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Modeling Guide for Daikin VRV in IES Virtual Environment 2015

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Introduction

This modeling guide contains step-by-step instructions for modeling Daikin VRV systems in IES Virtual Environment (VE) 2015. To purchase and learn more about IES VE, please visit https://www.iesve.com/software.

Please visit Daikin AC website: http://www.daikinac.com/content/resources/software-tools/#ies-ve or Daikin city website https://www.daikincity.com/ following the path: **Library Home > 07 VRV/LC Sales Partners > Sales Tools & Applications Resources > Sales and Applications Tools > Energy Simulation** for new products information update.

The air-cooled system is modeled through the Daikin Module (Daikin Plugin) in VE, which is capable of sizing and thermal simulation of both Daikin air-cooled heat pump and heat recovery equipment (RXYQ and REYQ series). This module will select a system capable of meeting the needs of the simulated model which includes condensers, fan coils and branch selector boxes (for heat recovery systems). The effect of temperature controls, i.e. set-points, time schedules, setback temperature, etc. will also be considered.

The following additional variables have been taken into account in the simulation process as well:

- Heat recovery efficiencies
- Pipe length corrections
- Height difference corrections
- Oil return
- Defrost of the outdoor coil
- The power input of outdoor units, indoor unit fan and auxiliary power consuming components

This Module is specifically written for Daikin VRV systems and is not suitable as a selection or simulation tool for any other VRF systems. Features like continuous heating during defrost, heat recovery efficiency, pipe length correction are either unique to Daikin or can differ in operational effectiveness which can create significant changes in efficiency for other systems.

This guidebook assumes that the user is already familiar with the Virtual Environment and has the ability to assign systems and profiles to the model.

This document is intended to provide necessary guidance to help designers optimize the design of Daikin VRV systems based on building energy cost. This guide should be used as a guideline only. The modeling accuracy is highly dependent on the user input data and it is the users' responsibility to understand how the input data will affect the program output.

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Program Installation

Please purchase the software first and then follow the instructions provided by the software provider.

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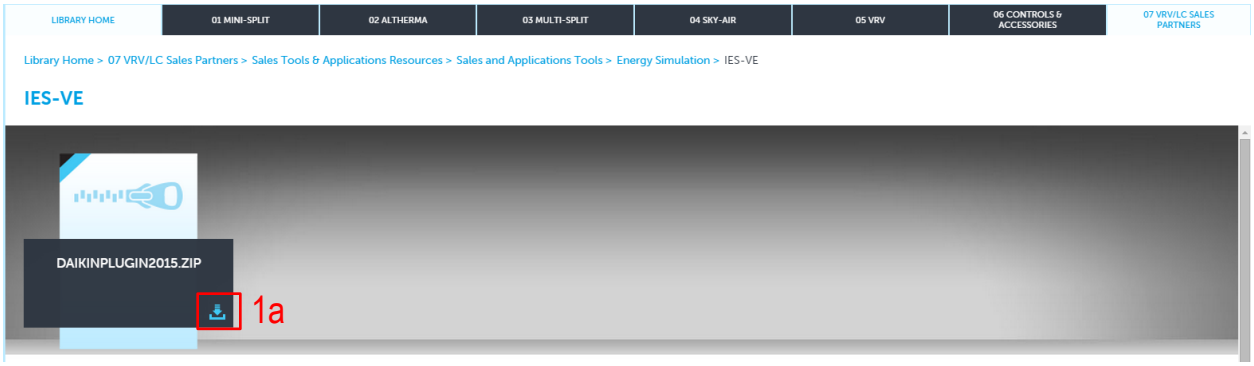
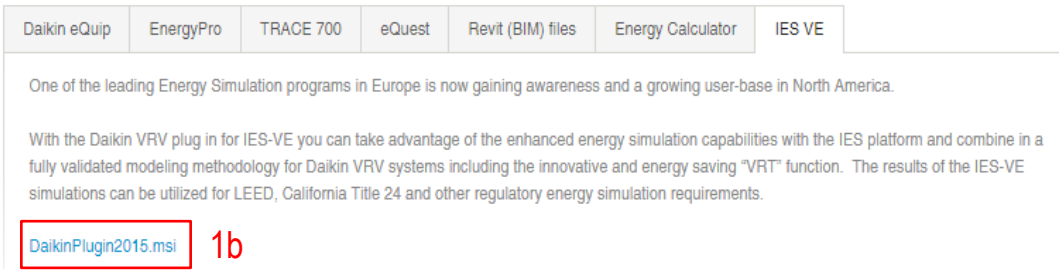
Installing the Daikin Module

This session demonstrates how to install the Daikin Module into IES VE.

1. There are ways to download the plugin. When downloading it, there may be an alert from windows firewall, as it is an installation (.msi) file. Please make selections that will allow its download and installation.
    a. If you have a Daikin City account, you can download the DaikinPlugin2015.zip file from Daikin City **Library Home > 07 VRV/LC Sales Partners > Sales Tools & Applications Resources > Sales and Applications Tools > Energy Simulation**. Click the blue arrow to download.



    b. For other users, it can be downloaded following the link: http://www.daikinac.com/content/resources/software-tools/#ies-ve



2. Unzip the DaikinPlugin2015.zip file and double click the DaikinPlugin2015.msi file.
3. Follow the instructions to install the plugin.

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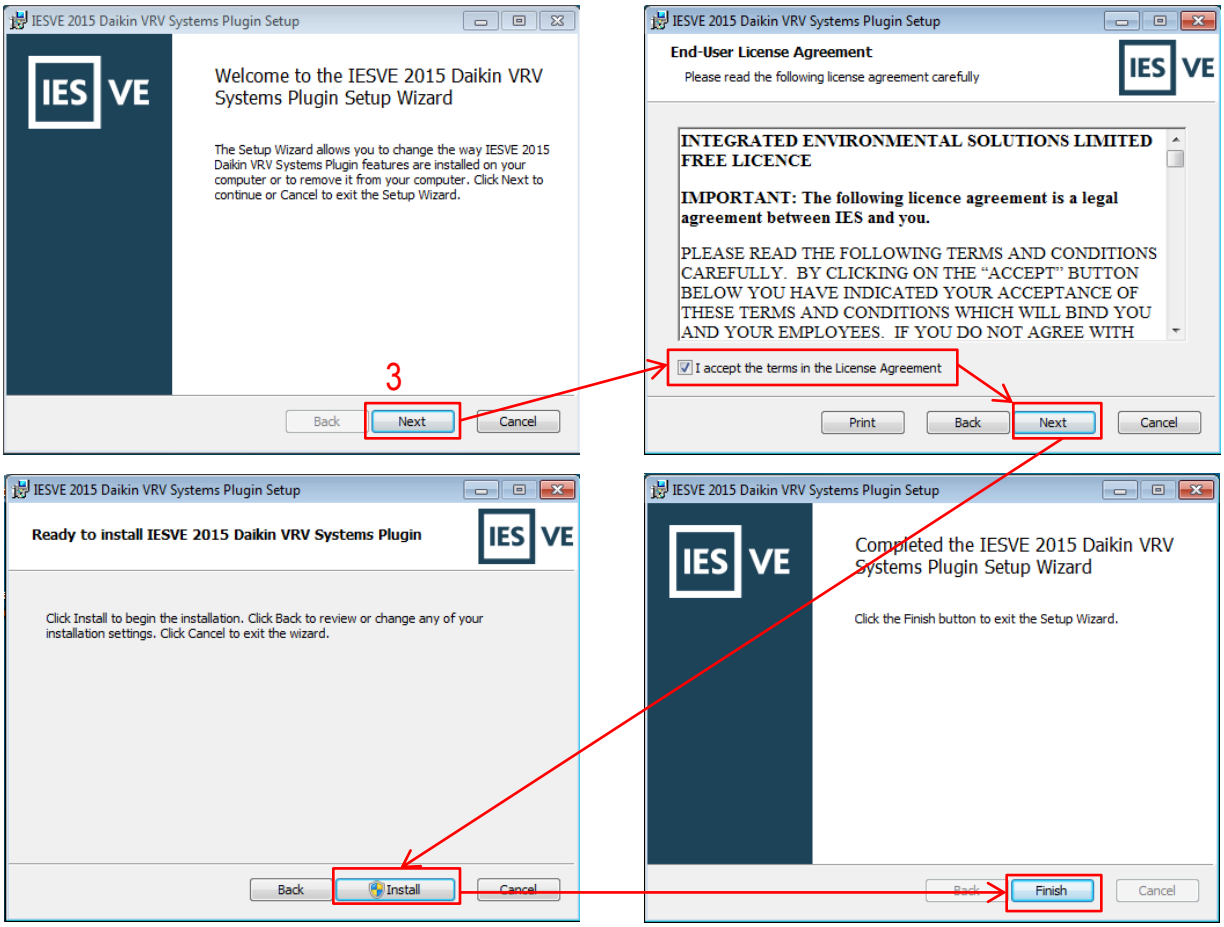
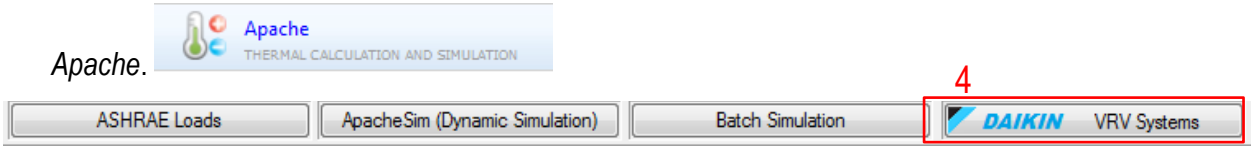


