VRVPro V5.0.0
User's Manual

Floor plan drawing,
Air Conditioning Device Selection,
Ventilation Design,
Cool/Heat Calculation,
Temperature Simulation

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1 Understanding the Basics of VRVPro

VRVPro is a comprehensive software package allowing you creating a floor plan, performing a load calculation, designing ventilation, selecting air conditioning devices and performing a temperature simulation. In addition to these basic functions, it also reads AutoCAD files, offers 3D perspective views, calculates an estimate of the yearly energy consumption and creates reports with a large amount of overviews.

Figure 1 gives three different views of the same project:

1. The picture at the left gives the original AutoCAD drawing with the rooms, the corridors, the walls…etc. Each room has a name and a surface. Such a plan is the starting point to create a floor plan.
2. The picture in the middle is the VRVPro floor plan containing conditioned (in gray) and unconditioned (in blue) rooms, ventilation devices with their ducting and air conditioning devices with their piping. Rooms have labels with user-selected content, such as its name and surface, but also for instance the required airflow and cool or heat loads.
3. The picture at the right is a 3D drawing of this floor plan. VRVPro offers 3D perspective views of a single floor plan, but also of the complete building.

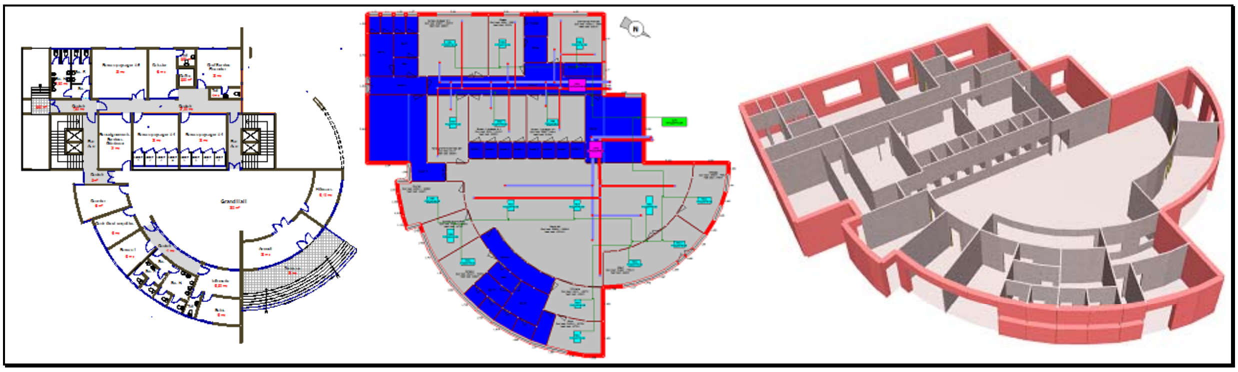


Figure 1: Designing ventilation and air conditioning, starting from an AutoCAD drawing

Before start working with VRVPro, it is necessary to understanding a few important concepts, which are explained in the next sections:

- VRVPro only supports the selection of Daikin ventilation and air conditioning devices. These are stored in a device database that is integrated into the executable program (see section 1.1).
- To perform load calculations, duct design and temperature simulation, VRVPro uses a second database containing heat sources, constructions, occupancy data and climate files. As some of these data are location specific, you may change definitions or add new ones (see section 1.2).
- If an engineering company made a load calculation, it is not necessary to redo this. Instead, after having created the floor plan, you may enter the calculated data and proceed immediately to the air conditioning device selection. So, VRVPro offers a simple drawing and selection mode, called the ***Quick*** mode. The comprehensive one is called the ***Expert*** mode, in which you can perform load calculations and temperature simulations (see section 1.3).
- A building, a floor and a room have several properties and settings. To simplify changes or to make sure all rooms use the same properties, VRVPro offers a percolation system in which properties set in a building are copied to floors and from floors to rooms (see section 1.4).
- At several places and at several points in time, you may have to enter data or select options that may be difficult to understand. VRVPro offers specific help explaining the data or option and also gives typical values to use (see section 1.5).
- VRVPro offers several ways to create a floor plan. A common method is using an existing floor plan as a template (see section 1.6), the most sophisticated of which is importing an AutoCAD drawing.

1.1 The Device Database

VRVPro integrates a Daikin device database in its executable program, as shown in Figure 2:

Figure 2: VRVPro with integrated device database

This approach has several advantages:

- VRVPro is independent from other files, making sure a user cannot accidentally move or delete them. All data are available and accessible at any time.
- The device database has an expiration date, as Daikin may decide to launch new devices, abolish existing ones or offer extra options. When the device database becomes outdated, so is VRVPro. A newer VRVPro version contains an updated device database.
- The device database data are read-only, making sure you get the same results, even across different projects.
- It is possible to have a VRVPro version specific for a given region, making sure you create projects using devices that are available in that region.

Although VRVPro integrates a device database, it does not offer any viewing of its data. Instead, VRVPro offers a command to execute a device database viewer program, which allows browsing through the different Daikin devices to check their properties, capacities and possible combinations.

Figure 3 shows the main screen of this viewer program with six images, each standing for a specific kind of devices. Clicking on an image opens up the corresponding section. All device sections are organized in a similar way:

- The devices are grouped in a hierarchical way: series, families and models. When selecting a given series, the browser only shows the families within that series. When selecting a given family, the browser displays the models within that family.
- The information for a given model is organized in tabbed windows (see also Figure 4). The ***Technical Data*** tab shows the properties that are important for the device selection, whereas the ***Options*** tab contains the possible combinations with other devices or options.
- If applicable, command buttons in the ***Technical Data*** allows displaying capacity data or capacity correction data. Depending on the kind of device (indoor unit, outdoor unit or ventilation device), extra tabbed windows show more specific information. For instance, an outdoor unit contains many different limits on piping lengths, heights and diameters.
- The ***Options*** image shows the different devices option per device category (indoor units, outdoor units, BS-boxes or ventilation devices) and their specific technical data.

Figure 3: The device database viewer program

Figure 4 shows the overview screen for the indoor units, with its hierarchical selection at the top and its detailed technical information at the bottom of the window. The device database viewer program may be considered as an interactive data book.

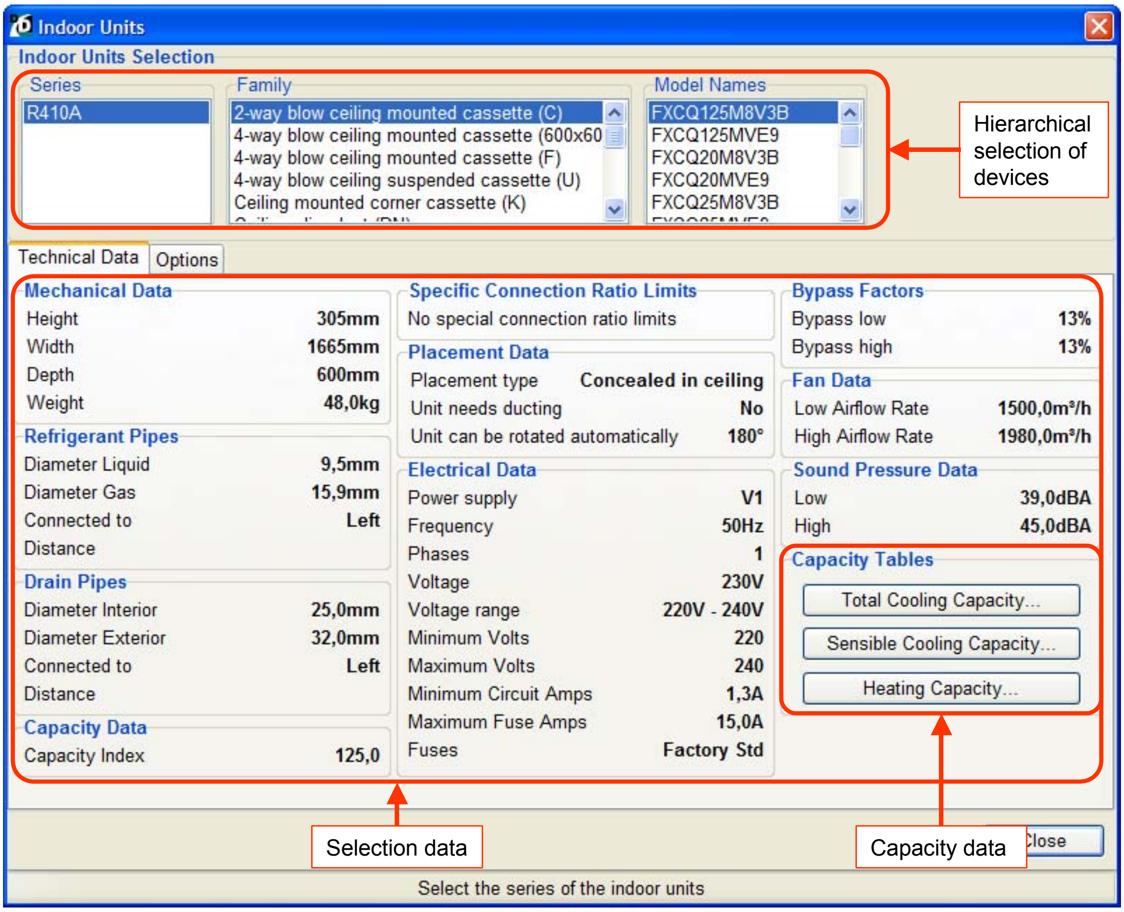


Figure 4: The indoor units overview

1.2 The Company Database

The company database mainly contains data needed for the load calculations and temperature simulations and is equally integrated in VRVPro, in the same way as the device database. However, several of these data are bound to the location, the region or the country. Although the company database contains many definitions, it may be necessary to adapt existing ones or add new ones.

When creating a new project, VRVPro copies its company database into the project file. As shown in Figure 5, any change or addition made to the company database is actually stored in this copied company database.

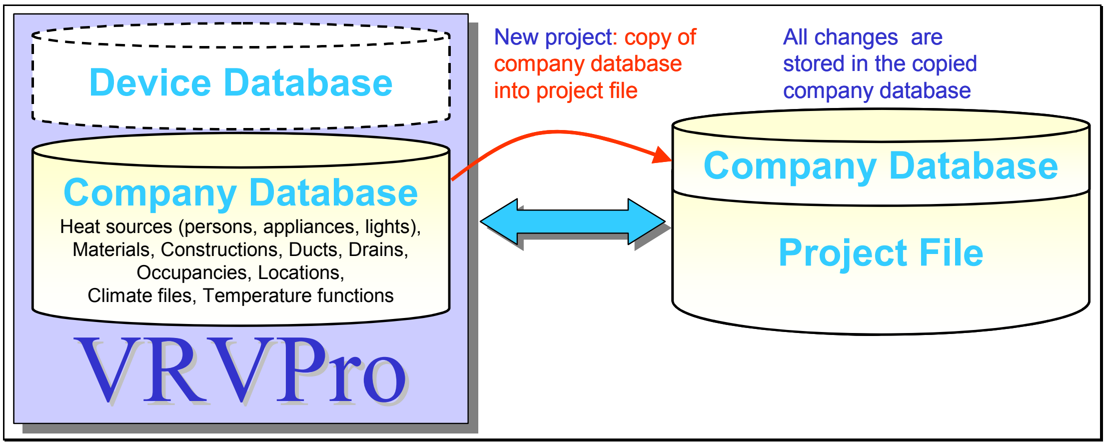


Figure 5: The company database integrated into VRVPro and used in the project file

Copying the company database into the project file is the default proposed way to start a new project. However, VRVPro also allows getting a company database from another project file, as shown in Figure 6. This is particularly interesting if that company database contains many changes or additions to the default company database.

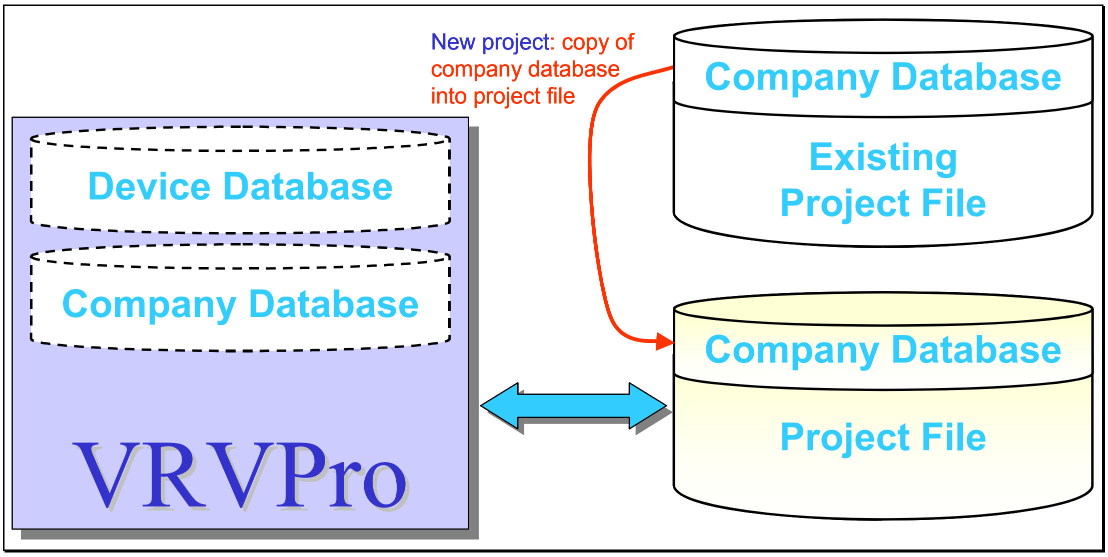


Figure 6: Using a company database from another project file

Figure 7 shows the VRVPro window when starting a new project. The first radio button ***Default*** is selected, which proposes to copy the company database from the VRVPro executable program (see also Figure 5). The second radio ***Based on existing project*** is the situation where you want to use a company database from another project file (see also Figure 6).

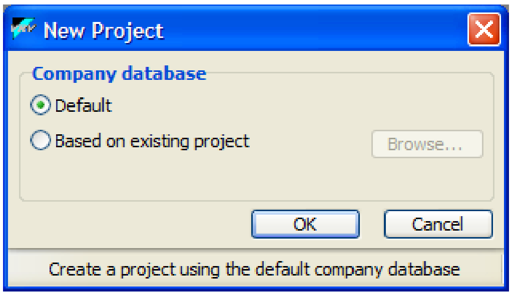


Figure 7: Starting a new project

When selecting this second option, a browse button allows searching for the project file in different folders.

In the same way as for the device database, VRVPro offers a command to view the company database, which is stored into the project file. Figure 8 shows the main screen of this viewer. It consists of a tabbed window, each tab containing specific definitions. This section will not explain these definitions, as they will be treated in chapter 5.

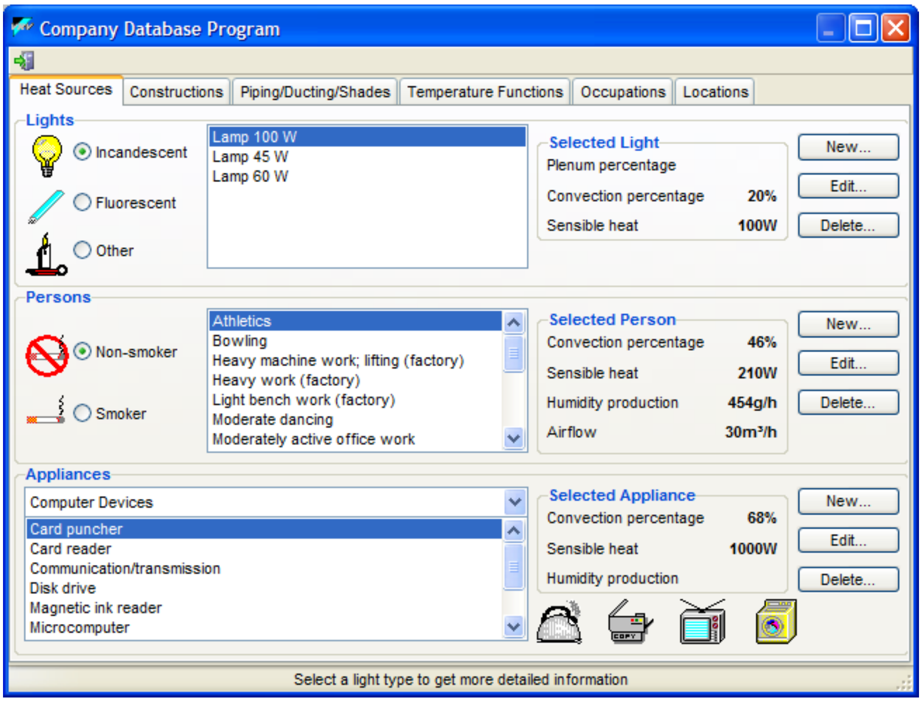


Figure 8: The main window of the company database viewer

To get the information about a definition, click on the definition. The detailed information then appears at the right side. For example, clicking on ***Lamp 100W*** in Figure 8, gives its information at the right (no plenum percentage, convection percentage = 20% and sensible heat = 100W).

The ***New***, ***Edit*** and ***Delete*** buttons next to each definition section allow adding, changing or deleting a definition.

1.3 The VRVPro Modes

When starting VRVPro the very first time on a computer, it will use the ***Quick*** mode. The next time you start VRVPro, it will use the last mode that was used. This may be the ***Quick*** or the ***Expert*** mode.
In the ***Quick*** mode, you create a floor plan, enter the required airflow and loads in all rooms, design a ventilation system and select the air conditioning devices. To draw a floor plan, VRVPro needs constructions for walls (outside and inside walls), ceilings, floors, windows and doors. These constructions are only needed to draw and not to make any calculation. So, VRVPro uses the first of these construction definitions from the company database.

In ***Expert*** mode, you equally start by creating a floor plan, but first have to select the constructions to use. Instead of entering the required loads, you now calculate the required loads, by entering the different heat sources and sources of airflow, such as ventilation and infiltration. As the sun is an important source of extra heat, the location definition becomes important to calculate the sun position with its direct and indirect sun radiation. The results of a load calculation are the required loads in all rooms. From there on, you design a ventilation system and select the air conditioning devices, as in the ***Quick*** mode. However, the data and properties specified and needed for the load calculation, can now be used for a temperature simulation, to calculate the evolution of the building over a complete year. As this calculation also determines the capacity to deliver by all ventilation and air conditioning devices, it also becomes possible to calculate the energy consumption over a year.

At any time, it is possible to change from the ***Quick*** mode to ***Expert*** mode. The first time you do this within a project, VRVPro will display a window, as shown in Figure 9, to select the different constructions for the building. The constructions used have a considerable impact on the load calculation and temperature simulation results. So, you should select them carefully or add new constructions first. You can do this by clicking the ***Browse*** command button at the bottom of the conversion window, which opens the Company Database main window (see section 1.2).

