UNR's Universal Thermal Model for RA Thermal Rating Verification

Presented by

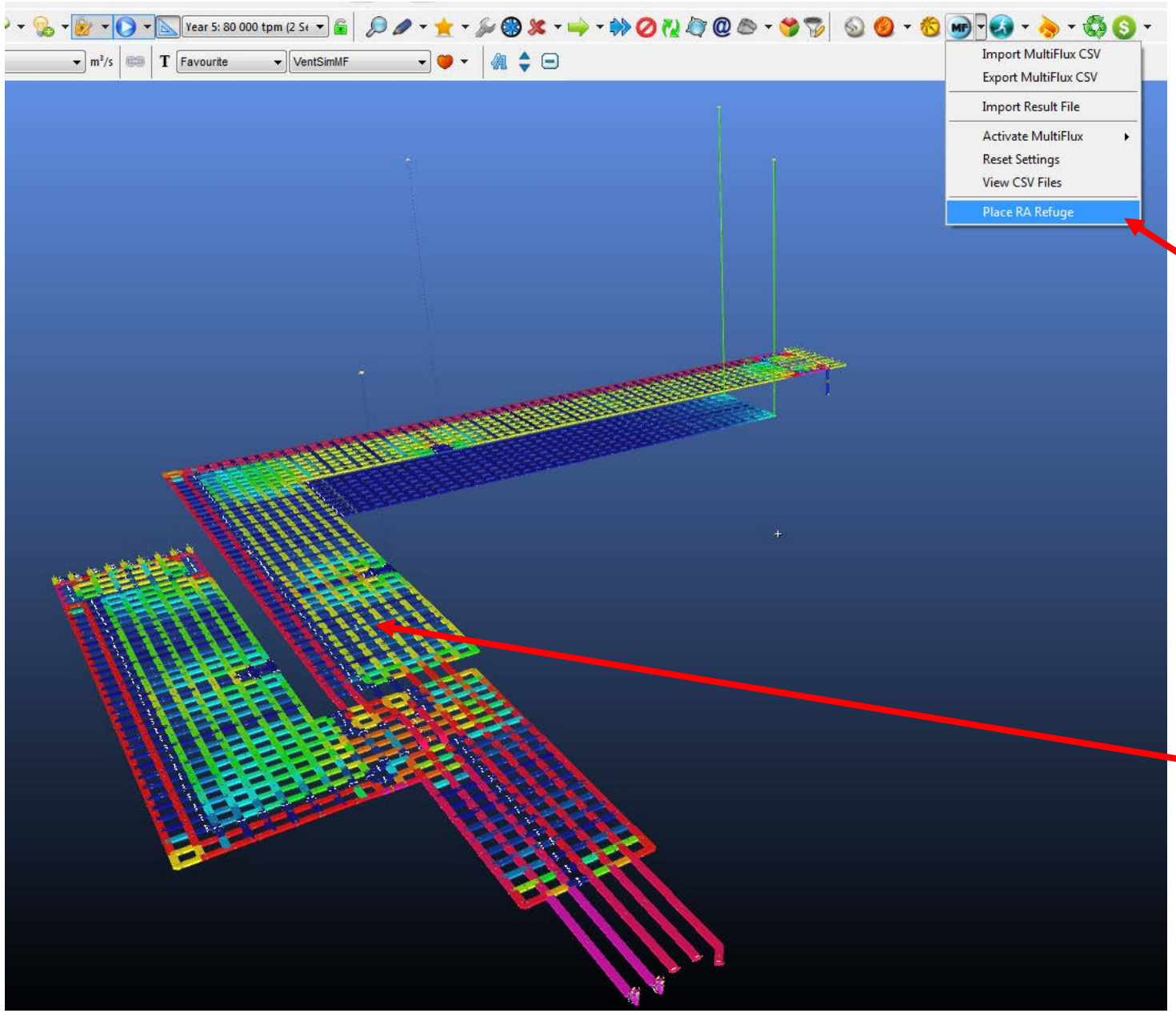
Dave Yantek, NIOSH Pittsburg Center

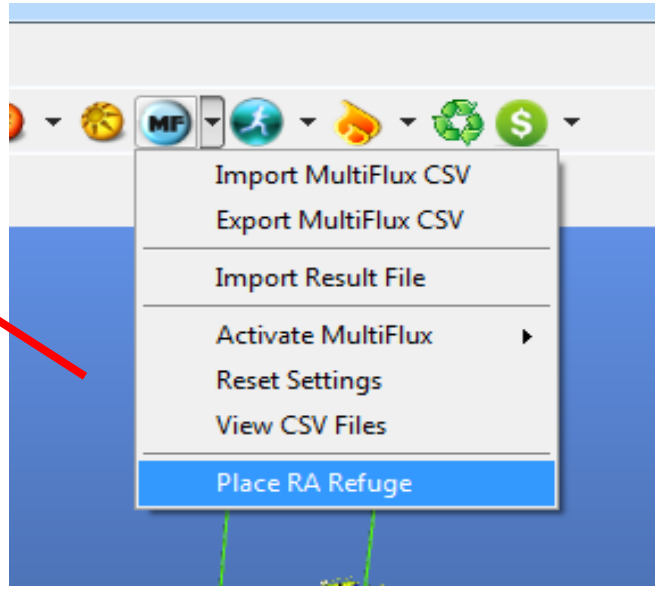
Contributed by

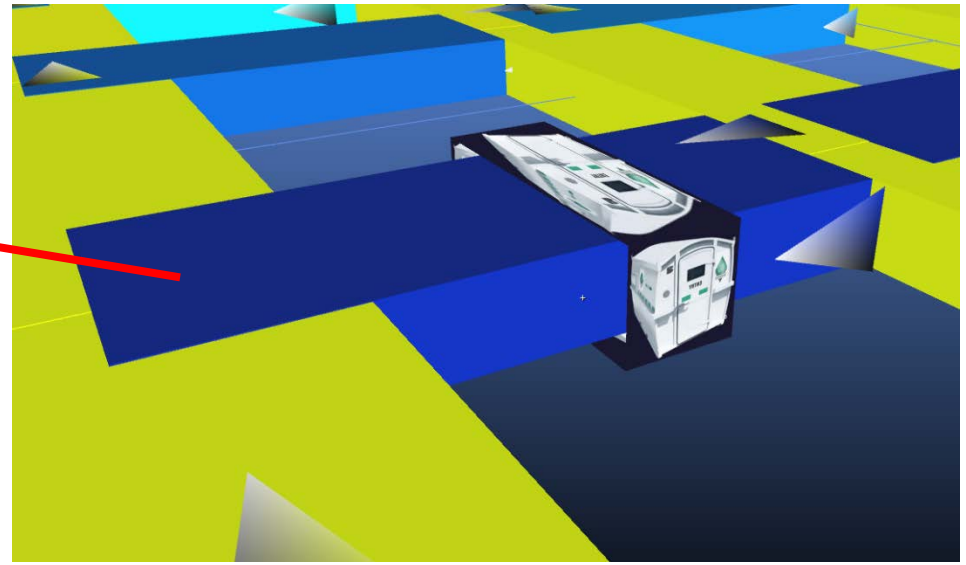
Davood Bahrami and George Danko, UNR (MULTIFLUX thermal model)

Craig Stewart and Craig Christensen, Chasm (Ventsim graphical User Interface)

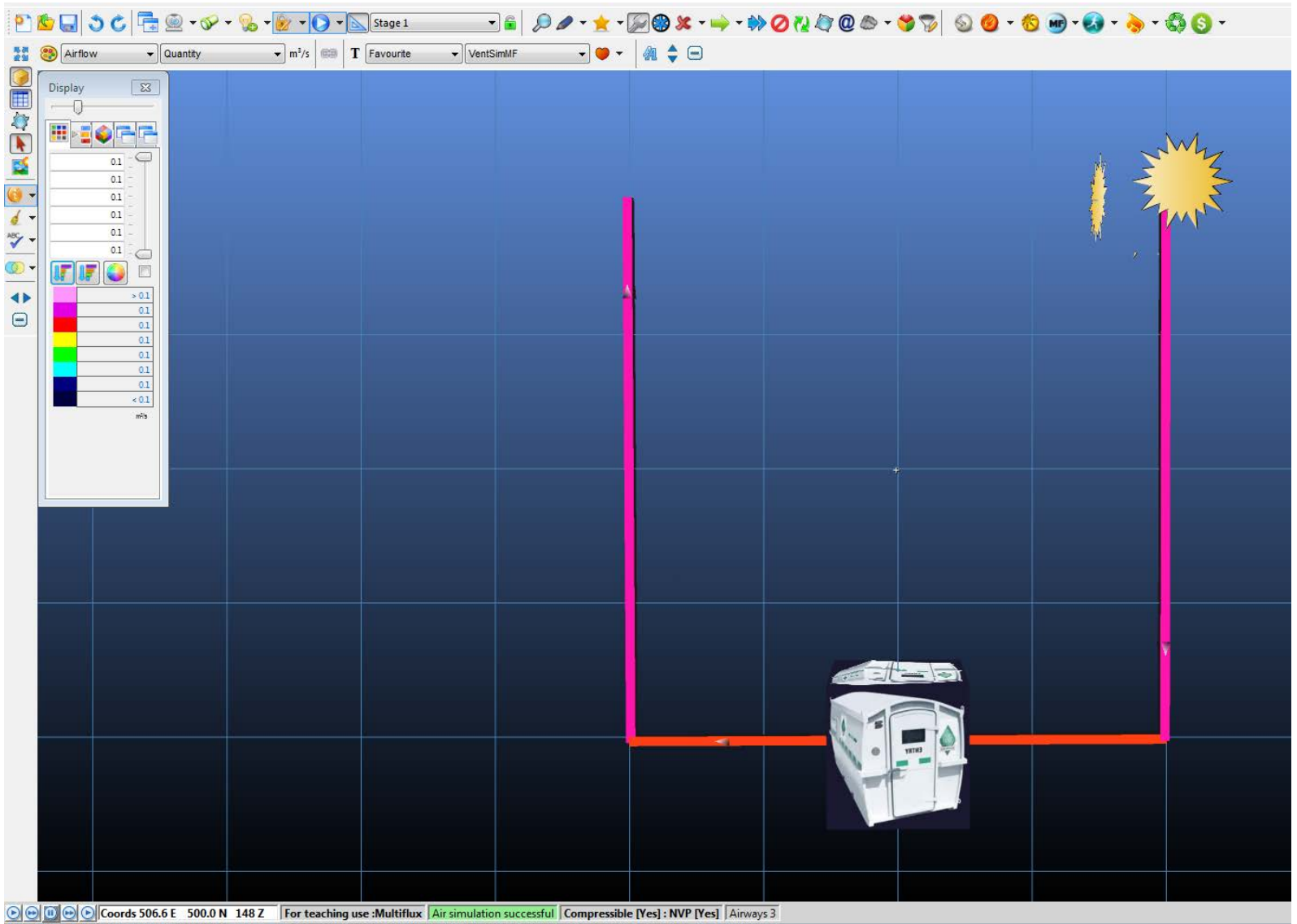
Insertion of the location of the RA in the mine in Ventsim's GUI





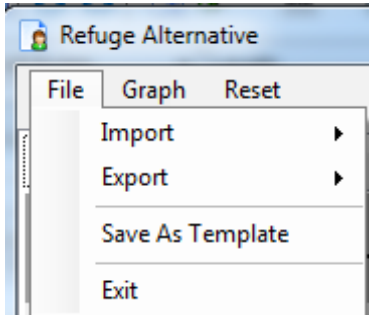


Simple mine layout: manual insertion of an RA



Data input tab for the RA in the GUI

File menu options



Refuge Alternative

File Graph Reset

Select Template

Room | HSE Data General | HSE Data Individual | Scrubber | Inside Conditions | Outside Conditions | RA Insulation | Miscellaneous

Refuge Alternative User Input Template

Capacity

Number of rows of occupants along length	5.00	
Number of occupants in each row	2.00	

Main Shelter Room Dimensions

Length	6.000	m
Width	2.90	m
Height	1.06	m

Utility Room Data

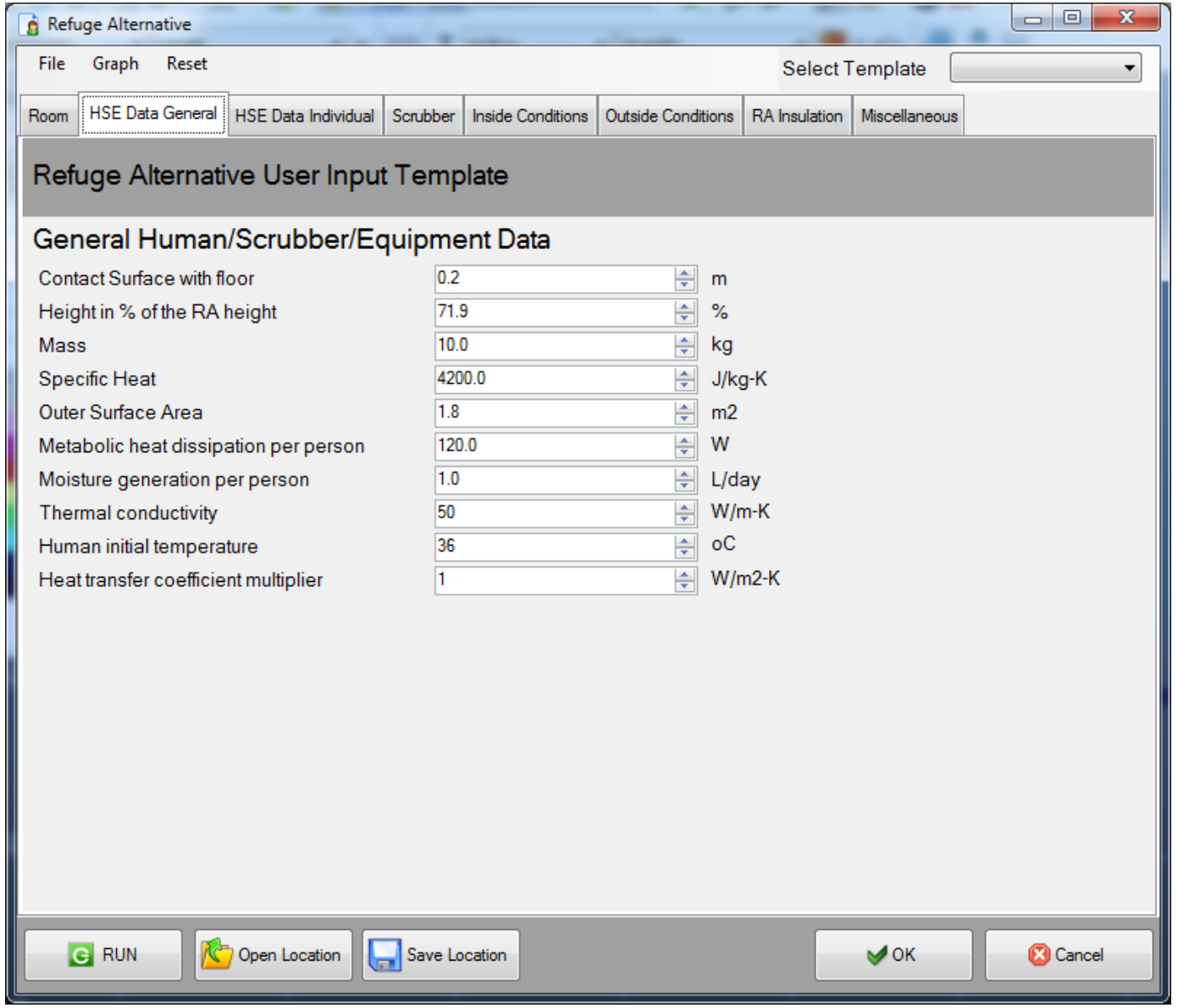
Length	0.99	m
Width	1.97	m
Height	1.06	m
Thickness	0.01	m
Thermal Conductivity	50	W/m-k
Heat transfer Coefficient Multiplier	1	

Connection between Utility Room and Main Shelter Room

Open connecting cross section surface area (%) (Percent of width x height of the RA):	100	%

RUN | Open Location | Save Location | OK | Cancel

Data input tab for the RA in the GUI



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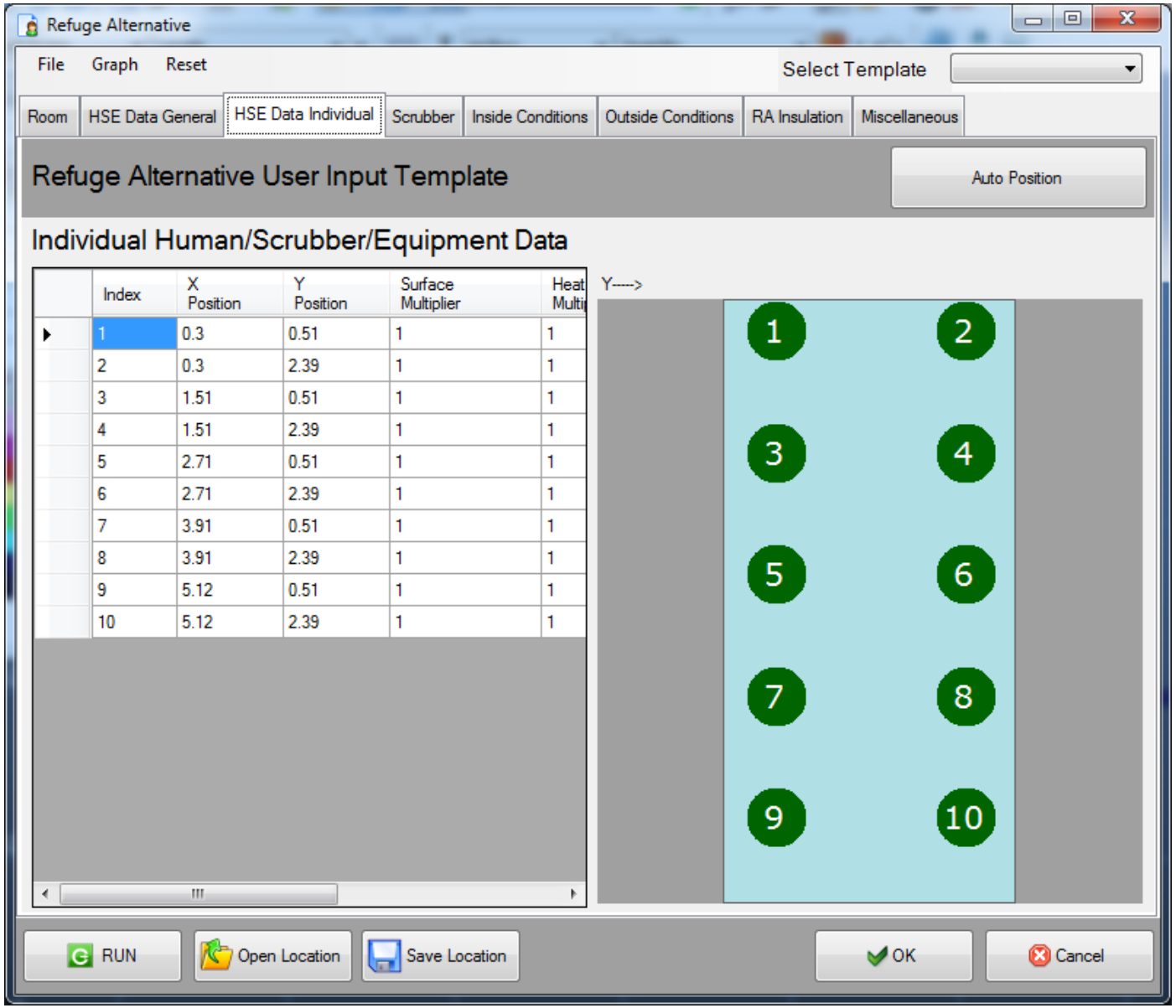

