Modifications to ESP-r input files

For AIM-2 modelling

The AIM-2 model accounts for infiltration into a specific zone. The inputs for this model are derived from the inputs to the HOT2000 interface.
In the .cfg file, under
* DATABASES
You will need to add the following line at the end of the list (after the *ctl)

***aim ../aim2/test.aim #aim -2 input file**

To let the program know that there will be an AIM-2 calculation performed.

You will need to create a new directory called aim2. This new directory will be at the same level as the cfg directory. You will also need to create an input file, in this directory, for the AIM-2 simulation. In the case outlined above, this file will be called test.aim.

The format of the input file is as follows:

```
#
# AIM-2 input file
#
#---Leakage description-----------------------------------------------------
1 3.00 10. 0 600.0   # blower door input; 3ac/h @50Pa; ELA dP=10Pa; ELA n/a
#                    # Set first number to 6(and no other data) for energ y
#                    # tight house
#---Leakage distribution----------------------------------------------------
0                     # Use default leakage distribution.
#                     # Set '1 0.1 0.6 0.2' for user input lea kage distribution.
#---Shielding and terrain data----------------------------------------------
3 7 2 1 10.0          # See subroutine
                     #/h3kdev/master/src/hot3000/cetc/aim2_pretimestep.F/AIM2_READIN
#---Height of building eaves (m)--------------------------------------------
6.0
#---Flue diameters (mm)-----------------------------------------------------
200.  0. 0. 50. 0.    # furnace, fire#1, fire#2, dhw#1, dhw#2.
#---Zone indices------------------------------------------------ ------------
1             # Zone whose temperature used to calculate density of indoor air.
2 1 2         # Total number of zones receiving infil; indices of zones receive infil.
2 0           # Index of basement zone (=0 if none), Crawl Space zone (0 if  none)
#-------------------------------------------------------------------------------
```

For BASESIMP modelling

The BASESIMP model calculates the heat loss from the basement. Two of the standard ESP-r input files need to be modified to account for this model.
In the .cfg file, under

```
*zon   2   # reference for basement
*opr ../zones/basement.opr  # schedules
*geo ../zones/basement.geo  # geometry
*con ../zones/basement.con  # construction
*bsm ../bsm/test.bsm        # basesimp
*zend
```

The format of the input file is as follows

```
2.50                    # height
2.00                    # depth
12.0                    # length
6.0                     # width
0.9                     # overlap (only important for BCCN_1 and BCCN_2)
1.8                     # rsi
0.85                    # soilk
8                       # wtable
8.9                     # Tg,avg
14.19942                # Tg,amp
0.3824999               # Ps
```

The second input file that requires modification is the .cnn file (the connections file). This file will automatically be modified if the basement boundary conditions are defined in the project manager.

To manually change the .cnn file, the 3rd, 4th, and 5th columns of the basement wall connections require the following input:

```
1   1   6   1  11  #    1  BASESIMP foundation
1   2   6   1  14  #    2  BASESIMP foundation
1   3   6   1  11  #    3  BASESIMP foundation
1   4   6   1  14  #    4  BASESIMP foundation
```

The value in the 3rd column will be 6 – this represents the BASESIMP model.
The value in the 4th column will be defined by the representative BASESIMP configuration. In the example above, this value is 1, which represents configuration BCIN_1. The table below gives the configuration number for each available BASESIMP configuration.
The value in the 5th column represents the percentage heat loss from the particular surface. All losses for a particular configuration must sum to 100%. These values can be approximated based on the ratio of surface area to total basement surface area.

For HVAC modelling

In the *.cfg file, insert an entry to indicate that there is an hvac system associated with the problem. Insert the reference to the hvac input file in the `* DATABASES` section, in the same way as the reference to the AIM-2 input file.

```
*hvac ../hvac/test.hvac     # hvac input file
```

Again, this input file is located in directory hvac, which is at the same level as the cfg, zones, and ctl directories.