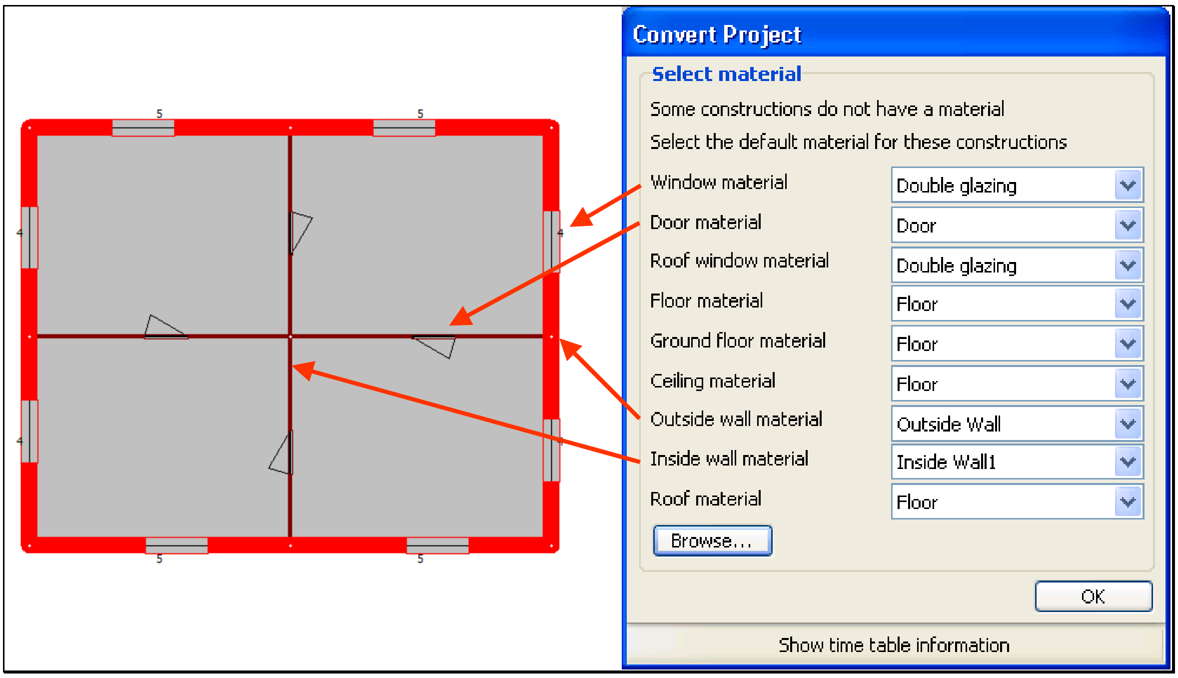


Figure 9: Changing over from Quick mode to Expert mode: selecting the constructions

VRVPro keeps the selected constructions, when changing back from ***Expert*** mode to ***Quick*** mode.

In addition to display a window to select the constructions, VRVPro also performs a check on missing data when changing from Quick mode to Expert mode. Where possible, it uses default values or default calculations to get initial data. At the end of the conversion, it displays a window with the different conversion warning messages, as shown in Figure 10:

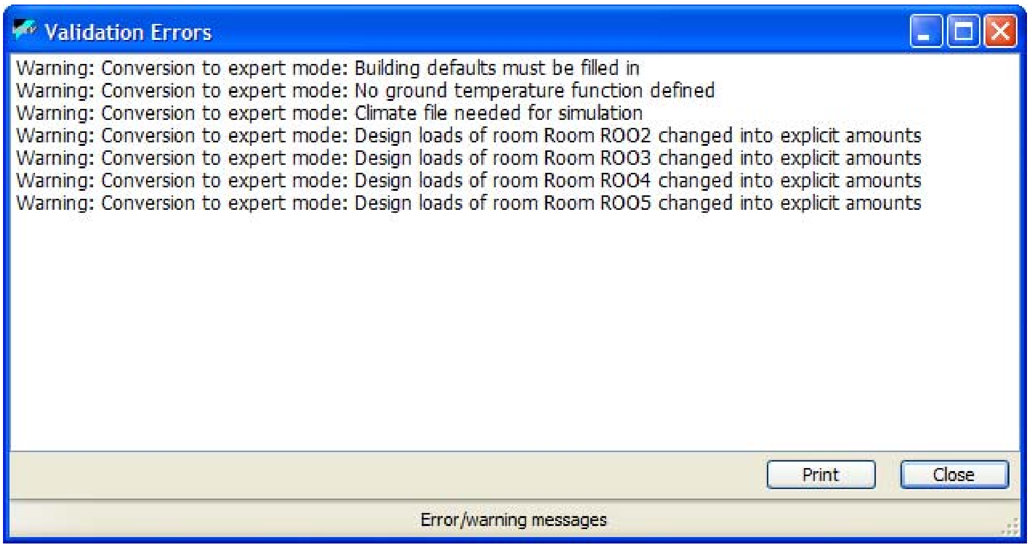


Figure 10: Changing over from Quick mode to Expert mode: conversion messages

It is important to check these messages and make sure the VRVPro assumptions are correct. The first three messages in Figure 10 also mention missing settings, which are needed when you want to perform a load calculation or temperature simulation.

1.4 Building, Floor and Room Properties

A room has many properties and you can set or change them at any time, by selecting the room on a floor plan and edit it. However, this becomes cumbersome if changing a property must be done for each individual room.

A more efficient approach is defining default properties at the building or floor level and copying them all rooms or to the rooms belonging to that floor. Figure 11 illustrates how you can copy properties from the building to the floors and from a floor to its rooms.

When you change any building property and then close the "***Building Properties***" window, VRVPro will pop up a window to copy these defaults to the rooms and floors, as shown at the top right of Figure 11. In this window, it will check only the classes of properties that were changed. Although not necessary, you may check the other classes as well.

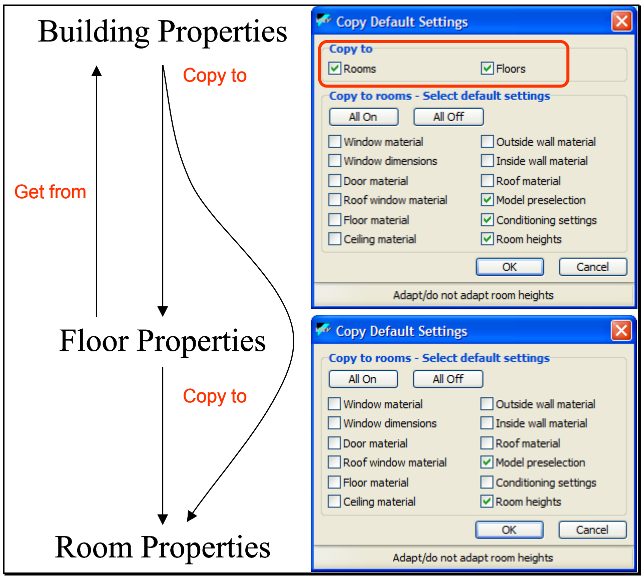


Figure 11: Setting room properties in a hierarchical way

When you change any floor property and then close the floor property window, VRVPro will pop up a window to copy these defaults to the rooms, as shown at the bottom right of Figure 11. After having changed some floor properties on a given floor, it is possible to restore the original properties by getting them from the building properties.

Although the building and floor properties are copied to the rooms, some building or floor properties cannot be set in an individual room. Two examples are a door and a roof construction. A door is between two rooms and a roof may cover all rooms of a floor. Setting the door construction in one room would introduce a contradiction in another room (the one the door is giving access to). So, it is not possible to set a door construction in a single room.

Another way to change a property in more than one room at once is using the multiple select. Click in the different rooms, while keeping the Ctrl button pressed. Each click in a room will select it, as shown in Figure 12.

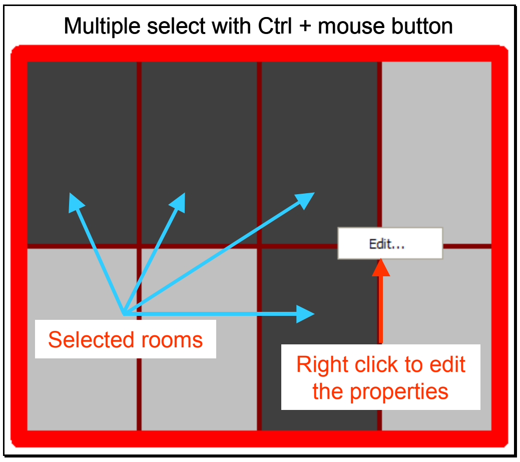


Figure 12: Multiple room selection

Now release the Ctrl button and click the right mouse button to bring up the edit command. Select it to open the room properties window. After you finished making the changes, VRVPro will only adapt the room properties that were adapted and keep the other properties untouched.

Multiple select is also possible for walls, windows, doors, ventilation and air conditioning devices.

1.5 Help and Help Icons

As shown in Figure 13, the bottom of each VRVPro window contains a help bar, in which appears a short explanation of the data entry field you have selected.

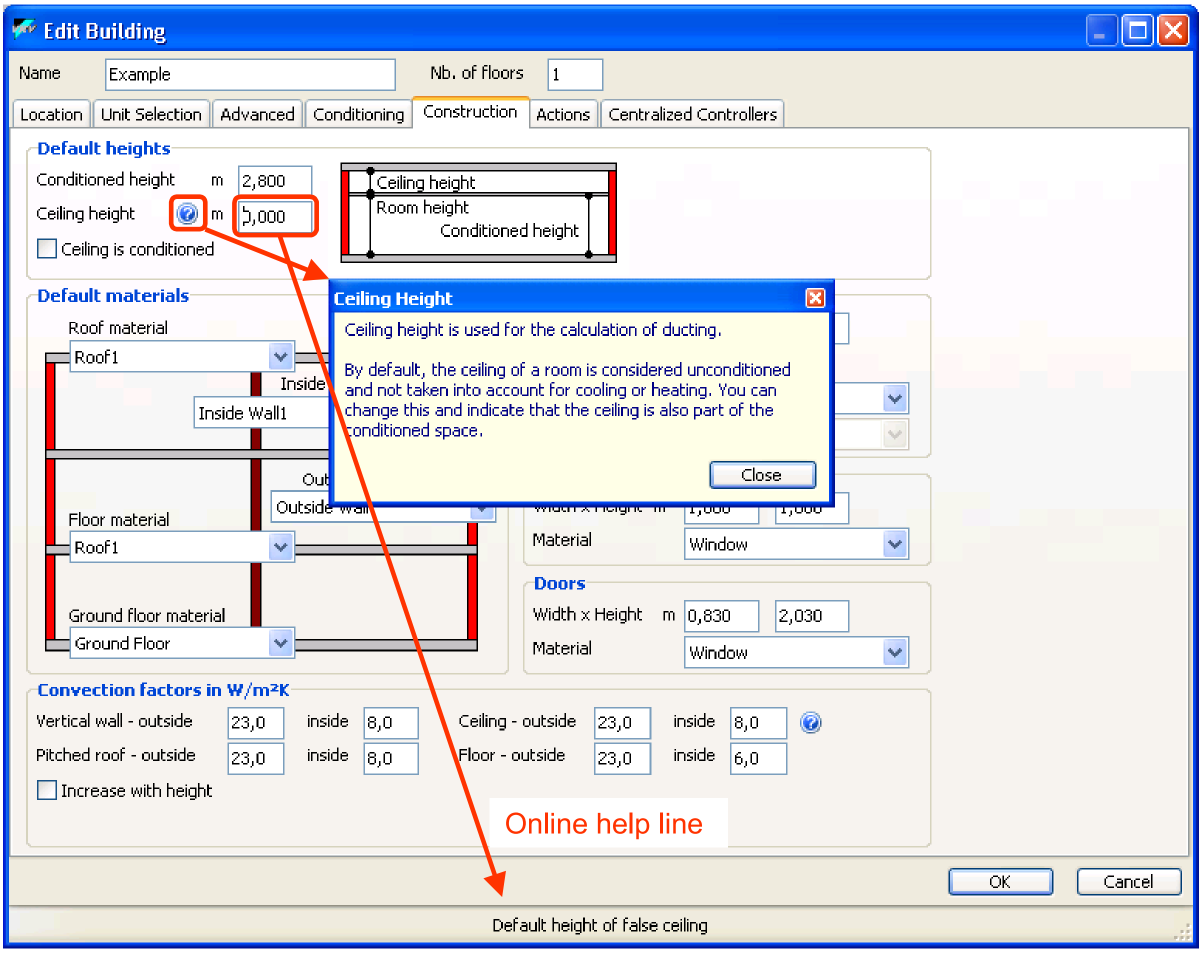


Figure 13: Online help and help icons

This one line help text also appears when you select a radio button (◉), a checkmark (☑), a command button or a list.

As some fields need more explanation than a single line of text, they are preceded or followed by a small blue question mark icon (?). Clicking on it brings up a window containing more elaborate explanations or some specific values and limits for that field to enter.

Specific values and limits are based on data found in ASHRAE Fundamentals Handbook, SI-edition or on data prescribed by Daikin.

1.6 Using Drawing Templates

For the majority of projects to realize, there is a floor plan available in one or other form. This may be in electronic form or on paper, which can be scanned to get it electronically.

Floor plans come in many forms and shapes. Some give many details, where others only show the minimum information. AutoCAD floor plans may contain a large number of layers, each containing specific information, where others contain all information in a few layers. Those layers follow different naming conventions, making it difficult to find what content is in what layer. Moreover, floor plans may have been drawn using different scales and may come in one (large) AutoCAD file or several independent files.

To perform load calculations and temperature simulations, VRVPro not only needs floor plans with correct distances and surfaces, but also with detailed definitions of constructions, such as material layers in walls and the transmittance factor of windows. To combine the advantages of having a floor plan in electronic form and creating a floor plan with the required properties, VRVPro offers a number of very effective functions to draw over an existing floor plan (see chapter 2, Drawing a Floor Plan).

A new VRVPro floor plan starts as a simple rectangle of 10m x 8m, over which you can place a floor plan template, by selecting in from the floor edit window, as shown in Figure 14:

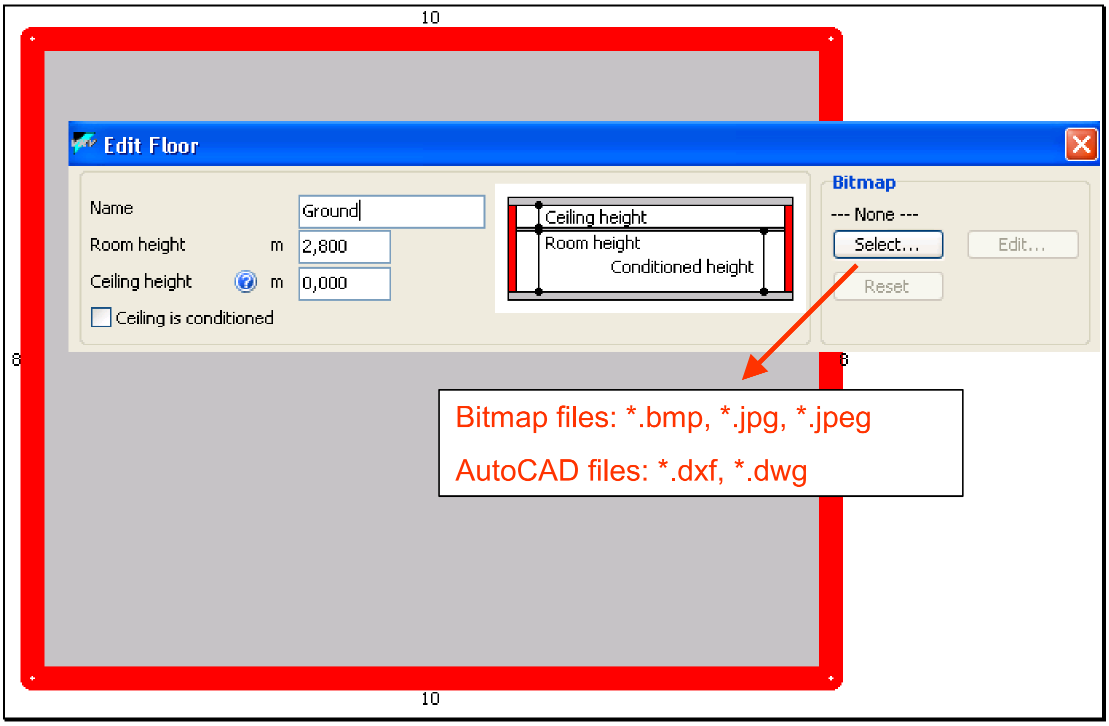


Figure 14: Loading a floor plan template

1.6.1 Loading Bitmap Templates

The simplest to load, but also the most limited ones are bitmap templates. They have a fixed resolution and zooming them in too much makes a drawing unreadable. However, if they were created with an adequate resolution, they will serve their purpose.

When loading a bitmap drawing, a window comes up to show it and to define its scale, by drawing a line of a given length on the bitmap, as shown in Figure 15:

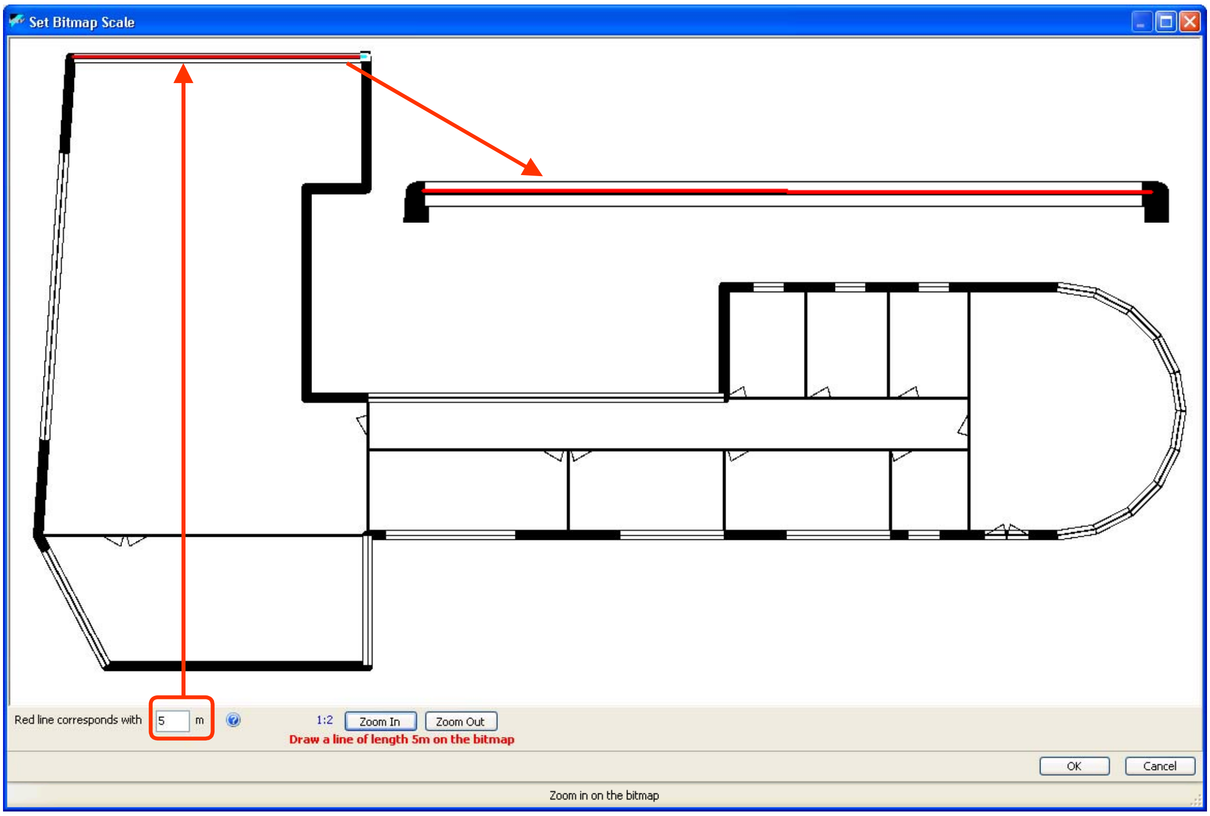


Figure 15: Loading a bitmap template and setting its scale

By default, VRVPro proposes a line of 5m, but you can change it to any length. To actually draw or adapt the line, proceed as follows:

- When the mouse cursor is at the starting point of the line, press the left mouse button. While holding the left mouse button pressed, draw a line that corresponds with a known distance on the floor plan. Release the left mouse button.
- If you move the mouse cursor outside the drawing area while drawing a line, the drawing will be scrolled. So, the full drawing does not have to fit on the screen to define its scale.
- Once a line is drawn, you can move its start or end point. Select the start or end point with the left mouse button. Move the point by dragging the mouse or using the arrow keys of the keyboard.

As VRVPro measures distances between walls from the centerlines the walls, the scale line you draw must start and end at wall centerlines, as shown in the detail of Figure 15. When closing the window with the scaled bitmap template, VRVPro will display it as a template on its floor plan. However, the floor plan template may not position exactly on the VRVPro floor plan. So, one last action is synchronizing the origin point of the floor plan template with the reference corner on the VRVPro floor plan.

By default, the VRVPro has its reference corner at the upper left of the floor plan. You can change this by selecting any point on a floor plan wall and define it as the new reference corner.

So, at any time, VRVPro knows the reference corner of its floor plan. However, this is not the case for a loaded floor plan template. Its origin point may be anywhere on that bitmap drawing.