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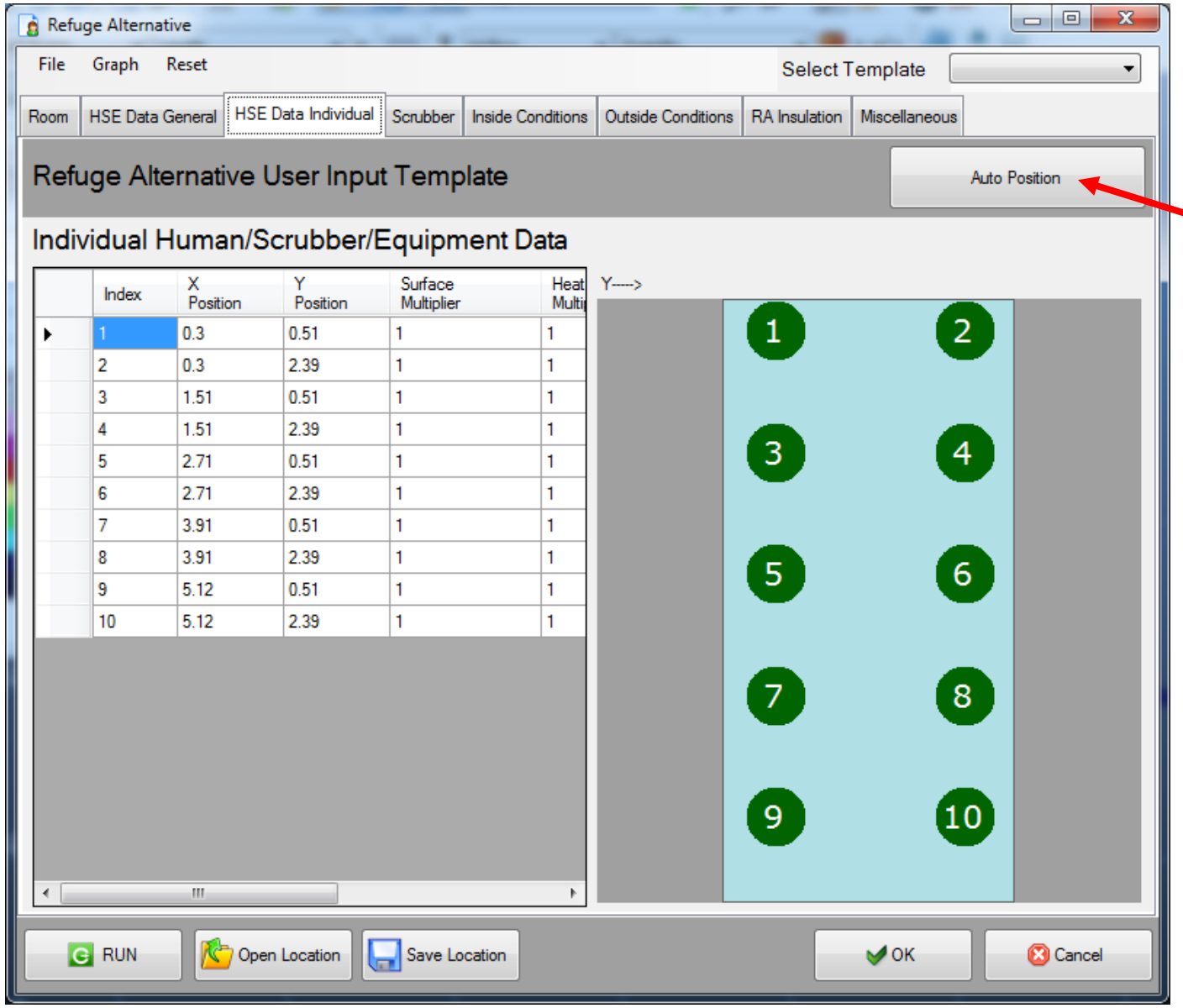
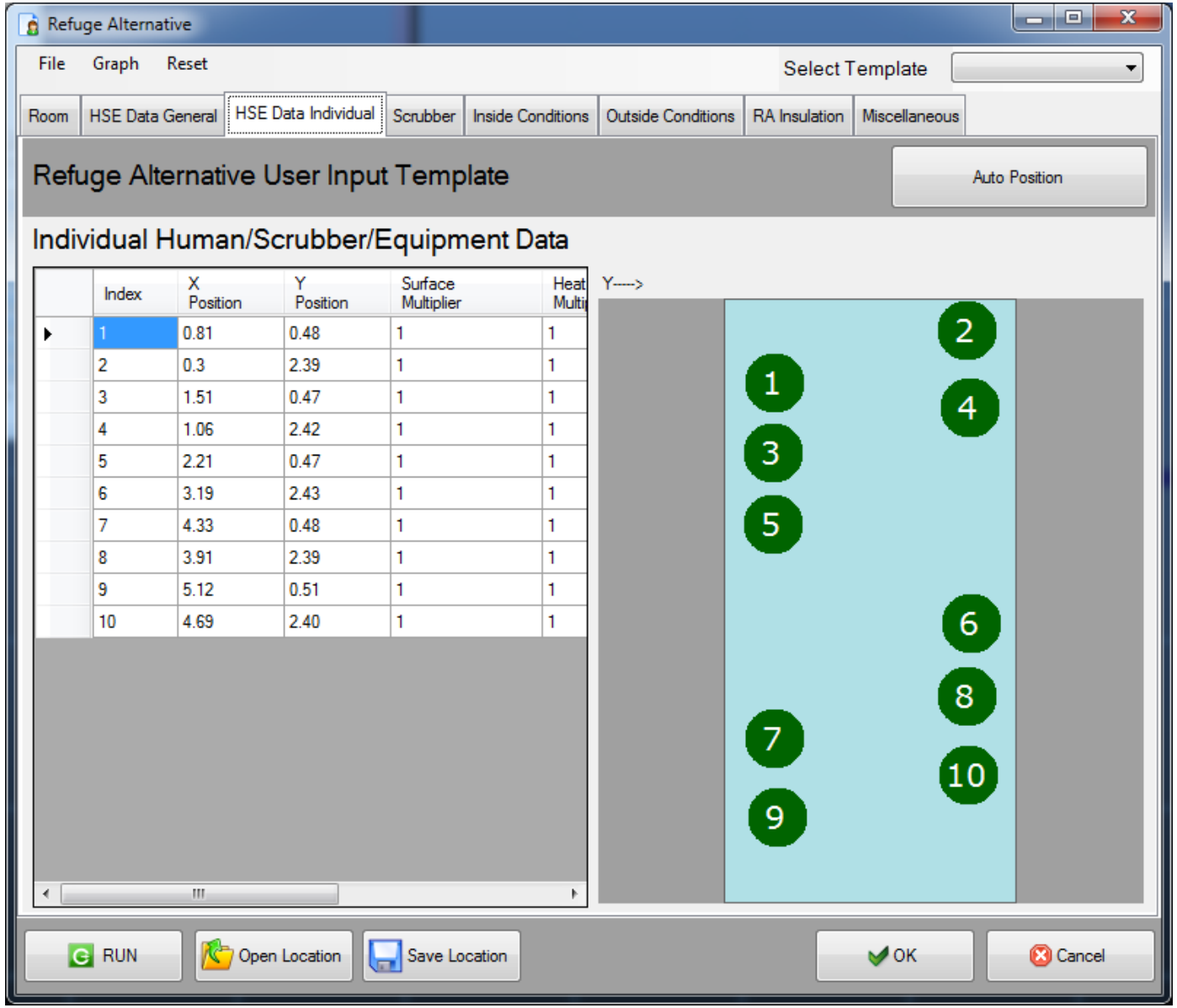


Auto Position:
Default uniform arrangement of occupants

Data input tab for the RA in the GUI

Modified arrangement of occupants by manually moving the occupants or entering new data



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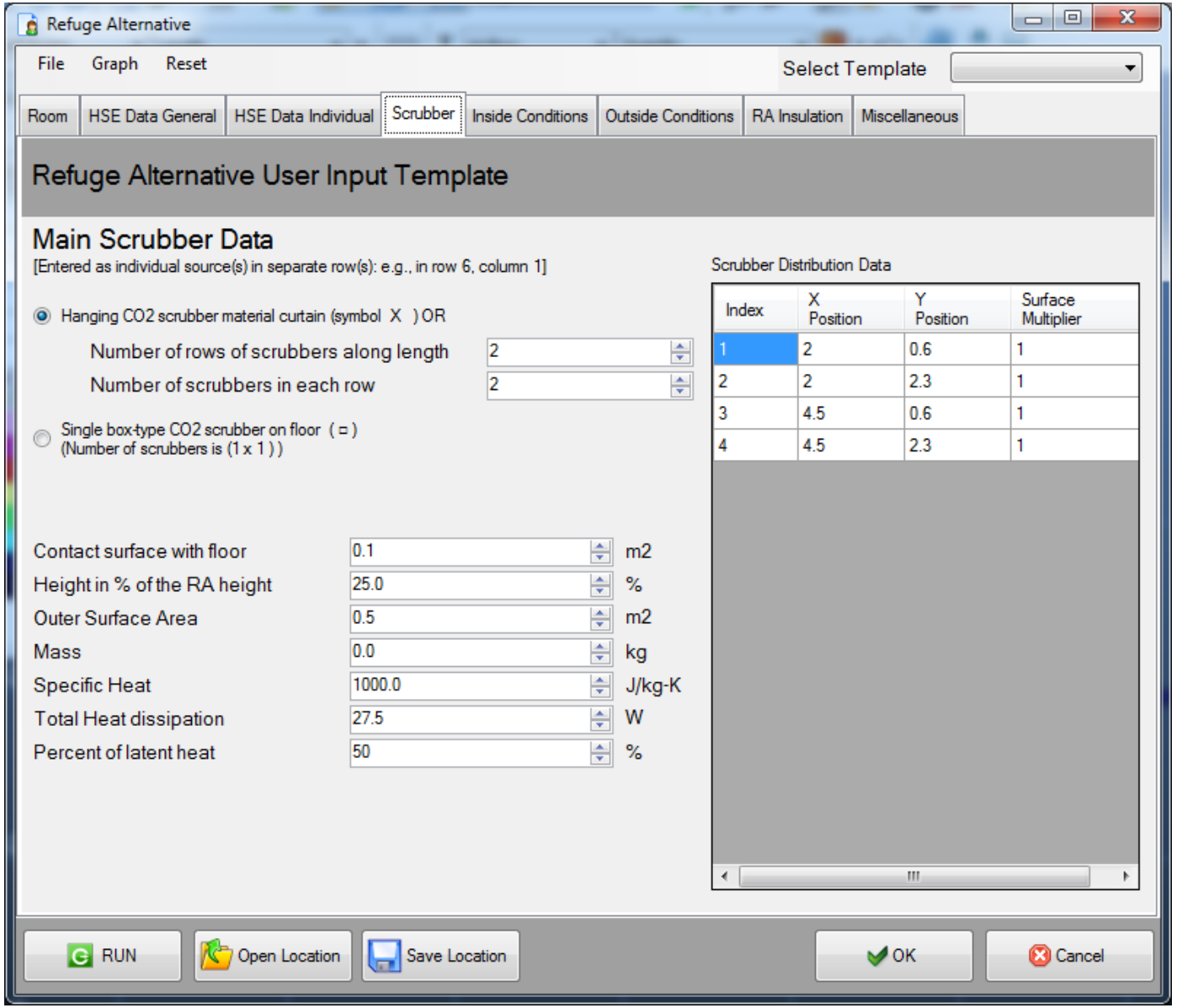
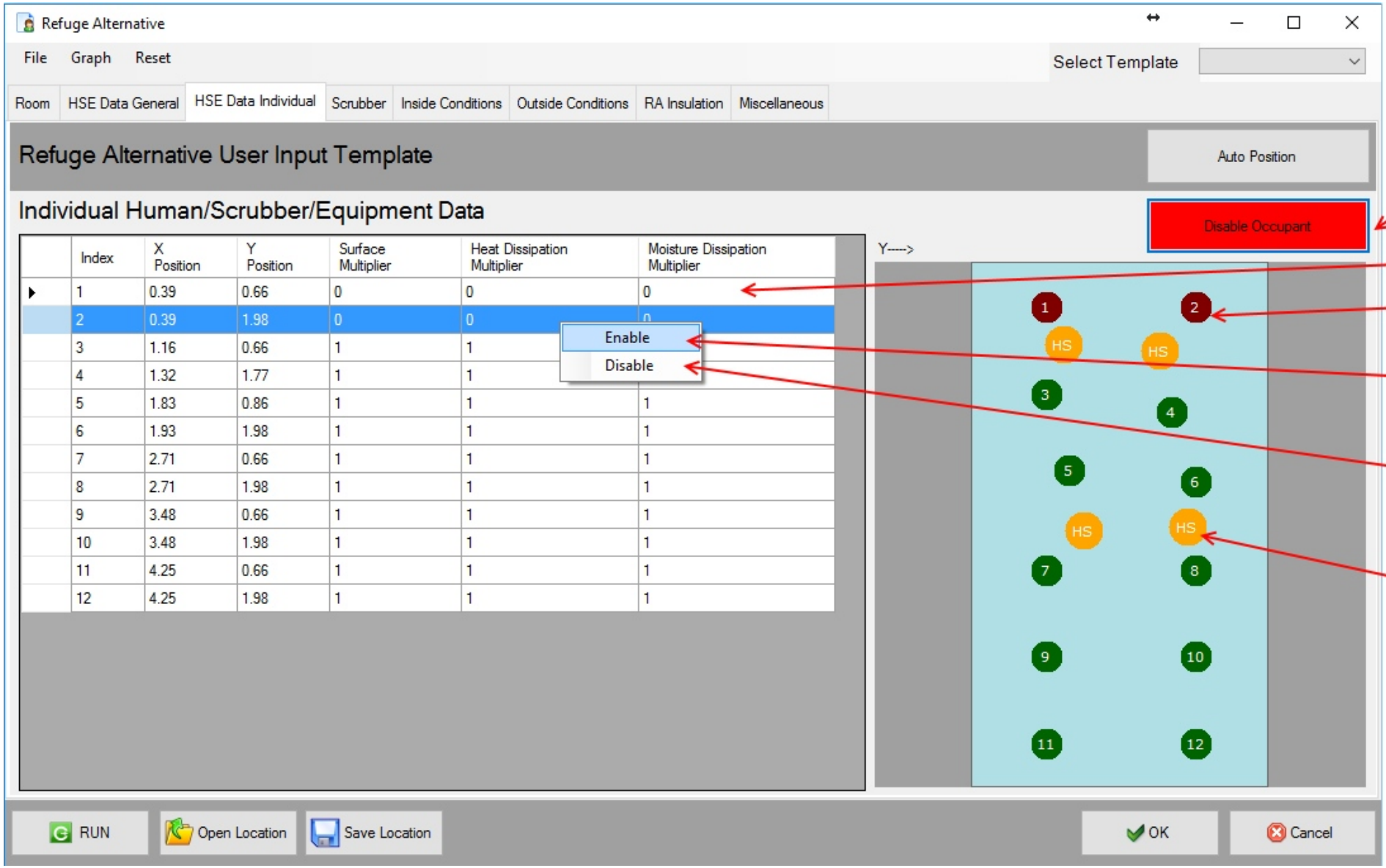


