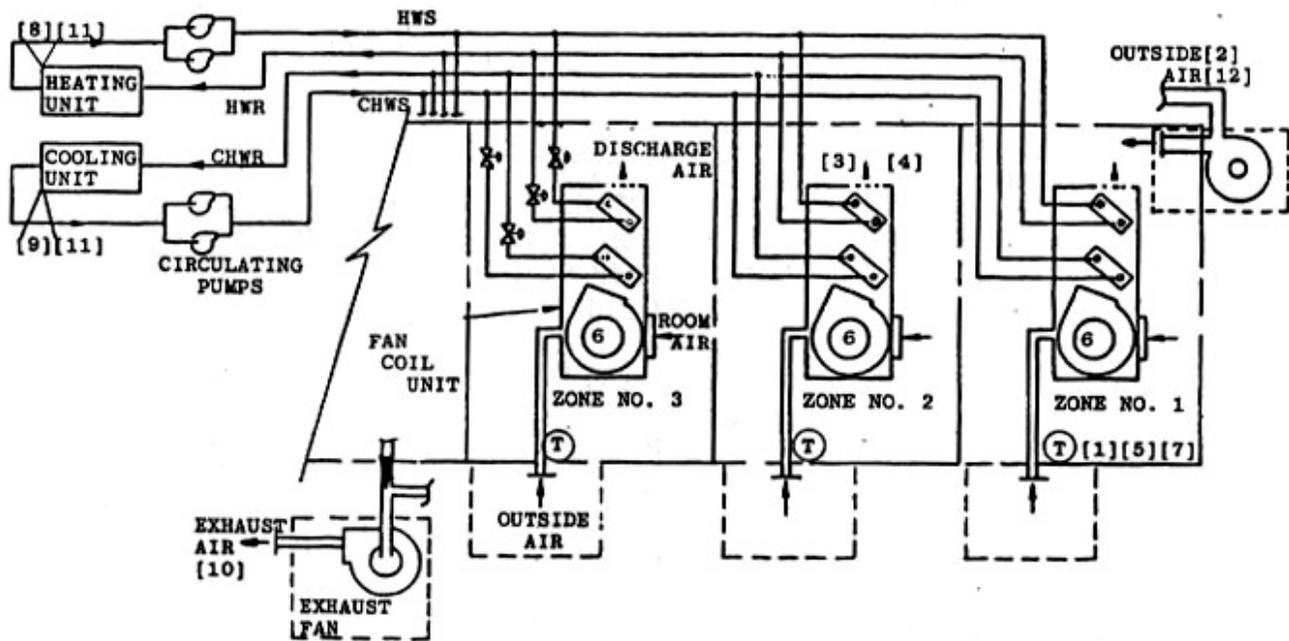


Figure 3.14: Four-Pipe Fan Coil System (FPFC)

*Suggested minimal input for FPFC system:*

INPUT SYSTEMS ..

SYSTEMS-REPORT SUMMARY=(SS-A,SS-O) ..

\$ SYSTEMS SCHEDULES

FANS-ON = SCHEDULE THRU DEC 31 (WD) (1,7)(0) (8,18)(1)  
 (19,24)(0)  
 (WEH) (1,24)(0) ..

COOLSETPT = SCHEDULE THRU DEC 31 (WD) (1,7)(99) (8,18)(76)  
 (19,24)(99)  
 (WEH) (1,24)(99) ..

HEATSETPT = SCHEDULE THRU DEC 31 (WD) (1,7)(55) (8,18)(72)  
 (19,24)(55)  
 (WEH) (1,24)(55) ..

DHW = SCHEDULE THRU DEC 31 (WD) (1,7)(0)  
 (8,18)(1.0) (19,24)(0)  
 (WEH) (1,24)(0) ..

OFFICE = ZONE  
 DESIGN-HEAT-T = 72  
 DESIGN-COOL-T = 74  
 HEAT-TEMP-SCH = HEATSETPT [1]  
 COOL-TEMP-SCH = COOLSETPT [1]  
 OA-CFM/PER = 15 .. [2]

AC-SYST = SYSTEM  
 SYSTEM-TYPE = FPFC  
 MAX-SUPPLY-T = 110 [3]  
 MIN-SUPPLY-T = 55 [4]  
 NIGHT-CYCLE-CTRL = CYCLE-ON-ANY [5]  
 FAN-SCHEDULE = FANS-ON [6]  
 ZONE-NAMES = (OFFICE) .. [7]

P1 = PLANT-ASSIGNMENT  
 SYSTEM-NAMES = (AC-SYST)  
 DHW-BTU/HR = 10000  
 DHW-SCH = DHW ..