(i) Furnace

The format of the .hvac file to model a furnace is as follows:

```
1 0.                                    # number of HVAC systems; altitude
1 1 2                                   # furnace; primary system; # zones served
7 2 1 0.5 3 0.5 10000. 0.75 1 300. 500. 1  # type; fuel; 1st zone; fraction to 1st
                                        # 2nd zone; fraction to 2nd; SS capacity;
                                        # eff; fan ops; fan power; pilot pwr; duct
```

(ii) Air-Conditioner

For systems with only an air-conditioner, the format of the .hvac file is as follows:

```
1 0                                        # number of HVAC systems, altitude
7 1 2                                      # HVAC system type; priority; zones served
2 1 1 0.5 2 0.5 10000. 3. -1 -1 1 300. 1   # AC type; priority; 1st zone; fraction; 2nd
                                           zone; fraction; capacity; COP; flow rate;
                                           rated flow rate; circulation fan mode;
                                           power; duct
0.75 1 1.5 1 1 3                           # sensible heat ratio; cooling type; flow
                                           rate, open window area, control function
```

(iii) Furnace and Air-Conditioner

The format of the .hvac file to model both a furnace and an air-conditioner is as follows:

```
2 0.                      # header line: there are 2 HVAC systems
1 1 2                     # Furnace inputs
7 2 1 0.5 3 0.5 10000. 0.75 1 300. 500. 1
7 1 2                      # air-conditioning inputs
2 1 1 0.5 2 0.5 10000. 3. -1 -1 1 300. 1
0.75 1 1.5 1 1 3
```

Note that a blank line has to be inserted at the end of the hvac input file.

An explanation of the individual variables, i.e., what type 7 represents, is presented in the coding documentation for the specific HVAC systems. A brief explanation is given for the furnace inputs at the end of this document.

For HRV and Mechanical Ventilation Modelling

In the *.cfg file, insert an entry to indicate that there is an HRV or mechanical ventilation system associated with the problem. Insert the reference to the HRV input file in the * DATABASES section, in the same way as the reference to the AIM-2 input file.

```
*mvnt   ../mvnt/Sample.vnt       # mechanical ventilation input file
```

Again, this input file is located in directory mvnt, which is at the same level as the cfg, zones, and ctl directories.

The format of the input file is as follows:

```
#
# Sample ventilation system input file
#
2 # Central Ventilation System (CVS) type (1=None, 2=HRV, 3=Fans with no heat
recovery)
#---HRV test data (temperature C, effectiveness %, fan + preheater power watts) -----
0.     80.0    117.  # "high" temperature
-25.   77.0    123.  # "low"  temperature
# ---CVS supply air flow rates (L/s)
55.
25.   # HRV efficiency in cooling mode (used by A/C model)
0.    # Pre-heater capacity (watts)
# CVS temperature control data (flag,low temperature trip, high temperature trip)
7   0.    0.  # flag 3 = Temperature controlled, or 1,2,4,5,6,7 = N/A
# (Other values were used in AUDIT2000 for various scheduling options)
#--- HRV duct data
# Vent. Duct Location: # of zone in which duct is located
```

```
# Duct Type: # 1=Flexible, 2=Sheet metal with liner, 3=Ext. insulated Sheet metal
# Sealing Characteristic: # 1=Very Tight, 2=Sealed, 3=Unsealed
#
# Location,Type,Sealing, Length(m), Diameter(mm),Insul.RSI
     1       2     3        1.5       152.4        0.1   # Supply duct
     1       1     2        2.5       152.4        0.1   # Exhaust duct
#------ End of Part 1: Central ventilation system inputs
#
#------ Part 2 (replaces part 1 if Fans, No Heat recovery)
#---CVS supply, exhaust air flow rates (L/s), total fan power(watts)
# 15.    45.   37.5
# CVS temperature control data (flag,low temperature trip, high temperature  trip)
#7   0.    0.  # flag 3 = Temperature controlled, or 1,2,4,5,6,7 = N/A
#------ End of Part 2
#
#--- Part 3 : "Other" fans (point exhaust and supply fans)
2   # Type (1=None, 2=Other)
# Supply, Exhaust flow(L/s), Total fan power(watts)
    0.           12.             27.7
```