So, you have to define the origin of the bitmap drawing, by right clicking the mouse outside the floor plan. This brings up the menu with floor commands, one of which is "***Set Bitmap Origin***", as shown in Figure 16.

Select this command and click on the intended origin point ***on the bitmap drawing***. VRVPro will then align both that point with its reference corner and make sure the bitmap drawing is positioned correctly.

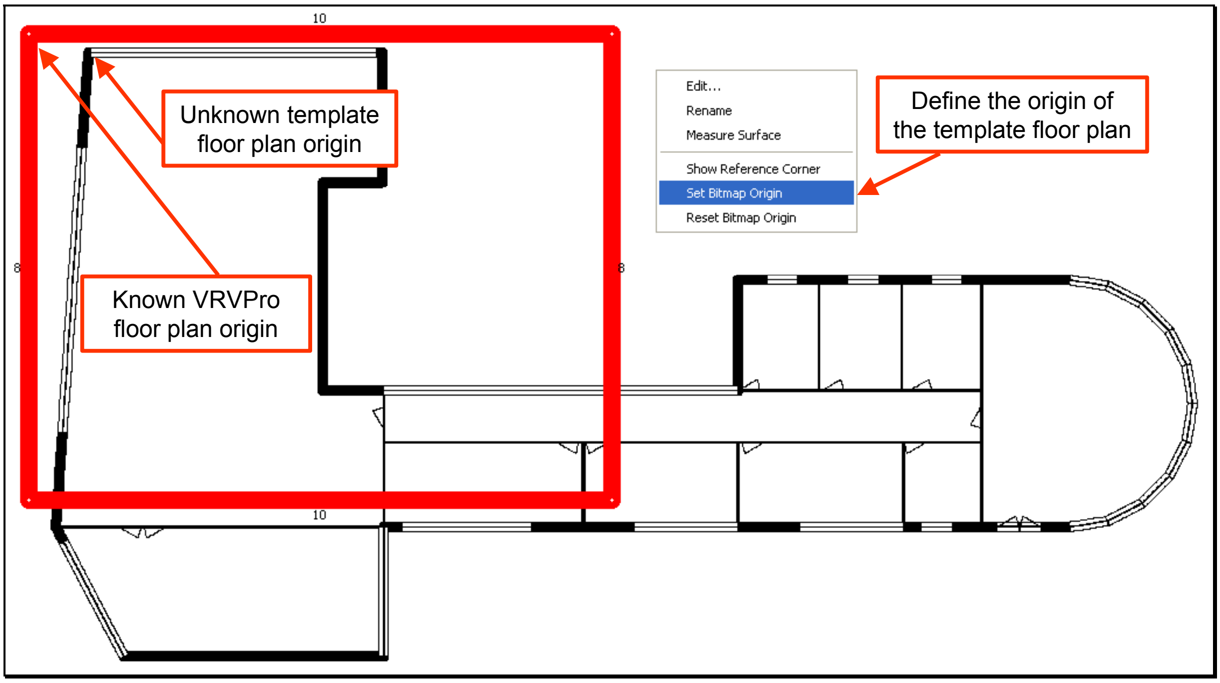


Figure 16: Synchronizing the floor plan origins

Once the floor plans are adjusted, but even before, you can check if the scale you defined by drawing that line (see Figure 15) is accurate enough by checking a known surface. To that purpose, the menu with floor commands also contains the command "***Measure Surface***" (see Figure 16).

After selecting this command you can click on the corner of a room and drag the mouse while keeping the button pressed. A dashed rectangle will appear and will follow the mouse cursor until you release the mouse button. At that moment, a small window will display the surface of that rectangle.

Once you have loaded the floor plan template, correctly scaled and aligned it, you can start drawing over it, as explained in the next chapter (see chapter 2, Drawing a Floor Plan).

1.6.2 Loading AutoCAD Templates

AutoCAD files contain vector drawings, which can be scaled at any value, and consist of a number of layers, which can be switched off to hide particular parts of a drawing. The advantage of a vector drawing it its flexibility, its disadvantage is the time needed to redraw all vectors. As VRVPro floor plans also are vector drawings, using an AutoCAD drawing as a floor plan template would considerably slow down VRVPro. For that reason, VRVPro converts an AutoCAD drawing into a bitmap, after you have selected the required layers and defined the scale to use.

You load an AutoCAD drawing follows:

- Select and load an AutoCAD file in the same way as a bitmap file (see Figure 14).
- For AutoCAD files, VRVPro first brings up a window as in Figure 17, containing three selection criteria: the required layout, the required layers and the required drawing:

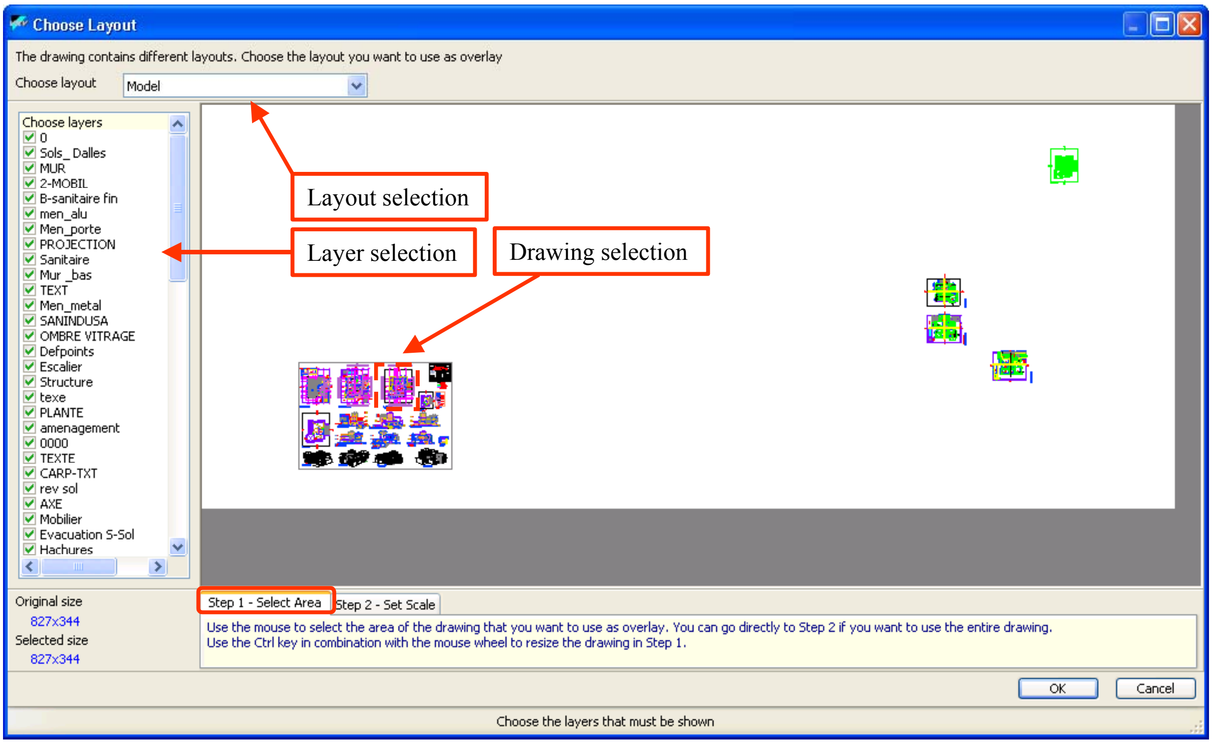


Figure 17: Selecting the required drawing from an AutoCAD file

- An AutoCAD drawing may contain several layout definitions, of which the first one is the most commonly used. So, VRVPro selects this layout and you probably seldom will have to change it.
- Some layers may show extra information, frames, tables or extra text. These are not relevant for the use of the floor plan template in VRVPro. Checking them off will hide these data from the AutoCAD file. Depending on the name conventions used or on the information available from the creator of AutoCAD file, it may be easy or difficult to decide what layers to select or to hide. Although it may take some time, reducing the complexity of an AutoCAD drawing by hiding layers will result in a floor plan that is easier to interpret for the purpose of dimensioning an air conditioning system.
- The actual drawing may be as tiny as shown in Figure 17, containing about 16 different and detailed drawings in the rectangle at bottom left and four others in the rest of the overview. It may also be an AutoCAD file containing only one drawing at a readable scale. The first step is selecting the required drawing by clicking the mouse and dragging the cursor while keeping the mouse button pressed down. VRVPro displays the actual selection in a rectangle with a white background color and paints the remaining of the drawing in dark gray.

- As soon as you have selected the drawing, VRVPro scales it up or down to a readable size and displays the result in a second tab of the AutoCAD selection window, as shown in Figure 18. VRVPro will convert this result into a bitmap, but first allows you to scale it up or down. The larger the scale, the larger the bitmap. The maximum size of the bitmap is a drawing of 6000 x 6000 pixels, which is more than 120Mbyte. Selecting a proper scale will keep the bitmap small enough to work swiftly and large enough to see all necessary details when zooming in the result.

In case the original selection was not satisfactory, you can always come back to the first window and select the AutoCAD drawing again.

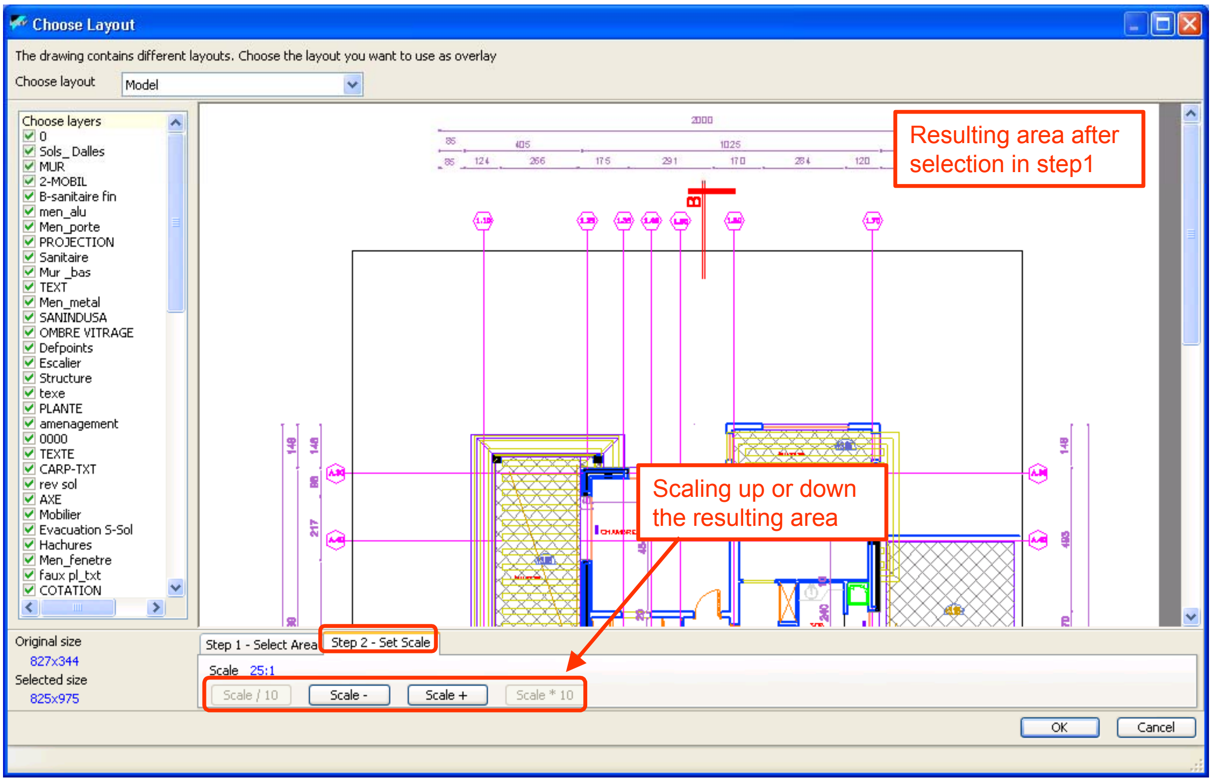


Figure 18: Scaling the selection before conversion to bitmap

- After you close this window, VRVPro loads the bitmap representation of the AutoCAD drawing, in which you have to draw a scale line as explained in section 1.6.1.

1.6.3 Using an Existing Floor Plan

By default, VRVPro assumes that a floor plan template is an imported bitmap or AutoCAD drawing. However, it is also possible to use an existing floor as a floor plan template for a new floor. This floor may be the previous floor (i.e. the floor lower than the current one) or the next one (i.e. the floor higher than the current one).

To change the floor plan template from an imported drawing to the previous or next floor, click the file menu and select the "***Options***" command. This brings up a window, containing the floor plan template setting at the bottom left (see Figure 19).

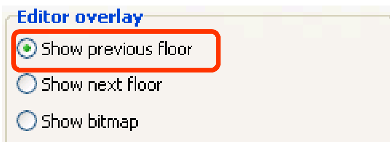


Figure 19: Setting the kind of floor plan template

By changing this setting from "***Show bitmap***" (the VRVPro default) to "***Show previous floor***", VRVPro will show the walls of the previous floor as a floor plan template for the current floor.

If the current floor were identical or at least very similar to the previous floor, it would be easier to copy the floor. Note that the VRVPro copy function allows selecting what to copy from that floor, as explained in the next chapter (see chapter 2, Drawing a Floor Plan).

2 Drawing a Floor Plan

This chapter explains how to create a floor plan, using the simple floor plan template, shown in Figure 15 and Figure 16. This floor plan template is also used in VRVPro training courses.

2.1 Starting a New Project

It takes a while to start up VRVPro, as it first loads its databases, after which it shows an empty main window with a menu and a tool bar at the top. The very first time VRVPro starts, the title bar also mentions "***Quick***", which stands for the Quick mode (see section 1.3). If you already used VRVPro, it will start up in the mode you were last using it.

In case VRVPro is in the Expert mode, set it back to the Quick mode, by selecting the "***Options***" command in the File menu. This brings up the options window, in which you select "***Quick selection mode***" at its top.

To start a new project, either click on the icon "***New***" in the tool bar or select the command "***New***" from the File menu, as shown in Figure 20:

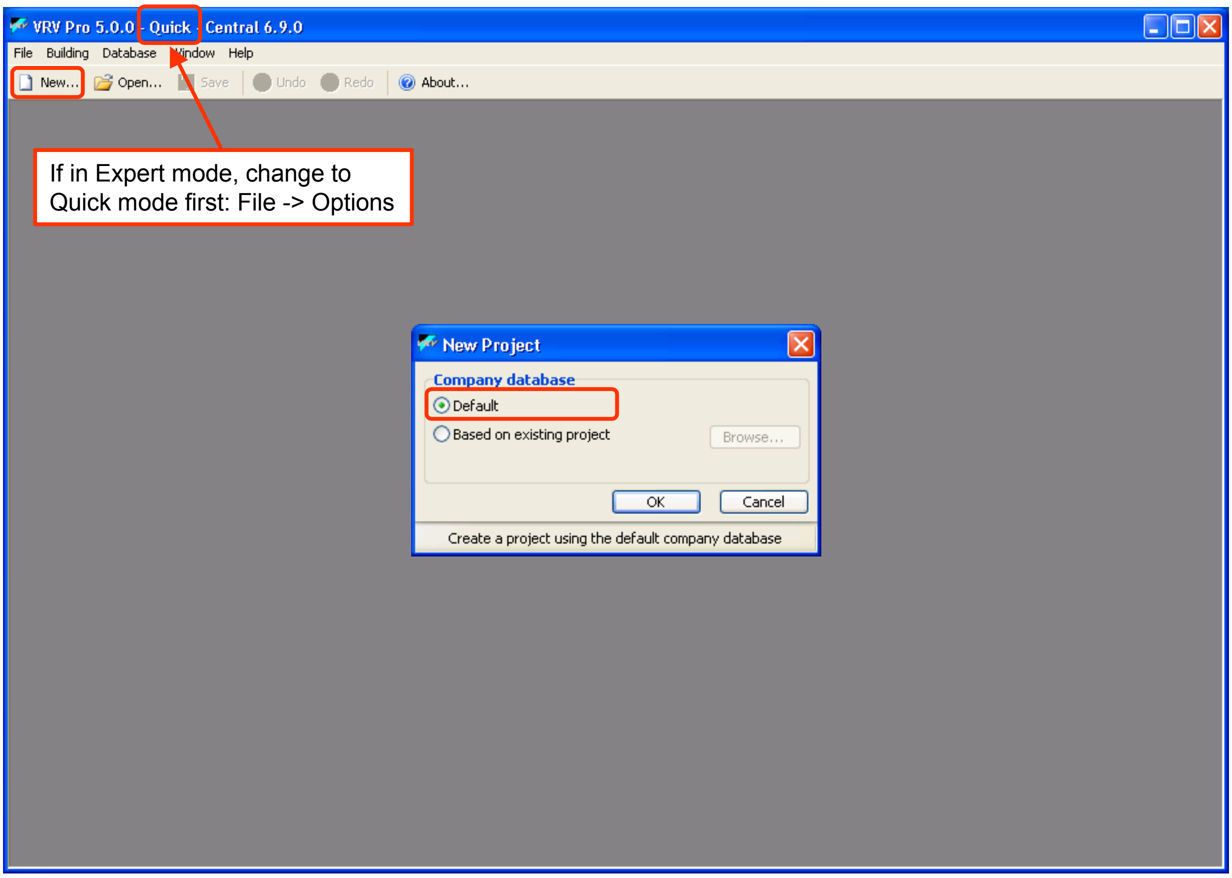


Figure 20: The VRVPro main window after clicking "New (project)"

VRVPro now displays the window with the company database to use (see section 1.2 for more details). Select the default company database. This brings up the "***Building Properties***" window (see also section 1.4), in which you have to enter several properties that will apply to the building and to all rooms of that building.

Figure 21 shows the "***Building Properties***" window in Quick mode, together with different marked zones to enter properties:

- The zones marked in **red** are data that you have to enter or that you should at least check. In addition to some obvious data such as the building (project) name and the number of floors, the following data are important:
  - ***Cooling and heating loads per m²***. As this is the Quick mode, you have to enter the required loads in each room. However, VRVPro may alleviate your task by using these loads per m² to calculate initial values in each room.
  - ***Ceiling height***. If you use a rectangular ducting for the ventilation, it may be installed in a false ceiling and some air conditioning devices can only be mounted in a false ceiling.
- The zones marked in **blue** you have to enter the properties once. The next time, VRVPro will use the settings of the last time you were using it:
  - In Quick mode, the location data are used to make the selection of ventilation devices.
  - The model pre-selection defines the type of air conditioning devices that will be selected by default.