4. Once the module has been installed, an additional button appears at the bottom of the screen in *Apache*.



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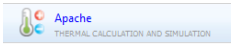
Creating a Daikin VRV System

Before entering the module, either one or more VRV systems should be created as Apache Systems. This session demonstrates how to create a Daikin VRV system in Apache and how to assign rooms to different outdoor units.

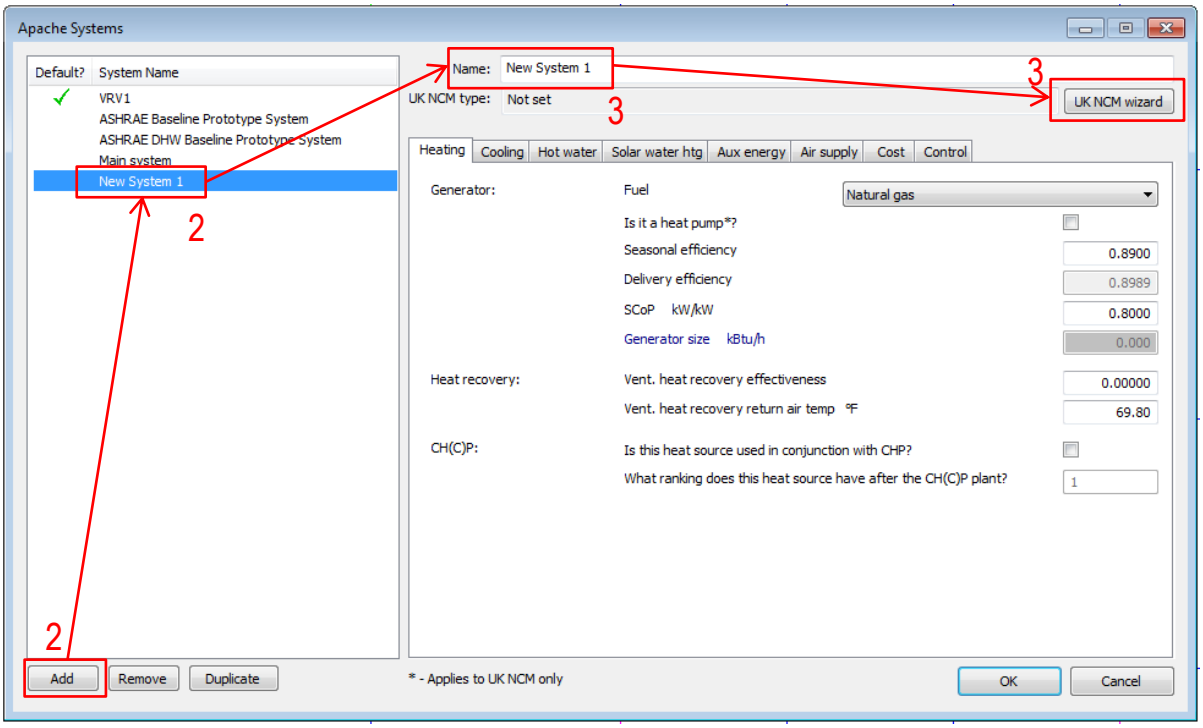
It is the users' responsibility, however, to optimally design and zoning the systems. Also, this session only provides the necessary steps to set up the VRV system in IES VE. Users should make their own choices and inputs on the other variables that are not mentioned in this guide.

Create Systems

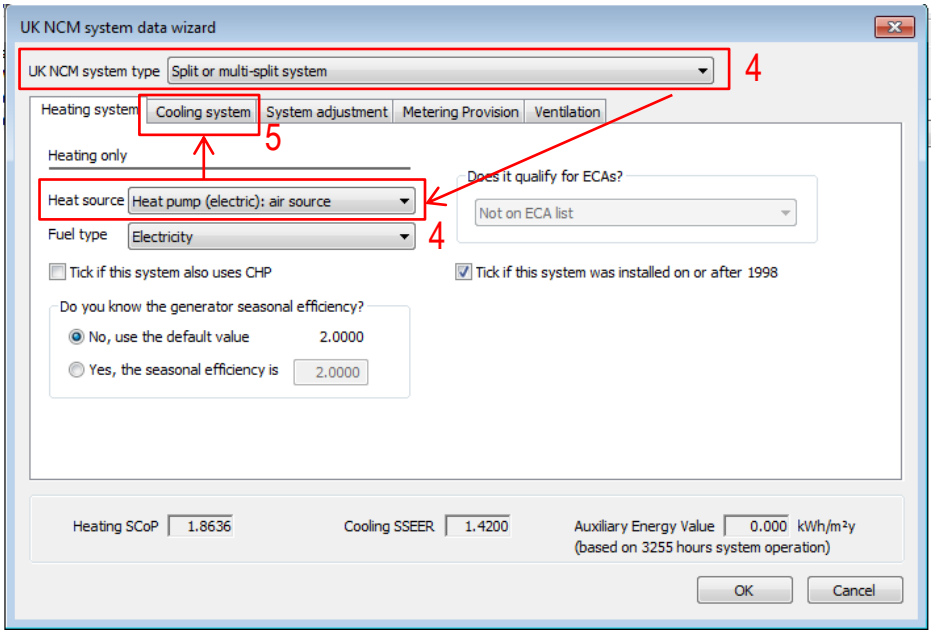
1. A completed building model with the desired geometry and internal gains should be read first into the software. Then in Apache 

select the '*Apache Systems*' in the upper row.