The following modifications are required to this input file based on effectiveness. The user will input a specific effectiveness (x). This will be the high temperature effectiveness (80 in the example above), and (x/80*77) will be the low temperature effectiveness (77 in the example above). In all cases, the input effectiveness must be greater than 0, and less than 100%.

For DHW Modelling

In the *.cfg file, insert an entry to indicate that there is a domestic hot water system associated with the problem. Insert the reference to the DHW input file in the * DATABASES section, in the same way as the reference to the AIM-2 input file.

```
*dhw  ../hvac/test.dhw                  # DHW input file
```

This input file is located in the hvac directory.

The format of the input file is as follows:

```
#Number of Tanks
1
#fNumOfOccupants. This value is fixed from 1.0 to 100.0 people
4.0
#Mean Ground Temp (0.0 - 100.0)
11.1
# Ground Temp Amp (0.0 - 100.0 (c))
5.92
#fHotSupplyTemp   (0.0 -100.0 (c) )
55.0
#
#TankLoop
#Zone Location of Tank (Zone Number 1- 10)
1
#iFuelType (1-elec, 2-Gas 3-oil, 4-propane, 5-wood 6-Solar)
1
#iTankType(1-20 as listed)
15
#fDOEEF (0.0-2.0) Efficiency of tank.
0.822
#fHeatInjectorPower(Watts) (0.0 - 1000000.0)
```

```
1000000.0
#fPilotEnergyRate (Watts) (0.0-10000.0)
0.0
#fTankSize (1.0-5000.0 litres)
200.0
#fTemperatureBand (0.0 - 99.0 C)
0.0
#fBlanketRSI (0.0 - 99.0)
0.0
```

Input File Format

.aim file inputs

First Line

airtight_type = Air tightness type as defined in HOT2000 interface:
1=blower door test; 2=quick blower door test;
3=loose; 4=average; 5=present; 6=energy tight.
ACH_50Pa = Air change rate @ 50Pa. Only used if blower door inputs given.
ELA_given = Flag indicating whether user input ELA: 0=no input; 1=input given.
ELA_cm = Equivalent leakage area in cm^2. Only used if blower door inputs given.
ELA_deltaP = Pressure difference in Pa for ELA_cm.

Second Line (Leakage description)

userspec_leakage = flag indicating whether user has specified leakage fractions for ceiling, wall, and floor:
0 indicates user input not given;
1 indicates user input given.
AIM2_ceil_frac = Ceiling leakage fraction.
AIM2_wall_frac = Wall leakage fraction.
AIM2_floor_frac = Floor leakage fraction.

Third Line (Shielding and Terrain Data)

AIM2_terrain_weather = Terrain flag at weather station:
1=Open sea,fetch > 5 km
2=Mud flats,no vegetation
3=Open flat terrain, grass
4=Low crops, x/H > 20
5=High crops, scattered obstacles
6=Parkland, bushes, x/H ~ 10
7=Suburban, forest
8=City centre
AIM2_terrain_building = Terrain flag at building site. Same options
as for AIM2_terrain_weather.
AIM2_wall_shielding = Flag indicating local shielding on walls:
1=No local shielding
2=Light local shielding
3=Heavy
4=Very heavy
5=Complete (by large buildings)
AIM2_flue_shielding = Flag indicating local shielding on flue. Same options as for AIM2_wall_shielding.
AIM2_anemom_height = Height of anenometor at weather station (m).

Fourth Line (Height of building eaves)

AIM2_eaves_height = Height of building eaves (m).