RA Example: a 10-person RA with hanger-type CO_2 scrubber



Toggles disable/Move Mode

Disabled sets all 3 Multipliers to 0

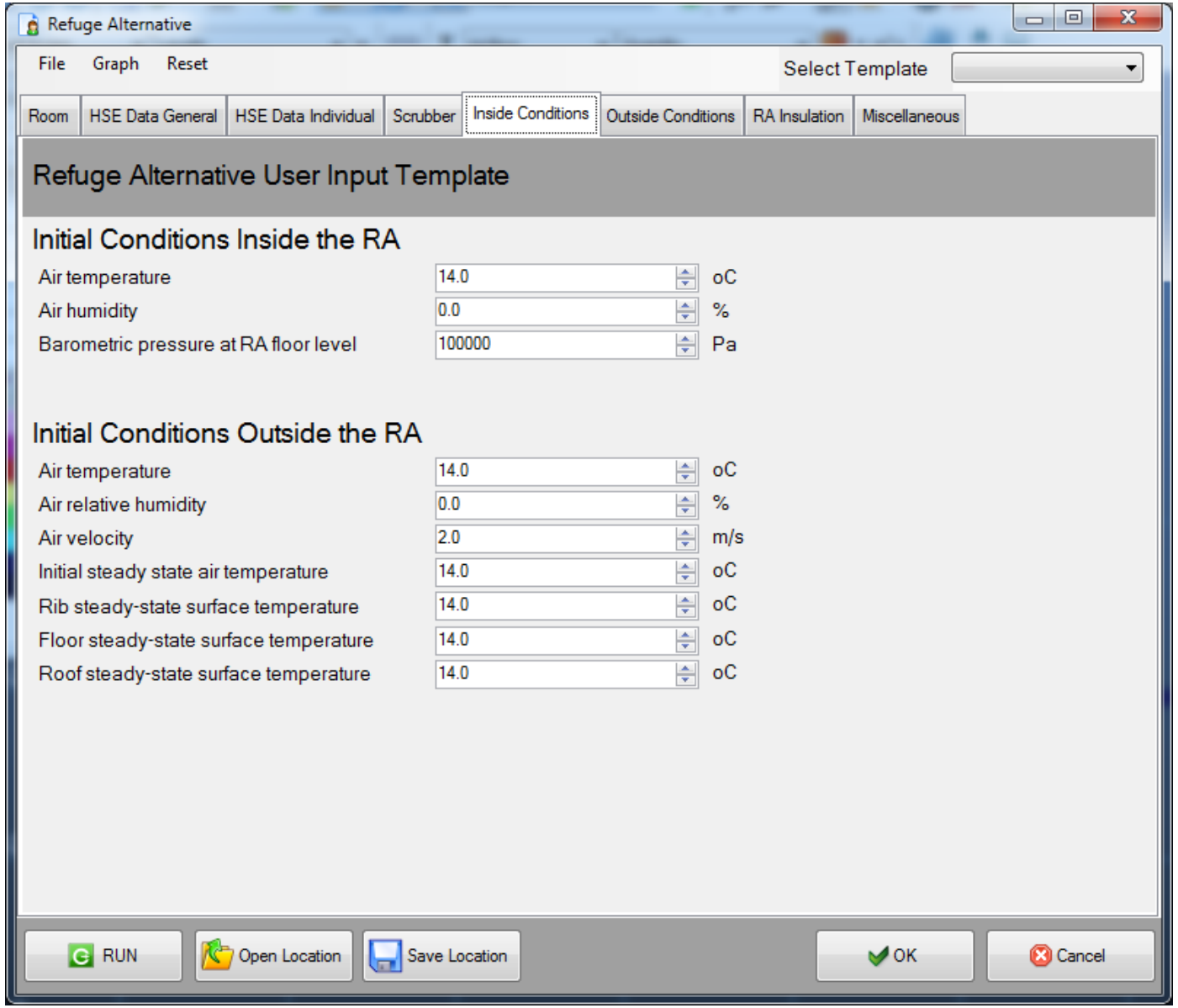
Disabled items are red

Pressing enabled here will flick all Multipliers to 1

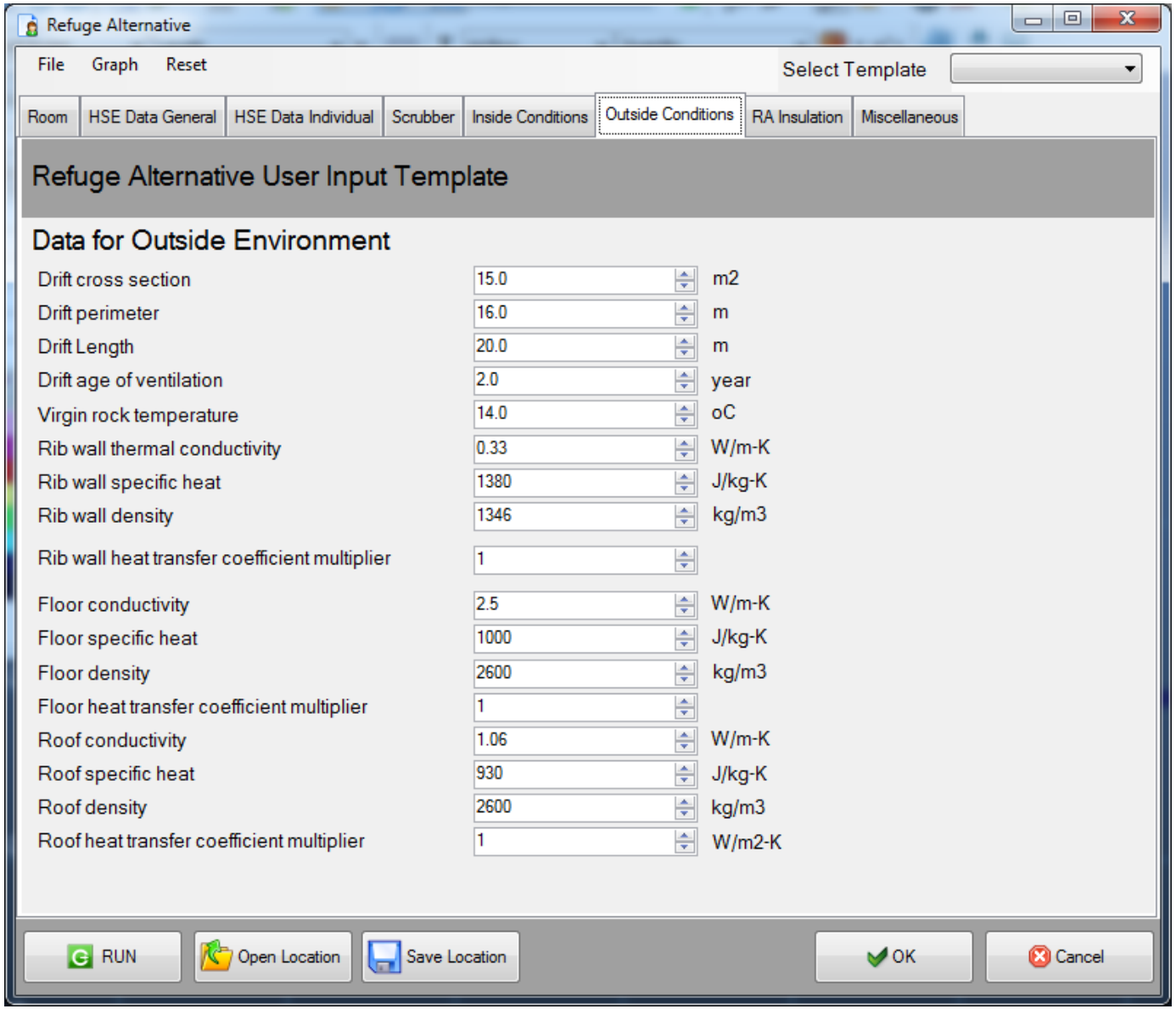
Pressing Disabled here will disable the occupant by setting all multipliers to 0

Hanger Scrubber Icon Movable by Dragging just like the Occupants

Data input tab for the RA in the GUI



Data input tab for RA from within the GUI



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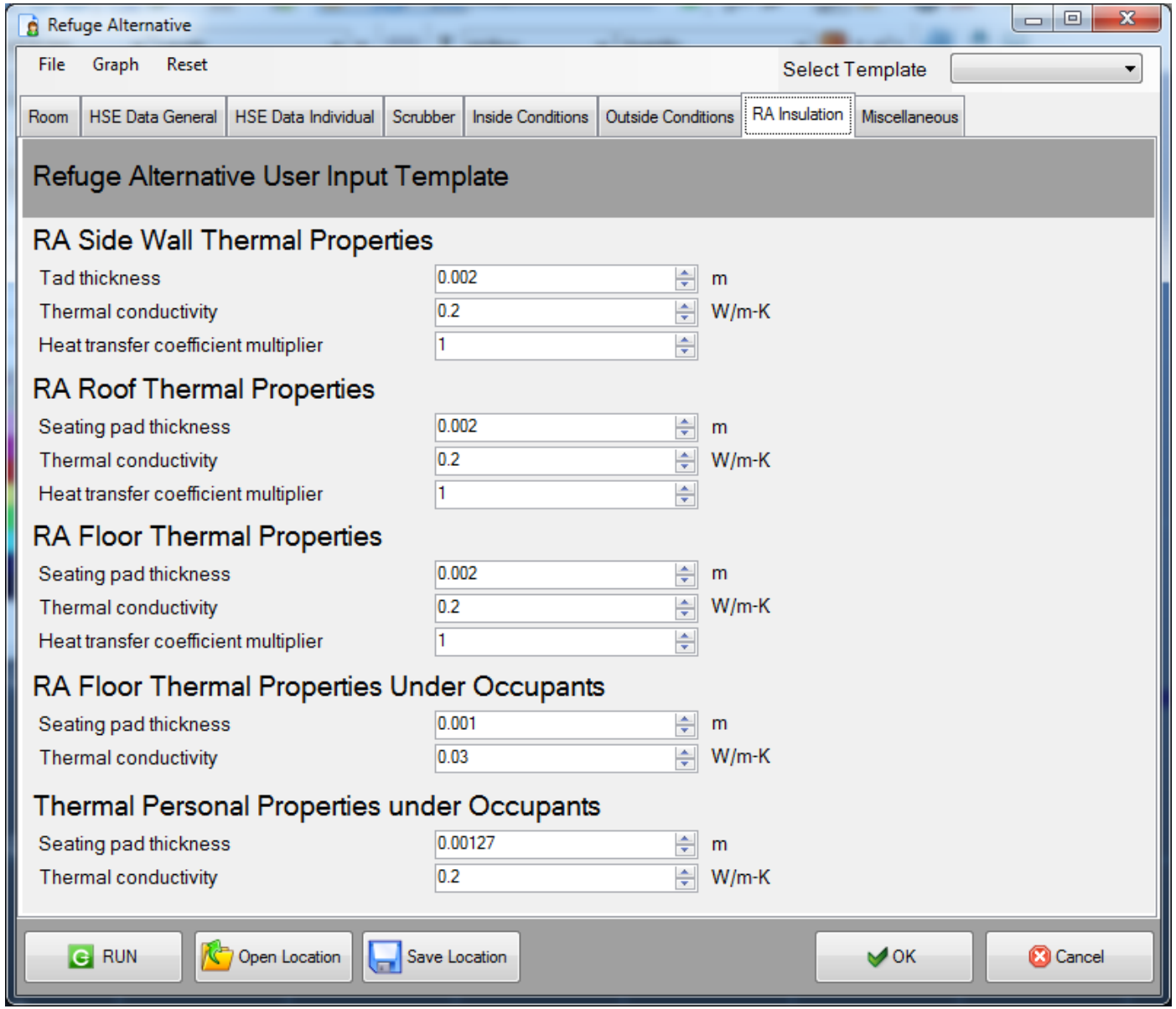

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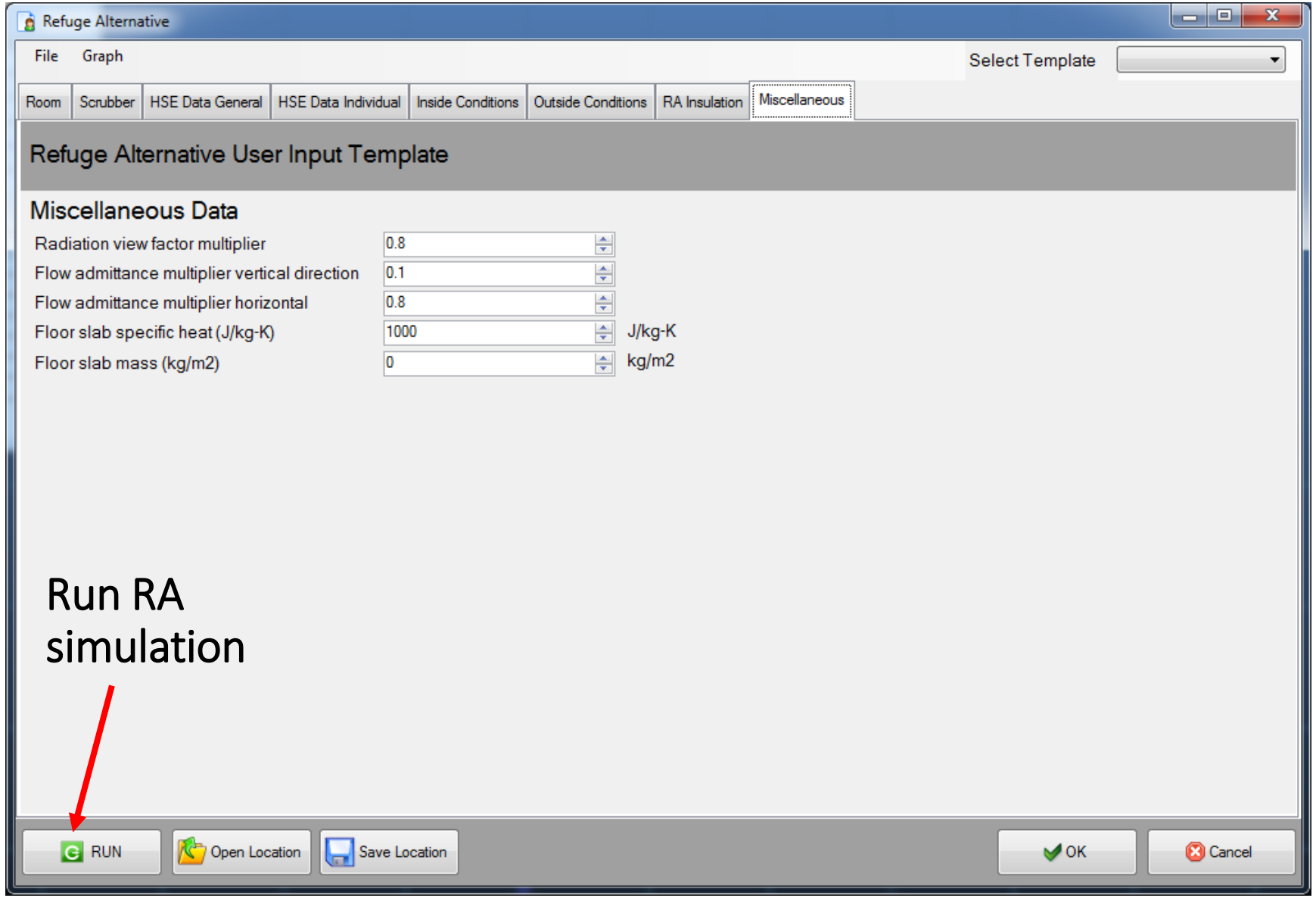
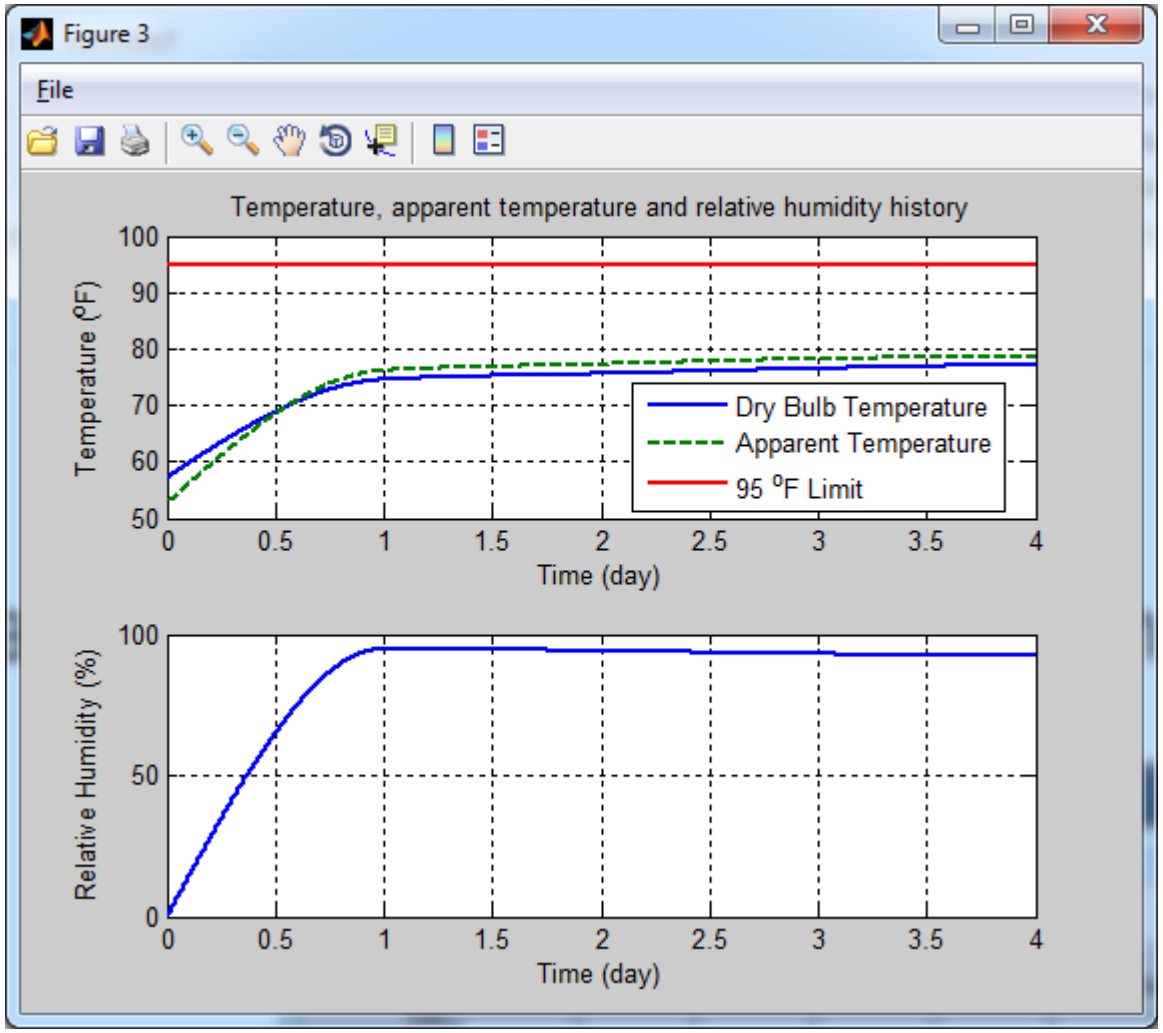
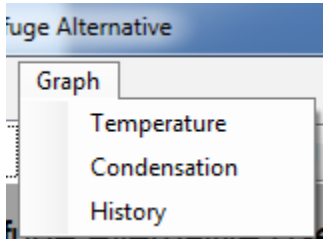


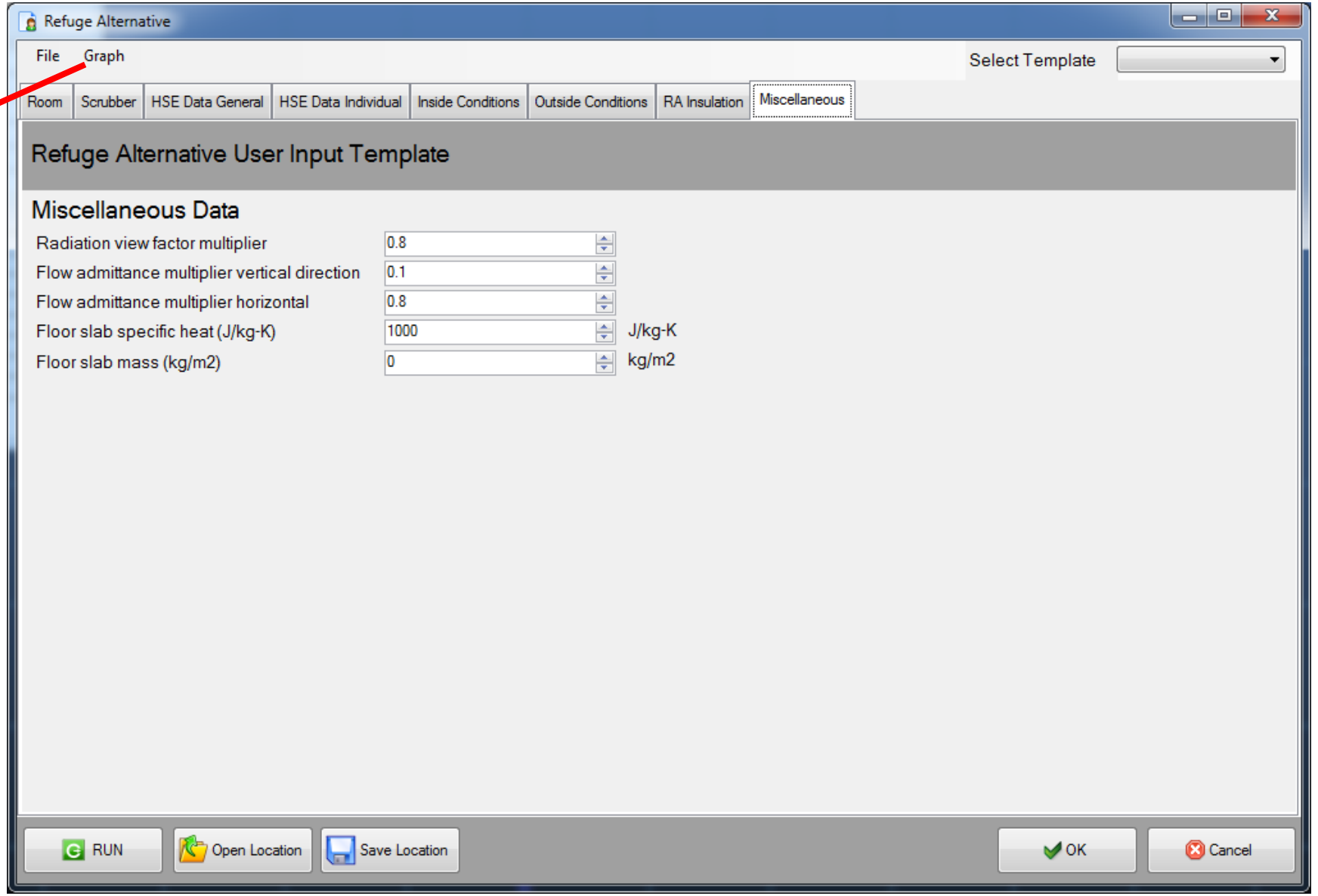
Temperature history plot upon successful completion of simulation