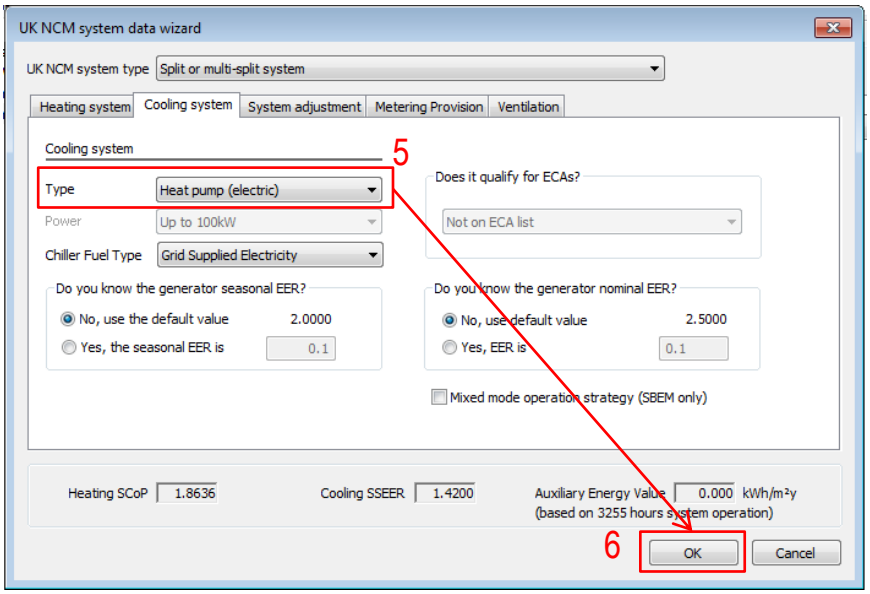
2. Click '*Add*', a '***new system 1***' will appear in the system lists in the left column.



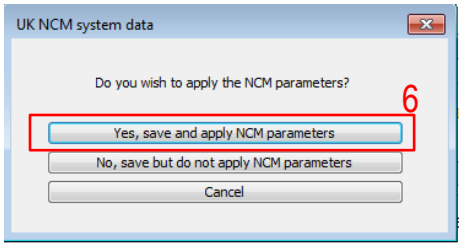
3. One system is corresponding to one outdoor unit, so a preferable or distinguishable name for each system should be entered. Then click on '*UK NCM wizard*'.
4. Select '*Split or multi-split system*' in the scroll down list of the system type. Then select '*Heat pump (electric): air source*' in the heat source scroll down list.



5. Switch to '*Cooling system*' and select '*Heat pump (electric)*' for the type. There is no need to input other values in the wizard, as it does not affect the calculation in the Daikin Module.

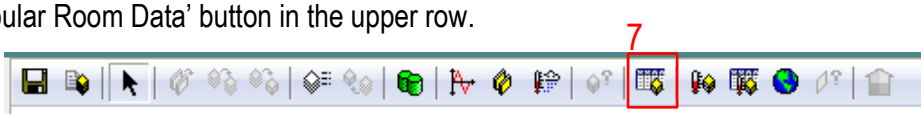


6. Then click '*OK*' and choose '*Yes, save and apply NCM parameters*' in the popup window. The 'new system 1' is set up as VRV system. If there is more than one VRV system (outdoor unit), repeat step 2 to 5 for each system. After setting up all the VRV systems, click 'OK' in the left corner to close the '*Apache system*' window.

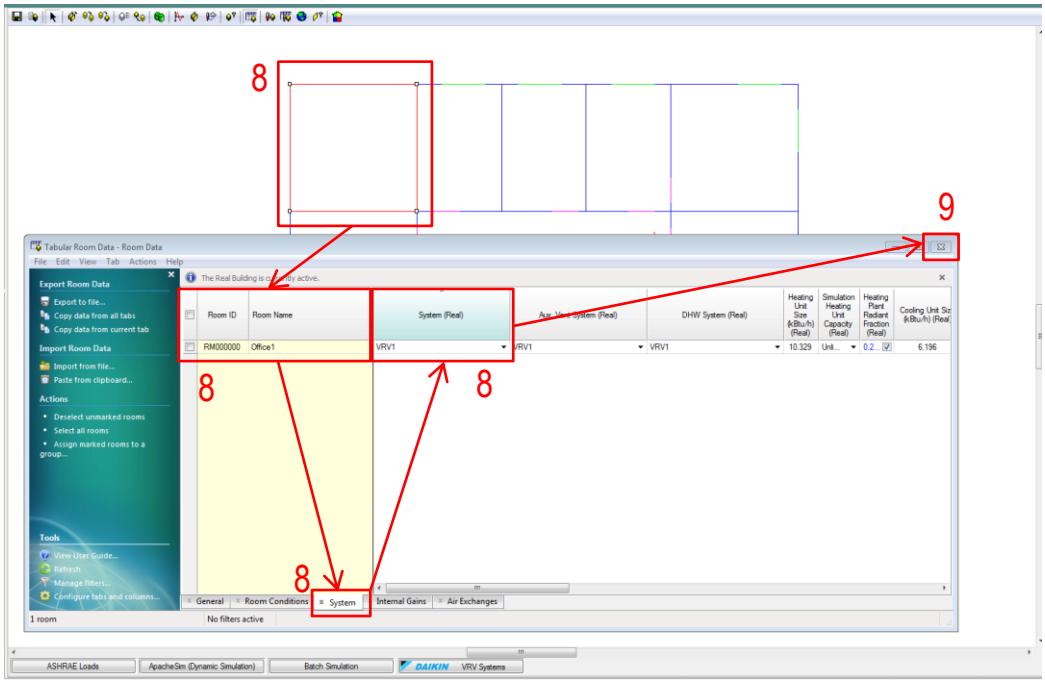


Assign Rooms to Systems

7. Click 'Tabular Room Data' button in the upper row.



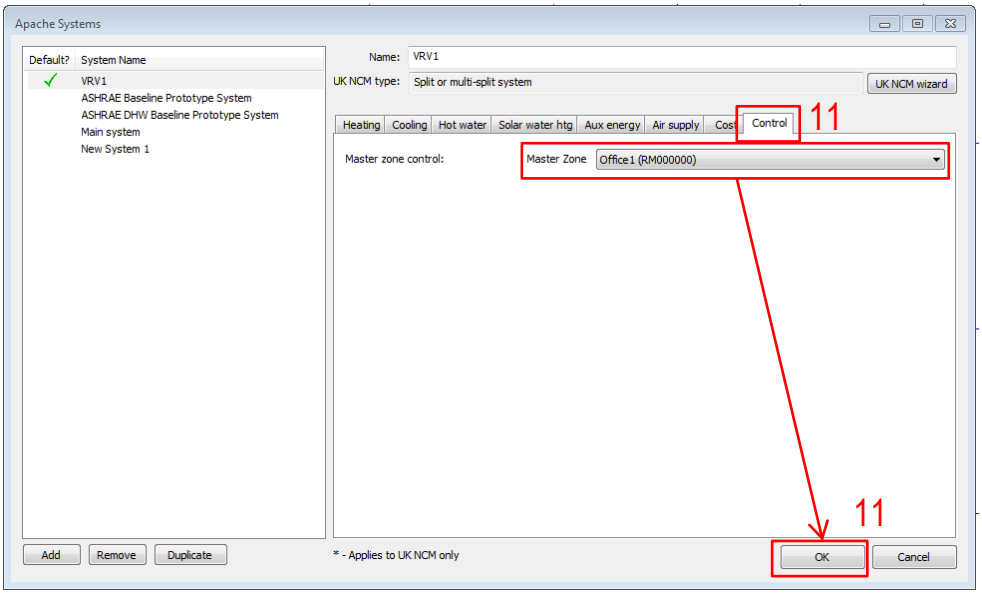
8. The Tabular Room Data window will pop out. Click on one or more rooms in the building geometry, so the room will appear in the room list. Switch to 'System' and select the desired VRV system for each room. Make sure that all the conditioned rooms are assigned to the right VRV system.