Fifth Line (Flue diameters)

AIM2_furnace_flue = Diameter of furnace flue (mm).
AIM2_fire_flue1 = Diameter of #1 fireplace flue (mm).
AIM2_fire_flue2 = Diameter of #2 fireplace flue (mm).
AIM2_DHW_flue1 = Diameter of primary DHW system flue (mm).
AIM2_DHW_flue2 = Diameter of secondary DHW system flue (mm).

Sixth Line

AIM2_ref_zone = Number of zone whose temp used as reference for infil calcs.

Seventh Line

AIM2_num_zones_infil = Number of zones that receive infiltration.

AIM2_zone_infil(i) = Zone number of i'th zone that receives infiltration.

Eighth Line

AIM2_basement_zone = Zone number of basement.
AIM2_crawlspace_zone = Zone number of crawl space.

.bsm file inputs

Foundation height
Foundation depth
Foundation length
Foundation width
Insulation overlap for "combination" configurations
Insulation resistance in RSI
Soil conductivity
Water-table depth
Annually-averaged soil temperature
Amplitude of ground-temperature's annual sine wave
Phase lag of ground-temperature's annual sine wave

The configuration values required for the .cnn file are as follows:

1 BCIN_1	**26** BCEB_2	**51** SCB_24	**76** BCEB_8	**101** BCEB_6	**126** BCEB_10
2 BCIN_2	**27** BCEB_3	**52** SCB_25	**77** BCEB_9	**102** BWIA_1	**127** BCEB_11
3 BCIN_3	**28** SCN_1	**53** SCB_26	**78** BWEN_3	**103** BWIA_2	**128** BCEA_3
4 BCIN_4	**29** SCN_2	**54** SCB_29	**79** BBIB_3	**104** SCA_1	**129** BCEA_9
5 BCEN_1	**30** SCN_3	**55** SCB_30	**80** BBIB_4	**105** SCA_2	**130** BCEA_10
6 BCEN_2	**31** SCN_4	**56** SCB_33	**81** SCB_31	**106** SCA_9	**131** BCEA_11
7 BCEN_3	**32** SCN_7	**57** SCB_34	**82** SCB_32	**107** SCA_10	**132** BWIB_1
8 BCEN_4	**33** SCN_8	**58** SCB_35	**83** SCB_37	**108** BBIN_1	**133** BWIB_2
9 BCNN_1	**34** SCB_1	**59** SCB_36	**84** SCB_38	**109** BCEN_5	**134** BWIB_4
10 BCNN_2	**35** SCB_2	**60** SCA_17	**85** SCB_39	**110** BCEN_6	**135** BWIA_3
11 BCCN_1	**36** SCB_3	**61** SCA_18	**86** SCB_40	**111** BBIA_1	**136** BWEB_1
12 BCCN_2	**37** SCB_4	**62** SCA_19	**87** BBEB_1	**112** BBIB_1	**137** BWEB_2
13 BWNN_1	**38** SCB_5	**63** SCA_20	**88** BBEN_1	**113** BBIB_2	**138** BWEB_3
14 BWIN_1	**39** SCB_6	**64** SCA_21	**89** BBEN_2	**114** BCCB_9	**139** BWEB_4
15 BWIN_2	**40** SCB_9	**65** SCA_22	**90** BBIA_2	**115** BCCB_10	**140** BBIB_5
16 BWIN_3	**41** SCB_10	**66** SCA_23	**91** BBIN_2	**116** BCCA_1	**141** BBIB_6
17 BWEN_1	**42** SCB_11	**67** SCA_24	**92** BCCB_8	**117** BCCA_4	**142** BBEB_3
18 BWEN_2	**43** SCB_12	**68** BCCN_3	**93** BCCA_7	**118** BCIB_7	**143** BBEB_4
19 BCIB_1	**44** SCB_13	**69** BCCB_4	**94** BCCA_8	**119** BCIB_8	**144** BBEB_5
20 BCIB_2	**45** SCB_14	**70** BCEA_1	**95** BCCN_4	**120** BBEB_2	**145** BBEA_2
21 BCIB_3	**46** SCB_17	**71** BCEA_4	**96** BCCN_5	**121** BCIA_3	
22 BCIB_4	**47** SCB_18	**72** BCIA_1	**97** BCEA_5	**122** BCIA_5	
23 BCIB_5	**48** SCB_21	**73** BCIA_4	**98** BCEA_6	**123** BCIA_6	
24 BCIB_6	**49** SCB_22	**74** BCEA_7	**99** BCEB_4	**124** BCIB_9	
25 BCEB_1	**50** SCB_23	**75** BCEA_8	**100** BCEB_5	**125** BCIB_10	