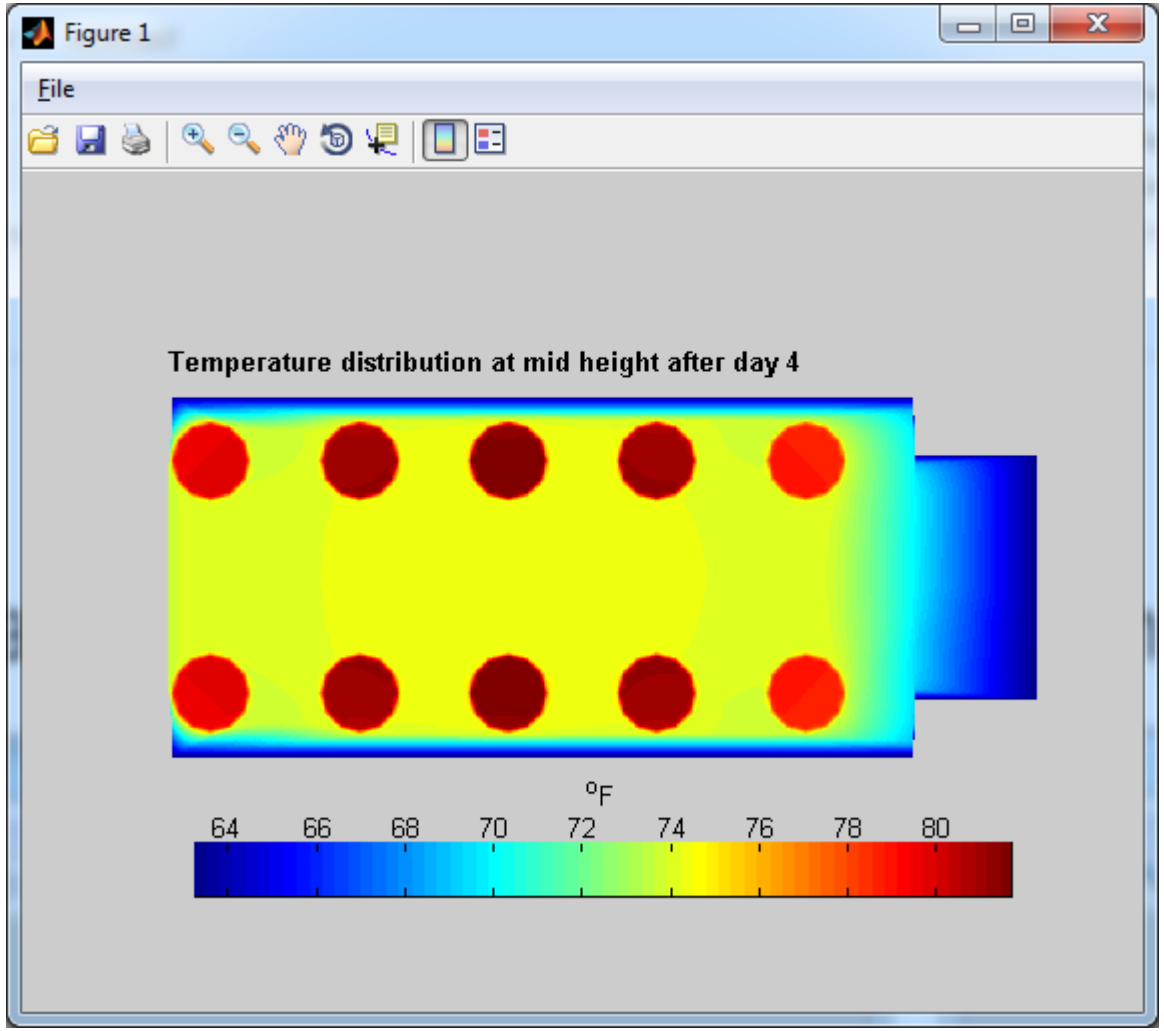
Data input tab for RA from within the GUI

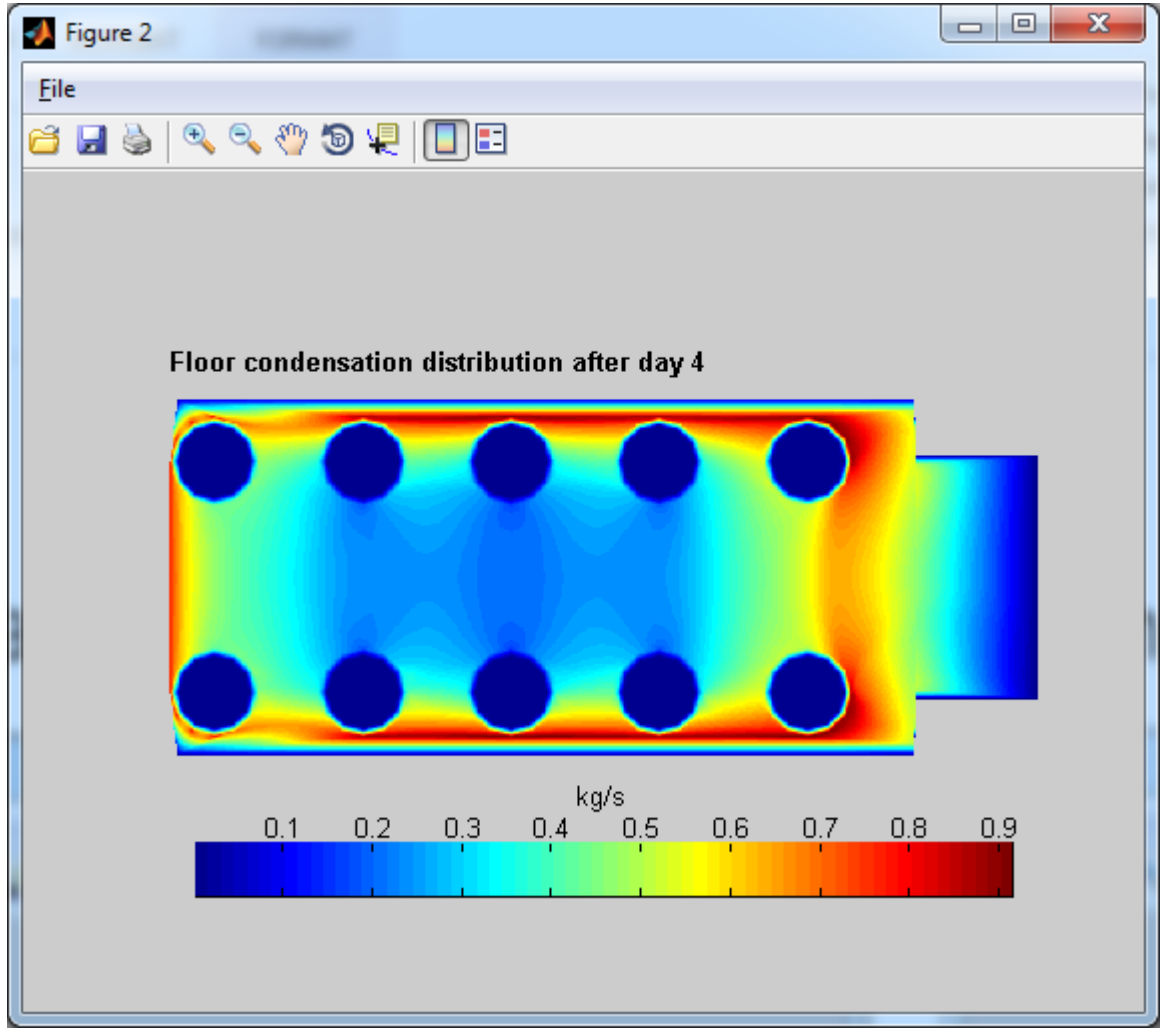
Graph menu options





More results for the 10-person RA, uniform distribution of occupants, hanger-type CO_2 scrubber

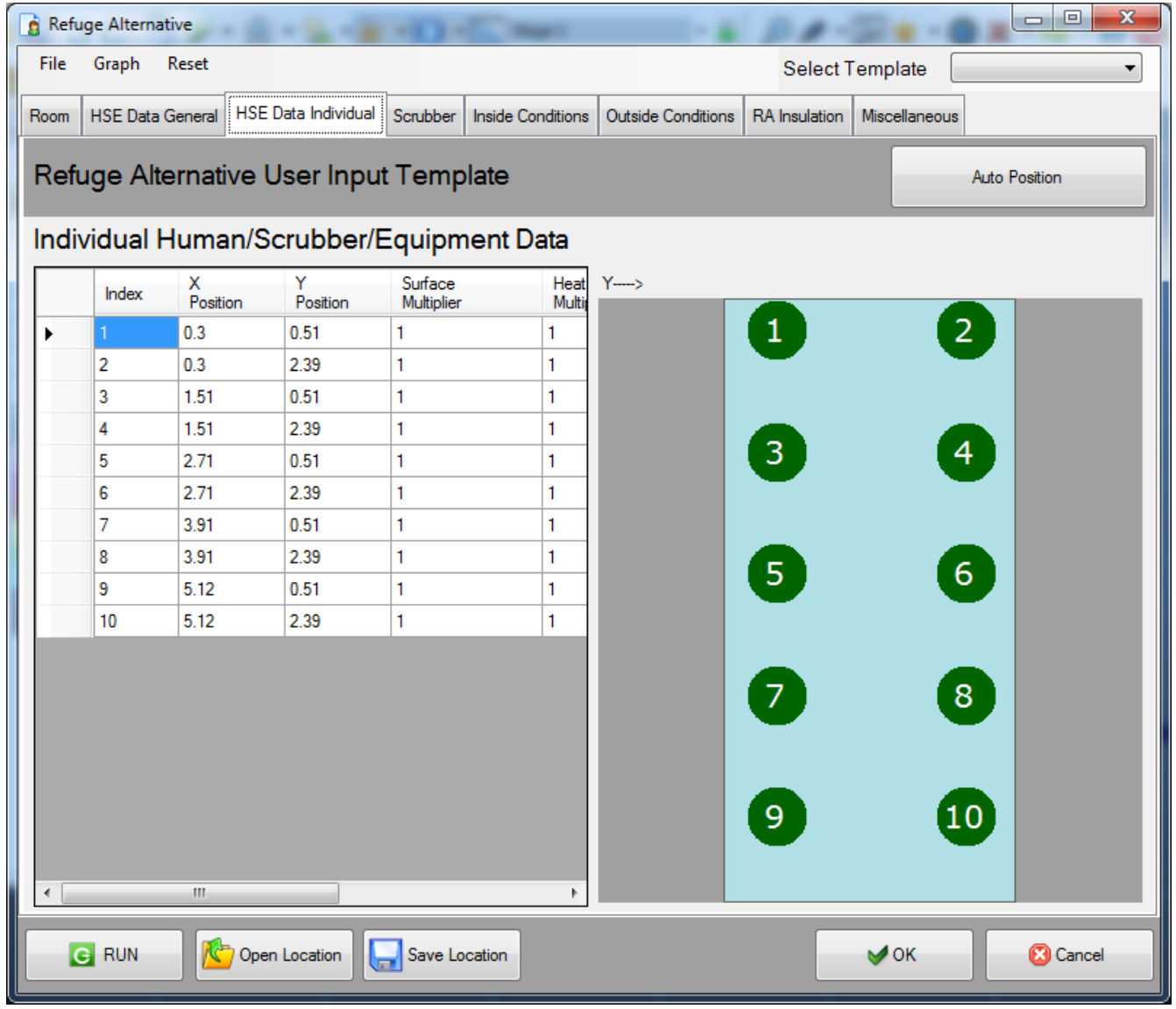




Temperature and condensation distribution maps

Results of RA examples

Example 1: 10-person RA, uniform distribution of occupants, hanger-type CO_2 scrubber, 57.2 ^{o}F ambient temperature (repeated)



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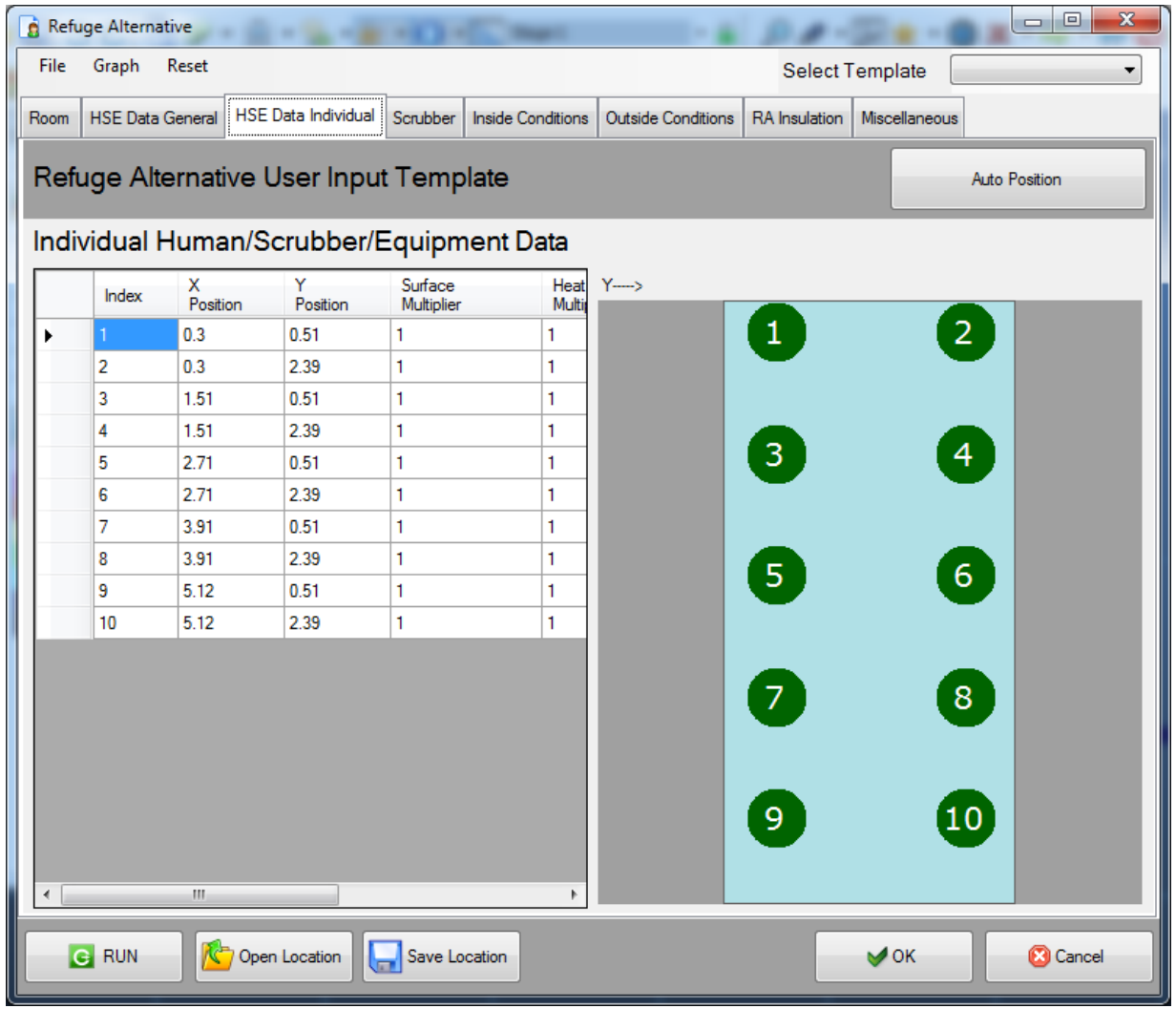