9. Close the window.

10. Open the '*Apache systems*' again.

11. Switch to '*Control*' panel. Select one room as the master zone control for all the VRV systems. Then click '*OK*'.



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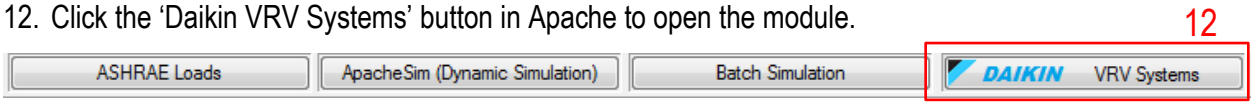
Daikin VRV Module

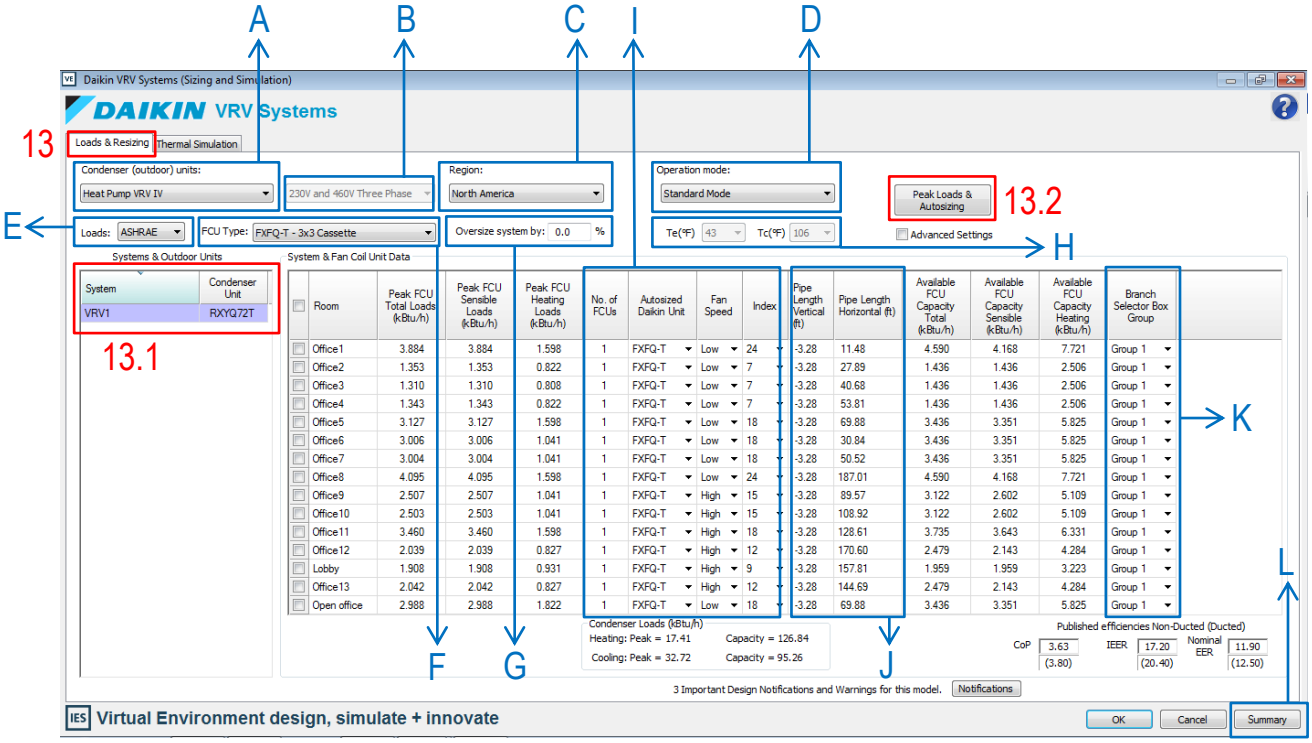
This session explains all the possible options in the Daikin Module and demonstrates how to properly simulate VRV systems using this module.

12. Click the 'Daikin VRV Systems' button in Apache to open the module.



Loads & Resizing

13. When opening the Daikin Module, there are two panels shown in the label tab: *Loads & Resizing* and *Thermal Simulation*. The loads and sizing should be calculated first to enable the thermal simulation.



13.1. All the VRV systems set up in 'Apache Systems' will be listed in the left column. If there is any names listed under 'System' are in grey, right click on the name and select '*Add to calcs*'.

13.2. Click on the '*Peak Loads & Autosizing*' button to run the loads and sizing calculation. The tool will automatically size the system based on the calculated load.

13.3. After running the calculation, the condenser unit number, FCU loads and sizing selection, pipe length, etc. will be shown as in the figure below. All the variables in blue columns can be modified now to meet the requirements.

A. Select the outdoor unit type: *Heat Pump VRV III*, *Heat Pump VRV IV*, *Heat Recovery VRV III* and *Heat Recovery VRV IV*.

B. Select the voltage and electric phase for the outdoor unit if VRV III is selected. For VRV IV, the data is the same for 230 V and 460 V.

C. Select the region where the products are released. The default region is '*North America*'.

D. Select the operation mode for VRV IV: *Standard Mode*, *Hi Sensible Mode* and *Automatic Mode*. The *Standard Mode* is operating with fixed evaporator and condenser temperature (*Te* and *Tc* in Column H). In *Hi Sensible Mode*, a fixed value of *Te* (43, 48 or 52F) can be defined by the user. The *Automatic Mode* is operating with varying *Te* and *Tc*, showing the benefit of the VRT feature (variable refrigerant temperature).

E. Select the load calculation method. The default input is '*ASHRAE'* for North America region.

F. Select the major indoor unit type. It includes all the currently available indoor unit type.

G. Select the oversizing factor for the system. Normally, there is no need to oversize a VRV system.

H. Select the *Te* value when using the Hi Sensible Mode.

I. Select the indoor unit type for a specific room, if it is different from the choice in Column F. The '*No. of FCUs*', '*Fan speed*' and '*Index*' will change automatically based on users' choice. Users can also impose their own choice on '*Fan Speed*' and '*Index*'.

J. Input the Pipe length both vertically and horizontally if the user intends to do so. Otherwise, the vertical pipe length is set to default and horizontal pipe length will be calculated based on the building geometry.

K. Select the Branch Selector Box Group if it is in the system design.

L. Click on '*Summary*' will generate an Excel file showing the calculation results.

* NOTE: Do not click on the 'OK' button unless it is done. Otherwise, the tool will not save the calculation results and a re-calculation is needed when open the tool again.

14. After setting all the blue columns, there is no need to re-run the calculation again. Switch to the '*Thermal Simulation*' Tab.

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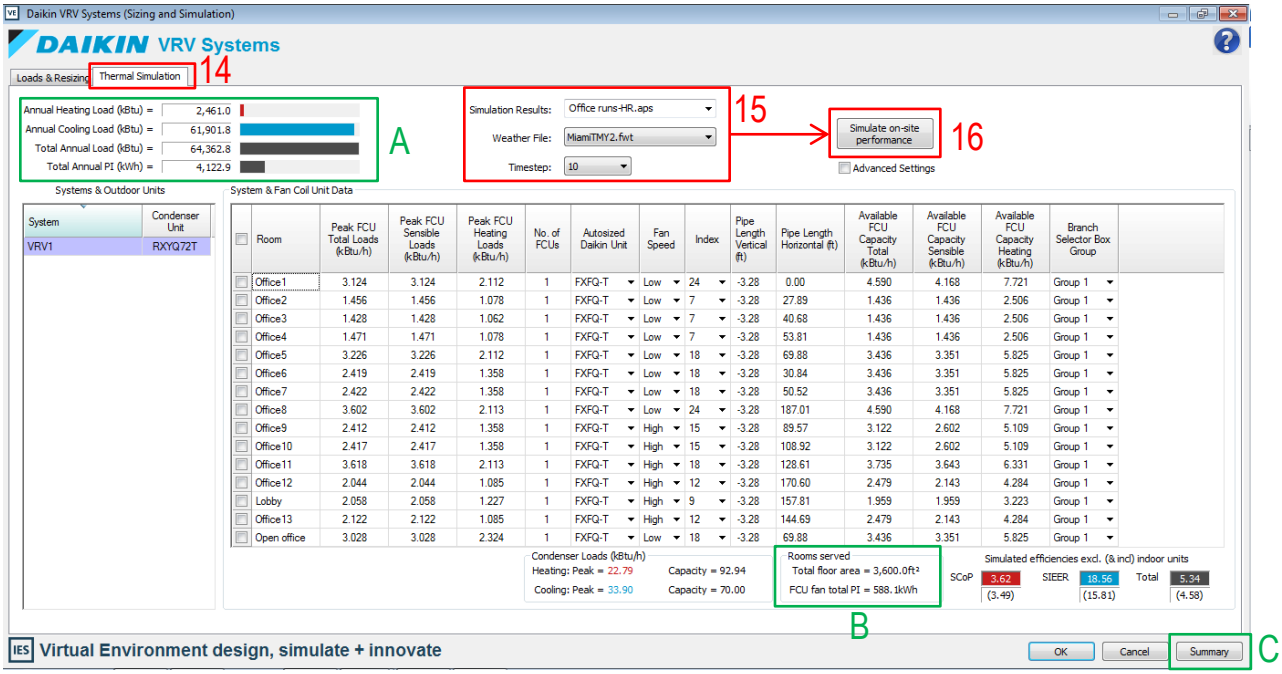
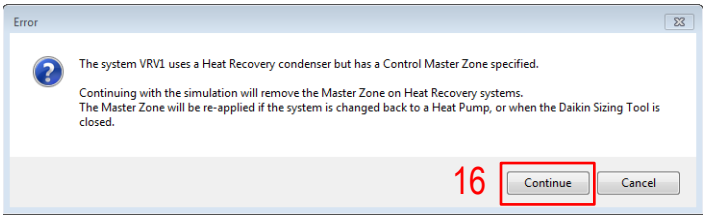
Thermal Simulation