.hvac file inputs

(i) Furnace

Record 1 (Integer): 1

Number of hvac systems being simulated. In this case there is only 1 hvac system, furnace, simulated. In the case of an air-source heat pump with a backup system, this entry will be 2

Record 2, 1st entry (Integer): 1

Indicates the system type. For a furnace this is 1. For an air-source heat pump it is 7

Record 2, 2nd entry (Integer): 1

1 for a primary system and 2 for a secondary or backup system. For a furnace only simulation, this is always 1.

Record 2, 3rd entry (Integer): 2

Total number of zones served by hvac system.

Record 3, 1st entry (Integer): 7

Variation of furnace type

1	simple wood furnace
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 furnace
9	direct vent non-condensing
10	induced draft
11	mid-efficiency
12	electric forced air
13	wood coal furnace

Record 3, 2nd entry (Integer): 2

Furnace fuel type

1	electric
2	natural gas
3	oil
4	propane
5	wood

Record 3, 3rd entry (Integer): 1

Number of first zone served by furnace

Record 3, 4th entry (Real): 0.4

Fraction of equipment capacity reaching first zone

Record 3, 5th entry (Integer): 3

Number of second zone served by furnace

Record 3, 6th entry (Real): 0.6

Fraction of equipment capacity reaching second zone

Record 3, 7th entry (Real): 10000

Furnace steady-state capacity (W)

Record 3, 8th entry (Real): 0.75

Furnace steady-state efficiency

Record 3, 9th entry (Integer): 1

Indoor circulation fan mode of operation

no fan
fan in auto mode
fan in continuous mode

Record 3, 10th entry (Real): 300

Indoor fan power consumption (W). If negative and the fan operation is either auto or continuous, a value is estimated by the program based on correlations.

Record 3, 11th entry (Real): 500

Pilot power (W) for furnaces with a continuous pilot.

Record 3, 12th entry (Integer): 1

Flag for forced-air duct system simulation. Not currently used.

Note that a blank line has to be inserted at the end of the hvac input file.

.vnt file inputs

First Line

Central Ventilation System (CVS) type

1	None
2	HRV
3	Fans with no heat recovery)

If Type 1 chosen:

Second Line
- Other Fans Type, point exhaust and supply fans
  - 1 None
  - 2 Other

Third Line
- First Entry
  - Central Ventilation System Supply flow rate, L/s
- Second Entry
  - Central Ventilation System Exhaust air flow rate, L/s
- Third Entry
  - Total fan power(watts)

If Type 2 chosen:

Second Line
- High Temperature HRV test data
  - First Entry
    - Temperature, °C,
  - Second Entry
    - Effectiveness, %
  - Third Entry
    - Fan + Pre-heater Power, Watts

Third Line
- Low Temperature HRV test data
  - First Entry
    - Temperature, °C,
  - Second Entry
    - Effectiveness, %
  - Third Entry
    - Fan + Pre-heater Power, Watts

