Modeling HVAC Systems in HOT3000

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Modification to the ESP-r Configuration File

In order to specify that there is an HVAC system associated with the problem, the configuration file has to include the entry ***hvac ../hvac/hvacfilename.hvac**. Figure 2 shows a section of a configuration with the addition associated with the HVAC file.

```
* CONFIGURATION3.0
# ESRU system configuration defined by file
# bld_basic.cfg
*date Thu Dec 14 13:28:08 2000  # latest file modification
*root bld_basic
*zonpth ../zones                  # path to zones
*netpth ../networks               # path to networks
*ctlpth ../ctl                    # path to controls
*radpth ./                        # path to radiance files
*imgpth ../images                 # path to project images
*indx    1 # Building only
 51.700   -0.500   # Latitude & Longitude (diff from meridian)
      2   0.200   # Site exposure & ground reflectivity
* DATABASES
*prm  /usr/esru/esp-r/databases/constr.db2
*mlc  /usr/esru/esp-r/databases/multicon.db2
*opt  /usr/esru/esp-r/databases/optics.db2
*prs  /usr/esru/esp-r/databases/pressc.db1
*evn  /usr/esru/esp-r/databases/profiles.db1
*clm  /usr/esru/esp-r/climate/clm67
*pdb  /usr/esru/esp-r/databases/plantc.db1
*hvac ../hvac/hvacfilename.hvac
*ctl  ../ctl/bld_basic.ctl
*year  1967 # assessment year
```

Specification of HVAC file in ESP-r configuration file

Furnace/Boiler System

```
a       1 0.
b       1 1 2
c       7 2 1 1. 2 0. 2000. 0.75 1 300 0. 500. 1
```

Figure 1: Sample ESP-r HVAC file for furnace/boiler system simulation

Table 1: Variables in HVAC file for furnace/boiler system simulation

Data Row	Field	Description	.hvac file value	Case	Type	Comments
A	1	Number of HVAC systems	1		Integer	
	2	Site altitude	0.		Real	
B	1	HVAC system type	1	Furnace	Integer	Beginning of furnace/boiler data
			2	Boiler		
	2	System priority	1	Primary	Integer	Priority is set to 2 when system is backup
	3	Number of zones served by HVAC system			Integer	File in Figure 1 has two zones
C	1	Furnace type	1	Advanced air tight wood	Integer	Not all furnace types work with each of the fuel types. - For electric furnaces, the valid furnace type numbers is 12 - For natural gas furnaces, the valid furnace type numbers are 5,6,7,8, and 10 - For oil furnaces, the valid furnace type numbers are 3,4,8,9,11, and 14 - For propane furnaces, the valid furnace type numbers are 5,6,7,8, and 10 - For wood furnaces, the valid furnace type numbers are 1,2, and 13
			2	Catalytic converter		
			3	Flame retention head		
			4	Flue vent damper		
			5	Spark ignition		
			6	Spark ignition and vent damper		
			7	Continuous pilot		
			8	Condensing		
			9	Direct vent non condensing		
			10	Induced draft		
			11	Mid efficiency		
			12	Electric forced air		
			13	Wood furnace		
			14	Oil Furnace or Boiler		
	2	Fuel type	1	Electric	Integer	Make sure the correct combinations listed above for fuel types and furnace types are satisfied
			2	Natural gas		
			3	Oil		
			4	Propane		

			5	Wood		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
	7	Equipment capacity			Real	In Watts
	8	Steady-state efficiency			Real	
	9	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		
	10	Circulation fan power			Real	If < 0, power is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file
	11	Draft fan power			Real	In Watts This is > 0 only for induced draft and condensing furnaces/ boilers. If not known, 75 W is ok For furnaces/boilers other than condensing and induced draft, enter 0
	12	Pilot energy			Real	In Watts If not known, 500 W is ok
	13	Duct system flag	1		Integer	Not used now but value needed End of furnace/boiler data

Baseboard System

```
a       1 0.
b       3 1 2
c       1 1. 2 0. 2000 0.75 1 300
```