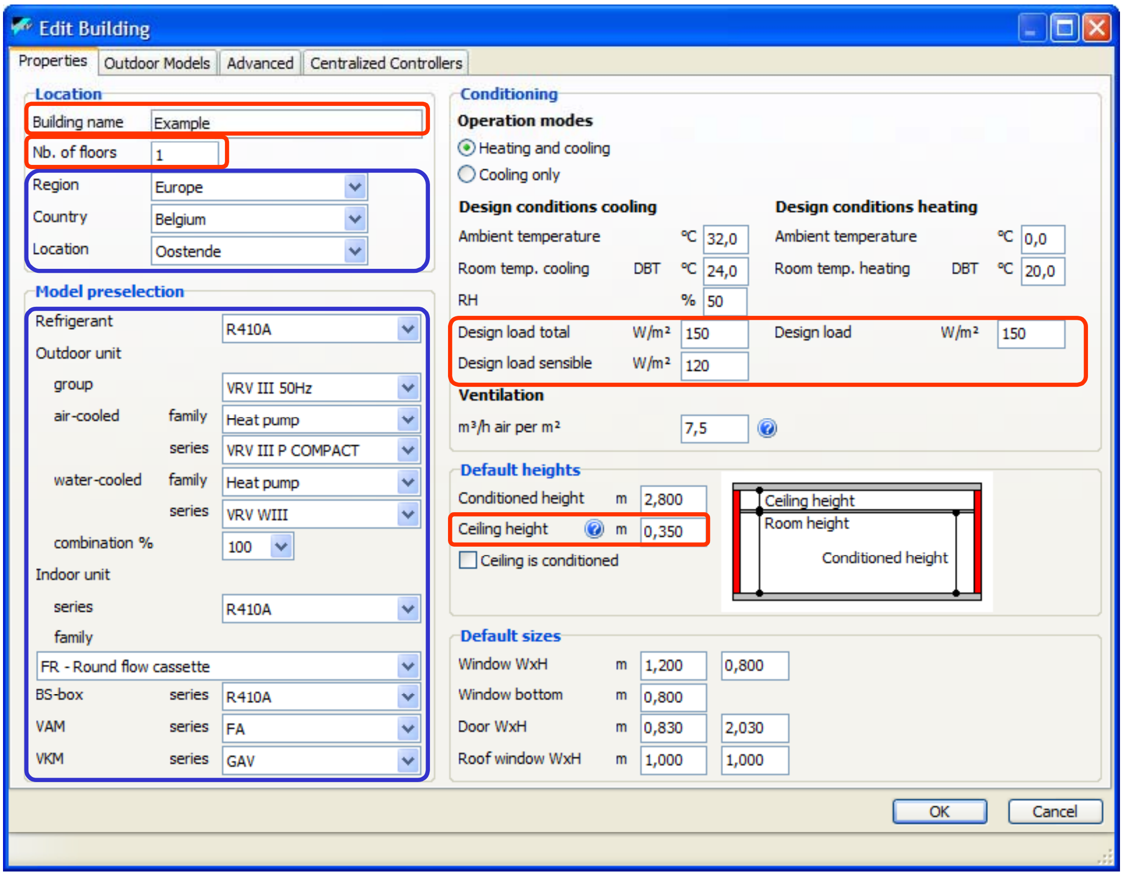


Figure 21: The building properties window in Quick mode

The other zones contain the default values that VRVPro proposes.

Although you have to fill in these data when starting a new project, you can change them at any time later, by selecting the command "***Properties***" from the building menu.

After you close this window, VRVPro will display a window as in Figure 11 (see section 1.4) to copy the settings to the floors and the rooms. VRVPro then creates the first floor in the project and displays the floor properties window, as shown in Figure 22, in which you have to enter the floor name. The other data fields have been copied from the building properties. If needed, you can overwrite them for this floor, as explained in 1.4.

In this window, you can also load a floor plan template, by clicking the select button in the upper right corner, as explained in detail in section 1.6.

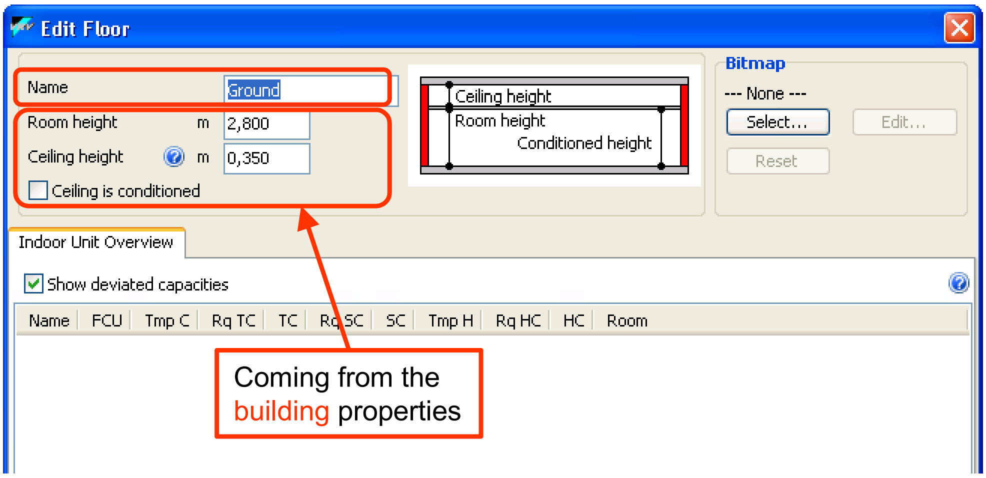


Figure 22: The floor properties window in Quick mode

When closing the floor properties window without selecting a floor plan template, will display a default 10m x 8m floor plan, together with a tool bar at the top and a list of floors with a command bar at the left, as shown in Figure 23:

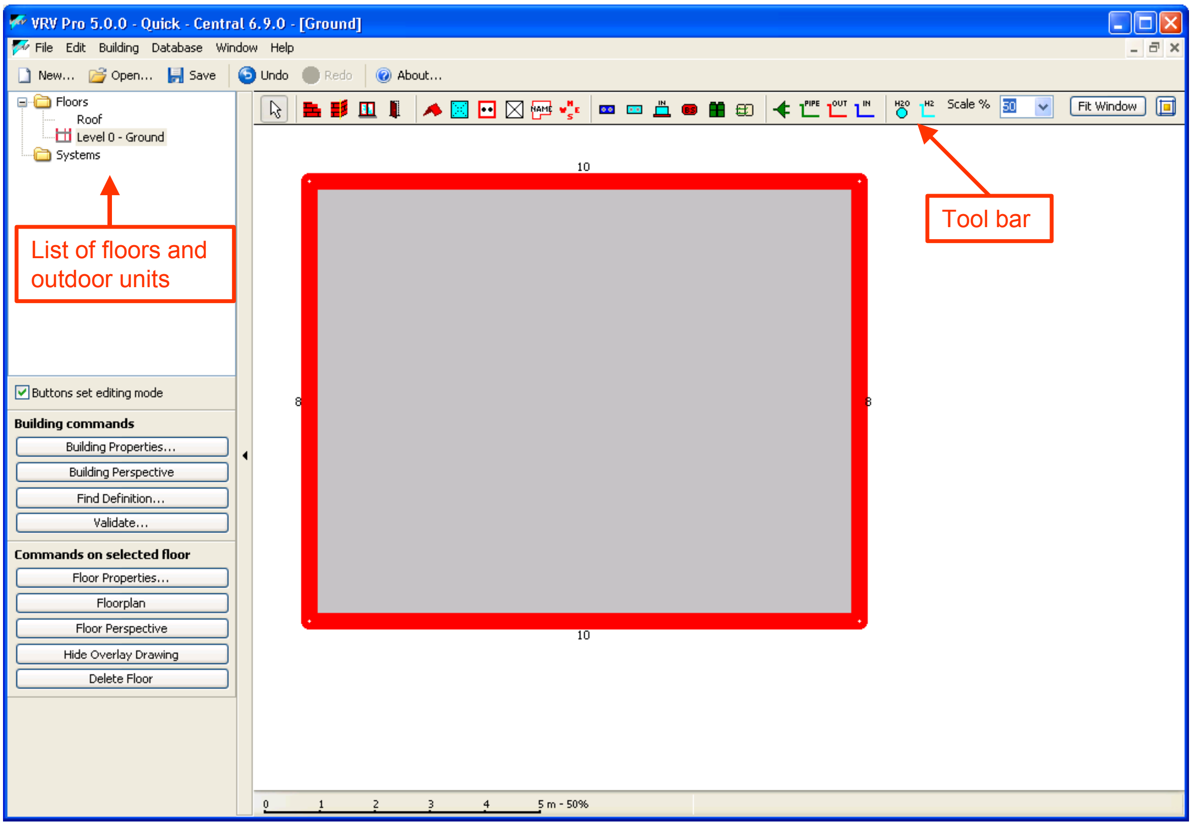


Figure 23: Default floor plan (10m x 8m) with tool bar and floor command bar

At any moment in time, you can still load a floor plan template, by clicking with the right mouse button outside the floor plan and by selecting the (floor) edit command to bring up the floor properties window again (see Figure 22 and section 1.6).

With the default floor plan in place and possibly with a loaded floor plan template, you can start creating the required floor plan.

2.2 A Note About Drawing Modes

Drawing a floor plan is adding elements and correcting others. To perform them, a drawing package can offer two different methods:

1. Modal drawing
   In modal drawing, you first select the function (e.g. add a window to a wall) and then you select the walls one by one. Each time you select a wall, a window will be added. To stop adding windows, you have to switch back to selecting by using the select tool.
   This method is excellent when you have to draw many identical elements, such as adding windows to wall.

2. Modeless drawing
   In modeless drawing, you first select an element (e.g. a wall), and then you select the required function on it from a tools icon or a menu, after which you return to the selection mode. You can only perform functions on selected elements.
   This method is well suited when you have to perform several small corrections or changes.

By default, VRVPro starts in modal drawing by setting the checkmark "***Buttons set editing mode***", at the left of the main window (see Figure 23). Figure 24 shows the differences in the tool bar when selecting a modal or a modeless drawing mode.

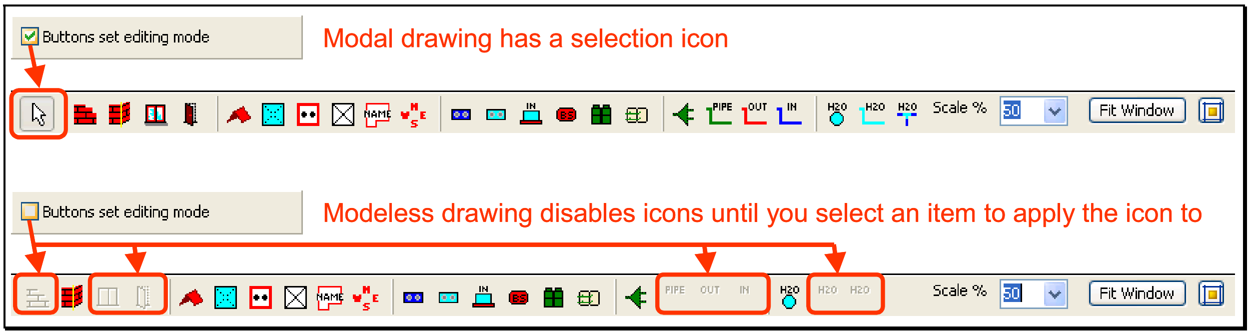


Figure 24: The different drawing modes and the corresponding tool bar

2.3 Drawing the External Walls

After having loaded a floor plan template and properly aligned its origin with the floor plan reference corner (see section 1.6), you get a result as shown in Figure 25:

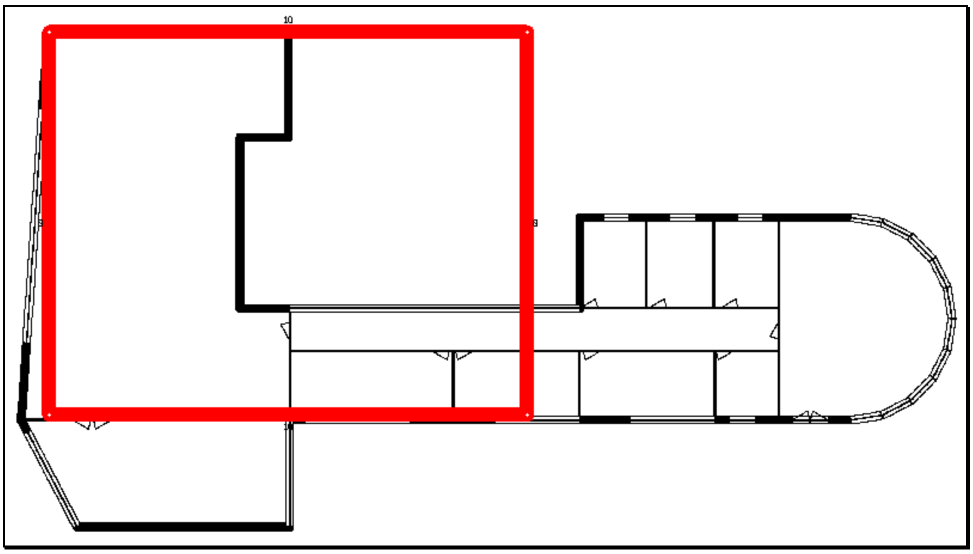


Figure 25: Starting situation after having loaded and aligned a floor plan template

Note that the vertical wall of the bitmap cuts the VRVPro wall at the top exactly in the middle. This is not surprising, as the scale line in Figure 15 was set to 5m.

The next step is to move the corners of the initial floor plan to the outer boundaries of the floor plan template, as shown in Figure 26:

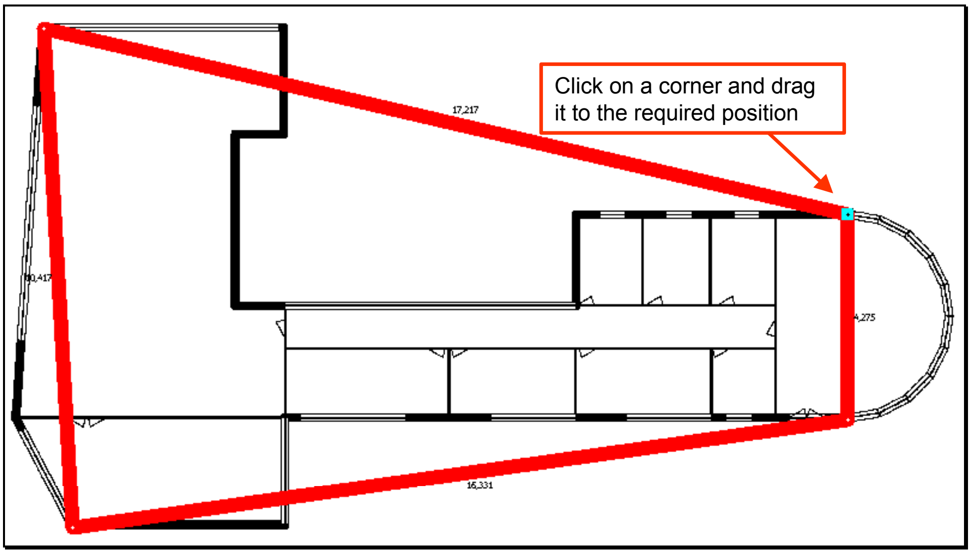


Figure 26: Moving the outer corners

To move a point, click on a corner and, while keeping the mouse button pressed, drag it to the required position. Figure 26 shows the result after having moved three corners. Note the rounded glass wall at the right of the floor plan template has not yet considered yet, as VRVPro offers a very elaborated function to draw circular arc walls (see section 2.7).

To place the external walls over those of the floor plan template, select the "***insert corner***" icon (). With this function, you can click on a wall, which automatically inserts a corner point, and drag that point to a required position. This is a quick method to place the external walls on the contour of the floor plan template. Figure 27 shows the result of those actions.

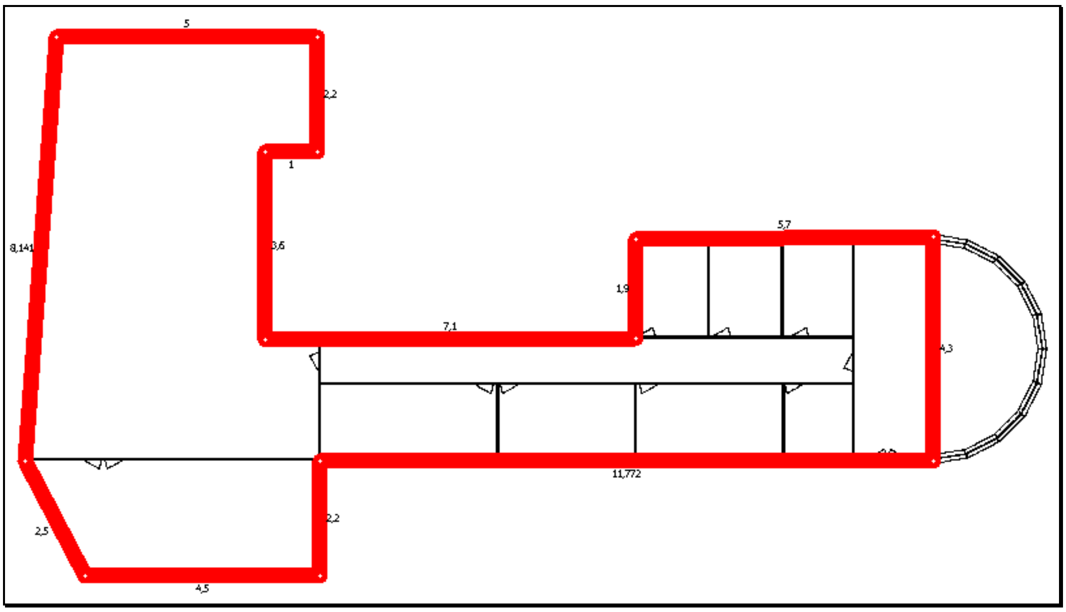


Figure 27: Placing the external walls

However, moving a corner with the mouse may give inaccurate results, especially concerning the straightness and the length of the walls.

If a wall is not straight (vertical or horizontal), click on it with the right mouse button to display the wall menu and select one of the commands at the bottom as shown in Figure 28 at the left. If you want to correct a wall length, select the "***Edit***" command from the wall menu and adapt the length, as shown in Figure 28 at the right.

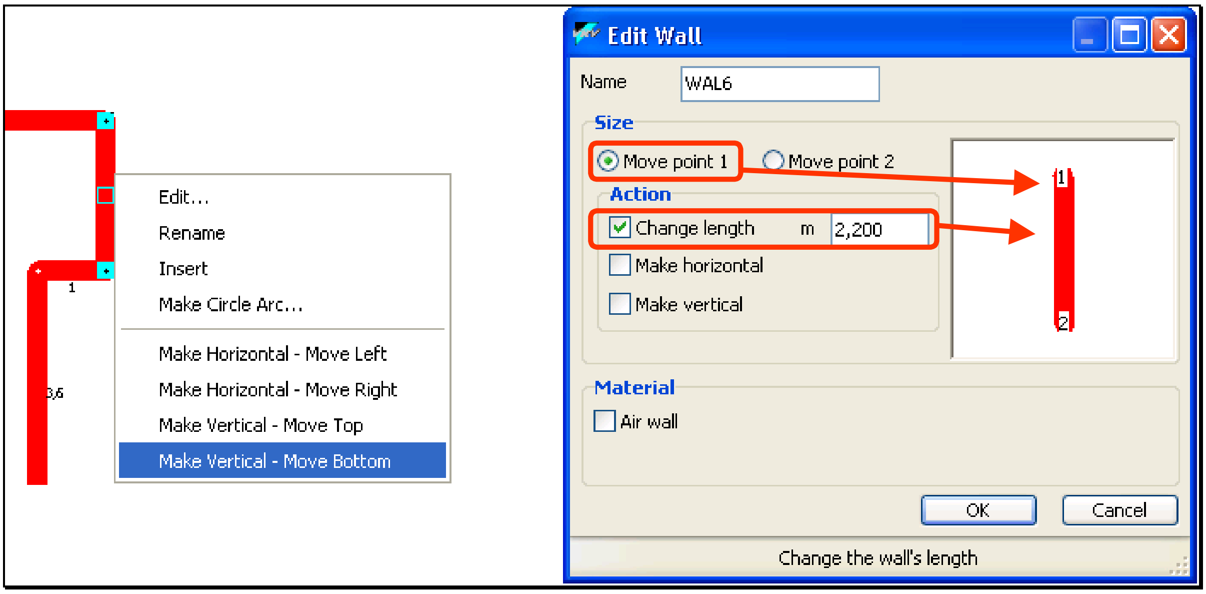


Figure 28: Correcting wall straightness and length

Note that VRVPro displays the wall lengths, allowing you to check them with the floor plan template. However, as explained in section 1.6.1 and in Figure 15, VRVPro measures walls between their centerlines.