END ..

COMPUTE SYSTEMS ..

INPUT PLANT ..

P1 = PLANT-ASSIGNMENT ..

PLANT-REPORT SUMMARY = (BEPS) ..

```

SHW = PLANT-EQUIPMENT   TYPE = DHW-HEATER       SIZE = -999 ..
HWG = PLANT-EQUIPMENT   TYPE = HW-BOILER        SIZE = -999 .. [8]
CHR = PLANT-EQUIPMENT   TYPE = HERM-REC-CHLR     SIZE = -999 .. [9]

```

```

PLANT-PARAMETERS  HERM-REC-COND-TYPE = AIR ..

```

```

END ..

```

```

COMPUTE PLANT ..

```

*Additional capabilities for this system:*

1) To enable an exhaust fan add the keywords EXHAUST-CFM = Value (CFM) and EXHAUST-KW = Value (.0001 is typical) to the ZONE keyword list. [10]

2) To disable the availability of either cooling or heating, insert schedules like that shown for TPFC; however, you may enter values representing outside air temperatures above and below which the cooling and heating is on, as follows: [11]

```

HEAT-ON = SCHEDULE  THRU MAY 15 (ALL) (1,24)(70)
                   THRU SEP 15 (ALL) (1,24)(0)
                   THRU DEC 31 (ALL) (1,24)(70) ..

```

```

COOL-ON = SCHEDULE  THRU MAY 15 (ALL) (1,24)(60)
                   THRU SEP 15 (ALL) (1,24)(1)
                   THRU DEC 31 (ALL) (1,24)(60) ..

```

3) Most fan coil systems do not have outside air intakes and make-up air is supplied to the corridor or to the back side of the fan coil unit. To simulate this configuration there has to be a corridor zone to which air can be supplied, because DOE-2 does not allow two air systems to be assigned to the same zone. See the example in the *Sample Run Book (2.1E)*, 31-Story Office Building, Run 3. [12]

### Residential System (RESYS)

RESYS models a split system with a direct expansion air-cooled condensing unit. Residences that do not include unconditioned zones (crawl spaces and attics) can be simulated as a single-zone residence served by one system.

This is the only system in DOE-2 that simulates openable windows for natural ventilation and cooling. The ventilation is simulated through the keywords NATURAL-VENT-SCH, VENT-TEMP-SCH, and NATURAL-VENT-AC. See p.4.76, the SYSTEM-AIR section, for a discussion of simulation theory.

RESYS can be run with a cooling-only condensing unit plus a heating coil or with a cooling/heating heat pump condensing unit:

**Residential System with DX Cooling and Heating Coil:** This version of RESYS provides heating through a hot water coil, electric heater, gas furnace or oil furnace. It also includes a cooling coil connected to an air-cooled condensing unit, supply fan, and openable windows to provide natural ventilation and cooling. Ordinarily, the electric load for both the supply fan and compressor are included in the cooling EIR.