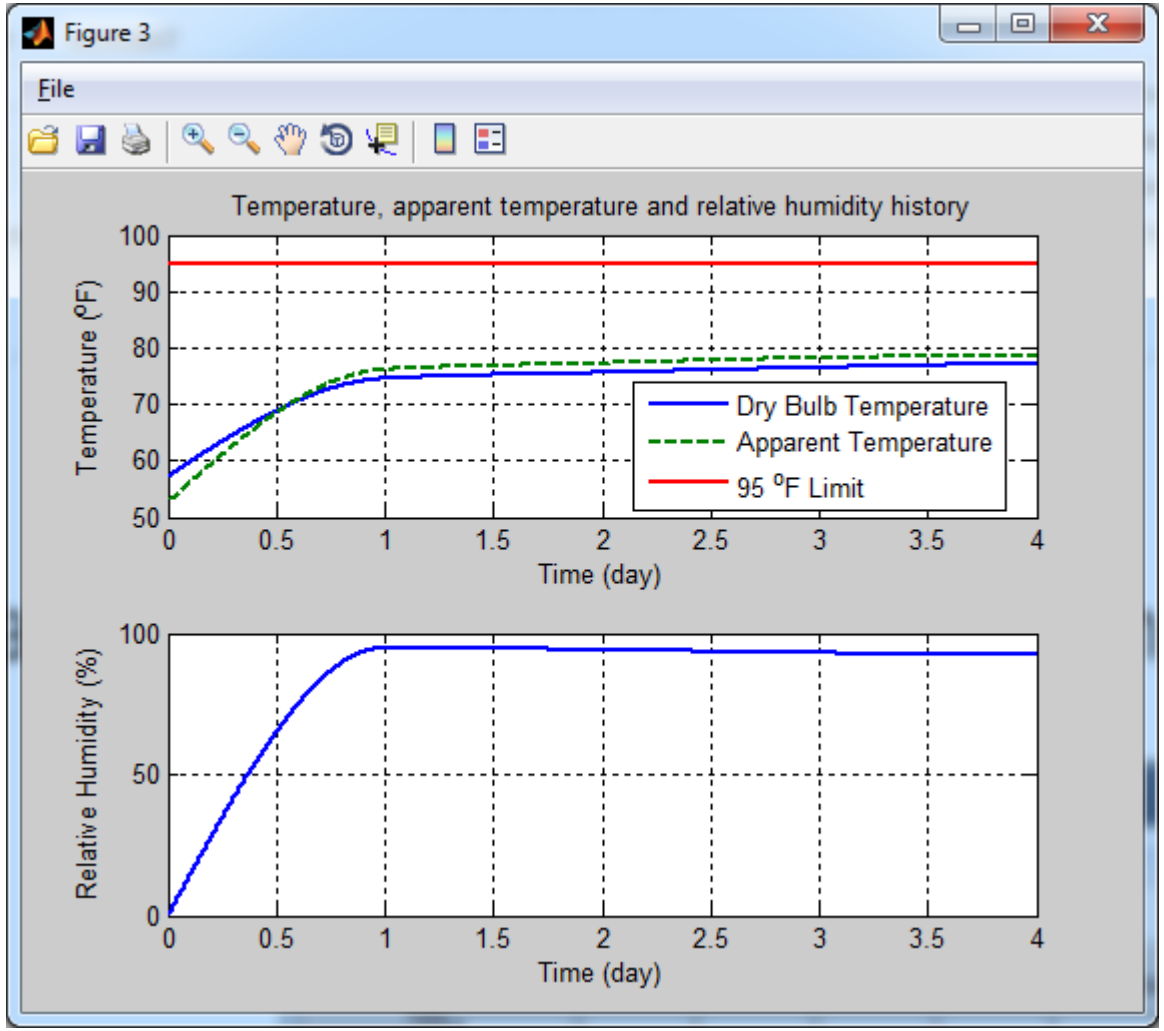

Temperature and humidity vs. time

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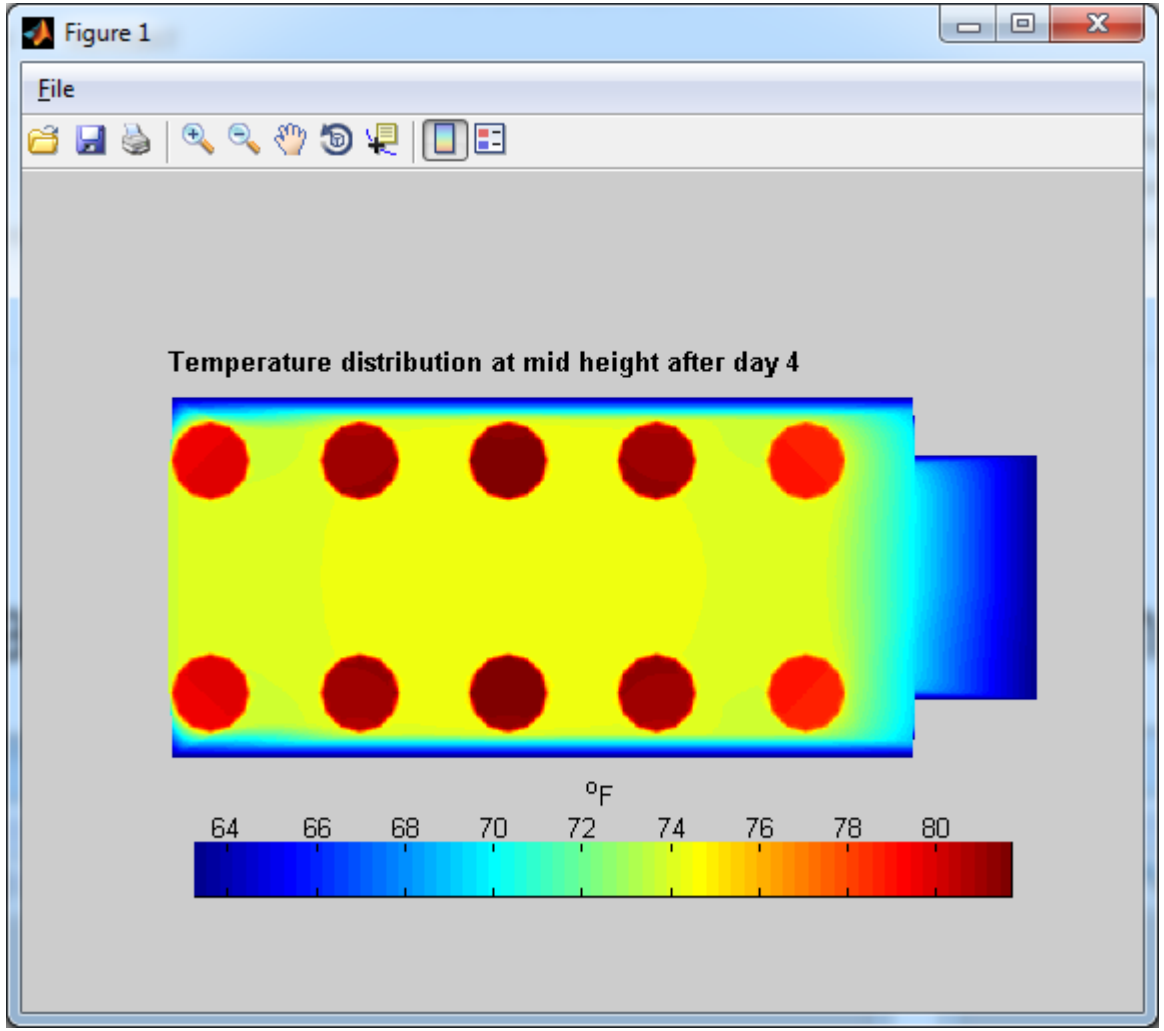
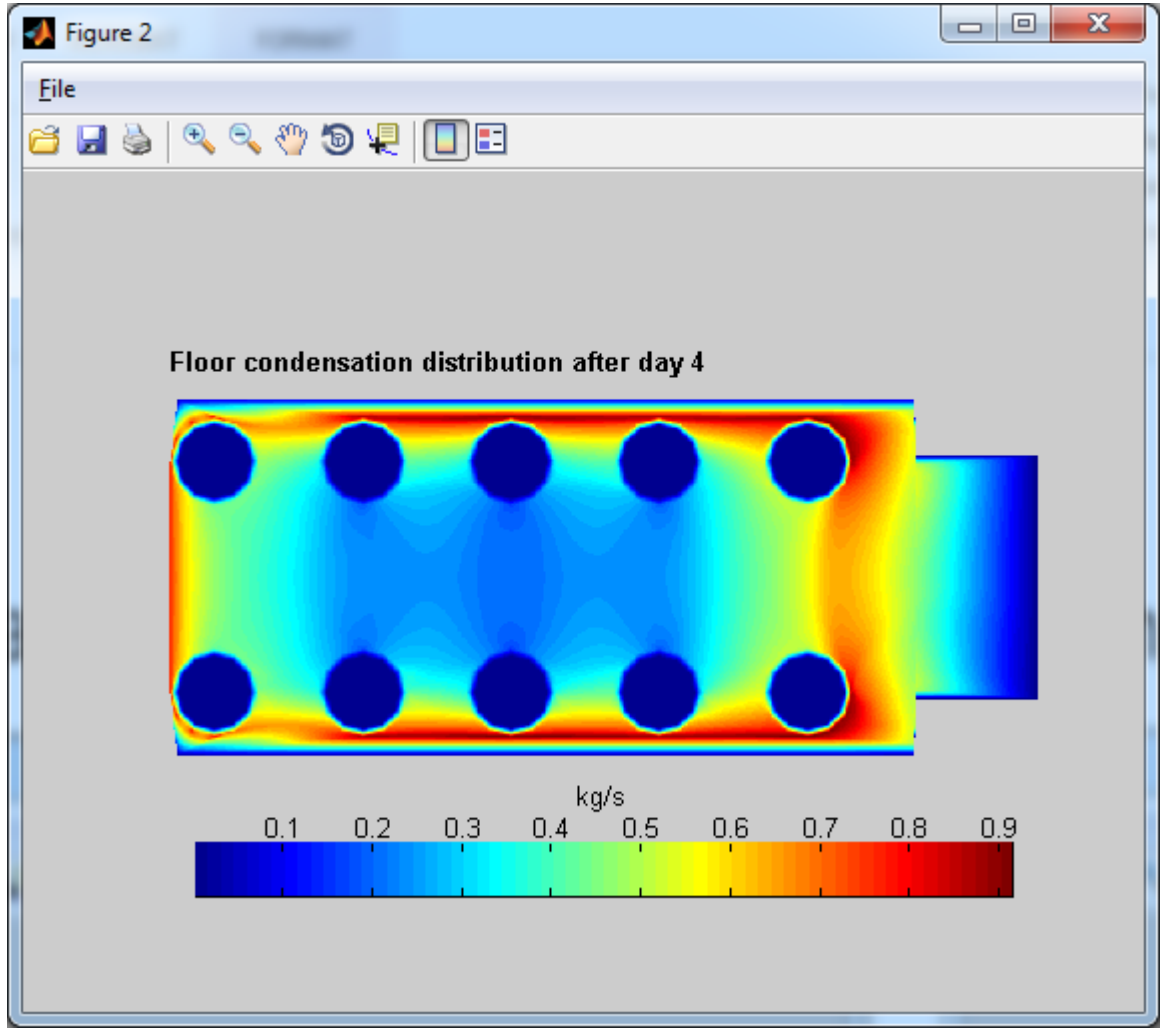
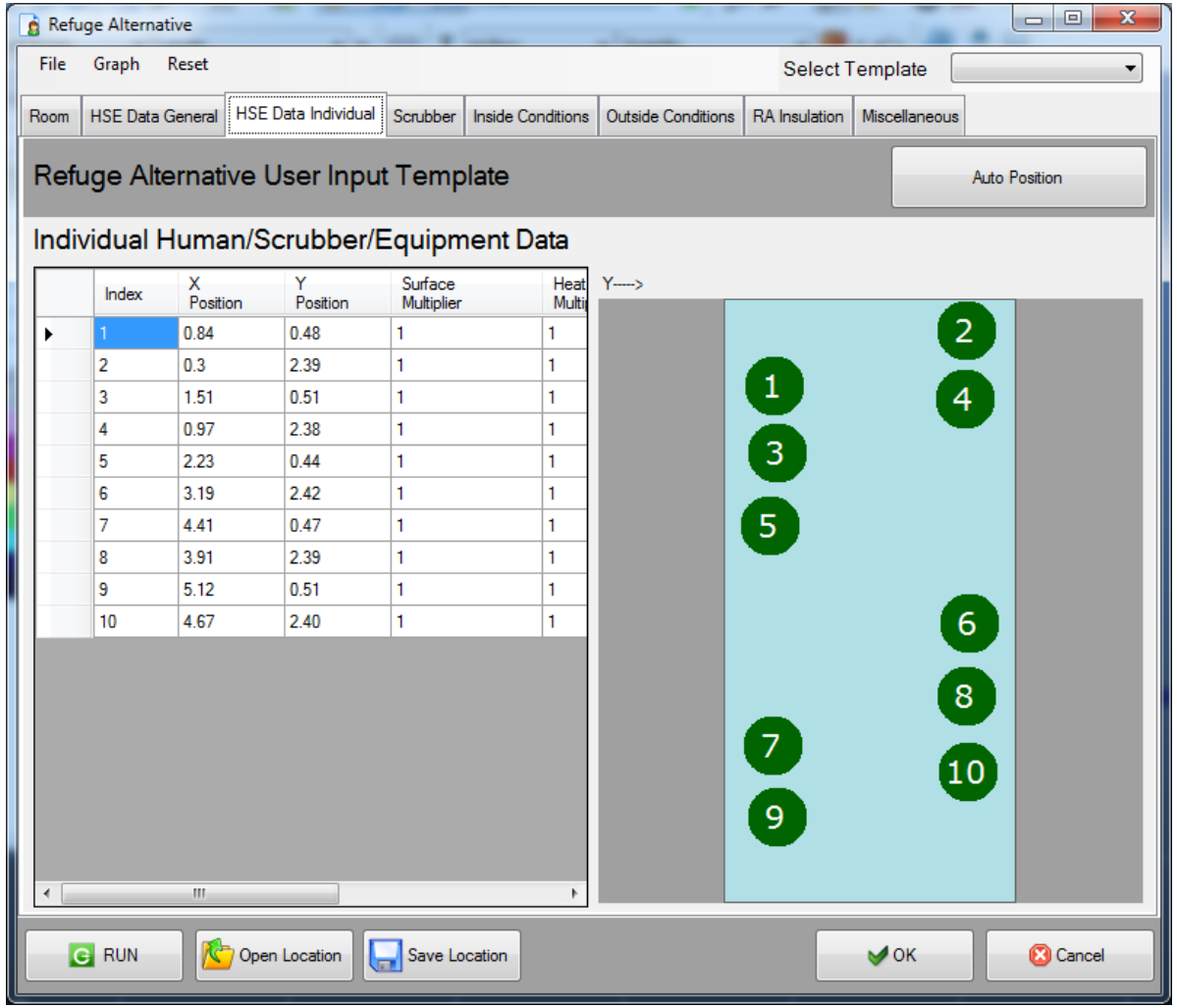


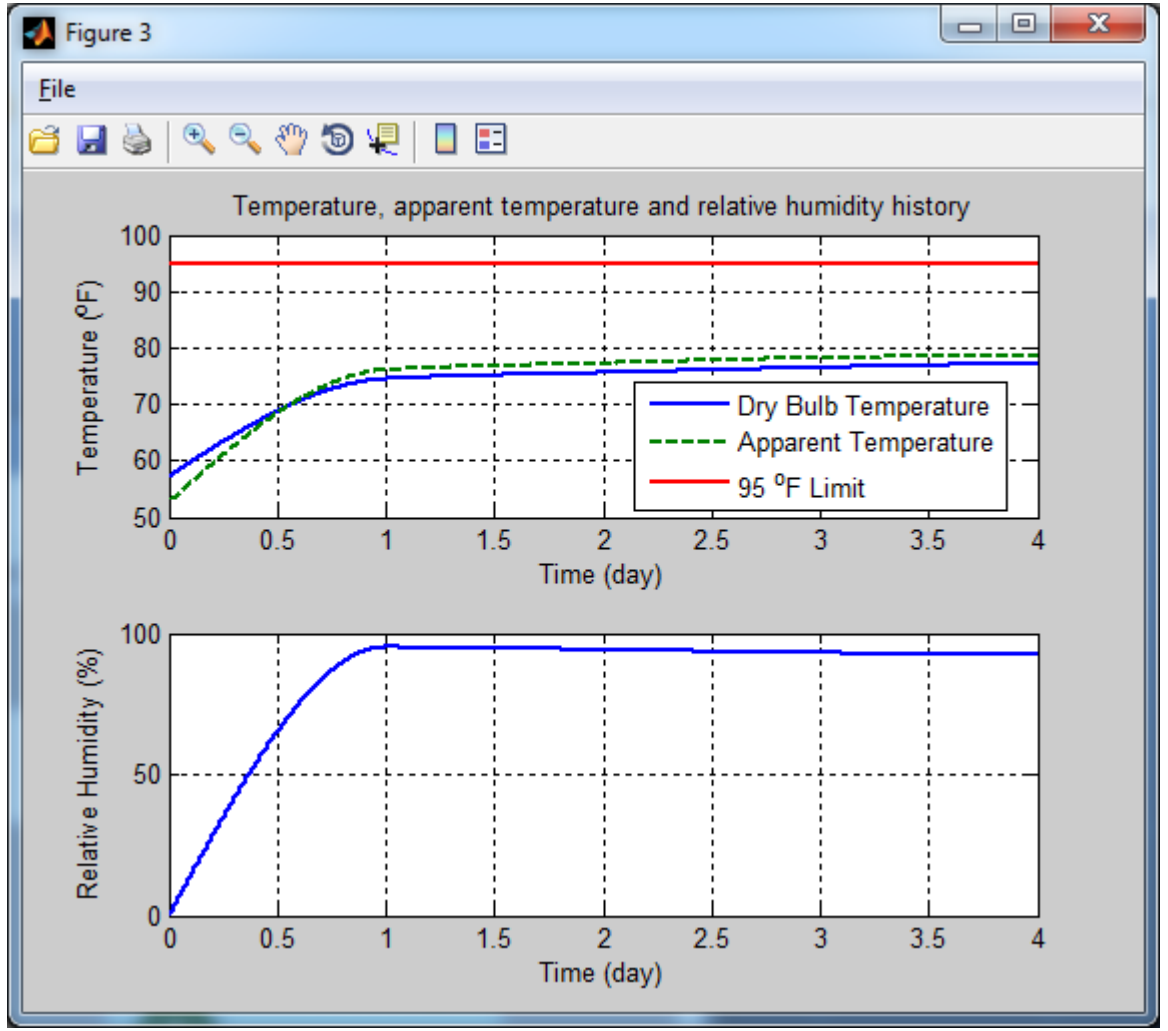


Temperature and condensation distribution maps

Example 2: 10-person RA, non-uniform distribution of occupants, hanger-type CO_2 scrubber, 57.2 °F ambient temperature

Manually moved occupants, other parameters unchanged





Temperature and humidity vs. time

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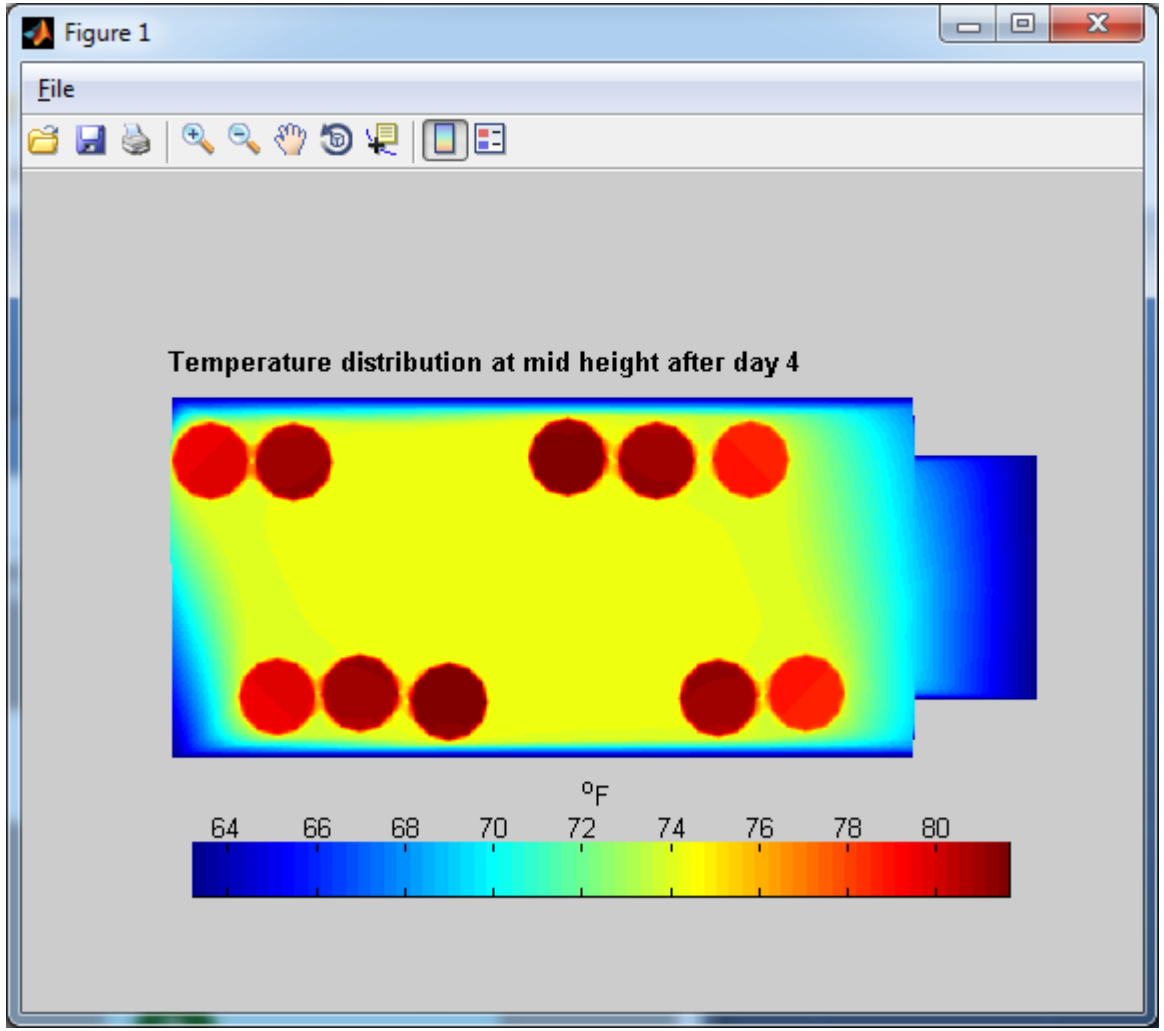
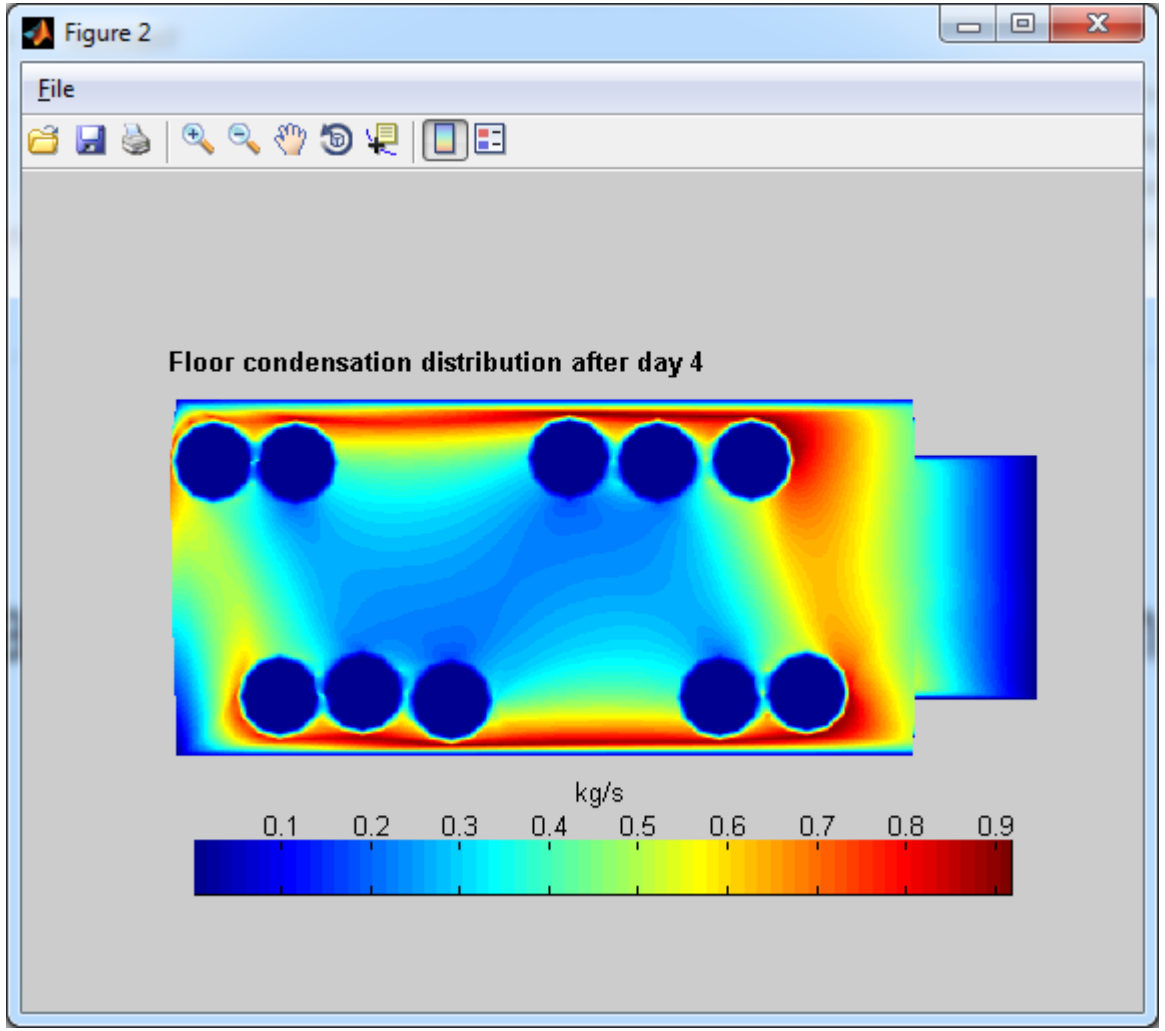
Manually moved occupants