2.4 Rescaling a Floor

At the moment you load a floor plan template, you may have made an error while drawing the scale line (see section 1.6 and Figure 15). Suppose that the scale line had to be 10m instead of 5m. So, you have to edit the bitmap scale, as shown in Figure 29:

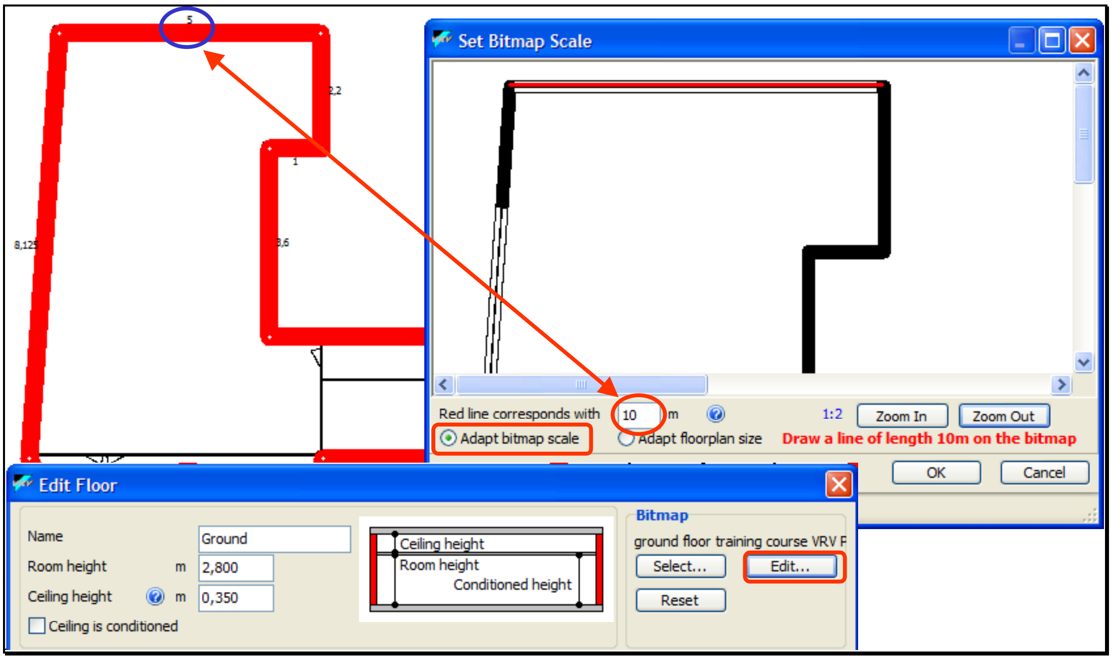


Figure 29: Adapting the bitmap scale

In the set bitmap window you enter the new length, that is 10m, and you select the "***Adapt bitmap scale***" radio button. This will change the scale of the bitmap: the wall that was originally 5m long now becomes 10m long. The floor plan that you draw over the template will not change. This gives a result as shown in Figure 30:

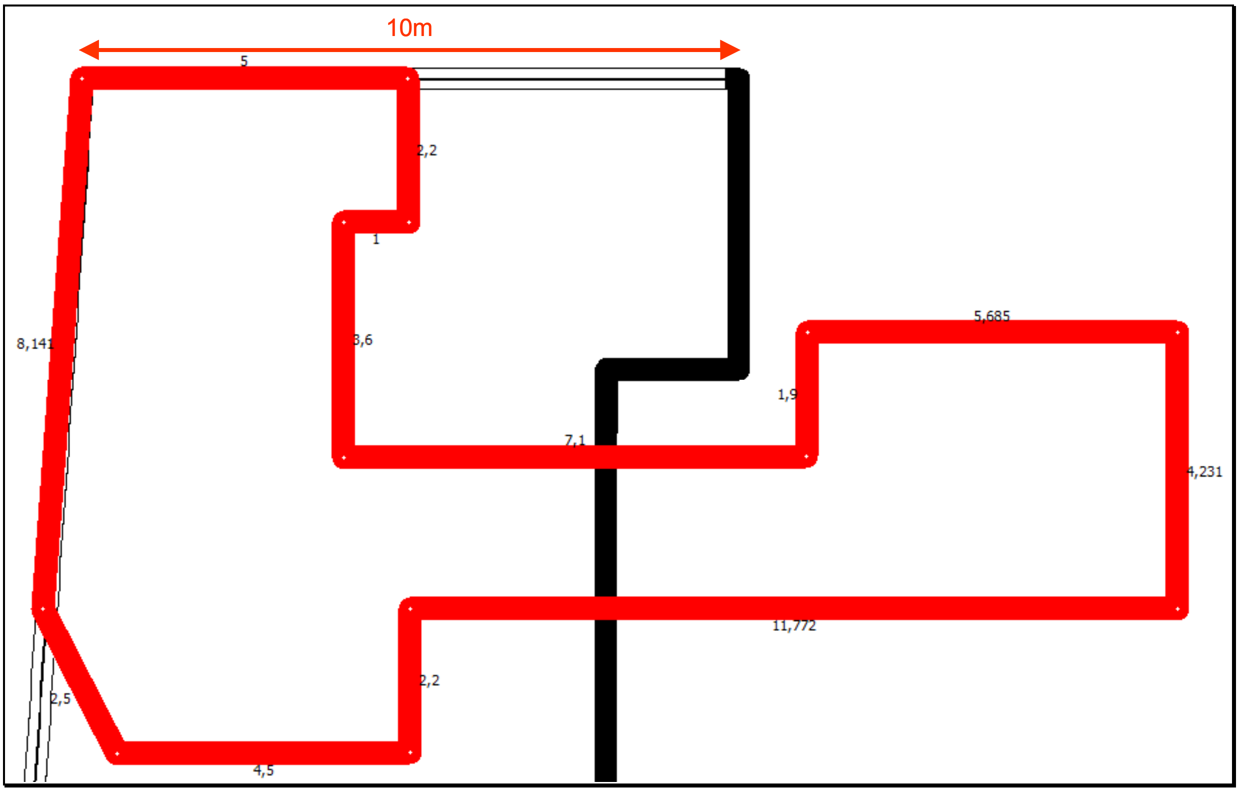


Figure 30: The result after scaling the floor plan template bitmap

Note that after having scaled a floor plan template, the bitmap origin may shift, so that you may have to align it again with your floor plan (see also Figure 16).

After having scaled the floor plan template bitmap, you may want to scale the floor plan itself too, instead of moving and adapting the external walls. So, edit the bitmap again, but now you have to scale the floor plan, as shown in Figure 31:

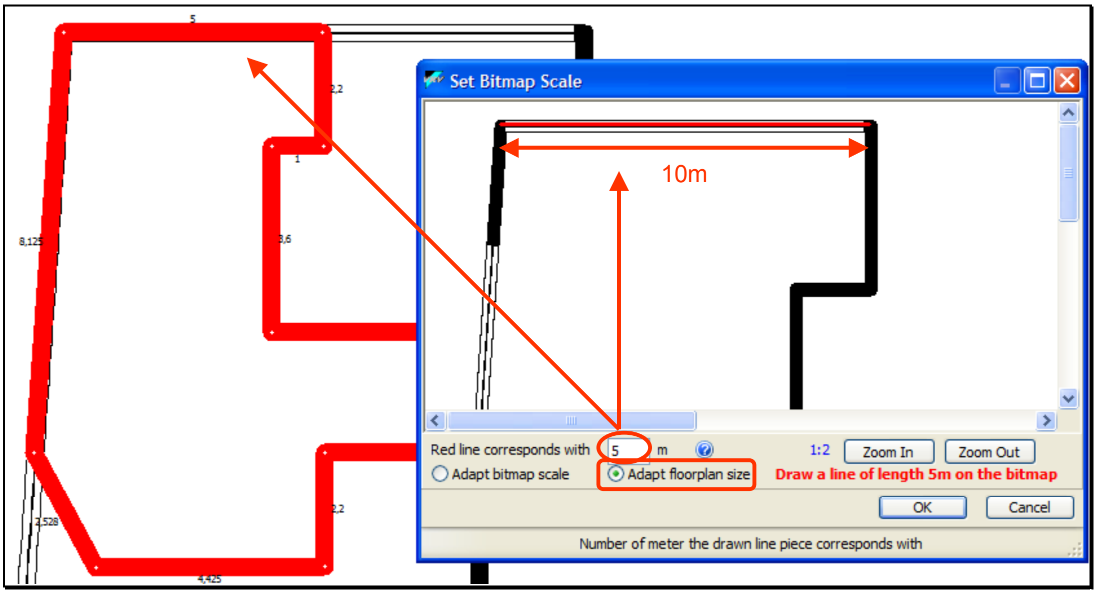


Figure 31: Resizing the floor plan

When scaling a floor plan, VRVPro uses the (floor plan template) bitmap length as a guideline. In Figure 31, the red line on the bitmap is still 10m. When you select the "***Adapt floor plan size***" radio button you have to enter 5m to let VRVPro scale up a 5m line (on a floor plan) to the required 10m (on the bitmap). Figure 32 shows the result of this rescaling.

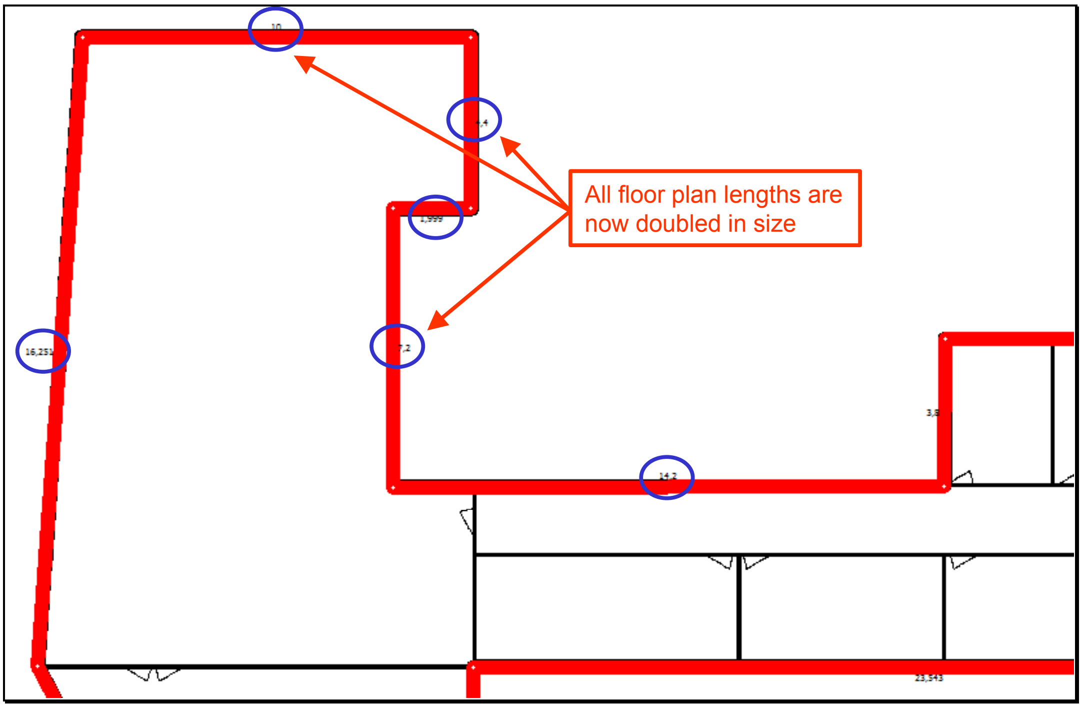


Figure 32: Floor plan template and floor plan after rescaling

Rescaling a floor plan is only possible if it does not yet contain windows and doors (see section 2.6). So, you should detect and correct scaling problems as soon as possible.

2.5 Drawing Internal Walls

To draw an internal wall, you need a corner point to start from. You can insert a corner point in the middle of a wall by selecting it. Then you either select the "***Insert***" command from the wall menu (see Figure 28 at the left) or you press the Insert (Ins) key. Figure 33 shows how to draw an internal wall with several intermediate corner points:

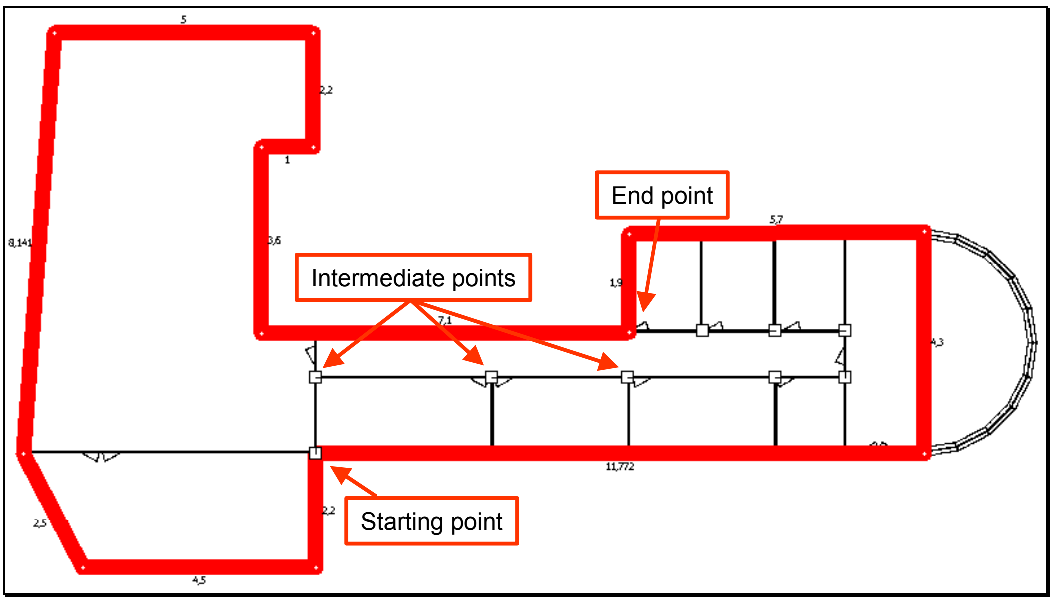


Figure 33: Drawing an internal wall with several intermediate corner points

To do that, proceed as follows:

- Click with the mouse on the starting point and, while keeping the mouse pressed, move the mouse to the first intermediate point. Now release the mouse. This inserts an intermediate corner point.
- Click on that point, move the mouse to the next intermediate, while keeping the mouse pressed and release the mouse. This inserts a new intermediate corner point.
- Repeat that process until you reach the end point. This may be an existing corner point or a wall. In case it is a wall, the end point will be inserted when you reach the wall and release the mouse. You have reached the wall if it becomes selected.

The resulting intermediate corner points simplify the drawing of the remaining walls: click on an intermediate corner point and while keeping the mouse button pressed, move the mouse to the opposite wall (in this example). Figure 34 shows the final result. As for the external walls, you may need to adapt the wall length or straightness, if necessary.

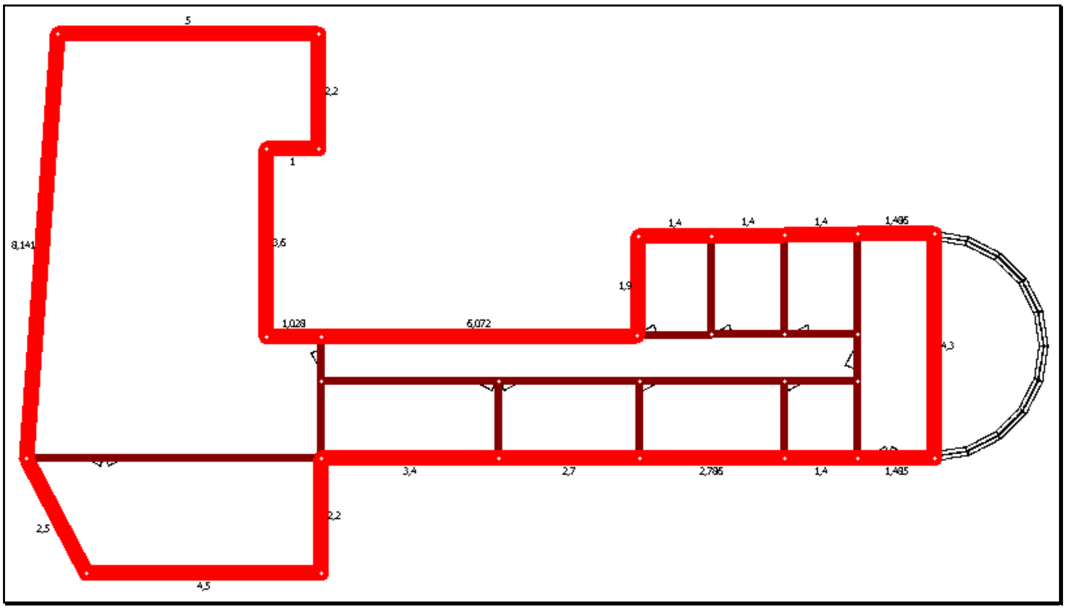


Figure 34: Completing the internal walls

2.6 Adding Windows and Doors

Windows and doors are only important if you are performing load calculations or temperature simulations, which you can do in Expert mode. In Quick mode, windows and doors are only decorations, making a floor plan more realistic and producing a nicer three-dimensional view (see section 2.9).

To place windows, select the corresponding drawing tool and click on each wall where you want a window. Each window will have a width, height and distance from the floor, as defined in the building or floor properties (see section 1.4), whatever you did last.

However, some windows on the floor may differ from these default values and you will have to edit the window as follows:

- Select the select tool, as explained in section 2.2 and shown in Figure 24.
- Now click on the window with the right mouse button and select the "***Edit***" command from the menu that appears.
- This brings up the window to edit a window or a door, as shown in Figure 35.

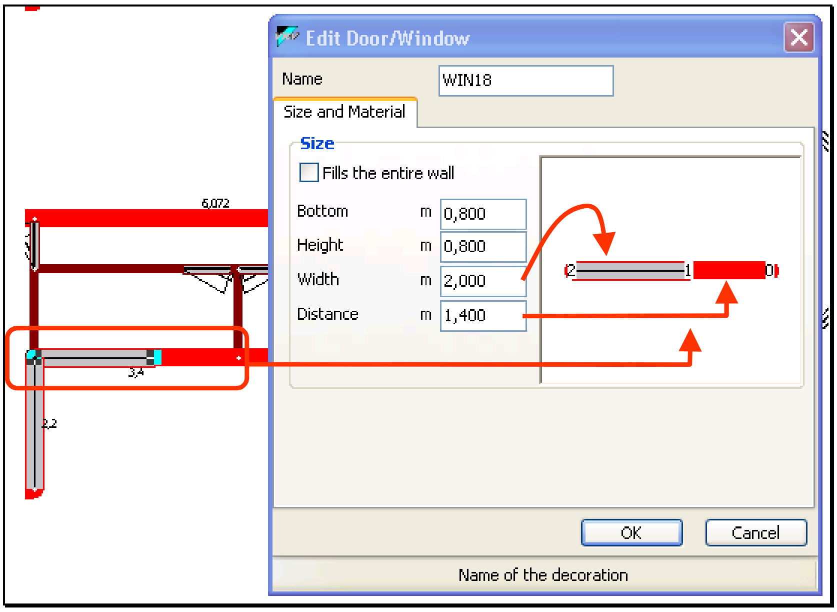


Figure 35: The window editing a window or a door

The window to adapt is on a wall of 3.4m. When changing its width, you may also have to change its distance from the corner point displayed in the window. In the example in Figure 35, the window width has been adapted from the default width of 1.2m to 2.0m. To keep the window at the left, the distance from the corner point 0 (the right end of the wall) also must be changed to 1.4m (as 2.0m window + 1.4m distance = 3.4m wall length).

At the top of the window in Figure 35, a checkmark appears. Checking it will change the window such that it will take the whole wall. Such a window can take the whole wall width, but also its height. You can set the latter with a second checkmark, as shown in Figure 36:

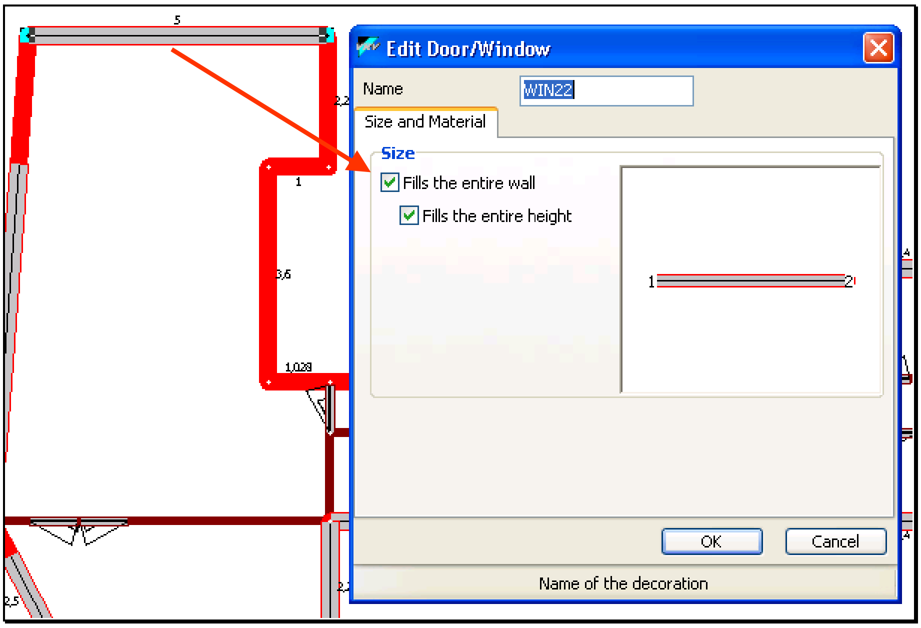


Figure 36: Creating a glass wall

VRVPro uses the same editing window for doors. However, it displays a more elaborate menu when you right-click a door. In fact, a door has a fixed side (the side that is attached to the wall) and a direction side (how do you open the door). When you place a door, VRVPro uses a default fixed side and direction, which you can change using one of the menu commands, visualized in. Figure 37.