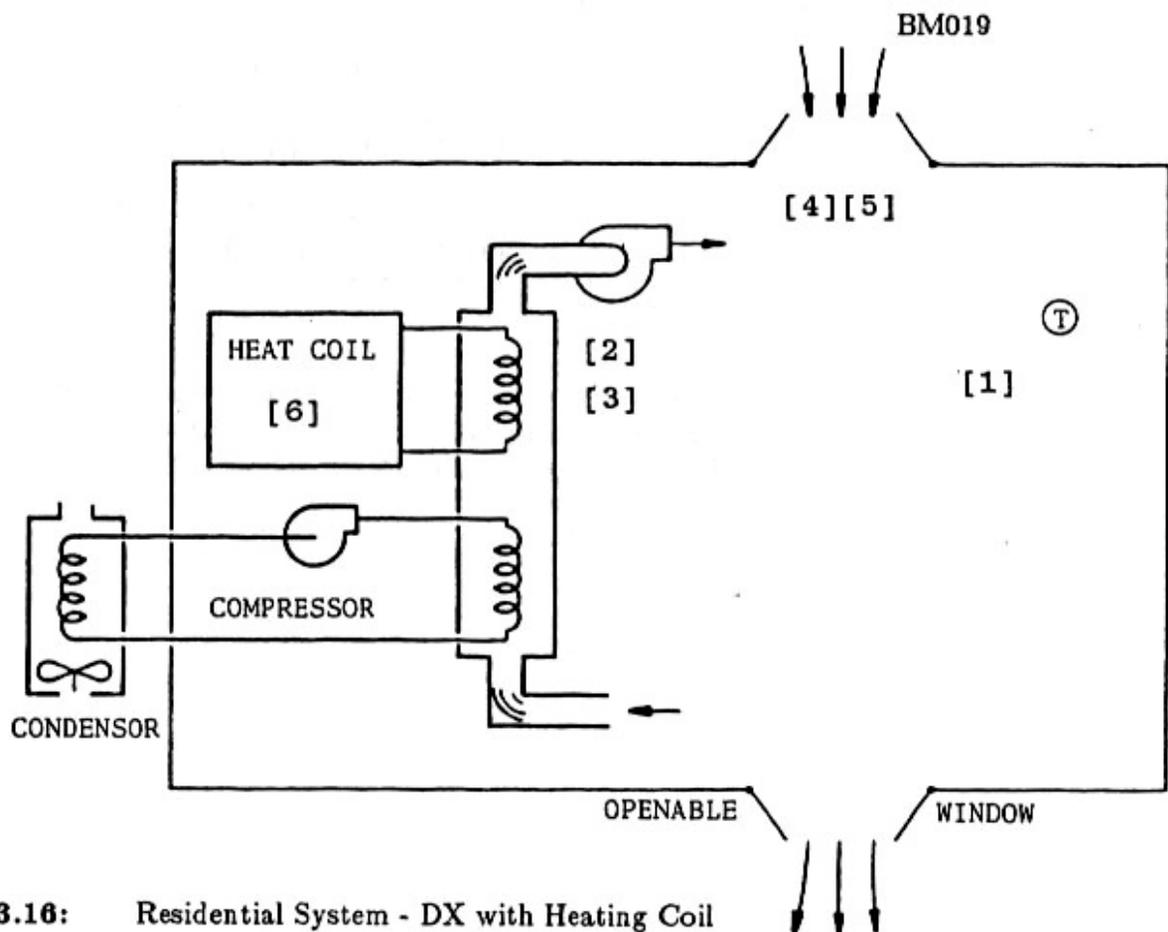
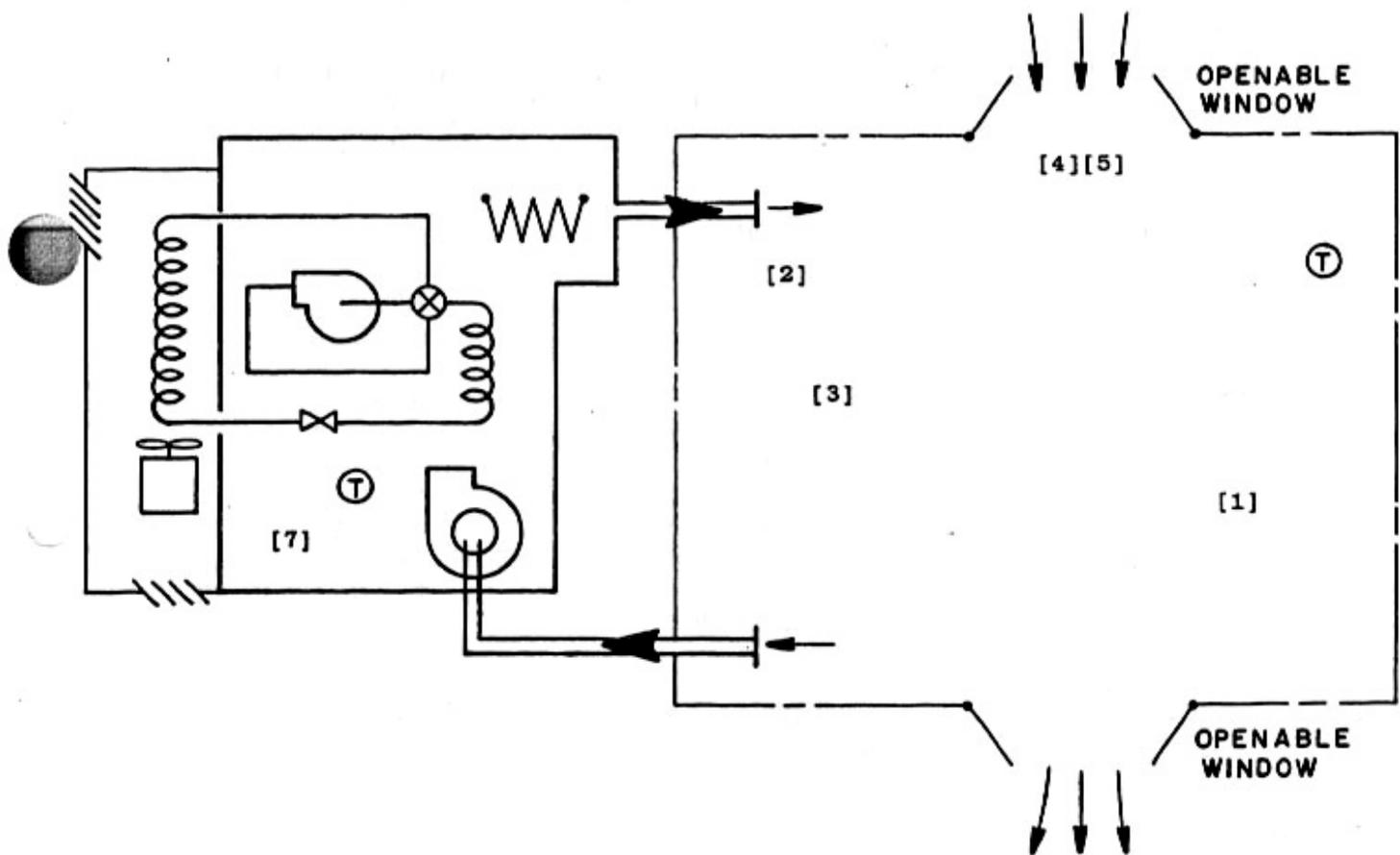