15. Input the file name to save the calculation results. The default weather file is the location selected in ModelIT. Then select a proper time step for the simulation.

* NOTE: The smaller the time step, the longer the simulation will take. Normally 6 or 10 minutes will result in an acceptable simulation. If a warning window pops up during the simulation, suggesting a smaller time step should be chosen, just change the time step to a smaller value, i.e. 1 or 2 minutes.



16. Click the '*Simulate on-site performance*' button to start the calculation. The final results will be shown as the figure above. For heat recovery systems, there is no need to set up a master zone control. So the following window will pop out. Click on 'Continue' to continue the calculation.

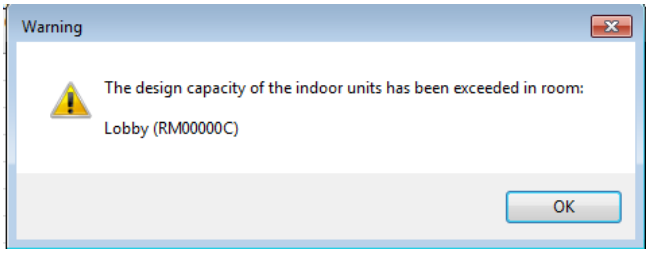


A. The total annual PI shown here is the energy consumption for cooling and heating.

B. The FCU fan total PI shown here for each VRV system should be added to the total energy consumption of the HVAC system. Please be noted that the fan PI consumption is not included in the results file in Vista and can only be obtained in here.

C. Click the '*Summary*' button will generate an Excel file showing the results.

* NOTE: Sometimes the window shown below will pop up suggesting that the design capacity of certain indoor units (or outdoor unit) has been exceeded. This is because the load, based on which the system is sized, is calculated using design condition, which may differ from the actual weather condition. So during the thermal simulation, there will be few hours the room load will exceed the selected capacity. To decide if this will affect the simulation results, the unmet load hours in Vista should be checked. If a large number of unmet load hours are found, indoor units with larger capacities should be manually selected or a larger than 1 oversizing factor should be applied in *step 13.3 Column G*. Otherwise, this warning can be ignored, as VRV systems can operate very well at more than 100 % part load, which, however, cannot be revealed in the software.



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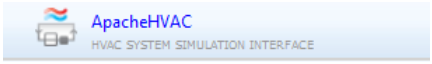
Modeling Water-cooled products in ApacheHVAC

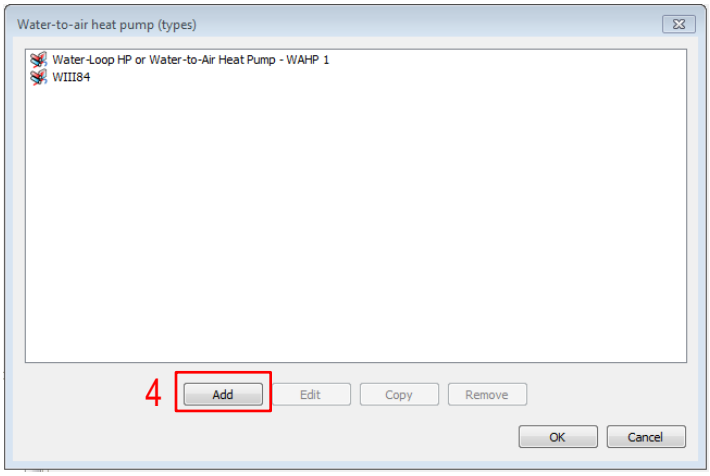
The aforementioned Daikin VRV Module can only model Daikin Air-cooled products. This session demonstrates how to model water-cooled products (RWEYQ series) in ApacheHVAC.

Since ApacheHVAC is capable of simulating complex systems and control strategies, the objective of this session is focused on how to set up water-cooled VRV components for further applications, instead of giving a comprehensive guidance about how to model systems in ApacheHVAC. It is users' responsibility, however, to fully understand the functions of the software and properly set up the simulation environment.

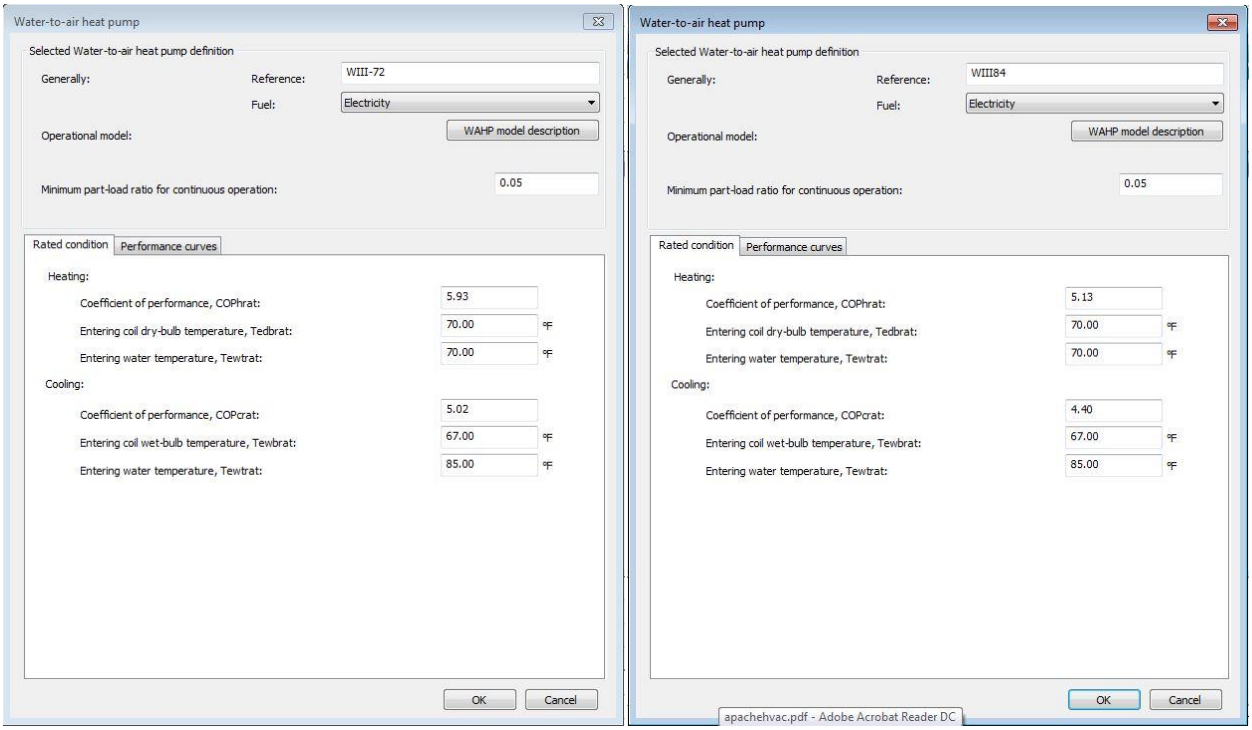
1. After setting up the building geometry, construction, internal gains, etc. in ModelIT, select '*ApacheHVAC*' in the left tree. 