Figure 2: Sample ESP-r HVAC file for baseboard system simulation

Table 2: Variables in ESP-r HVAC file for baseboard system simulation

Data Row	Field	Description	.hvac file value	Case	Type	Comments
A	1	Number of HVAC systems	1		Integer	
	2	Site altitude	0.		Real	
B	1	HVAC system type	3		Integer	Beginning of baseboard system data
	2	System priority	1	Primary	Integer	Priority is set to 2 when system is backup
	3	Number of zones served by HVAC system			Integer	File in Figure 2 has two zones
C	1	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	2	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	3	Number of second zone			Integer	Only needed when there are two zones
	4	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
	5	Equipment capacity			Real	In Watts
	6	Steady-state efficiency			Real	This is 1 for electric baseboard
	7	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		

	8	Circulation fan power			Real	In Watts If < 0, power is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file End of Baseboard system data

Heat Pump System (Heating Mode) with Furnace/Boiler Backup

```
a       2 0.
b       1 2 2
c       7 2 1 0.6 2 0.4 2000. 0.75 1 300 0. 500. 1
d       7 1 2
e       1 1 1 0.6 2 0.4
f       1000. 3.
g       1. 1.5 1 1 300. 400. 300. 1 -1
h       1 0. 1 1
```

Figure 3: Sample ESP-r HVAC file for HP/furnace system simulation

Table 3: Variables in ESP-r HVAC file for HP/furnace system simulation

Data Row	Field	Description	.hvac file value	Case	Type	Comments
A	1	Number of HVAC systems	2			Figure 3 is for a furnace backup
	2	Site altitude	0.		Real	
B	1	HVAC system type	1	Furnace	Integer	Beginning of furnace/boiler data
			2	Boiler		
	2	System priority	2	Backup	Integer	Priority is set to 1 when system is primary Always list backup system data before HP data
	3	Number of zones served by HVAC system			Integer	File in Figure 3 has two zones
C	1	Furnace/boiler type	1	Advanced air tight wood	Integer	Not all furnace types work with each of the fuel types. - For electric furnaces, the valid furnace type numbers is 12 - For natural gas furnaces, the valid furnace type numbers are 5,6,7,8, and 10 - For oil furnaces, the valid furnace type numbers are 3,4,8,9,11, and 14 - For propane furnaces, the valid furnace type numbers are 5,6,7,8, and 10 - For wood furnaces, the valid furnace type numbers are 1,2, and 13
			2	Catalytic converter		
			3	Flame retention head		
			4	Flue vent damper		
			5	Spark ignition		
			6	Spark ignition and vent damper		
			7	Continuous pilot		
			8	Condensing		
			9	Direct vent non condensing		
			10	Induced draft		
			11	Mid efficiency		
			12	Electric forced air		

			13	Wood furnace		
			14	Oil Furnace or Boiler		
	2	Furnace/boiler fuel type	1	Electric	Integer	Make sure the correct combinations listed above for fuel types and furnace types are satisfied
			2	Natural gas		
			3	Oil		
			4	Propane		
			5	Wood		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but valued needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
	7	Furnace/boiler heating capacity			Real	In Watts
	8	Furnace/boiler steady-state efficiency			Real	
	9	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		
	10	Circulation fan power			Real	In Watts If < 0, power is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file
	11	Furnace/boiler draft fan power			Real	In Watts This is > 0 only for induced draft and condensing furnaces/ Boilers. If not known, 75 W is ok For furnaces/boilers other than condensing and induced draft, enter 0

	12	Furnace/boiler pilot energy			Real	In Watts If not known, 500 W is ok
	13	Duct system flag	1		Integer	Not used now but value needed End of furnace/boiler data
D	1	HVAC system type	7	ASHP	Integer	Beginning of HP heating mode data
			8	GSHP		
			9	GCEP		
	2	System priority	1	Primary	Integer	Primary system
	3	Number of zones served by HVAC system	2		Integer	File in Figure 3 has two zones
E	1	Unit function	1		Integer	Heating function as opposed to cooling
	2	Heat pump type	1	ASHP Typical	Integer	
			2	ASHP Good		
			3	ASHP Poor		
			4	GSHP or GCEP		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
f	1	HP heating capacity			Real	In Watts
	2	Heating mode COP			Real	
g	1	Flow rate			Real	If < 0, value is set internally
	2	Flow rate at rating conditions	-1.		Real	If < 0 , value is set internally
	3	Circulation fan mode	1	Auto	Integer	Same mode as that for backup system
			2	Continuous		
			0	No fan		
	4	Circulation fan position	1	Blow through	Integer	Currently not used but value needed
			2	Draw through		