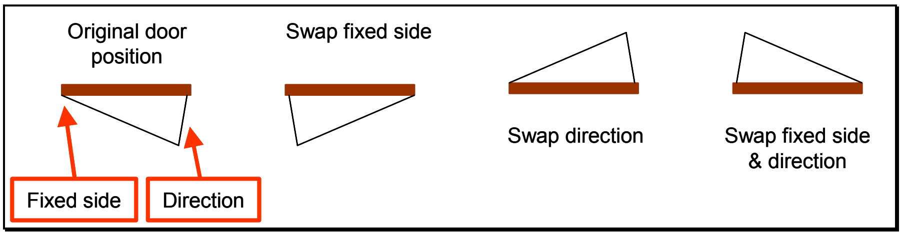


Figure 37: Changing the fixed side and direction of a door

After having entered all windows and doors, the floor plan will look as in Figure 38. As explained at the beginning of this section, windows and doors are only important in Expert mode.

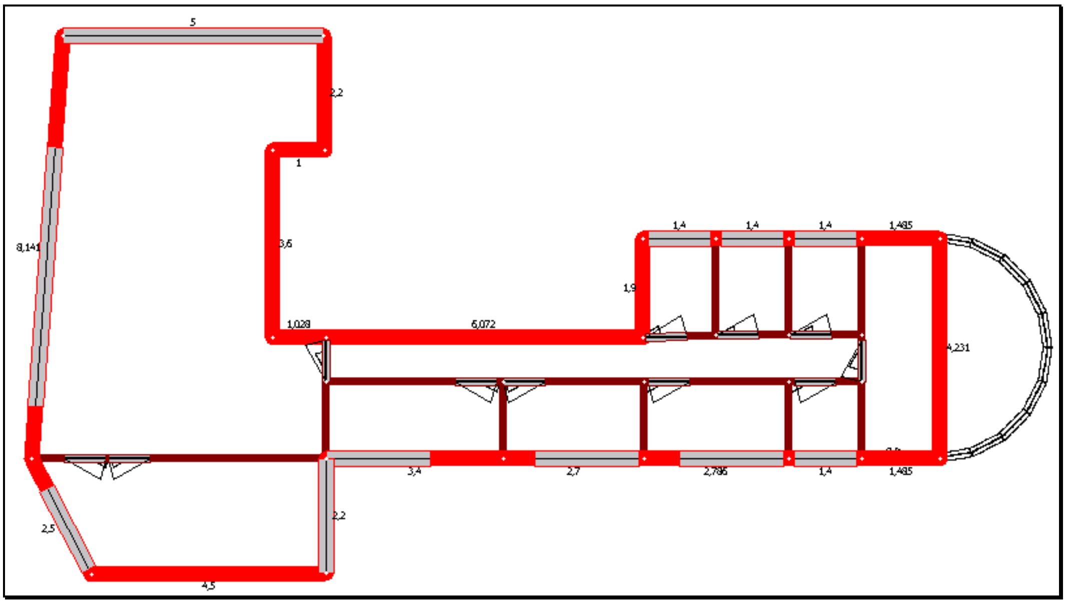


Figure 38: The floor plan with windows and doors

2.7 Drawing Circular Arc Walls

The circular arc wall to draw is one with full glass walls and consisting of 10 segments, as shown in Figure 39 at the right:

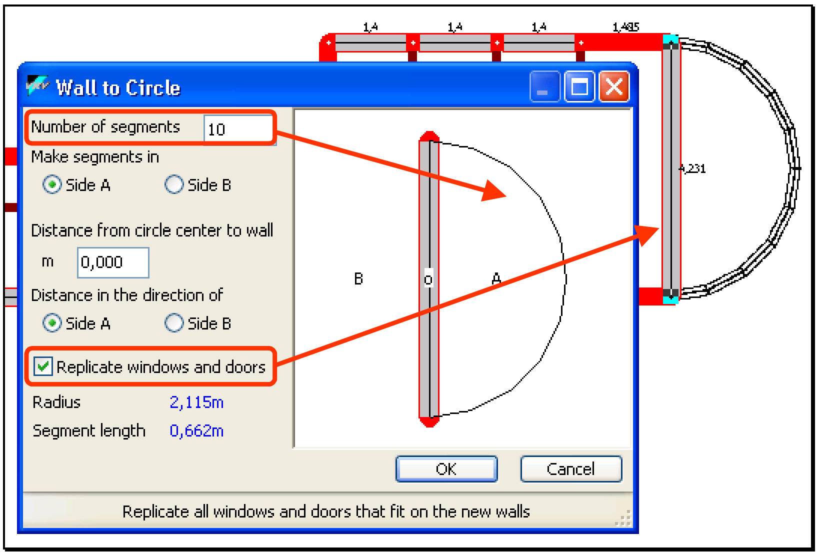


Figure 39: Defining a circular arc wall

Before creating that wall, place a window on the vertical wall, make it a full glass wall, right click on it to get the menu and select the "***Make Circle Arc***" command. This brings up a window as shown in Figure 39, offering several settings to create different kinds of circular arcs. The floor plan template shows a circular arc with 10 segments. So, only marked settings in Figure 39 are necessary to create the required circular arc.

The two remaining settings are (see also Figure 40):
1. You can decide for an outbound (convex) or inbound (concave) oriented arc.
2. The center of radius may be on the vertical wall, before the wall or after the wall.

The graphical representation in the right part of the edit window in Figure 39 changes instantaneously when you change any of the settings in its left part.

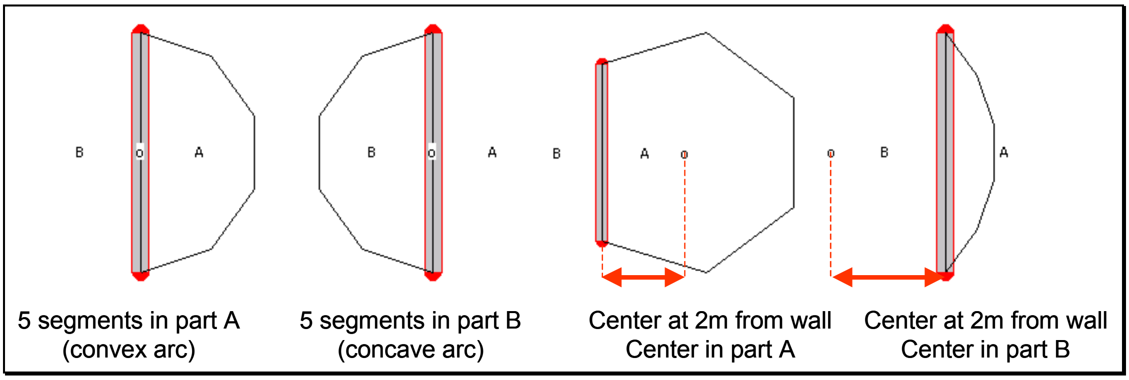


Figure 40: Visualization of different kinds of circular arcs

The creation of the circular arc concludes the drawing of the floor plan, as shown in Figure 41.

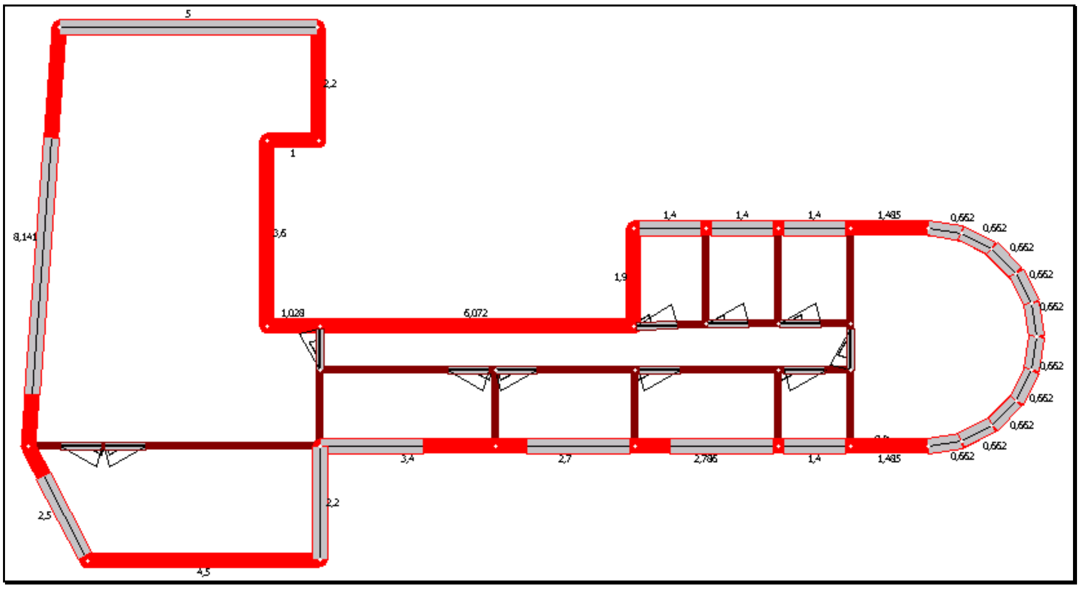


Figure 41: The floor plan after finishing the drawing

2.8 Defining the Room Properties

The floor plan template is no longer necessary now and may be hidden, by clicking the command "***Hide Overlay Drawing***", at the left of the main window (see also Figure 23). Figure 42 shows the floor plan without the floor plan template. The "***Hide Overlay Drawing***" command has now changed into a "***Show Overlay Drawing***" command.

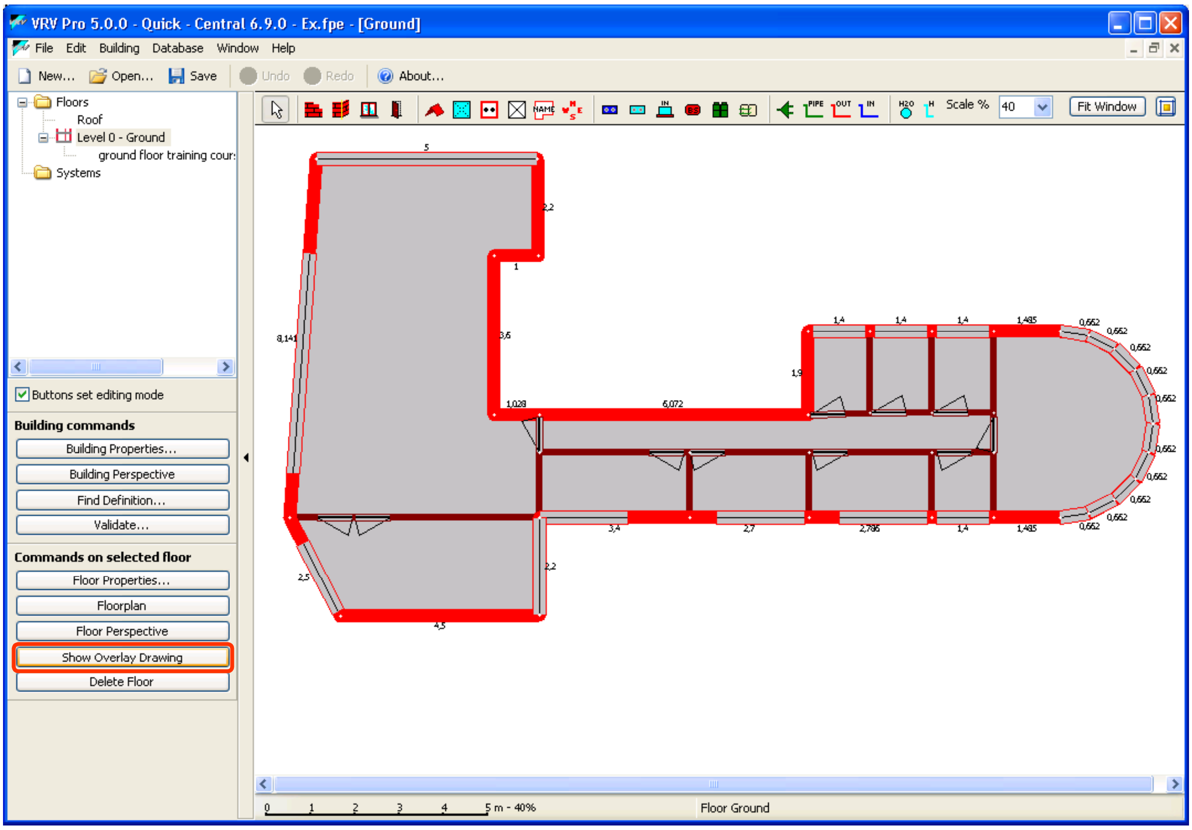


Figure 42: The floor plan after having hidden the floor plan template

The rooms have a gray color, which indicates that they are conditioned rooms (for color settings, see section 2.10.6). To see the properties of a room, click on it with the right mouse button and select the "***Edit***" command. This brings up a window as shown in Figure 43:

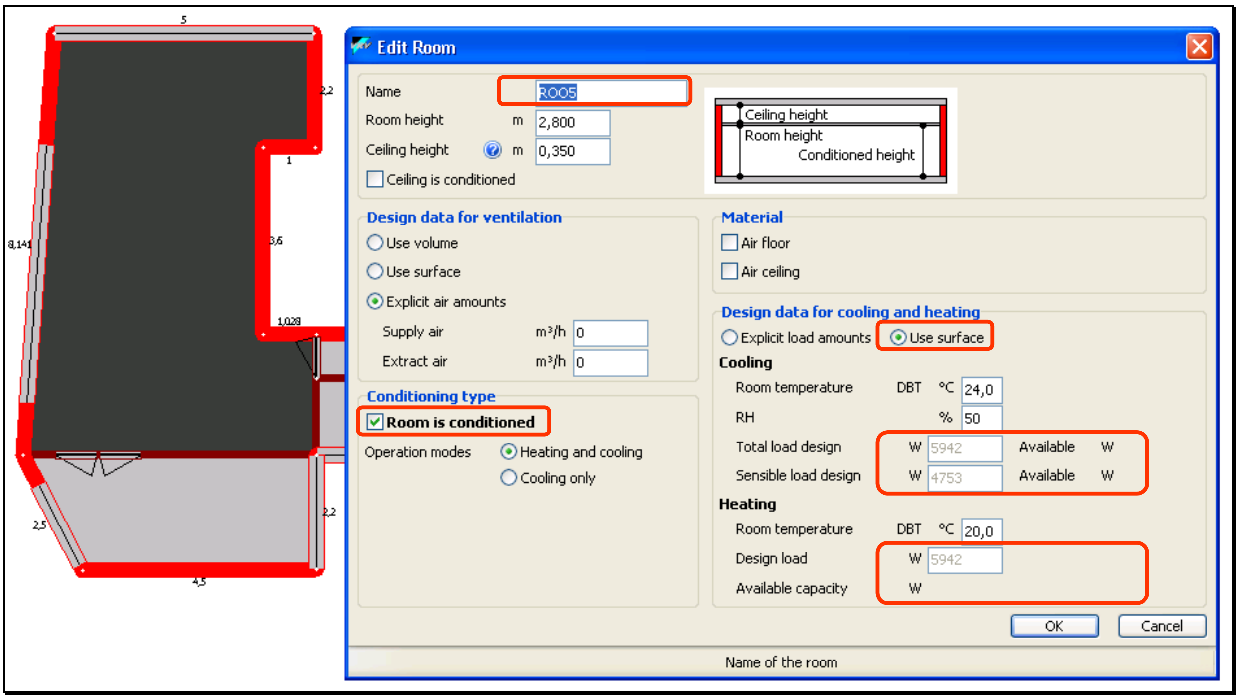


Figure 43: Room properties of a conditioned space

When a room is a conditioned space, you can define its operation modes and set the design data for cooling and heating. As you filled in load data per m^2 in the building properties (see Figure 21), VRVPro calculated the load for the selected room (see the marked areas at the right). You cannot change them, except if you change the "***Use surface***" selection into the "***Explicit load amounts***" selection. Note that these calculated loads are a VRVPro supported function. However, if you get calculated loads from an engineering company, please make sure to enter these values instead of the VRVPro values derived from a room surface.

A room also has a name. By default, VRVPro gives every room a numbered name. In Figure 43, the room name is "***ROO5***", but you can change it into "***Conference Room***", for instance.

In this floor plan, the corridor should be an unconditioned space. Edit that room and uncheck the "***Room is conditioned***" checkmark., as shown in Figure 44:

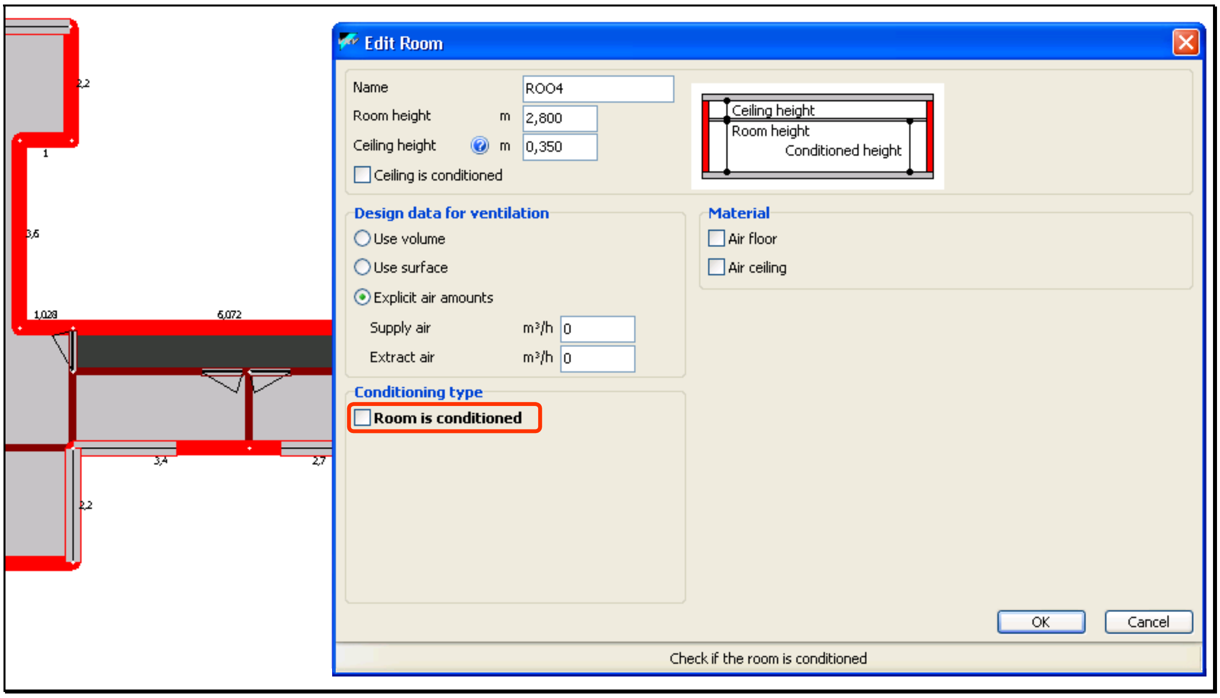


Figure 44: Defining a room as an unconditioned space

VRVPro displays an unconditioned space differently from the conditioned spaces, as shown in Figure 45. This concludes the drawing of the floor plan. It is now ready for the selection of air conditioning devices.