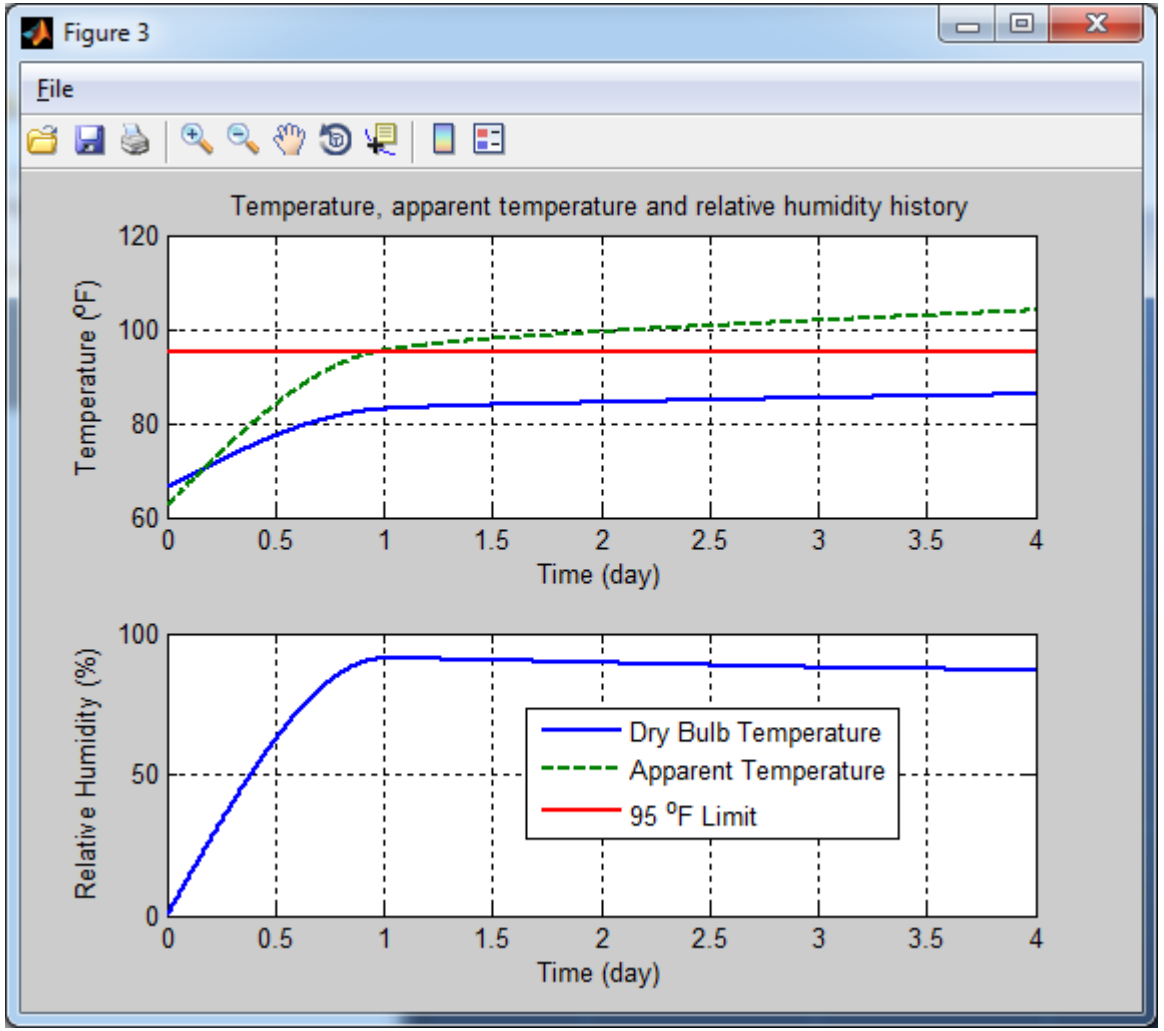




Temperature and condensation distribution maps

Example 3: 10-person RA, uniform distribution of occupants, hanger-type CO_2 scrubber, 66.2°F ambient temperature

The RA is not in compliance, Ta> 95°F



Temperature and humidity vs. time

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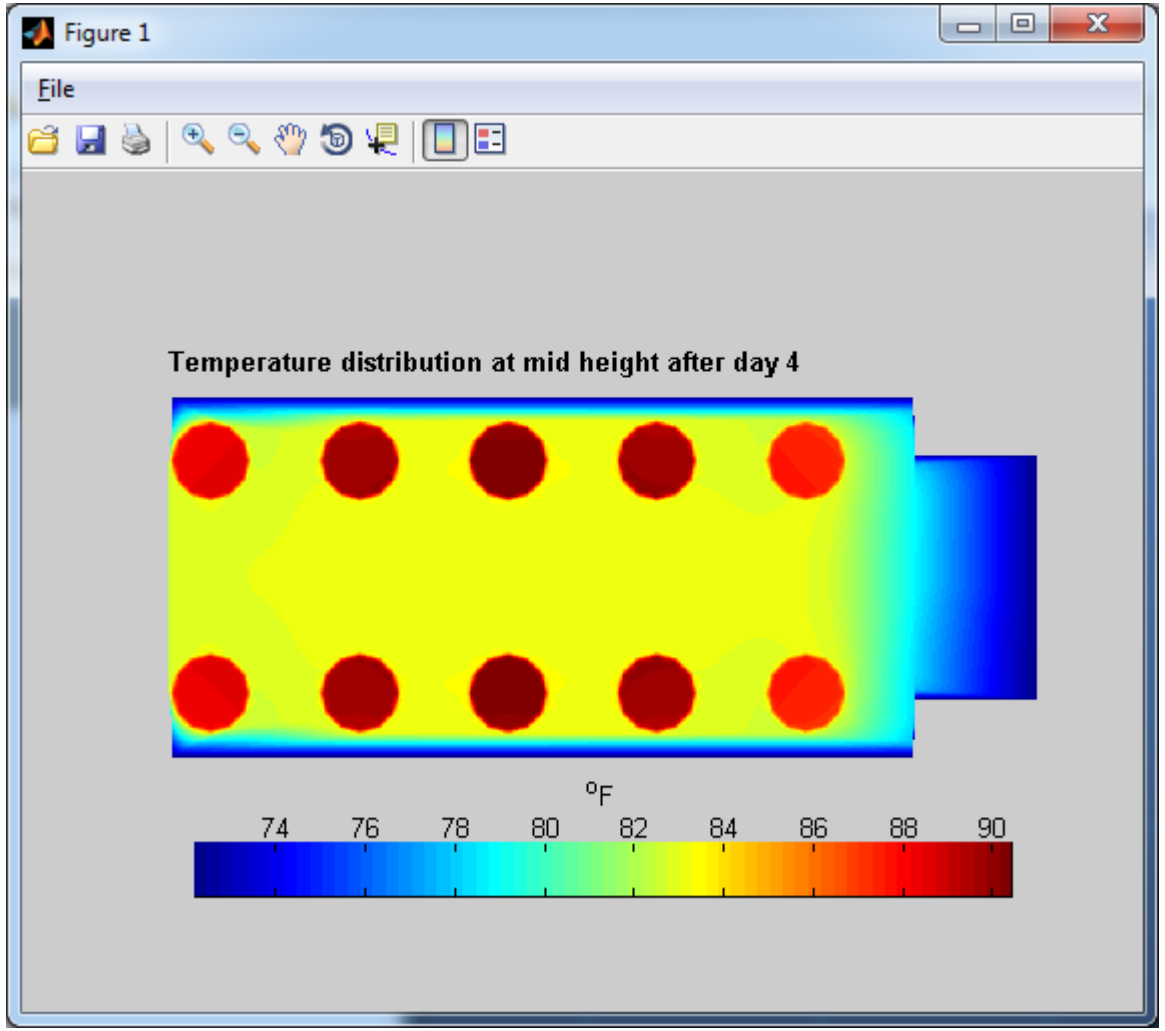
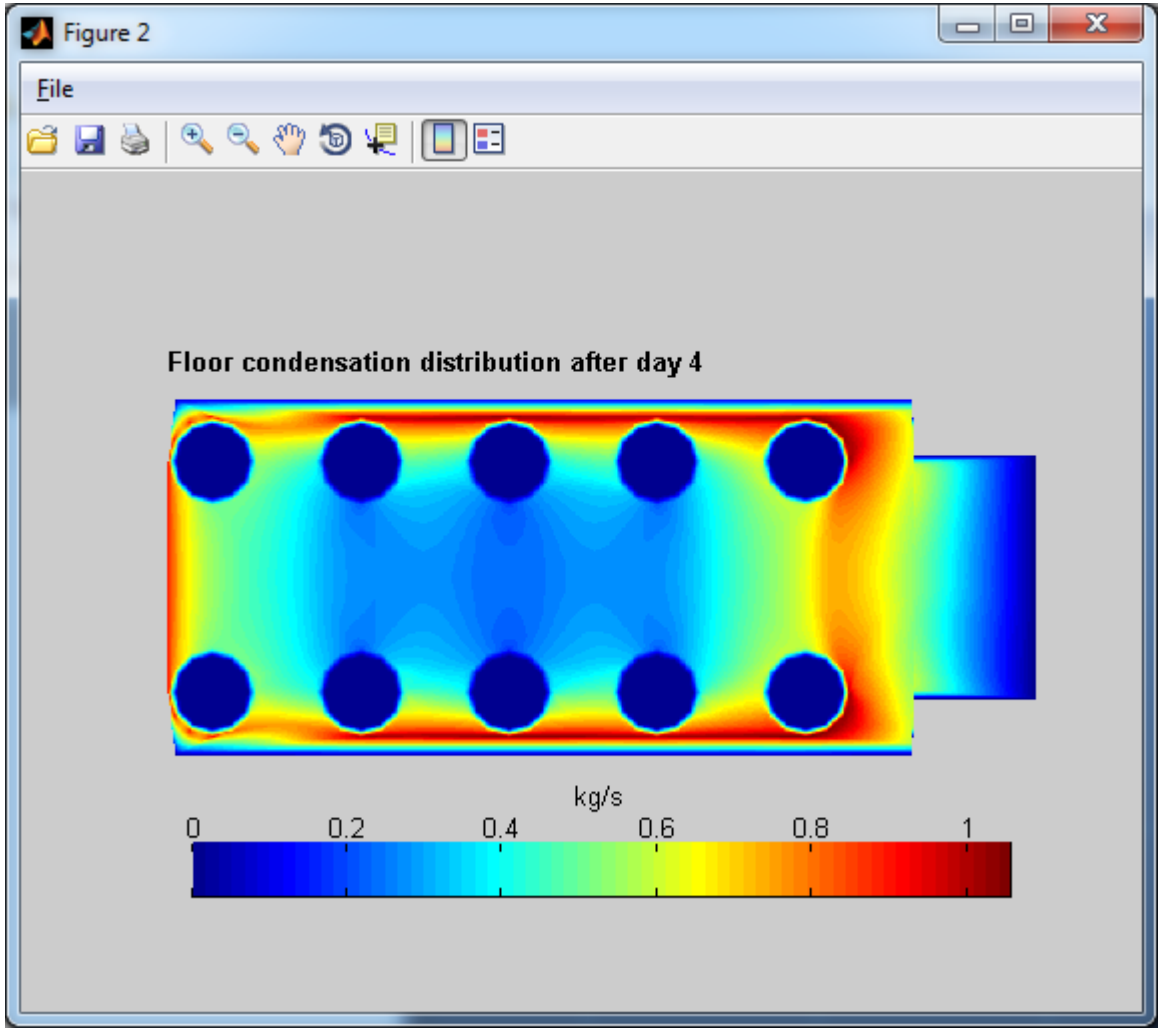
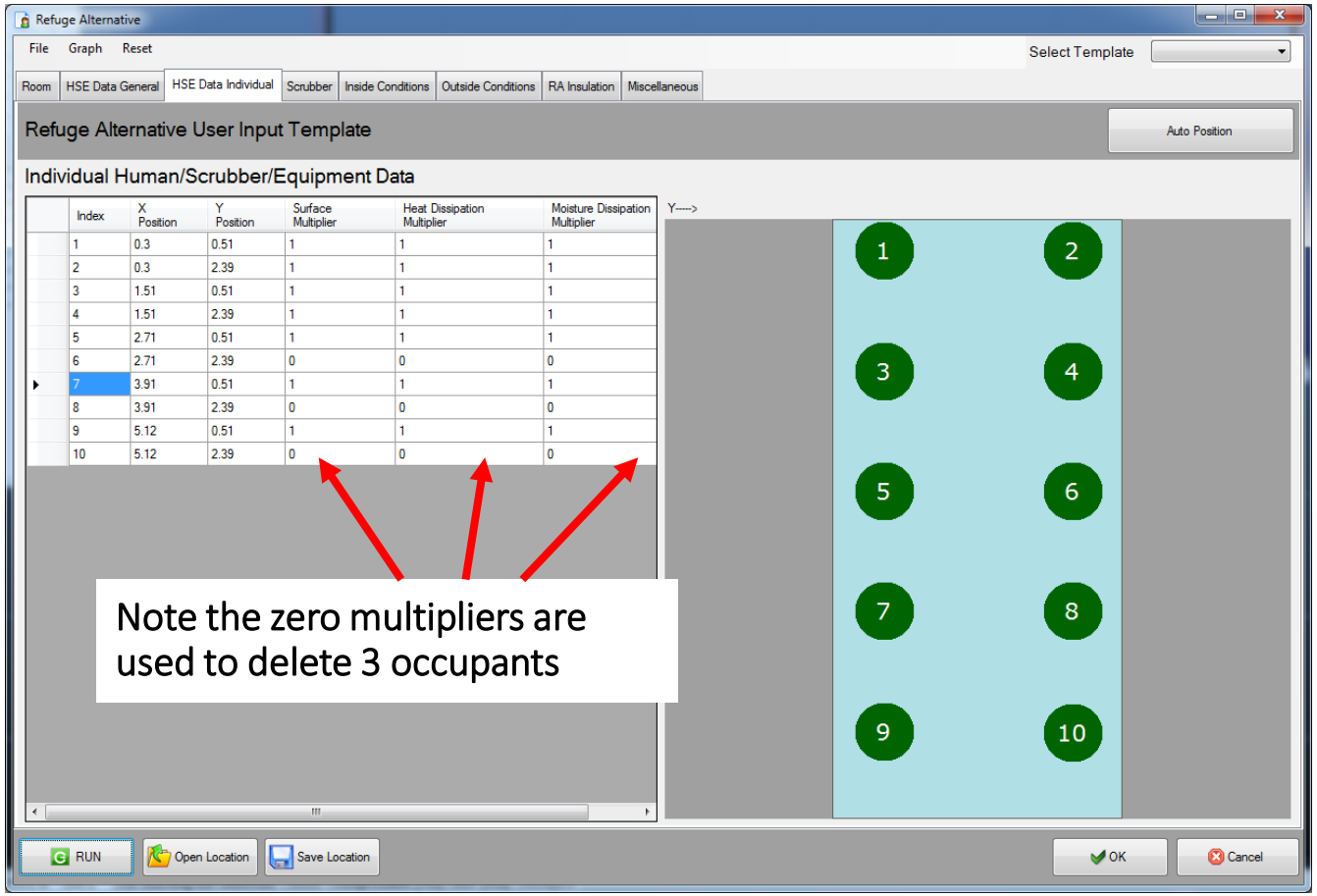


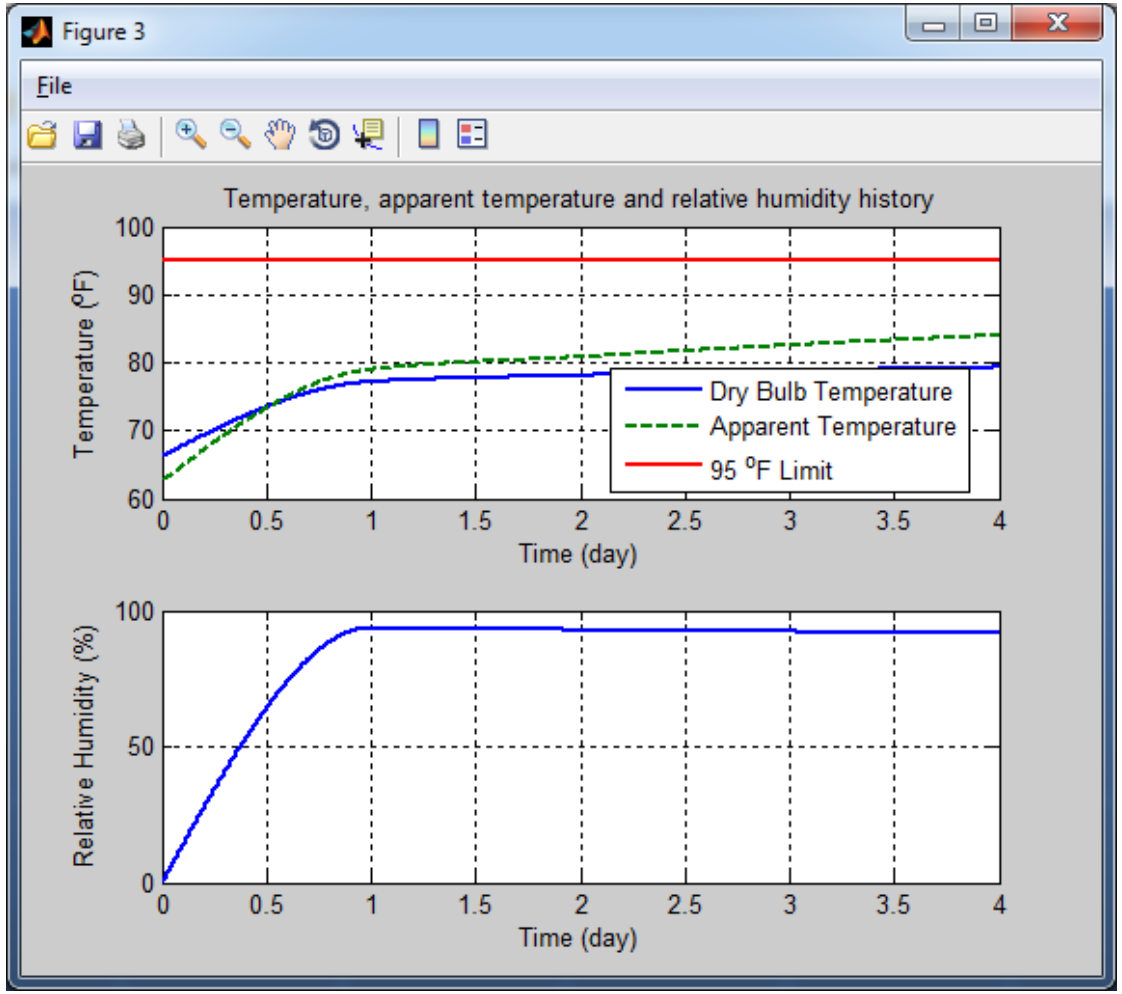


Temperature and condensation distribution maps

Example 4: 10-person RA, derated to 7-person occupancy, hanger-type CO_2 scrubber, 66.2°F ambient temperature