	5	Total circulation fan power			Real	In Watts If power < 0, value is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file If power > 0, use same value for primary and secondary system
	6	Outdoor fan power			Real	This is the fan for the outdoor evaporator of the heat pump Not used for ashp in heating but value needed
	7	Fan power associated with auto mode			Real	Not used for ashp in heating mode. Value still needed.
	8	Position of circulation fan during rating test	1	Blow through	Integer	Currently not used but value needed
			2	Draw through		
	9	Power of circulation fan during rating test			Real	In Watts If power < 0, value is estimated internally Not used but value needed
h	1	Temperature control	1	Balanced Point	Integer	
			2	Restricted		
			3	Unrestricted		
	2	Cutoff temperature			Real	In ^{o}C
	3	Type of backup system	1	Furnace	Integer	
			2	Boiler		
			3	Baseboards		
	4	System number associated with backup system			Integer	This is the system number in HVAC input file associated with backup system Backup system data has to be listed before HP data in hvac file End of HP heating mode data

Heat Pump System (Heating Mode) with Baseboard Backup

```
a       2 0.
b       3 1 2
c       1 1. 2 0. 2000 0.75 1 300
d       7 1 2
e       1 1 1 0.6 2 0.4
f       1000. 3.
g       1. 1.5 1 1 300. 400. 300. 1 -1
h       1 0. 1 1
```

Figure 4: Sample ESP-r HVAC file for HP/baseboard system simulation

Table 4: Variables in ESP-r HVAC file for HP/baseboard system simulation

Data Row	Field	Description	.hvac file value	Case	Type	Comments
A	1	Number of HVAC systems	2			Figure 4 is for a baseboard backup
	2	Site altitude	0.		Real	
B	1	HVAC system type	3		Integer	Beginning of baseboard system data
	2	System priority	2	Backup	Integer	Priority is set to 1 when system is primary Always list backup system data before HP data
	3	Number of zones served by HVAC system			Integer	File in Figure 4 has two zones
C	1	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	2	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	3	Number of second zone			Integer	Only needed when there are two zones
	4	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
	5	Equipment capacity			Real	In Watts
	6	Steady-state efficiency			Real	This is 1 for electric baseboard
	7	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		

	8	Circulation fan power			Real	In Watts If < 0, power is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file End of baseboard system data
d	1	HVAC system type	7	ASHP	Integer	Beginning of HP heating mode data
			8	GSHP		
			9	GCEP		
	2	System priority	1	Primary	Integer	Primary system
	3	Number of zones served by HVAC system	2		Integer	File in Figure 4 has two zones
e	1	Unit function	1		Integer	Heating function as opposed to cooling
	2	Heat pump type	1	ASHP Typical	Integer	
			2	ASHP Good		
			3	ASHP Poor		
			4	GSHP or GCEP		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
f	1	HP heating capacity			Real	In Watts
	2	Heating mode COP			Real	
g	1	Flow rate			Real	If < 0, value is set internally
	2	Flow rate at rating conditions	-1.		Real	If < 0 , value is set internally
	3	Circulation fan mode	1	Auto	Integer	Same mode as that for backup system
			2	Continuous		
			0	No fan		
	4	Circulation fan position	1	Blow through	Integer	Currently not used but value needed
			2	Draw through		

	5	Total circulation fan power			Real	In Watts If power < 0, value is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file If power > 0, use same value for primary and secondary system
	6	Outdoor fan power			Real	This is the outdoor fan for the evaporator
	7	Fan power associated with auto mode			Real	Not used for ashp in heating mode but value needed
	8	Position of circulation fan during rating test	1	Blow through	Integer	Currently not used but value needed
			2	Draw through		
	9	Power of circulation fan during rating test			Real	In Watts If power < 0, value is estimated internally Not used but value needed
h	1	Temperature control	1	Balanced Point	Integer	
			2	Restricted		
			3	Unrestricted		
	2	Cutoff temperature			Real	In ^{o}C
	3	Type of backup system	1	Furnace	Integer	
			2	Boiler		
			3	Baseboards		
	4	System number associated with backup system			Integer	This is the system number in HVAC input file associated with backup system Backup system data has to be listed before HP data in hvac file End of HP heating mode data