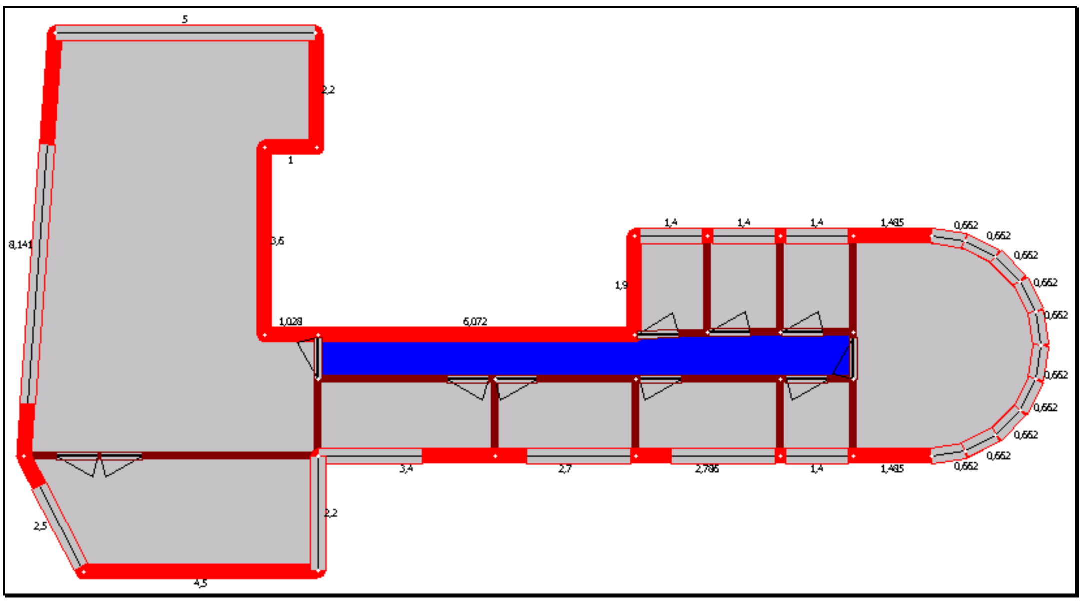


Figure 45: The floor plan with the corridor as an unconditioned space

2.9 Three-dimensional Views

If DirectX has been installed on your computer, VRVPro produces a Direct X perspective view, if you click the "***Floor Perspective***" command at the left of the screen, as shown in Figure 46:

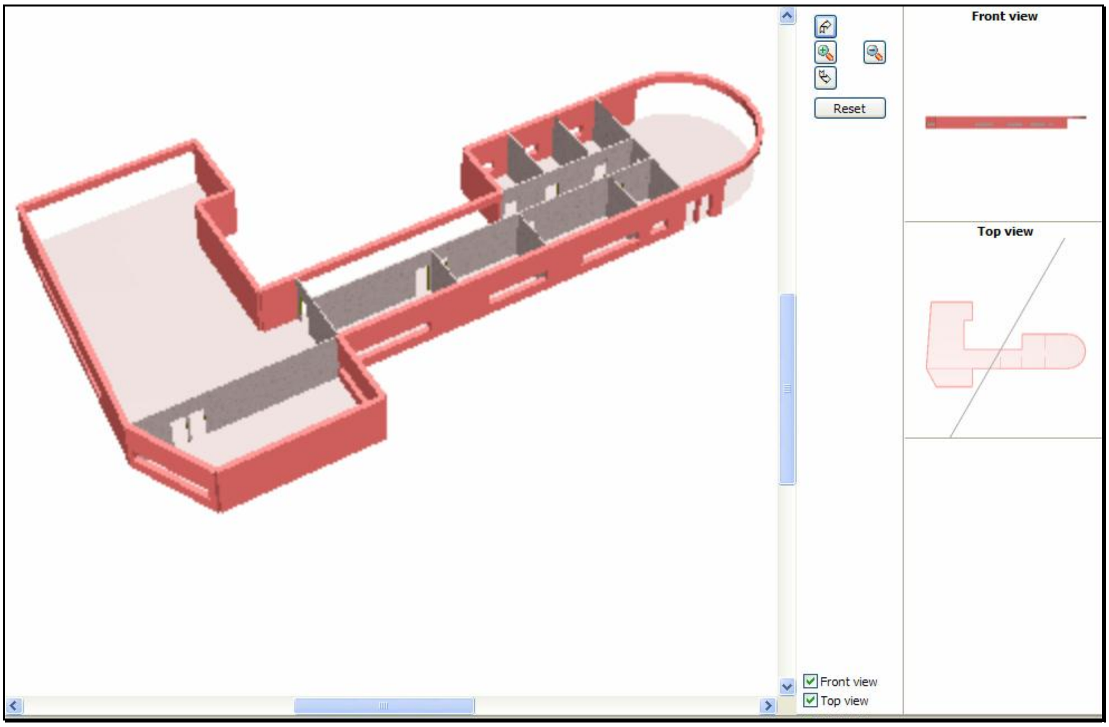


Figure 46: The Direct X perspective view of the floor plan

This is a true perspective (with a point at infinity), in which the walls have a calculated thickness using the same scale as for the rooms. It also contains buttons the walk around the building and to zoom in or out. The small pictures at the right (front view and top view) show your position to from which you are looking at the building.

A perspective view also contains a light source at the front of the building. When you walk up to the back of the building, you will notice that the walls have a darker color, as shown in Figure 47:

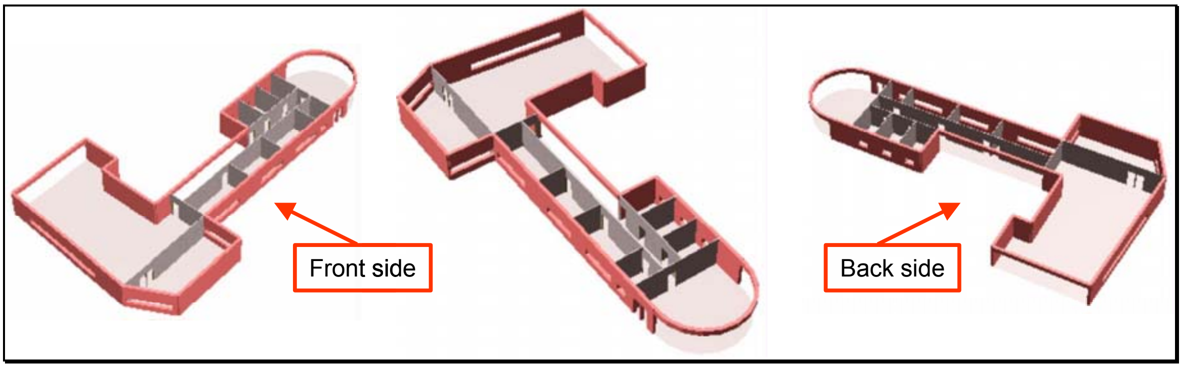


Figure 47: Effect of the light source varies depending on the position of the viewer

If there is no DirectX software, VRVPro automatically switches to its classic orthogonal view, as shown Figure 48:

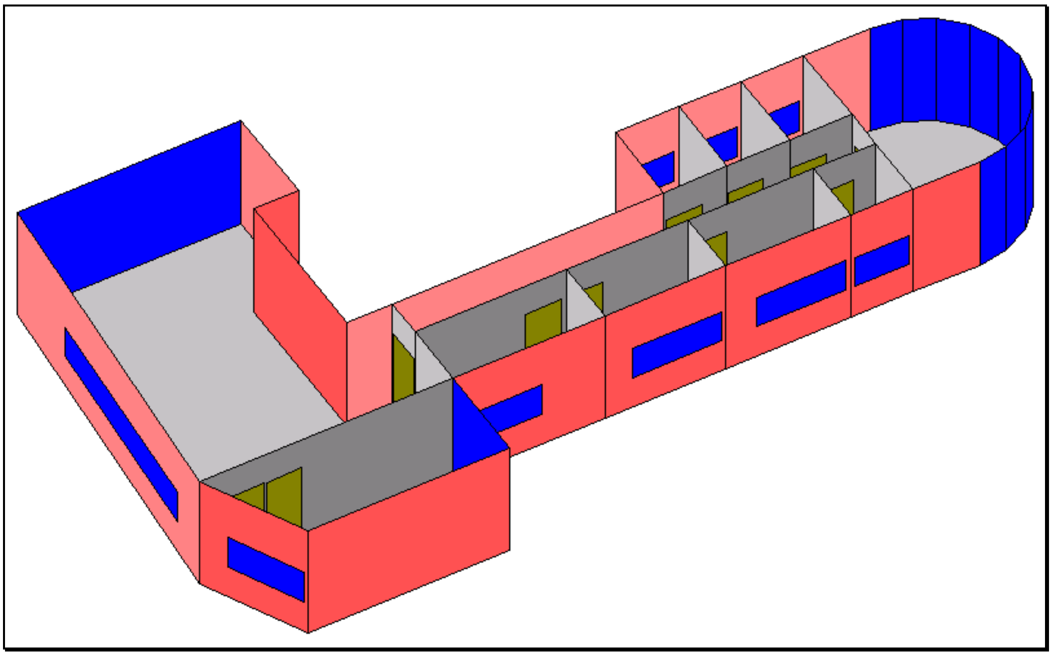


Figure 48: The classical perspective view of the floor plan

In an orthogonal view the walls keep their length, whereas a perspective view is a more realistic 3D view by changing the lengths in function of the position of the viewer.

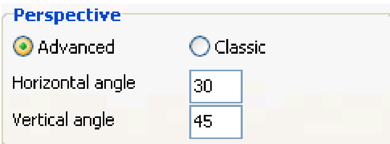


Figure 49: Setting the perspective view

You can also change explicitly from a DirectX perspective view to an orthogonal view and vice versa. Click the File menu and select the "***Options***" command. This brings up a window, containing the perspective setting in the middle at the right, as shown in Figure 49.

If a project contains more than one floor, you can also get a building perspective, by clicking the Building menu and selecting the "***Perspective***" command. This places all floors above each other and displays a perspective view of the whole building.

2.10 Extra Commands

2.10.1 Adding Room Labels

By selecting a room label () from the tool bar and clicking in a room, VRVPro will display a label containing the room name only, as shown in Figure 50 at the left:

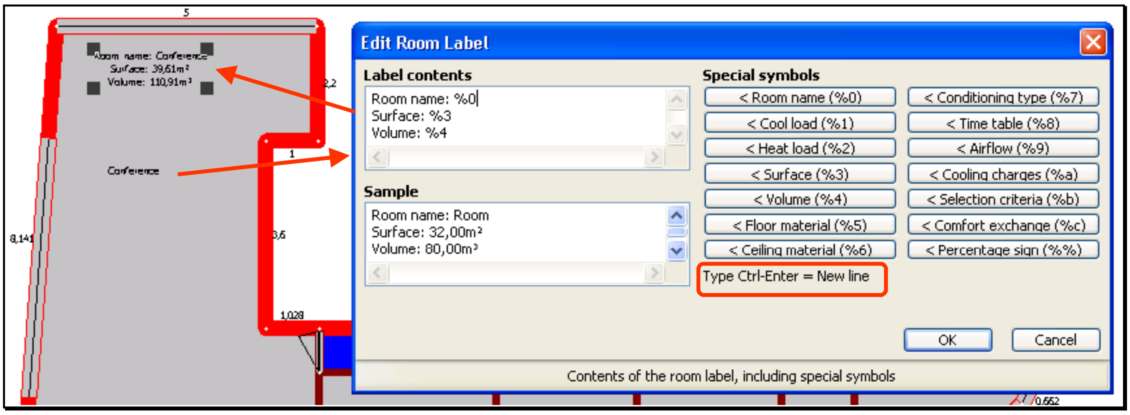


Figure 50: Defining the content of a room label

However, a room label may contain much more information, even calculated values, such as the room surface and volume, but also the required cool and heat load. There are two ways to change the content of a room label:

1. ***Local change***

   This is a change of the content of the selected labels. You can multiple select room labels in the same way as room (see Figure 12). After selection, right click to get the room label menu and select the "***Edit***" command. This brings up a window as shown in Figure 50 at the right. It contains three parts:

   a. The part to enter the required room label contents, at the top left of the window. This may be free text or parameters representing a calculated value. A parameter consists of the percent sign (%) followed by a number or letter. To enter an extra line, type Ctrl + Enter.

   b. The part containing command buttons to enter specific parameters, at the top right of the window. Note that you also may enter a parameter by typing it.

   c. The part at the bottom left of the window giving an example of how the room label would look like.

   The room label in Figure 50 shows the room name, its surface and its volume. To make the result easier to read, each parameter has been preceded by a short title.

2. ***Global setting***

   A global setting defines the contents of all next room labels that you will place on the floor plan. This setting is in the Options window. To get it, click on the File menu, then on the "***Options***" command and click on the "***Symbols***" tab. This gives the window as shown in Figure 51 at the left. Click on the "***Default Contents***" command to get the same window as in Figure 50 to define the contents of a room label. The label contents at the right in Figure 51 only contains the parameter "***%0***", standing for the room name.

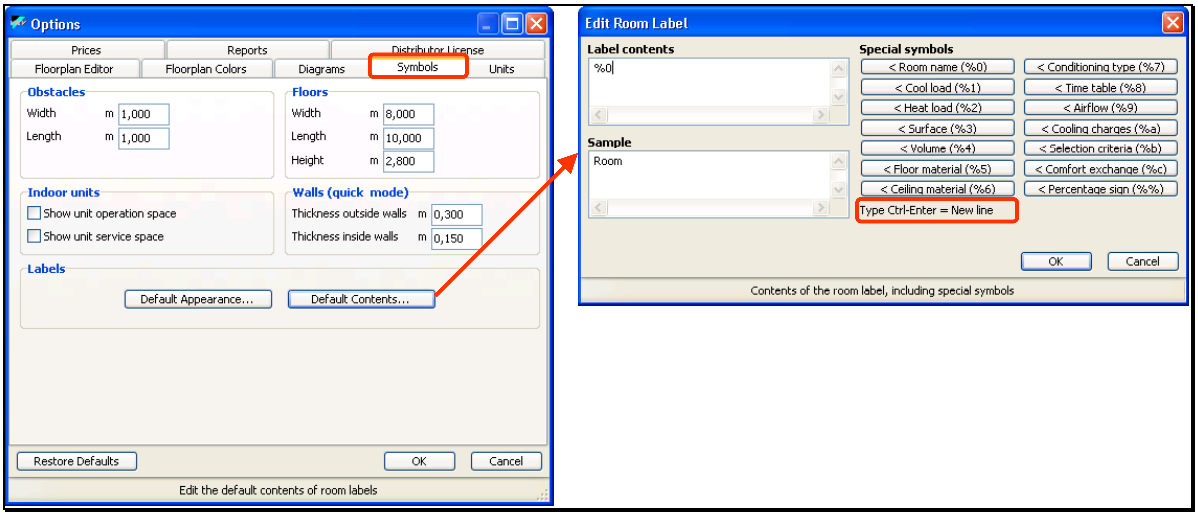


Figure 51: Defining the content of all next room labels

Clicking the "***Default Appearance***" command (see Figure 51 at the left) brings up a window to define the font size and the colors of the label, as shown in Figure 52. This window contains an extra command to copy these settings to all the (existing) room labels in the floor plan.

As for the content of a room label, it is also possible to change the font and label colors locally for the selected labels, by selecting the command "Appearance" from the men appearing by right clicking the selected labels.

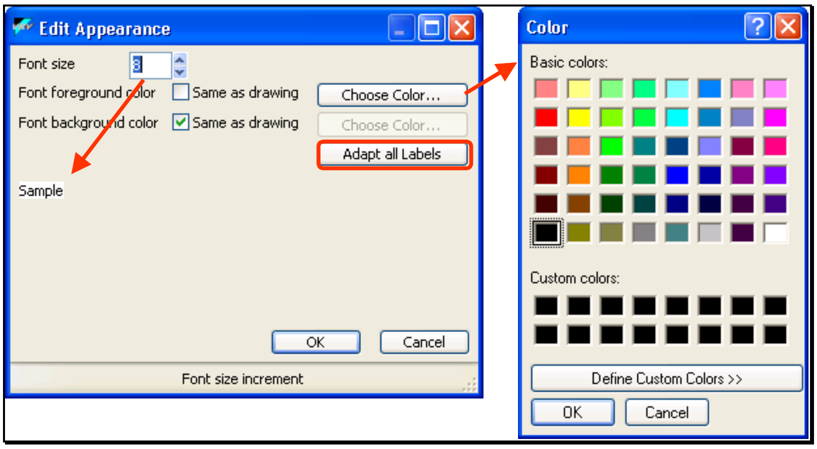


Figure 52: Defining the font size and colors of a room label

Figure 53 shows the floor plan with different labels. The conditioned rooms show the room name, the required cool load (total load and sensible load) and required heat load. The label in the corridor uses a different color and shows its room name and surface. The room labels in the smaller rooms only display the room name.

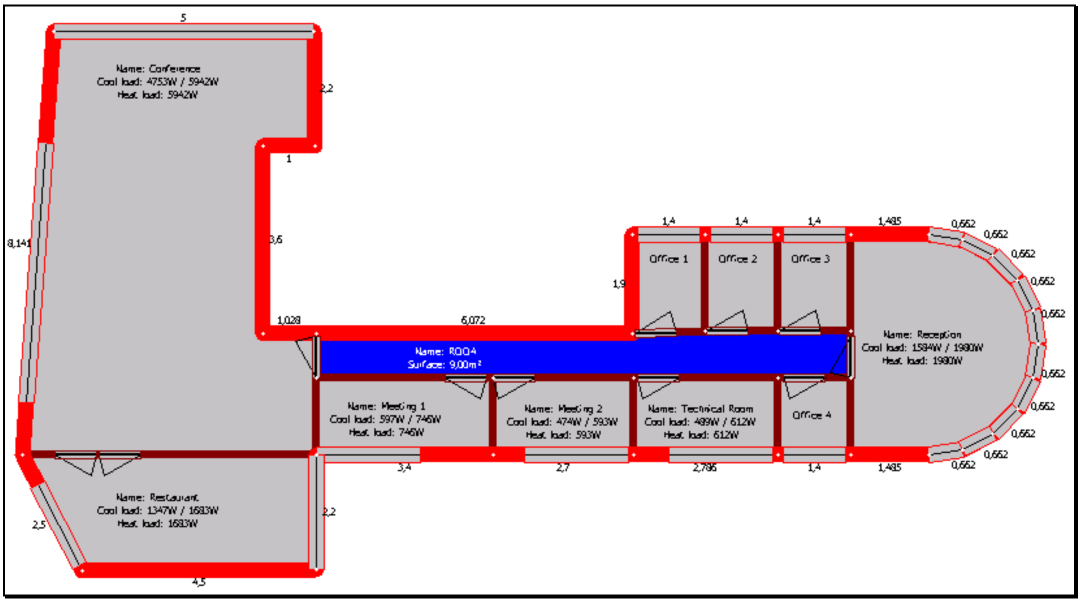


Figure 53: The floor plan with different room labels

2.10.2 Adding Obstacles

Suppose a room contains pillars, columns or large cabinets. These are obstacles you can add using the obstacle icon (⊠). Editing an obstacle brings up a window as in Figure 54:

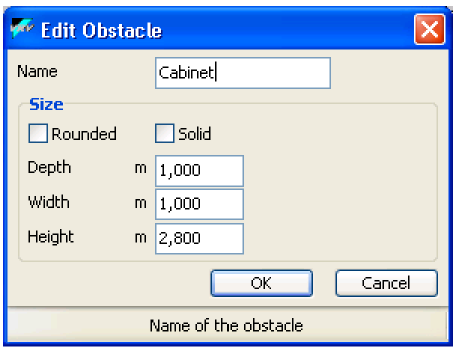


Figure 54: Defining an obstacle

An obstacle has dimensions and can be square or round. In Expert mode, it is also important to know whether the obstacle is hollow or solid. VRVPro displays a solid obstacle in white, while a hollow one has a transparent color. Figure 55 displays the floor plan with for column obstacles and one cabinet obstacle in room Conference.