2. From the popped out window (if no window pop out, click on '*Import from library*' on the upper first row ), select a multiplexed prototype system from the list that best represents the configuration for the actual project, e.g. PTAC (01a), package single-zone (03a), or DOAS with fan-coil units (09a). In this guide, a DOAS system with fan-coil units (09a) is used.
3. Select '*Water-to-air heat pumps (types)*' in the upper first row to create a water-cooled VRV component.

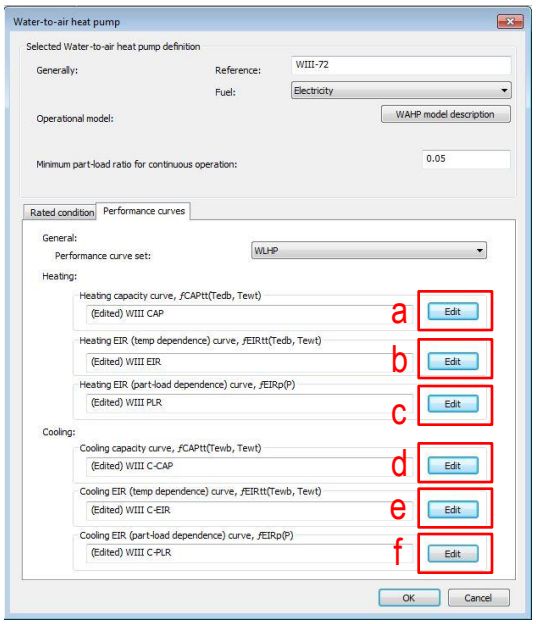
4. Click '*Add*' to add the component.



5. The WIII 72 series (RWEYQ 72, 144 and 216) has a different set of performance curves from the WIII 84 series (RWEYQ 84, 168 and 252). Please see the input entries for WIII 72 and 84 series, respectively, in the figures below.



6. Then click on the '*Performance curves*' tab and edit each performance curve. The following figures show the input entries for WIII 72 (left figure) and 84 (right figure) series, respectively.



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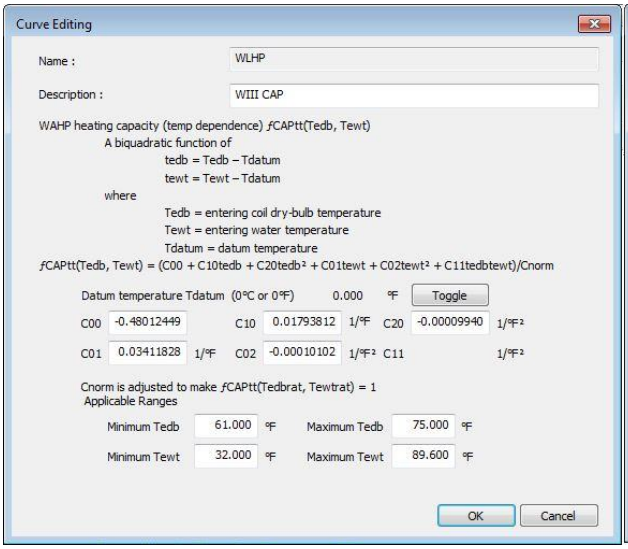
a. Heating capacity curve

For WIII 72 series:

c00 = -0.48012449, c10 = 0.01793812, c20 = -0.0000994

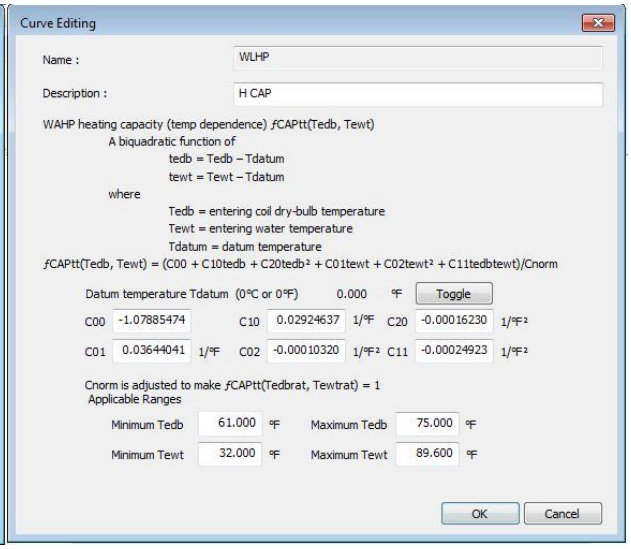
c01 = 0.03411828, c02 = -0.00010102, c11 = -0.00023545



For WIII 84 series:

c00 = -1.07885474, c10 = 0.02924637, c20 = -0.0001623

c01 = 0.03644041, c02 = -0.0001032, c11 = -0.00024923

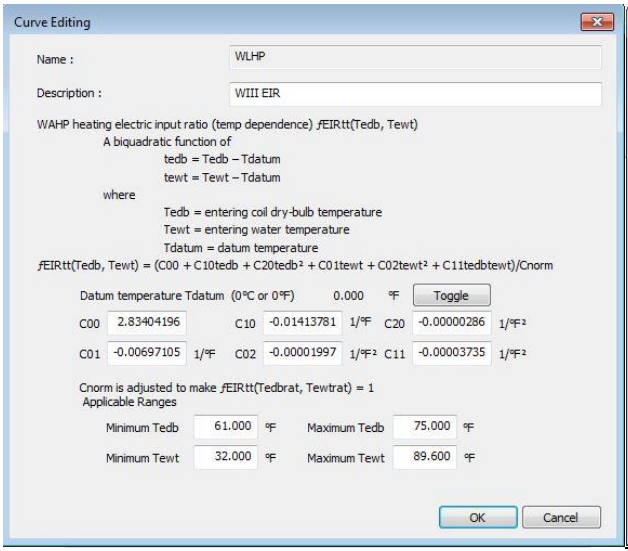


b. Heating EIR (temp dependence) curve

For WIII 72 series:

c00 = 2.83404196, c10 = -0.01413781, c20 = -0.00000286

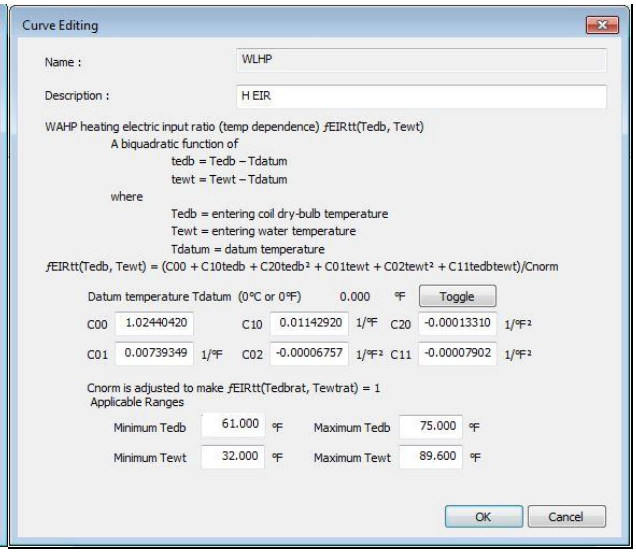
c01 = -0.00697105, c02 = -0.00001997, c11 = -0.00003735