Heat Pump System (Cooling Mode)

This is also used to model an air-conditioner

```
a       1 0.
b       7 1 2
c       2 1 1 0.6 2 0.4
d       2000. 1.5
e       1. -1 1 1 300. 400. 300. 1 -1
f       0.75 1
g       1
h       1 8760
I       24 0.25
j       1 1
```

Figure 5: Sample ESP-r HVAC file for HP cooling mode system simulation

Table 5: Variables in ESP-r HVAC file for HP cooling mode system simulation

Data Row	Field	Description	.hvac file value	Case	Type	Comments
a	1	Number of HVAC systems	1			
	2	Site altitude	0		Real	
b	1	HVAC system type	7	ASHP	Integer	Beginning of HP cooling mode data
			8	GSHP		
			9	GCEP		
	2	System priority	1	Primary	Integer	Primary system
	3	Number of zones served by HVAC system	2		Integer	File in Figure 5 has two zones
c	1	Unit function	2		Integer	Cooling as opposed to heating
	2	Heat pump type	1	ASHP Typical	Integer	
			2	ASHP Good		
			3	ASHP Poor		
			4	GSHP or GCEP		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5

d	1	HP cooling capacity			Real	In Watts Capacity does not include effect of circulation fan. This is then the total cooling capacity at the evaporator coil. This is capacity at ARI rating conditions (26.7 ^{o}C Tdb and 19.4 Twb ^{o}C)
	2	Cooling mode COP			Real	COP does not include effect of indoor circulation fan. It accounts for compressor power and power of outdoor fan. This is at ARI rating conditions (26.7 ^{o}C Tdb and 19.4 Twb ^{o}C)
e	1	Flow rate			Real	If < 0, value is set internally
	2	Flow rate at rating conditions	-1.		Real	If < 0, value is set internally
	3	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		
	4	Circulation fan position	1	Blow through	Integer	
			2	Draw through		
	5	Total circulation fan power			Real	In Watts If power < 0, value is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file If fan has one low continuous speed and one higher auto speed when the heat pump is on, enter fan power when heat pump is on here. In this case, fan operation is specified as auto. The fan power at low speed which is on continuously, needs to be specified as 100% convective internal gains in the operation file.

	6	Outdoor fan power			Real	This is the outdoor fan power associated with the condenser of the unit
	7	Fan power associated with auto mode			Real	In Watts If power < 0, value is estimated internally This entry is used to deal with fans with a low continuous speed when heat pump is off and a high auto speed when heat pump is on. This is equal to the total fan power (fan power at high speed) minus fan power at low speed. If the fan has a single speed, this entry is equal to the total fan fan specified under item 13.
	8	Position of circulation fan during rating test	1	Blow through	Integer	
			2	Draw through		
	9	Power of circulation fan during rating test			Real	In Watts If power < 0, value is estimated internally Power of circulation fan at rating test can be different from actual fan power installed
f	1	Sensible heat ratio			Real	This is capacity at ARI rating conditions (26.7 ^{o}C Tdb and 19.4 Twb ^{o}C)
	2	Cooling type	1	Conventional	Integer	
			2	Economizer		
Begin f2 = Conventional condition						
g	1	Number of outdoor air day types			Integer	This is the number of different day types for the description of the outdoor air schedule through the duct system
h	1	Number of different periods in day type 1			Integer	This is the number of periods that make up day type 1

	2	Hour of the year for end of day type 1			Integer	This is a number out of 8760. The hour indicates the hour of the year after which day type 1 is not valid anymore Repeat h1 and h2 above as many times as there are day types in the outdoor air schedule. All of this data is entered on record h
i	1	End hour for period 1 for day type 1			Integer	This is an hour number from 24. This is the hour after which period 1 for day type 1 is not valid anymore
	2	Outdoor air flow rate for period 1 of day type 1			Real	In m^3/s Repeat entries i1 and i2 above as many times as there are periods in day type 1. All the data for day type 1 is entered on the same record Repeat record i as many times as there are day types for the outdoor air schedule
End of f2 = Conventional condition						
Begin f2 = Economizer condition						
g	1	Economizer control type	1	Indoor/Outdoor Temp integrated compressor control and option of outdoor dry-bulb temp limit control	Integer	
			2	Indoor/Outdoor Temp non-integrated compressor control and option outdoor dry-bulb temp limit control		
			3	Enthalpy integrated compressor control and enthalpy limit control		