Reduced occupancy (10 to7) from one side of RA space





Temperature and humidity vs. time

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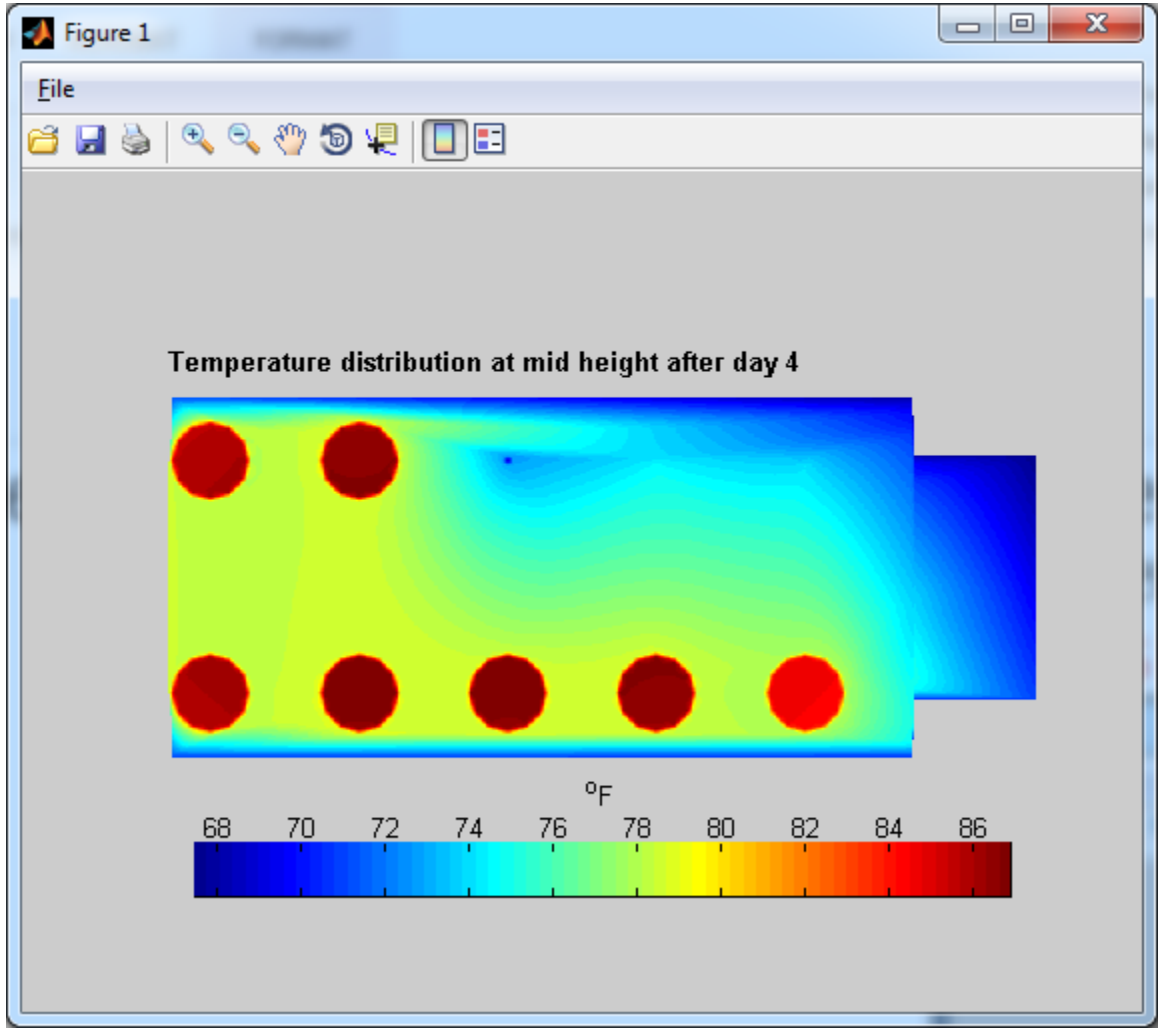
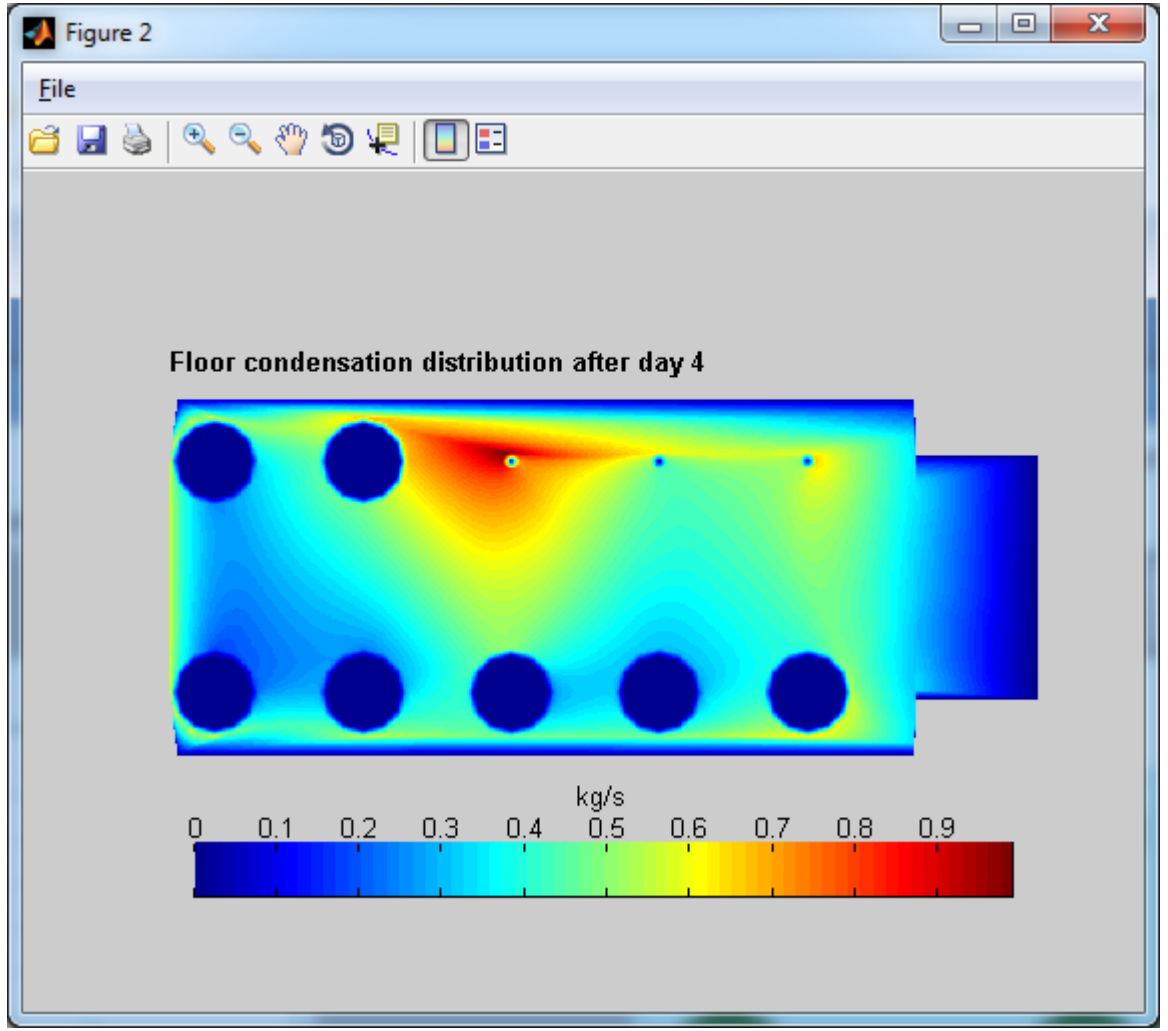
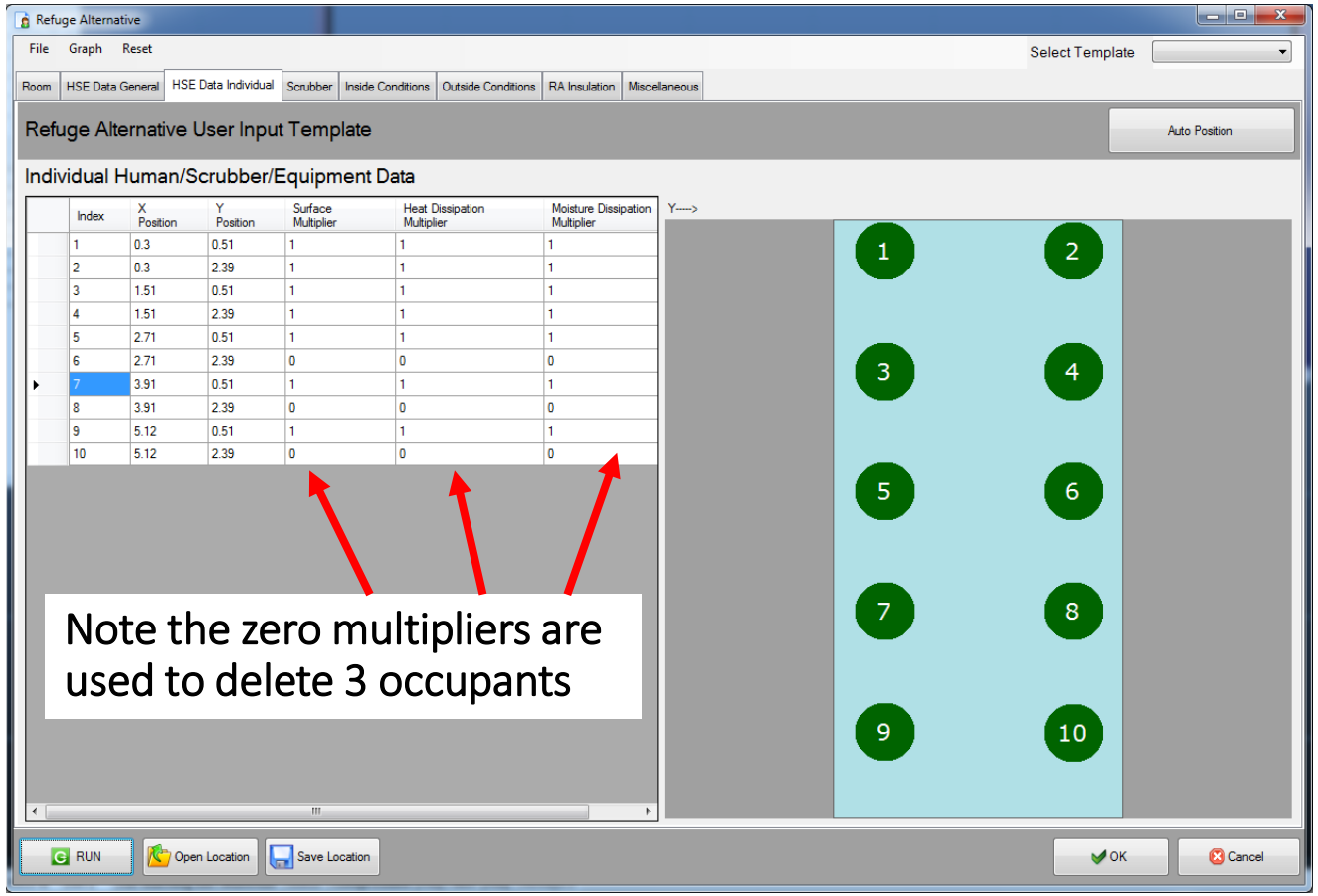


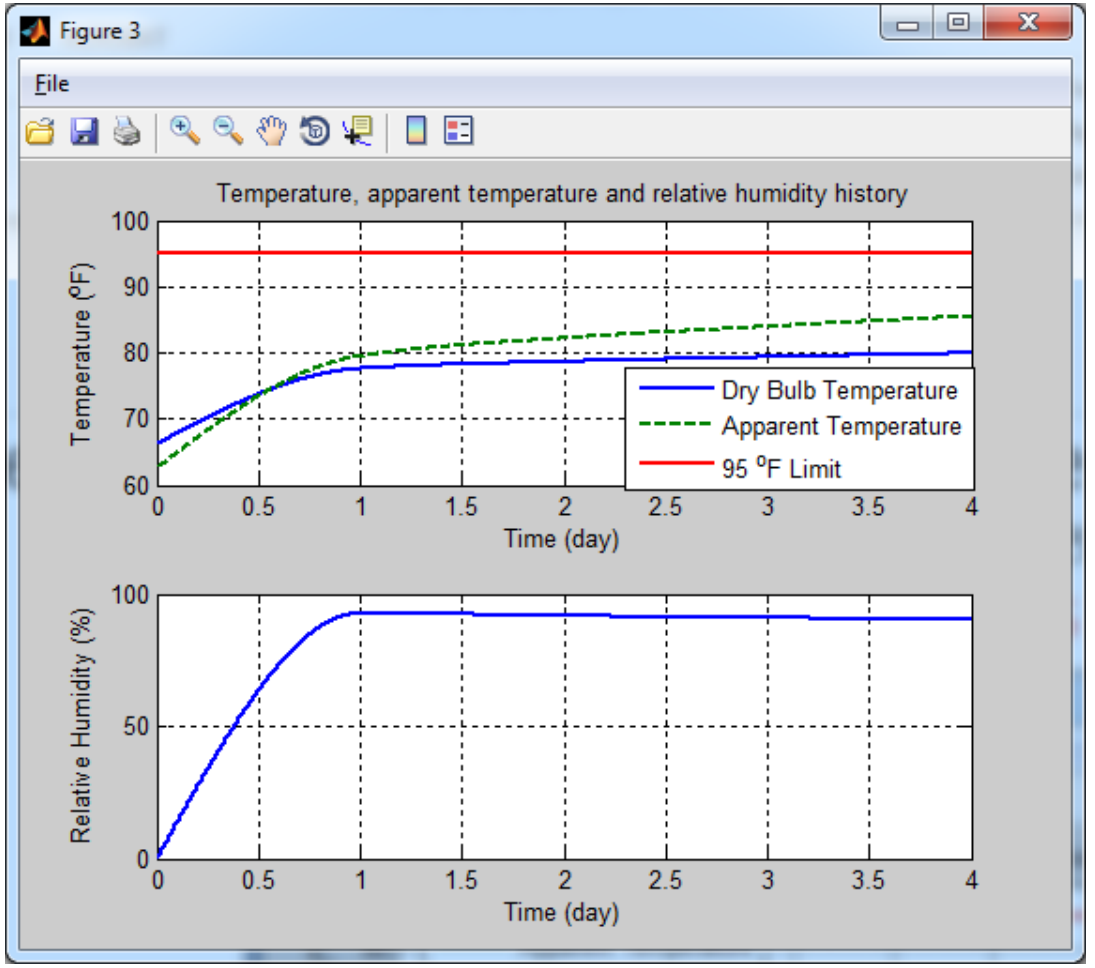


Temperature and condensation distribution maps

Example 5: 10-person RA, derated to 7-person occupancy, hanger-type CO_2 scrubber, 66.2°F ambient temperature

Reduced occupancy (10 to 7) from one end of RA space





Temperature and humidity vs. time

Example 5: 10-person RA, derated to 7-person occupancy, hanger-type CO_2 scrubber, 66.2°F ambient temperature