For WIII 84 series:

c00 = 1.0244042, c10 = 0.0114292, c20 = 0.0001331

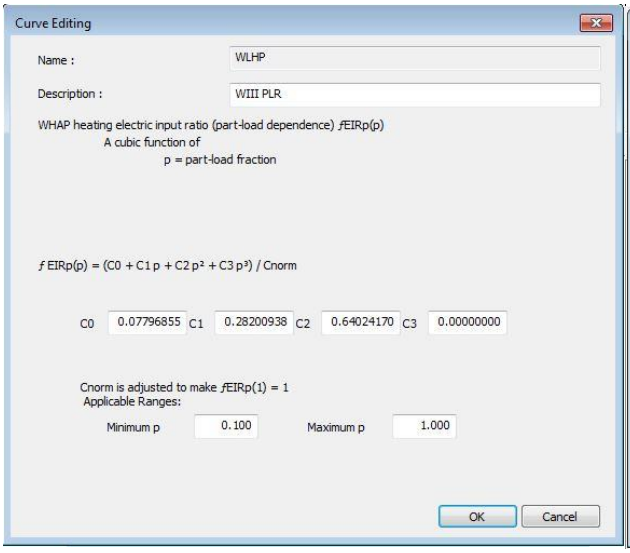
c01 = 0.00739349, c02 = -0.00006757, c11 = -0.00007902



c. Heating EIR (part-load dependence) curve

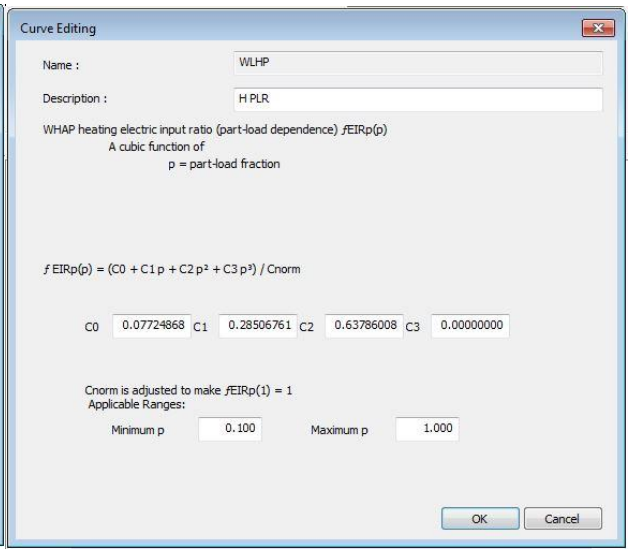
For WIII 72 series:

c0 = 0.07796855, c1 = 0.28200938, c2 = 0.6402417



For WIII 84 series:

c0 = 0.07724868, c1 = 0.28506761, c2 = 0.63786008

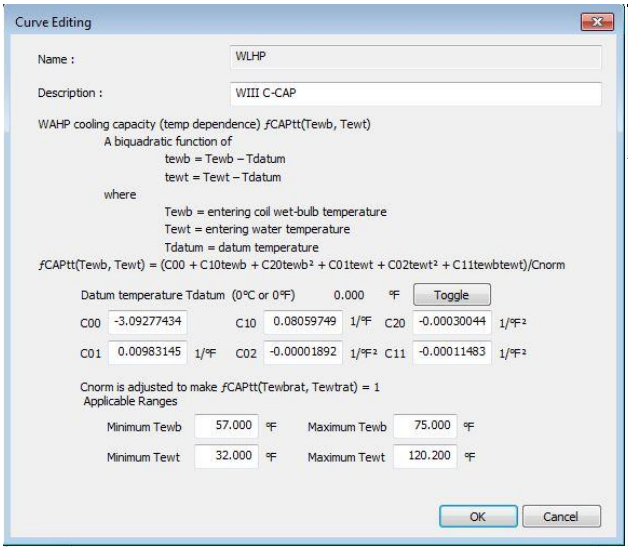


d. Cooling capacity curve

For WIII 72 series:

c00 = -3.09277434, c10 = 0.08059749, c20 = -0.00030044

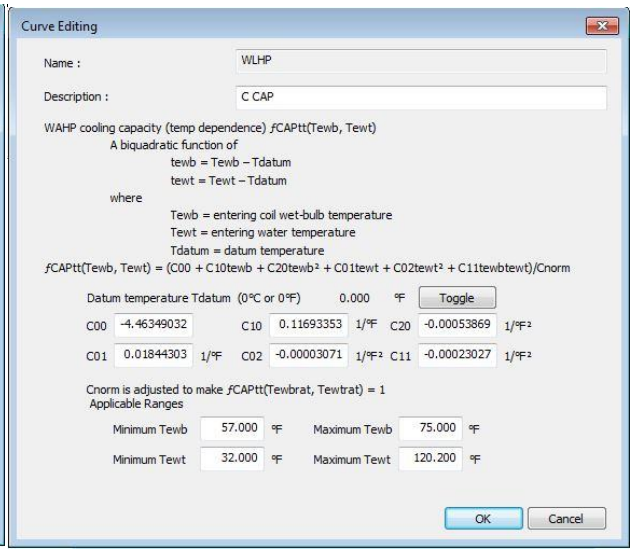
c01 = 0.00983145, c02 = -0.00001892, c11 = -0.00011483



For WIII 84 series:

c00 = -4.46349032, c10 = 0.11693353, c20 = -0.00053869

c01 = 0.01844303, c02 = -0.00003071, c11 = -0.00023027



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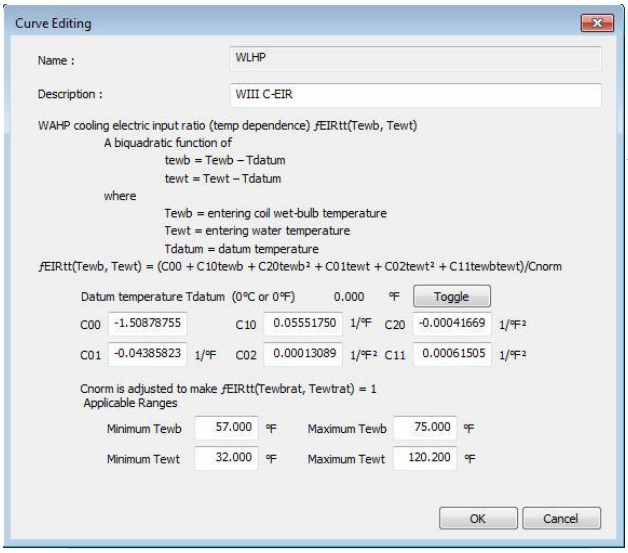
e. Cooling EIR (temp dependence) curve

For WIII 72 series:

c00 = -1.50878755, c10 = 0.0555175, c20 = -0.00041669

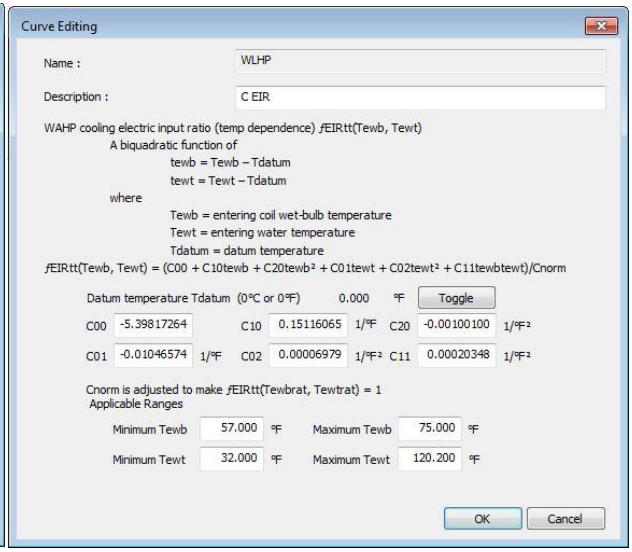
c01 = -0.04385823, c02 = 0.00013089, c11 = 0.00061505