			4	Enthalpy non-integrated compressor control and enthalpy limit control		
Begin g1 = 1 or 2 condition						
g	2	Economizer minimum outdoor air flow			Real	m^3/s
	3	Economizer indoor space set point			Real	^oC This is the indoor temperature set point below which the economizer is tuned off
	4	Economizer outdoor temperature limit			Real	^oC This is the outdoor dry bulb temperature above which the economizer is turned off
End of g1 = 1 or 2 condition						
Begin of g1 = 3 or 4 condition						
g	2	Economizer minimum outdoor air flow			Real	m^3/s
	3	Economizer indoor space set point			Real	^oC This is the indoor temperature set point below which the economizer is tuned off
	4	Economizer outdoor enthalpy limit control			Real	J/kg This is the outdoor air enthalpy above which the economizer is turned off
End of g1 = 3 or 4 condition						
End f2 = Economizer condition						
j or h	1	System number for heating mode	1		Integer	This is not used when heat pump is only used in cooling mode but need to enter value
	2	Control function number for cooling mode			Integer	This is the control function number in ESP-r ctl file associated with heat pump operation in cooling mode End of HP cooling mode data

Heat Pump System (Heating/Cooling Mode) with Furnace Backup

This is also the same when modeling an HP in heating mode with a furnace backup and a HP in cooling mode. If the HP in the heating mode has a baseboard system as backup, replace furnace data with baseboard data from Table 2.

```
a     3 0.
b     1 2 2
c     7 2 1 0.6 2 0.4 2000. 0.75 1 300 0. 500. 1
d     7 1 2
e     1 1 1 0.6 2 0.4
f     1000. 3.
g     1. 1.5 1 1 300. 400. 300. 1 -1
h     1 0. 1 1
i     7 1 2
j     2 1 1 0.6 2 0.4
k     2000. 1.5
l     1. -1 1 1 300. 400. 300. 1 -1
m     0.75 1
n     1
o     1 8760
p     24 0.25
q     1 1
```

Figure 6: Sample ESP-r HVAC file for HP (heating/cooling mode) with furnace backup simulation

Table 6: Variables in ESP-r HVAC file for ASHP (heating/cooling)(Air Source Heat Pump), GSHP (Ground Source Heat Pump) or GCEP (Ground Coupling Ecole Polytechnique) with furnace backup system simulation

Data Row	Field	Description	.hvac file value	Case	Type	Comments
a	1	Number of HVAC systems	3			
	2	Site altitude	0.		Real	
b	1	HVAC system type	1	Furnace	Integer	Beginning of furnace/boiler data
			2	Boiler		
	2	System priority	2	Backup	Integer	Priority is set to 1 when system is primary Always list backup system data before HP data
	3	Number of zones served by HVAC system			Integer	File in Figure 6 has two zones
c	1	Furnace/boiler type	1	Advanced air tight wood	Integer	Not all furnace types work with each of the fuel types. - For electric furnaces, the valid furnace type numbers is 12 - For natural gas furnaces, the
			2	Catalytic converter		
			3	Flame retention head		

			4	Flue vent damper		valid furnace type numbers are 5,6,7,8, and 10 - For oil furnaces, the valid furnace type numbers are 3,4,8,9,11, and 14 - For propane furnaces, the valid furnace type numbers are 5,6,7,8, and 10 - For wood furnaces, the valid furnace type numbers are 1,2, and 13
			5	Spark ignition		
			6	Spark ignition and vent damper		
			7	Continuous pilot		
			8	Condensing		
			9	Direct vent non condensing		
			10	Induced draft		
			11	Mid efficiency		
			12	Electric forced air		
			13	Wood furnace		
			14	Oil Furnace or Boiler		
	2	Furnace/boiler fuel type	1	Electric	Integer	Make sure the correct combinations listed above for fuel types and furnace types are satisfied
			2	Natural gas		
			3	Oil		
			4	Propane		
			5	Wood		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
	7	Furnace/boiler heating capacity			Real	In Watts
	8	Furnace/boiler steady-state efficiency			Real	
	9	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		
	10	Circulation fan power			Real	In Watts If < 0, power is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file