Fourth Line
- Central Ventilation System Supply air flow Rate, L/s

Fifth Line
- HRV efficiency in cooling mode

Sixth Line
- Pre-heater capacity, Watts

Seventh Line
- Central Ventilation System Temperature Control Data
  - First Entry
    - Flag
      - 1 N/A
      - 2 N/A
      - 3 Temperature Controlled
      - 4 N/A
      - 5 N/A
      - 6 N/A
      - 7 N/A
  - Second Entry
    - Low Temperature Trip
  - Third Entry
    - High Temperature Trip

Eighth Line
- Supply Duct
  - First Entry
    - Vent. Duct Location: # of zone in which duct is located
  - Second Entry
    - Duct Type:
      - 1 Flexible
      - 2 Sheet metal with liner
      - 3 Ext. insulated Sheet metal
  - Third Entry
    - Sealing Characteristic
      - 1 Very Tight
      - 2 Sealed

3 Unsealed

Fourth Entry
Duct Length, m

Fifth Entry
Duct Diameter, mm

Sixth Entry
Insulation RSI

Ninth Line
Exhaust Duct

First Entry
Vent. Duct Location: # of zone in which duct is located

Second Entry
Duct Type:
4 Flexible
5 Sheet metal with liner
6 Ext. insulated Sheet metal

Third Entry
Sealing Characteristic
4 Very Tight
5 Sealed
6 Unsealed

Fourth Entry
Duct Length, m

Fifth Entry
Duct Diameter, mm

Sixth Entry
Insulation RSI

If Type 3 chosen:
Second Line
First Entry
Central Ventilation System Supply flow rate, L/s

Second Entry
Central Ventilation System Exhaust air flow rate, L/s

Third Entry
Total fan power(watts)

Third Line
Central Ventilation System temperature control data

First Entry
Flag
1 N/A
8 N/A
9 Temperature Controlled
10 N/A
11 N/A
12 N/A
13 N/A

Second Entry
Low Temperature Trip

Third Entry
High Temperature Trip

.dhw file inputs

First Line
Number of Tanks for the C=FCT project this is limited to 1

Second Line
NumOfOccupants.
Range: 1.0 to 100.0 people

Third Line
Mean Ground Temp
Range: 0.0 - 100.0 °C

Fourth Line
- Ground Temp Amplitude
  - Range: 0.0 - 100.0 °C

Fifth Line
- HotSupplyTemp
  - Range: 0.0 - 100.0 °C

Sixth Line
- Zone Location of Tank
  - Zone Number
  - Range; 1-10

Seventh Line
- FuelType
  - 1 Electric
  - 2 Gas
  - 3 Oil
  - 4 Propane,
  - 5 Wood
  - 6 Solar)

Eight Line
- TankType
  - Propane,Gas
    - 1 Conventional_tank
    - 2 Conventional_tank_pilot
    - 3 Tankless
    - 4 Instantaneous
    - 5 Instantaneous_pilot
    - 6 Induced_draft_fan
    - 7 Induced_draft_fan_pilot
    - 8 Direct_vent
    - 9 Direct_vent_pilot
    - 10 Condensing
  - Oil
    - 11 Oil_conventional_tank
    - 12 Oil_tankless
  - Wood
    - 13 Wood_Fireplace
    - 14 Wood_stove_water_coil
  - Electric
    - 15 Elec_Conventional_tank
    - 16 Elec_Conserver_tank
    - 17 Elec_Tankless_Heatpump
    - 18 Elec_Heatpump
    - 19 Elec_Instantaneous
  - Solar
    - 20 Solar_Collector_System

Ninth Line
- Efficiency of tank
  - Range: 0.0 – 2.0

Tenth Line
- Heat Injector Power
  - Range: 0.0 - 1000000.0 Watts

Eleventh Line
- Pilot Energy Rate
  - Range: 0.0 - 1000000.0 Watts

Twelfth Line
- Tank Size
  - Range: 1.0-5000.0 Litres

Thirteenth Line
- Temperature Band
  - Range: 0.0 - 99.0 °C

Fourteenth Line
- Blanket RSI

Range: 0.0 - 99.0