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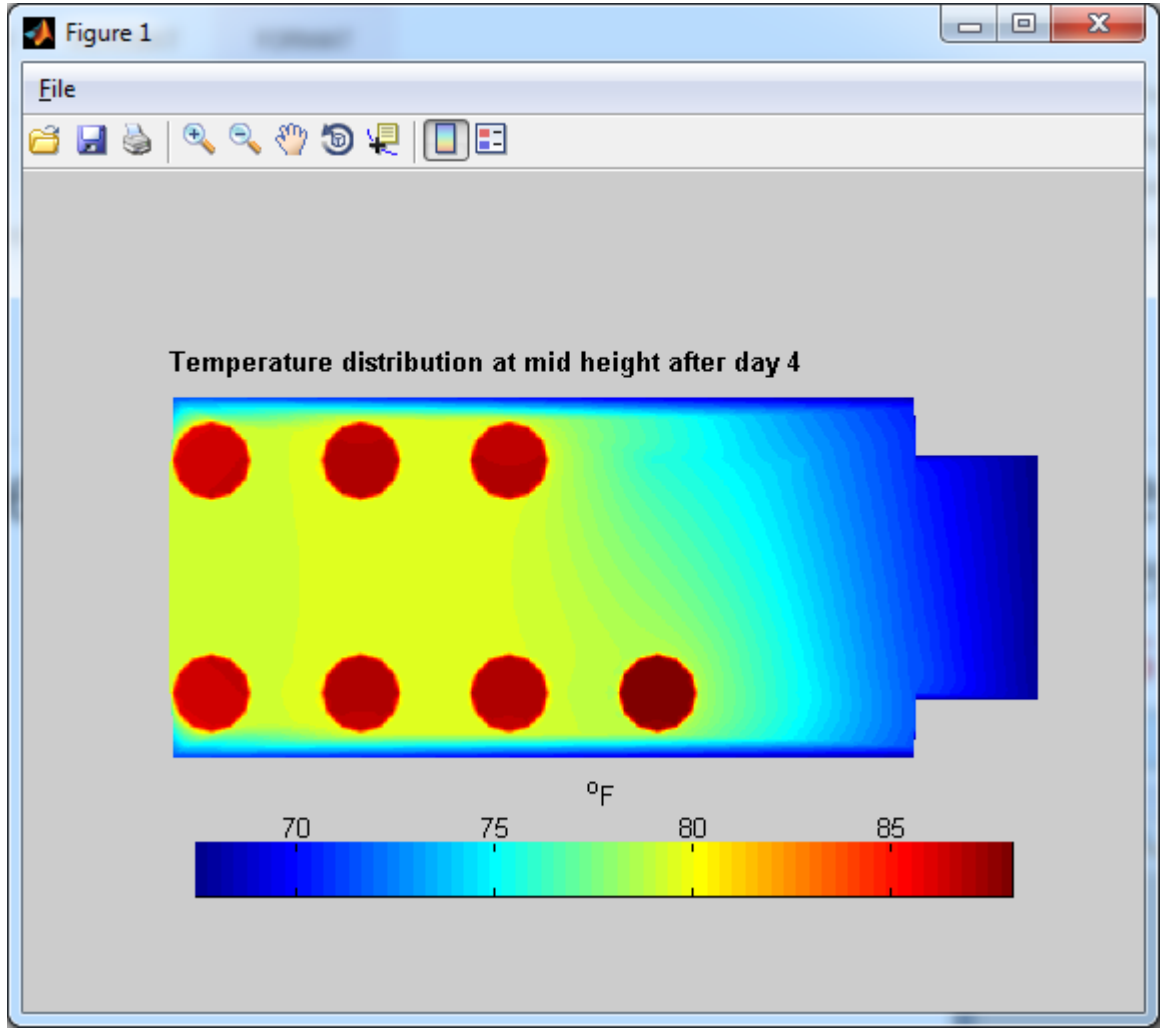
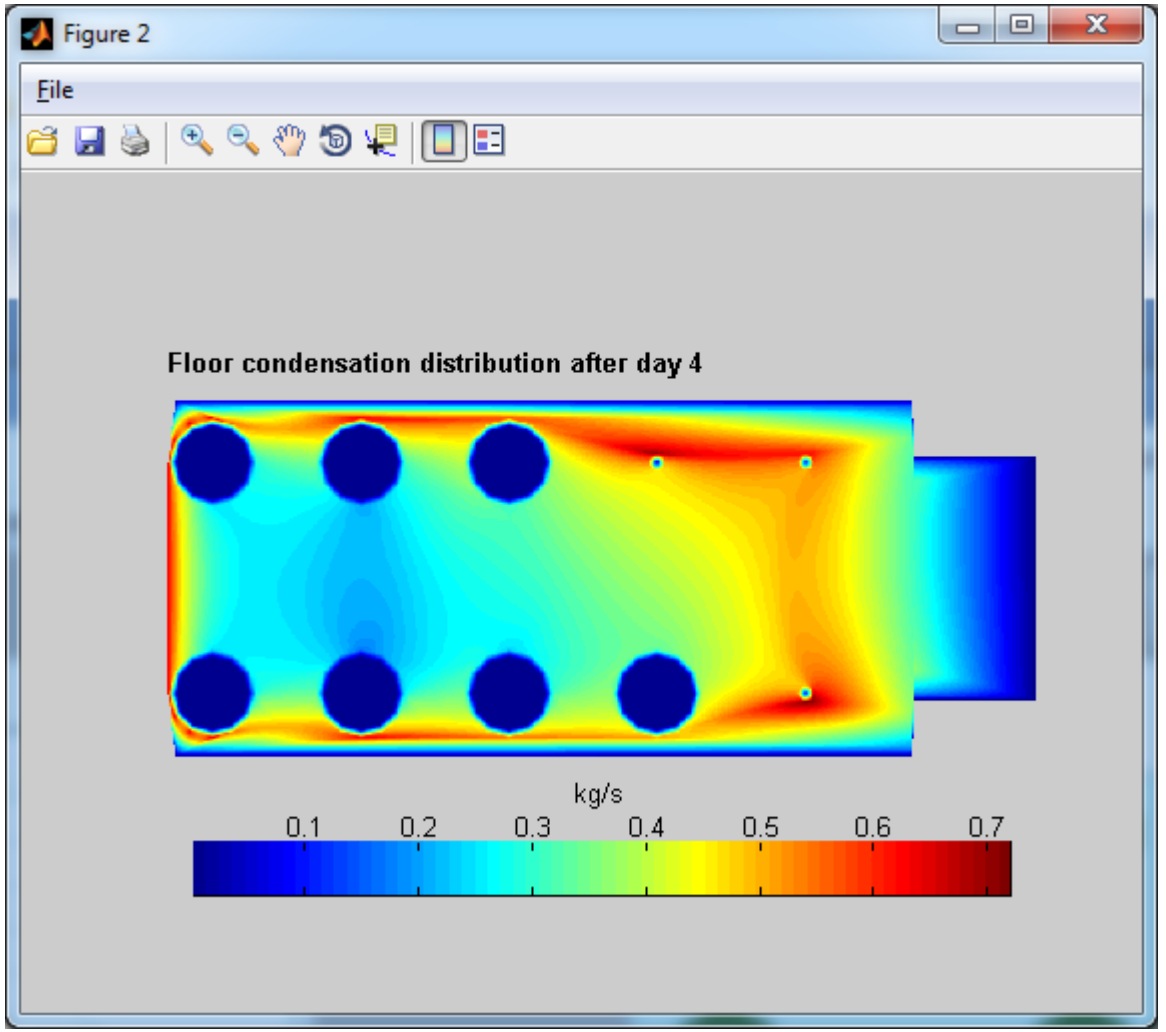
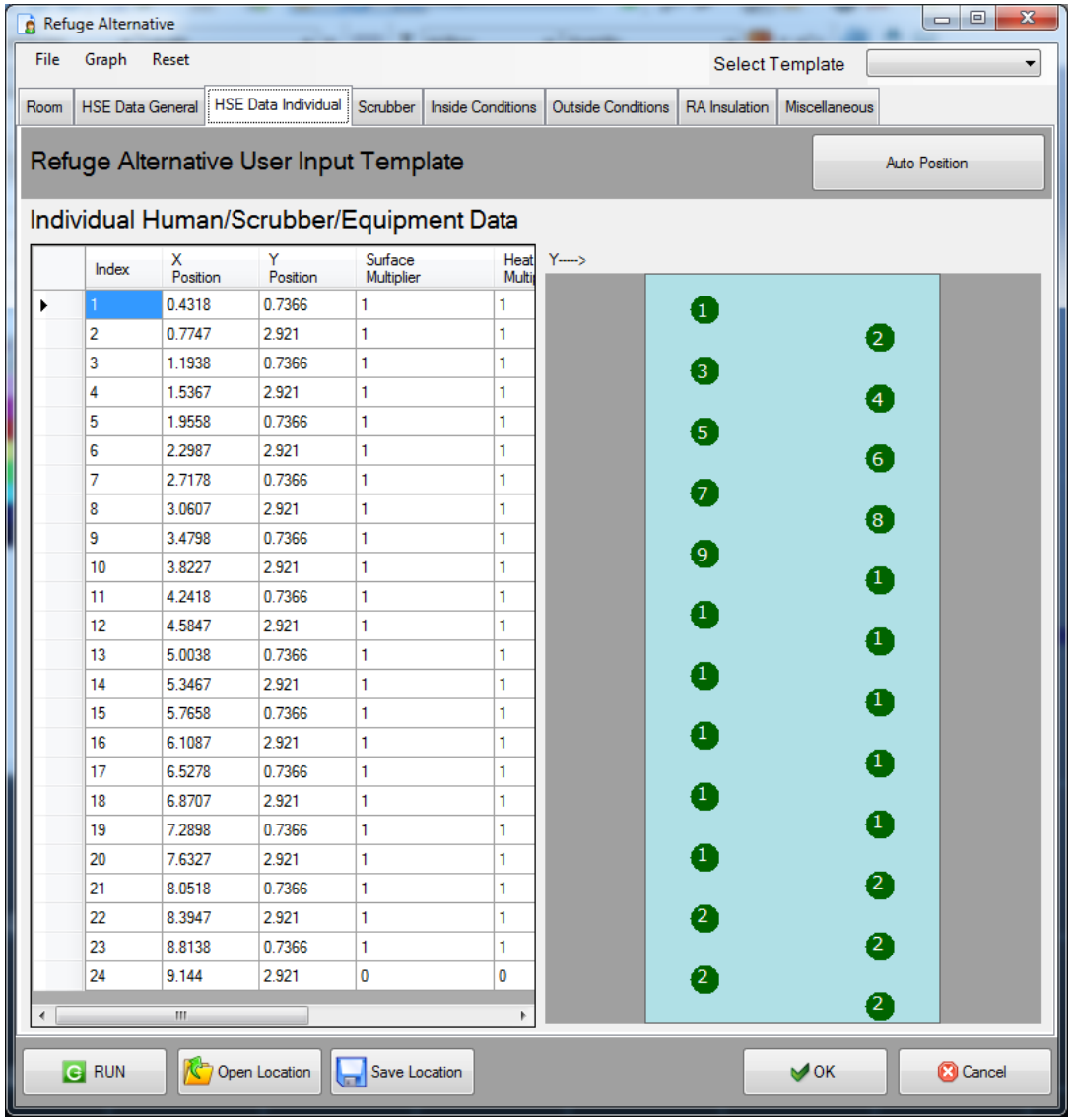
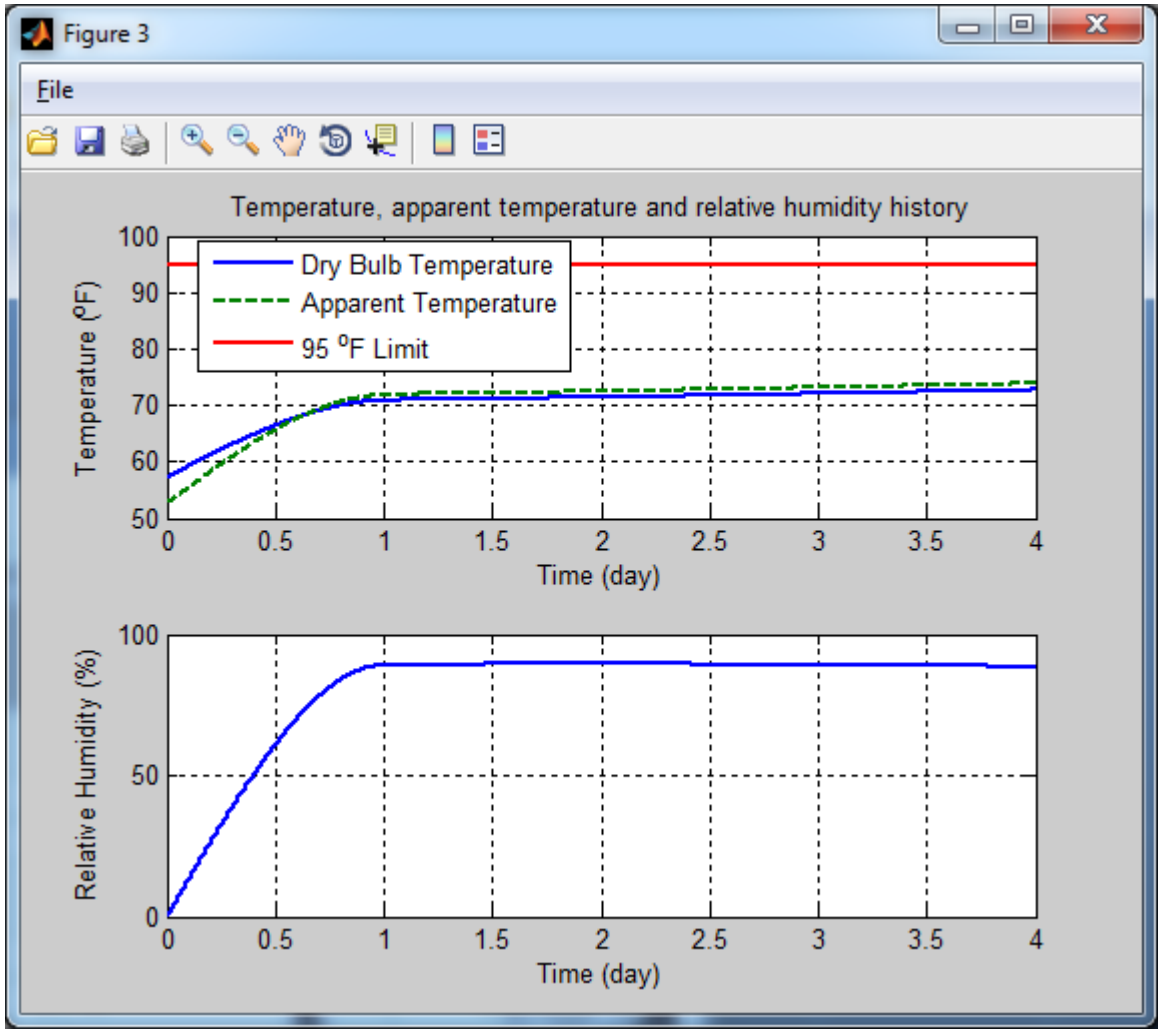




Temperature and condensation distribution maps

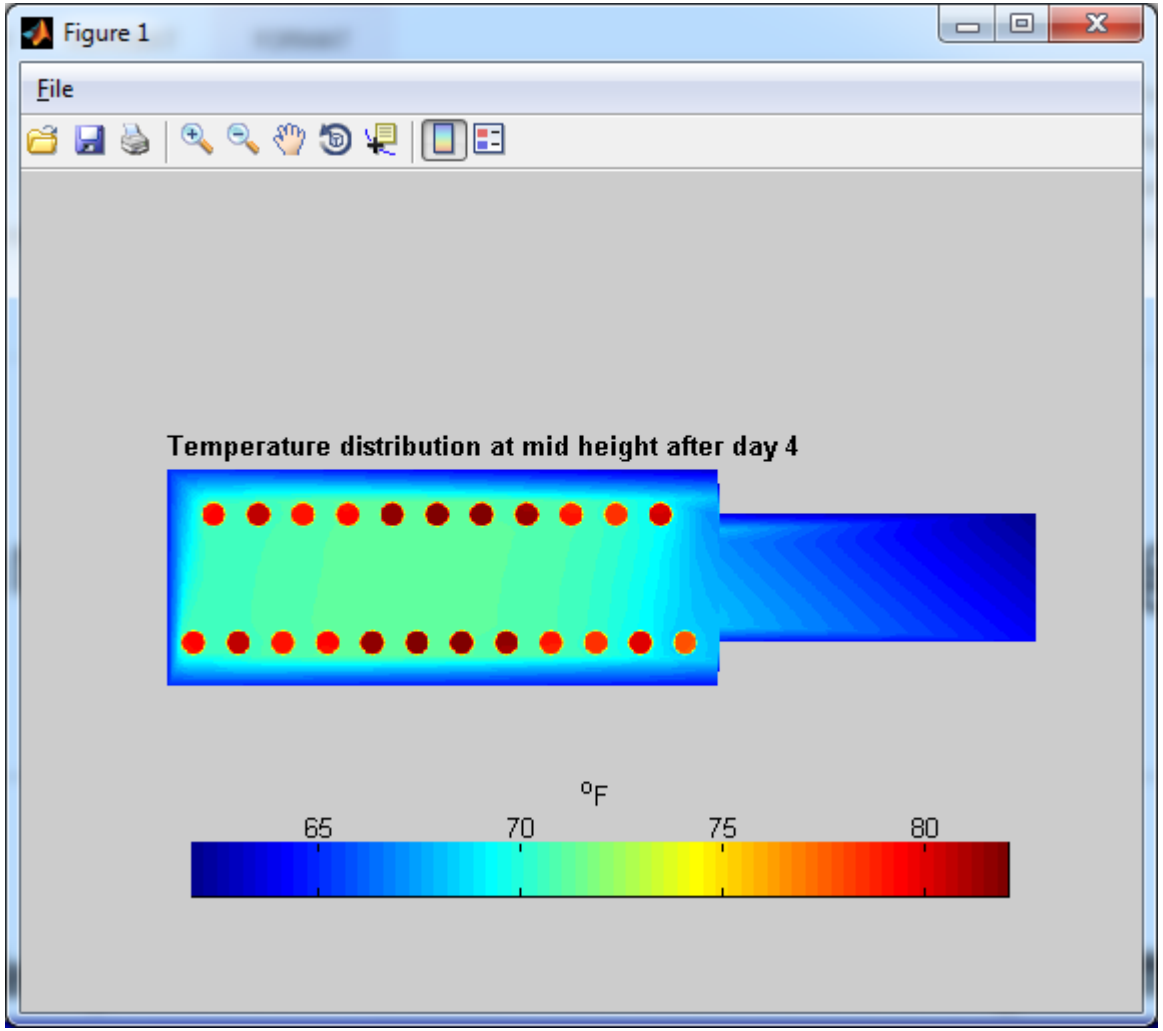
Example 6: 23-person RA, hanger-type CO_2 scrubber, 57.2 °F ambient temperature

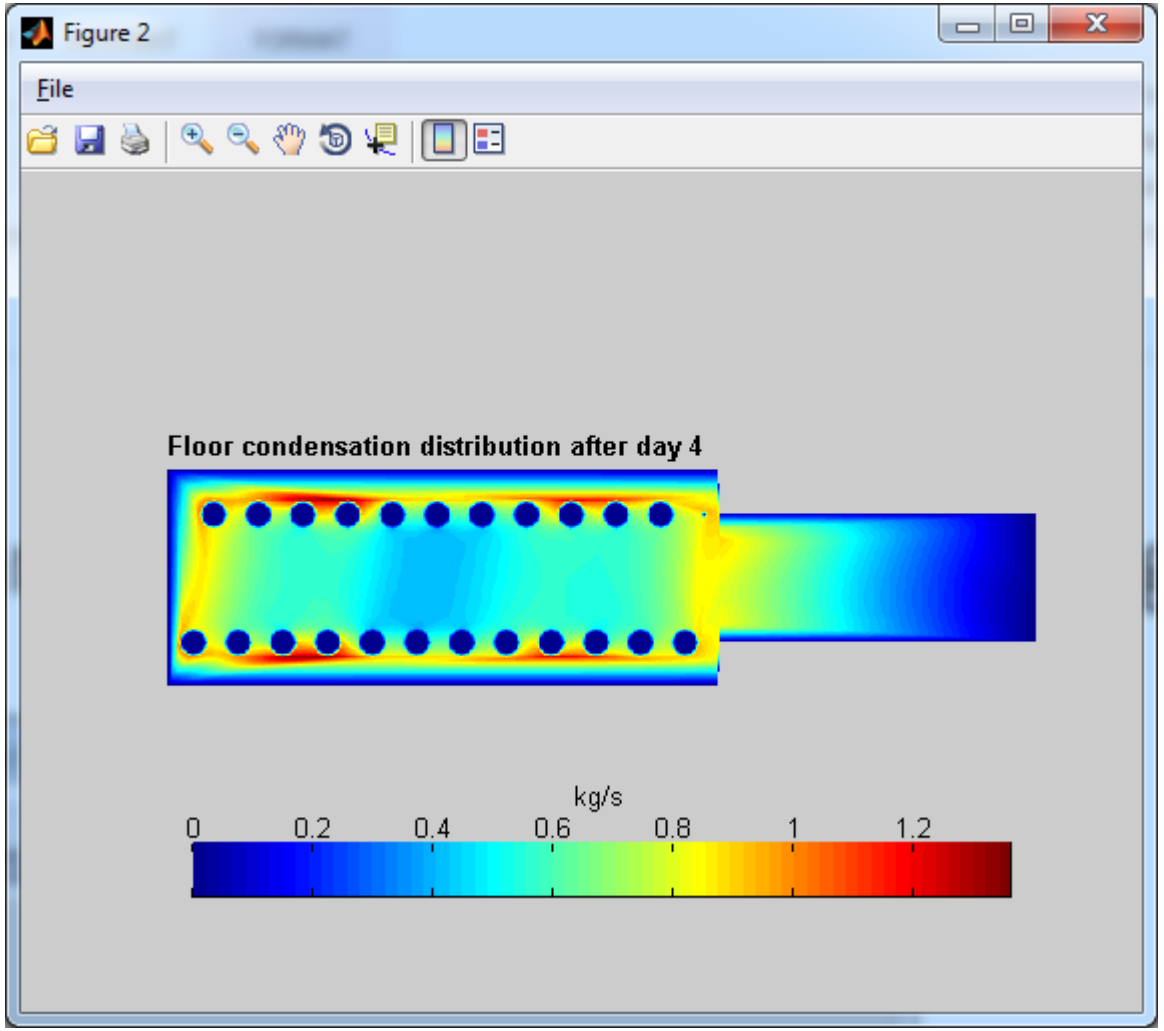




Temperature and humidity vs. time

Example 6: 23-person RA, hanger-type CO_2 scrubber, 57.2 °F ambient temperature





Temperature and condensation distribution maps

Conclusions and Recommendations

- UNR's universal RA model shown in the examples has matched the 10-person RA measurement results within a few percent from three different NIOSH experiments
- Five more sets of NIOSH's experimental results from different RA types are available for testing the universal thermal model
- The universal thermal model is integrated into Ventsim Visual mine ventilation and climate software which has customer support
- The model is easy to configure in a graphical environment and provides results for temperature, humidity, condensation, and air movement within the RA space; it gives results in a few minutes

Thank You

Question?