	11	Furnace/boiler draft fan power			Real	In Watts This is > 0 only for induced draft and condensing furnaces/boilers. If not known, 75 W is ok For furnaces/boilers other than condensing and induced draft, enter 0
	12	Pilot energy			Real	In Watts If not known, 500 W is ok
	13	Duct system flag	1		Integer	Not used now but value needed End of furnace/boiler system data
d	1	HVAC system type	7	ASHP	Integer	Beginning of HP heating mode data
			8	GSHP		
			9	GCEP		
	2	System priority	1	Primary	Integer	Primary system
	3	Number of zones served by HVAC system			Integer	File in Figure 6 has two zones
e	1	Unit function	1		Integer	Heating as opposed to cooling
	2	Heat pump type	1	ASHP Typical	Integer	
			2	ASHP Good		
			3	ASHP Poor		
			4	GSHP or GCEP		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
f	1	HP heating capacity			Real	In Watts
	2	Heating mode COP			Real	
g	1	Flow rate			Real	If < 0, value is set internally
	2	Flow rate at rating conditions	-1.		Real	If < 0 , value is set internally
	3	Circulation fan mode	1	Auto	Integer	Same mode as that for backup system
			2	Continuous		
			0	No fan		
	4	Circulation fan position	1	Blow through	Integer	Currently not used but value

			2	Draw through		needed
	5	Circulation fan power			Real	In Watts If power < 0, value is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file If power > 0, use same value for primary and secondary system
	6	Outdoor fan power			Real	This is the fan for the outdoor evaporator of the heat pump Not used for ashp in heating but value needed
	7	Fan power associated with auto mode			Real	Not used for heat pump in heating mode but value needed
	8	Position of circulation fan during rating test	1	Blow through	Integer	Currently not used but value needed
			2	Draw through		
	9	Power of circulation fan during rating test			Real	In Watts If power < 0, value is estimated internally Not used but value needed
h	1	Temperature control	1	Balanced Point	Integer	
			2	Restricted		
			3	Unrestricted		
	2	Cutoff temperature			Real	In ^{o}C
	3	Type of backup system	1	Furnace	Integer	
			2	Boiler		
			3	Baseboards		
	4	System number associated with backup system			Integer	This is the system number in HVAC input file associated with backup system Backup system data has to be listed before HP data in hvac file End of HP heating mode data
i	1	HVAC system type	7	ASHP	Integer	Beginning of HP cooling mode data
			8	GSHP		
			9	GCEP		
	2	System priority	1	Primary	Integer	Primary system
	3	Number of zones served by HVAC system	2		Integer	File in Figure 6 has two zones
j	1	Unit function	2		Integer	Cooling as opposed to heating
	2	Heat pump type	1	ASHP Typical	Integer	
			2	ASHP Good		
			3	ASHP Poor		

			4	GSHP or GCEP		
	3	Number of first zone			Integer	This is the number in the ESP-r cfg file associated with zone
	4	Fraction of equipment capacity to first zone	0.5		Real	Not used now but value needed
	5	Number of second zone			Integer	Only needed when there are two zones
	6	Fraction of equipment capacity to second zone	0.5		Real	Not used now but value needed Only needed when there are two zones Continue after this entry with zone numbers and fractions if number of zones is more than 2. Use value for fraction of 0.5
k	1	HP cooling capacity			Real	In Watts Capacity does not include effect of circulation fan. This is the total capacity at the evaporator coil This is capacity at ARI rating conditions (26.7 ^{o}C Tdb and 19.4 Twb ^{o}C)
	2	Cooling mode COP			Real	COP does not include effect of indoor circulation fan. It includes compressor power and outdoor fan power. This is at ARI rating conditions (26.7 ^{o}C Tdb and 19.4 Twb ^{o}C)
l	1	Flow rate			Real	If < 0, value is set internally
	2	Flow rate at rating conditions	-1.		Real	If < 0 , value is set internally
	3	Circulation fan mode	1	Auto	Integer	
			2	Continuous		
			0	No fan		
	4	Circulation fan position	1	Blow through	Integer	
			2	Draw through		