Figure 3.16: Residential System - DX with Heating Coil

**Residential System with Heat Pump:** This version of the system, the Residential Air-to-Air Heat Pump, is also for a single-zone constant-volume system intended for homes or offices. The rules stated in the RESYS system description apply to this version of the system. This unit provides forced-air heating and cooling. In its basic configuration it consists of a compressor, a four-way valve for reversing the refrigerant flow direction, air-cooled condenser with fan, evaporator with fan, filter (not shown), and thermostat. The condenser also serves as an evaporator and the evaporator as a condenser, depending on whether the unit is in the heating or cooling mode. The supply (indoor air) fan and the outdoor fan operate in a cycling mode. The unit may be specified with an auxiliary electrical heater. To use this type of RESYS specify HEAT-SOURCE = HEAT-PUMP. For additional heat pump capabilities, see "Heat Pump" p.A.5.

BM020



**Figure 3.17:** Residential Air-to-Air Heat Pump

*Suggested minimal input for RESYS system:*

INPUT SYSTEMS ..

SYSTEMS-REPORT SUMMARY=(SS-A,SS-O) ..

\$ SYSTEMS SCHEDULES

COOLSETPT = SCHEDULE THRU DEC 31 (WD) (1,7)(99) (8,18)(76)  
(19,24)(99)  
(WEH) (1,24)(99) ..

HEATSETPT = SCHEDULE THRU DEC 31 (WD) (1,7)(55) (8,18)(72)  
(19,24)(55)  
(WEH) (1,24)(55) ..

DHW = SCHEDULE THRU DEC 31 (WD) (1,7)(0)  
(8,18)(1.0) (19,24)(0)  
(WEH) (1,24)(0) ..

WINDOWS-OPENABLE = SCHEDULE THRU APR 15 (ALL) (1,24) (1)  
THRU OCT 15 (ALL) (1,24) (0)  
THRU DEC 31 (ALL) (1,24) (1) ..

OFFICE = ZONE DESIGN-HEAT-T = 72  
DESIGN-COOL-T = 74  
HEAT-TEMP-SCH = HEATSETPT [1]  
COOL-TEMP-SCH = COOLSETPT .. [1]

AC-SYST = SYSTEM SYSTEM-TYPE = RESYS  
MAX-SUPPLY-T = 110 [2]  
MIN-SUPPLY-T = 55 [3]  
NATURAL-VENT-AC = 10 [4]  
NATURAL-VENT-SCH = WINDOWS-OPENABLE  
HEAT-SOURCE = FURNACE [6]  
\$ or HEAT-PUMP [7]  
ZONE-NAMES = (OFFICE) ..

P1 = PLANT-ASSIGNMENT SYSTEM-NAMES = (AC-SYST)  
DHW-BTU/HR = 10000  
DHW-SCH = DHW ..

END ..

COMPUTE SYSTEMS ..

INPUT PLANT ..

P1 = PLANT-ASSIGNMENT ..

PLANT-REPORT SUMMARY = (BEPS) ..