For WIII 84 series:

c00 = -5.39817264, c10 = 0.15116065, c20 = -0.001001

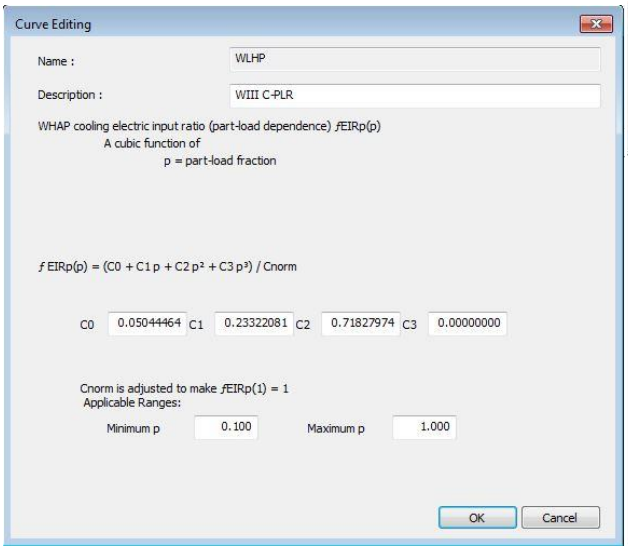
c01 = -0.01046574, c02 = 0.00006979, c11 = 0.00020348



f. Cooling EIR (part-load dependence) curve

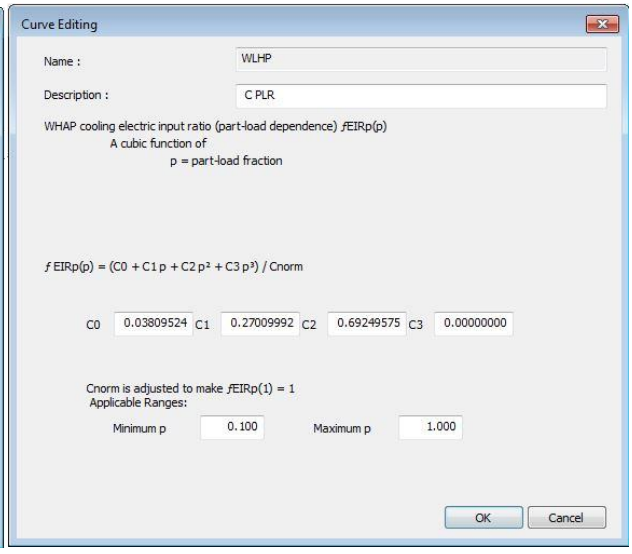
For WIII 72 series:

c0 = 0.05044464, c1 = 0.23322081, c2 = 0.71827974

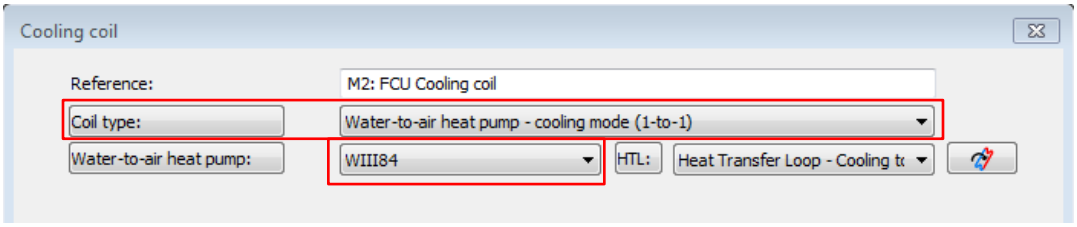


For WIII 84 series:

c0 = 0.03809524, c1 = 0.27009992, c2 = 0.69249575



7. After inputting all the numbers, click 'OK' to save the component. When defining the cooling and heating coils in the prototype system, the component defined will be available when choosing 'Water-to-air heat pump – cooling mode' as the Coil Type.

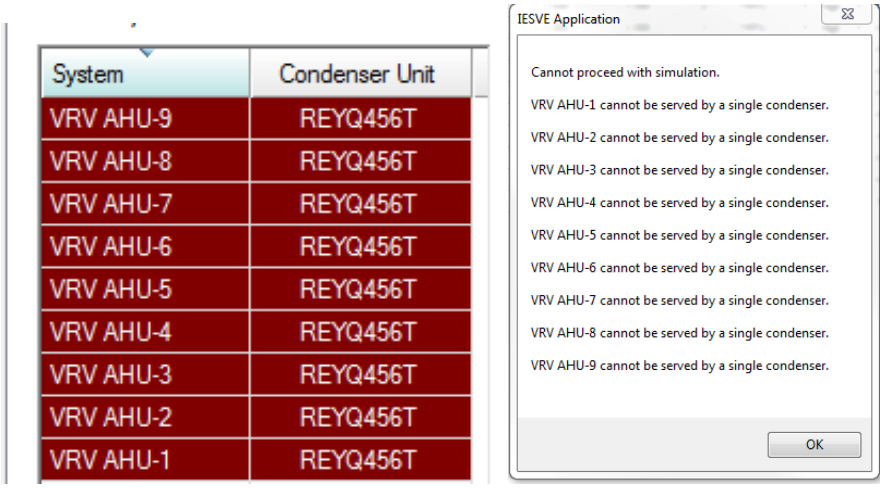


Modeling Tips

Generally, comprehensive training is required to better design and capture the thermal dynamics of the VRV system. This session is aiming to provide suggestions for optimal VRV system design and explanations to possible errors or warnings that might occur when using the tool.

- Zoning (assign rooms to outdoor units) is one of the crucial steps that determine the equipment specification and energy consumption of the system, especially for heat recovery units, as it affects not only the system sizing and operation mode, but also the piping length. It takes several tests before finding the optimal zoning strategy.
- Make sure to re-run the '*Peak loads & Autosizing*' (step 13.2) before going to the '*Thermal Simulation*', if anything outside the plugin is changed, i.e. room temperature set-point, internal gains, etc.
- If '*Thermal Simulation*' is not performed, the tool will NOT save the '*Peak loads & Autosizing*' results when closing and reopening the tool. So make sure the exported Excel sheet is saved for the current sizing results.

  The '*Peak loads & Autosizing*' results will be saved after reopening the tool only if the '*Thermal Simulation*' calculation is performed and 'Yes' is selected to update the system efficiency when closing the tool. The '*Thermal Simulation*' results, especially the fan power consumptions, however, will not be saved in any matter.
- The simulation results that can be opened in VistaPro may differ from the results seen in the plugin. This is because after a single plugin simulation, plugin will place the system efficiency into the Apache system but another simulation in Apache system outside of the plugin is needed based on the updated efficiency for the results to be shown properly in VistaPro.
- If the condenser units in the left tree is covered in red and the window pops up when trying to run the '*Thermal Simulation*', it means the zone load has exceeded the possible maximum capacity of one outdoor unit. The solution for this problem is to assign fewer rooms to one outdoor unit, or divide one large room into two smaller spaces.



System	Condenser Unit
VRV AHU-9	REYQ456T
VRV AHU-8	REYQ456T
VRV AHU-7	REYQ456T
VRV AHU-6	REYQ456T
VRV AHU-5	REYQ456T
VRV AHU-4	REYQ456T
VRV AHU-3	REYQ456T
VRV AHU-2	REYQ456T
VRV AHU-1	REYQ456T

- If the load calculation has been performed in Apache or ApacheHVAC before using the plugin, the following error will appear to prevent from further calculation in plugin. The solution to this one is to build up another identical project that only runs the plugin.