	5	Circulation fan power			Real	In Watts If power < 0, value is estimated internally If the fan is in continuous mode, fan power need to be included as internal gain in the ESP-r opr file If fan has one low continuous speed and one higher auto speed when the heat pump is on, enter fan power when heat pump is on here. In this case, fan operation is specified as auto. The fan power at low speed which is on continuously, needs to be specified as 100% convective internal gains in the operation file.
	6	Outdoor fan power			Real	This is the outdoor fan power associated with the condenser of the unit
	7	Fan power associated with auto mode			Real	In Watts If power < 0, value is estimated internally This entry is used to deal with fans with a low continuous speed when heat pump is off and a high auto speed when heat pump is on. This is equal to the total fan power (fan power at high speed) minus fan power at low speed. If the fan has a single speed, this entry is equal to the total fan fan specified under item 13.
	8	Position of circulation fan during rating test	1	Blow through	Integer	
			2	Draw through		
	9	Power of circulation fan during rating test			Real	In Watts If power < 0, value is estimated internally
m	1	Sensible heat ratio			Real	This is capacity at ARI rating conditions (26.7 ^{o}C Tdb and 19.4 Twb ^{o}C)
	2	Cooling type	1	Conventional	Integer	
			2	Economizer		
Begin m2 = Conventional condition						

n	1	Number of outdoor air day types			Integer	This is the number of different day types for the description of the outdoor air schedule through the duct system
o	1	Number of different periods in day type 1			Integer	This is the number of periods that make up day type 1
	2	Hour of the year for end of day type 1			Integer	This is a number out of 8760. The hour indicates the hour of the year after which day type 1 is not valid anymore Repeat o1 and o2 above as many times as there are day types in the outdoor air schedule. All of this data is entered on record o
p	1	End hour for period 1 for day type 1			Integer	This is an hour number from 24. This is the hour after which period 1 for day type 1 is not valid anymore
	2	Outdoor air flow rate for period 1 of day type 1			Real	In m^3/s Repeat entries p1 and p2 above as many times as there are periods in day type 1. All the data for day type 1 is entered on the same record Repeat record p as many times as there are day types for the outdoor air schedule
End of m2 = Conventional condition						
Begin m2 = Economizer condition						
n	1	Economizer control type	1	Indoor/Outdoor Temp integrated compressor control and option of outdoor dry-bulb temp limit control	Integer	This is a temperature based control with the compressor and the economizer running together to meet the load when the economizer can not meet the load by itself
			2	Indoor/Outdoor Temp non-integrated compressor control and option outdoor dry-bulb temp limit control		This is a temperature based control with the compressor and the economizer not allowed to run together to meet the load when the economizer can not meet the load by itself
			3	Enthalpy integrated compressor control and enthalpy limit control		This is an enthyalpy based control with the compressor and the economizer running together to meet the load when the economizer can not meet the load by itself

			4	Enthalpy non-integrated compressor control and enthalpy limit control		This is an enthalpy based control with the compressor and the economizer not allowed to run together to meet the load when the economizer can not meet the load by itself
Begin n1 = 1 or 2 condition						
n	2	Economizer minimum outdoor air flow			Real	m^3/s
	3	Economizer indoor space set point			Real	^oC This is the indoor temperature set point below which the economizer is tuned off
	4	Economizer outdoor temperature limit			Real	^oC This is the outdoor dry bulb temperature above which the economizer is turned off
End of n1 = 1 or 2 condition						
Begin of n1 = 3 or 4 condition						
n	2	Economizer minimum outdoor air flow			Real	m^3/s
	3	Economizer indoor space set point			Real	^oC This is the indoor temperature set point below which the economizer is tuned off
	4	Economizer outdoor enthalpy limit control			Real	J/kg This is the outdoor air enthalpy above which the economizer is turned off
End of n1 = 3 or 4 condition						
End m2 = Economizer condition						
q or o	5	System number for heating mode			Integer	This is the system number in HVAC input file associated with HP in heating mode
	6	Control function number for cooling mode			Integer	This is the control function number in ESP-r ctl file associated with heat pump operation in cooling mode End of HP cooling mode data