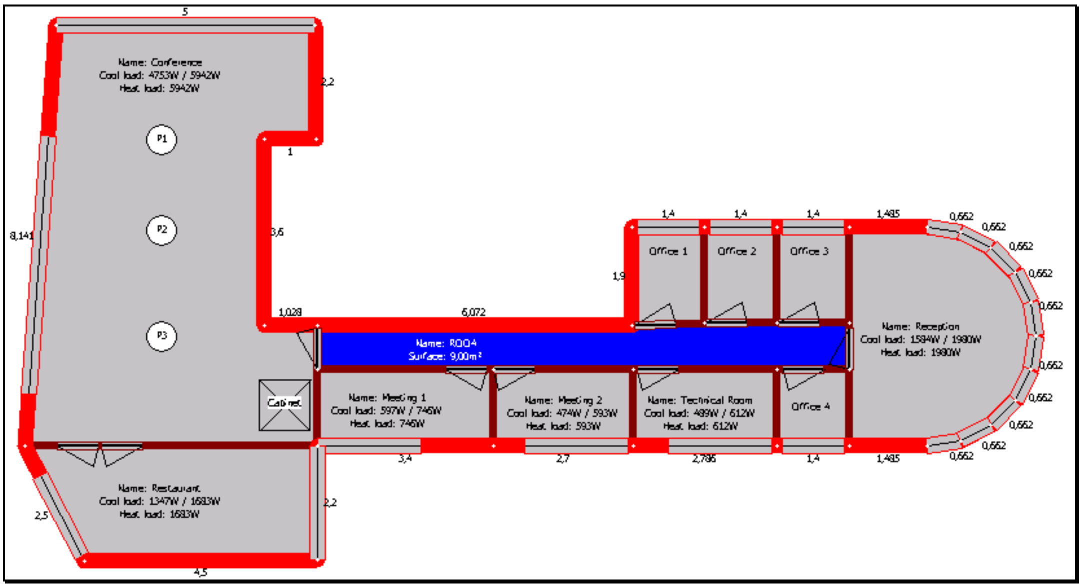


Figure 55: The floor plan containing different obstacles

2.10.3 Finding a Definition

Even before adding the air conditioning devices, a large floor plan contains a considerable amount of elements, each having their name. To find for instance a room, a device or any kind of element, VRVPro offers a search function. Click on the Building menu and select the "***Find Definition***" command to activate it. This brings up a window as shown in Figure 56, in which you select the kind of element to look up (e.g. a room) and from the list that appears, you select the required element (e.g. the room "Meeting 1").

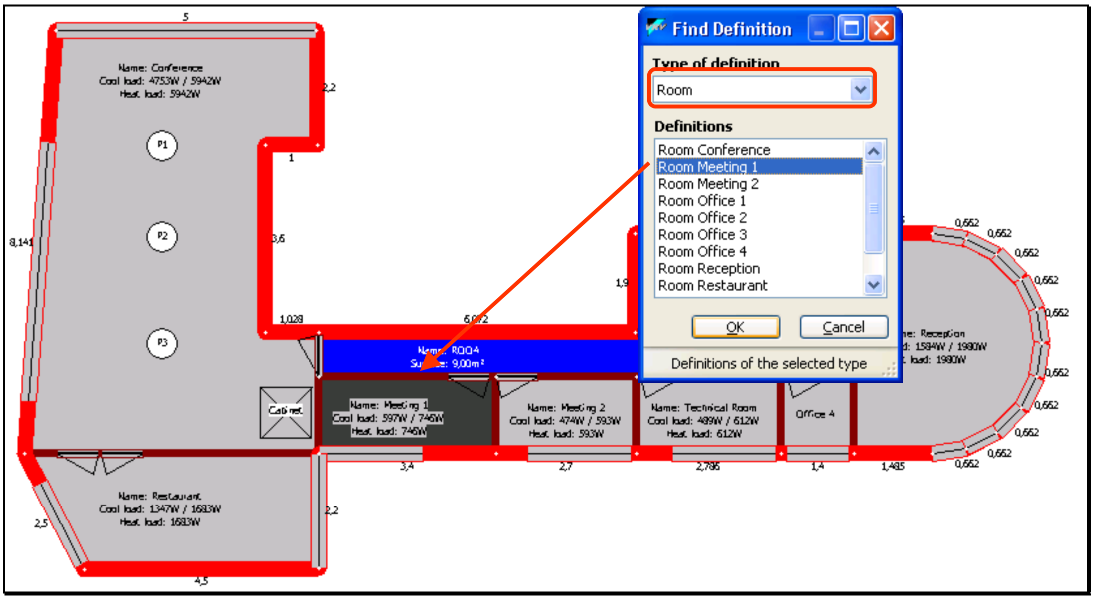


Figure 56: The find definition window and its selection action in the floor plan

VRVPro loads the floor plan in which the element appears, displays that floor plan and selects the element found, as shown in Figure 56.

2.10.4 Editor Palette

As explained in the previous section, it may become difficult to find elements in a large and complex floor plan. A floor plan equally quickly becomes filled with (extra) information, making it difficult to see the original floor plan with its rooms and walls. For that reason the VRVPro Windows menu contains the "***Editor Palette***" command. Selecting it brings up a window as shown in Figure 57 at the right, in which you can uncheck all elements that you temporarily want to hide.

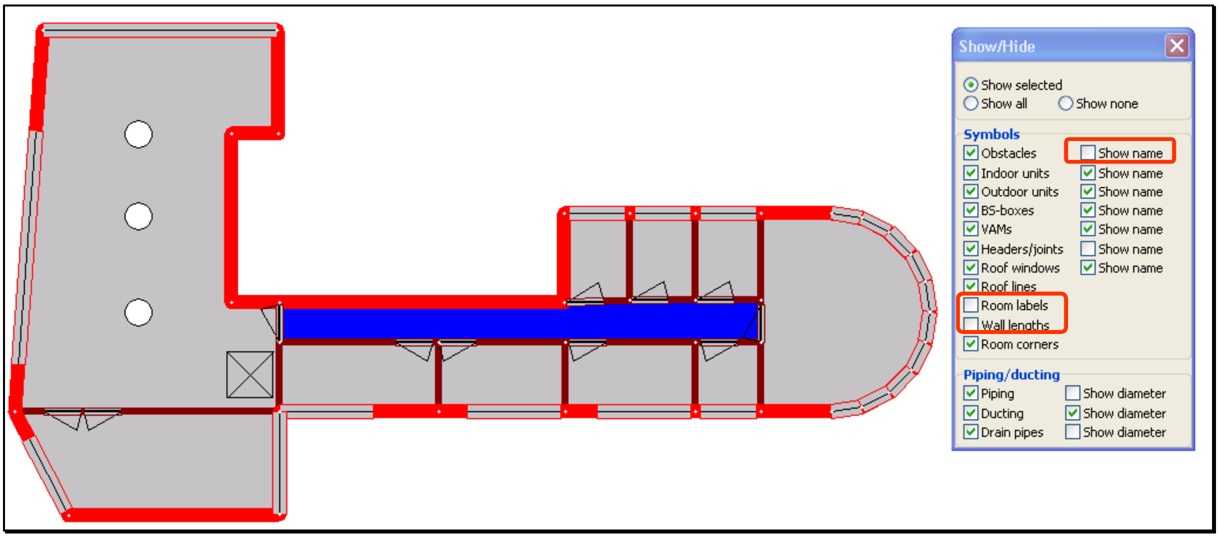


Figure 57: Using the editor palette to show or hide elements or their name

In Figure 57, the names of the obstacles have been hidden, together with the room labels and the wall lengths. This immediately improves the general overview of the floor plan.

Note that VRVPro stores these settings on your computer and not in the project file. So, you get the same settings if you open different project files.

2.10.5 Adding a Wind Rose

The orientation of a building may differ from North. In that case, it is interesting to put a wind rose on the floor plan, using the wind rose icon (). When you put a wind rose on a floor plan, VRVPro will put it on all existing floors of the building at exact the same position. After that, you can move the different wind roses independent from each other.

Editing a wind rose brings up a window as in Figure 58. In addition of placing a wind rose, you can also enlarge it by selecting it and by pulling one of the little black selection rectangles.

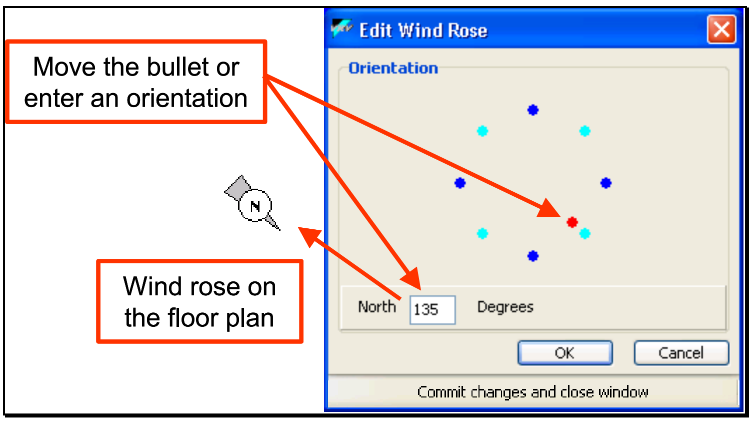


Figure 58: Defining a wind rose

2.10.6 Floor Plan Settings

VRVPro offers a few settings for the floor plan in its Options window. Open it by clicking the File menu and selecting the "***Options***" command as shown in Figure 59:

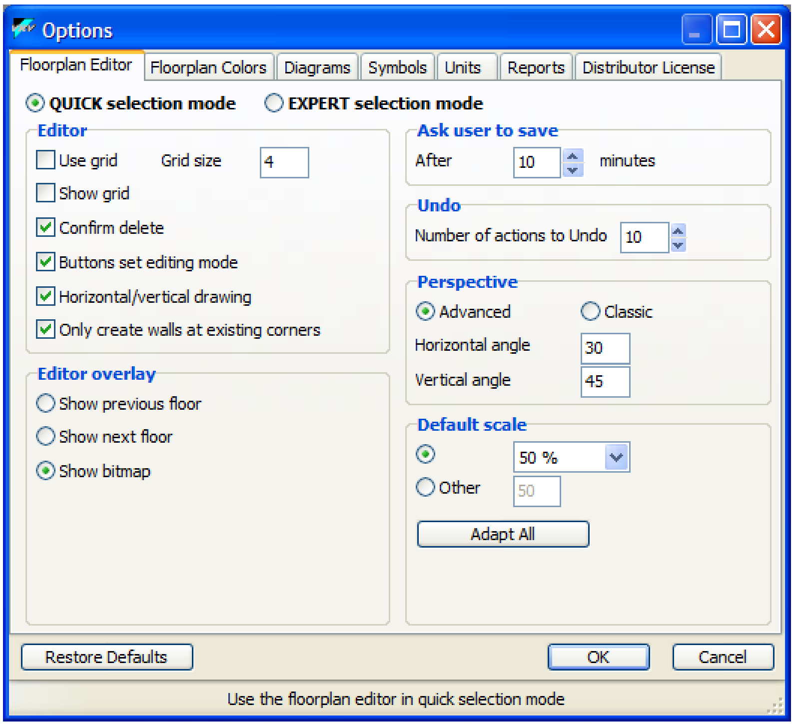


Figure 59: The floor plan settings in the Options window

Some of these settings have been explained in other sections (see Figure 19 in section 1.6.3 and Figure 49 in section 2.9). So, this section describes the remaining settings:

- Editor Settings change the behavior of the floor plan editor while you are drawing:
  - A grid defines "***gravity***" points, used when drawing walls, pipes (see chapter 3, Selecting Air Conditioning Devices) or ducts (see chapter 4, Designing a Ventilation Strategy). Instead of drawing a smooth line, a line point is "attracted" to the closest grid point. "***Use grid***" activates the grid and "***Show grid***" displays it as in Figure 60:

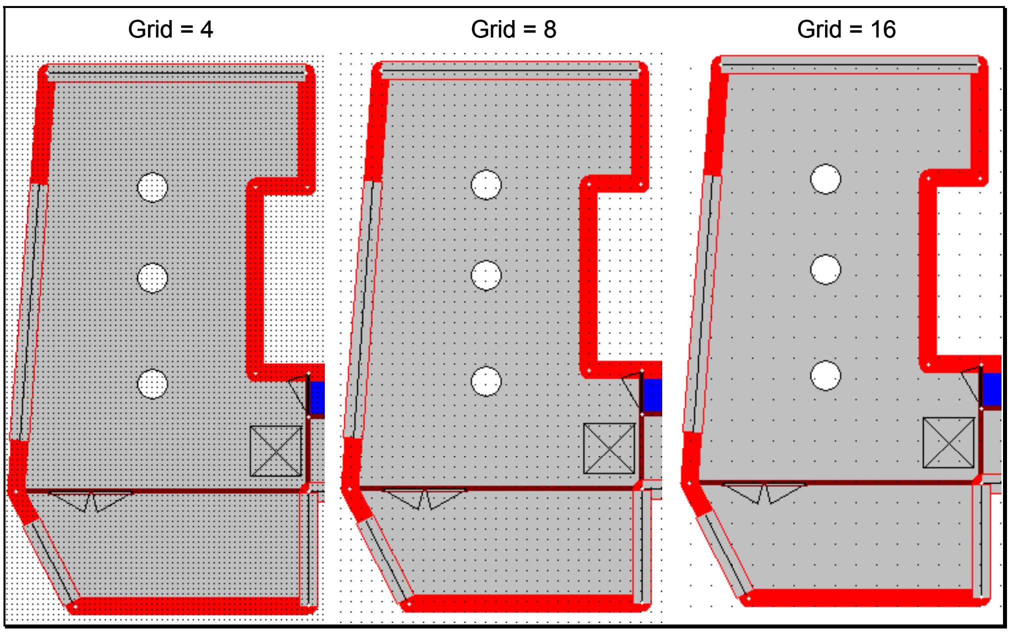


Figure 60: Using different grid settings

- When checking "***Confirm delete***", VRVPro will display a confirmation message each time you delete an item from the floor plan.
- The "***Buttons set editing mode***" has been explained in section 2.2, Figure 24
- You can overrule the "***Horizontal/Vertical drawing***" setting by keeping the Alt key pressed while drawing a wall, a pipe or a duct (see also section 3.2.2 for a practical example of this function).
- When unchecked, the "***Only create walls at existing corners***" setting allows drawing walls from the position where you clicked the wall. VRVPro automatically inserts a corner point and allows you to draw from there. Although this function reduces the number of user actions (as it is no longer necessary to insert a point first), it also is a source of many problems for inexperienced users, such as inserted a large amount of (unexpected) points or creating "*invisible*" rooms. ***Before using this function, make sure you understand its operation.*** It is a good idea to try it on an example project first, before using it on real project files.

- Save Settings
  After 10 minutes (by default), VRVPro will display a blinking icon (see Figure 61) to show you it is time to save your project. This icon disappears after you saved the project and will reappear again 10 minutes later. You disable this function by entering "***0 minutes***".

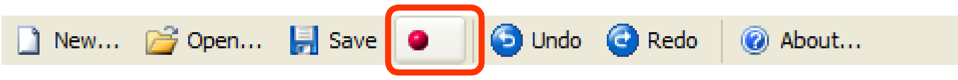


Figure 61: Save request from VRVPro

- Undo Settings
  VRVPro supports a maximum of 10 undo actions. This is also the default setting. However, you may reduce this number, if necessary.
- Scale Settings
  When opening a project and displaying a floor plan, VRVPro will draw it using a default scale (50%). At any time, you may change this scale and enforce it on all open floor plans, by pressing the "***Adapt all***" command button.

2.10.7 Validating the Floor Plan

The Building menu contains the "***Validate***" command, allowing you to check the floor plan for possible errors. VRVPro. This command first will show a small window in which you can set the maximum number of errors and warnings to detect during the validation. When clicking the OK button of that window, the actual validation starts. At the end of this process, VRVPro displays the validation errors window, as shown in Figure 62

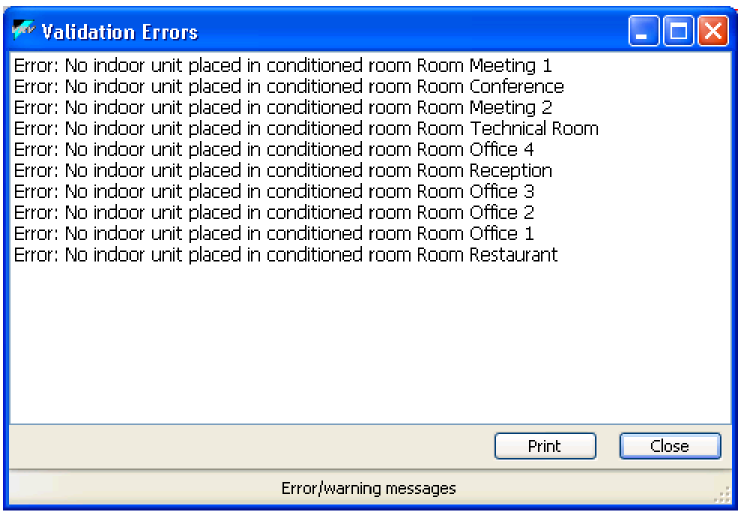


Figure 62: The result of the validation of the current floor plan

When double-clicking a validation message, VRVPro will load the floor plan containing the the element referring to in the message and select that element. This function is similar to the find definition function, described in section 2.10.3.

VRVPro is mainly a selection, analysis and simulation tool. So, it considers conditioned rooms without any air conditioning devices as errors, as you can see in Figure 62. Validation and user controlled validations are much more important in Expert mode.

2.10.8 Copying a Floor

A building may consist of several floors, each with an identical or at least a similar layout. Instead of drawing these floors starting from a standard rectangular floor plan, it is easier to create a new floor by copying it from an existing floor.

The first step is changing the number of floors in the building properties window (see Figure 22). This creates a new level in the tree view at the left. Click on the level to open a window as shown in Figure 63, to create a floor by copying it from an existing floor or by creating a default rectangle:

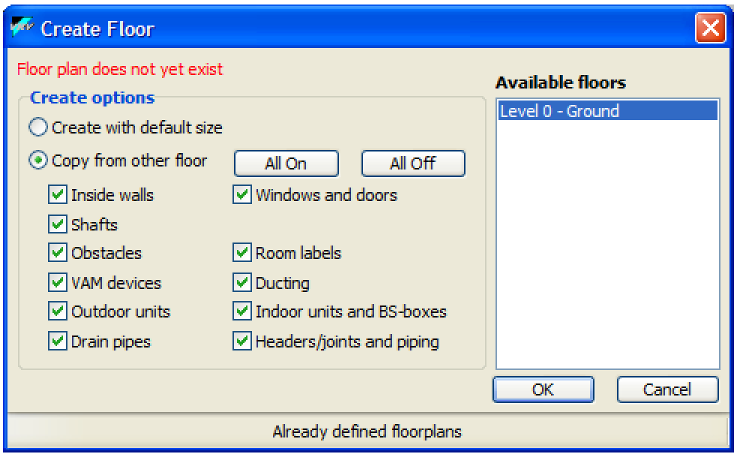


Figure 63: Copying a floor

When copying a floor from an existing floor, you can select the elements you want to copy and then select the floor from which you want to copy. When deselecting elements, VRVPro makes sure the copied floor is still a valid floor plan:

- When deselecting the VAM devices, VRVPro also deselects the ducting.
- When deselecting the indoor units and BS-boxes, VRVPro also deselects the drain pipes, the piping and the header/joints.

2.10.9 Color Definitions

VRVPro uses quite a number of colors, organized in two color schemes: one for the elements on a floor plan and one for elements in piping and wiring diagrams. You can change all these colors in the Options window by clicking File menu, selecting the "***Options***" command and either clicking the "***Floor plan colors***" or "***Diagrams***" tab, as shown in Figure 64.

To change a color, click on the colored square to bring up a color selection window (see also Figure 52 at the right). To change a line style, select it from the available styles in the list boxes.

Note the "***Restore Defaults***" command button at the bottom left of the Options window, allowing you to restore the initial default settings.

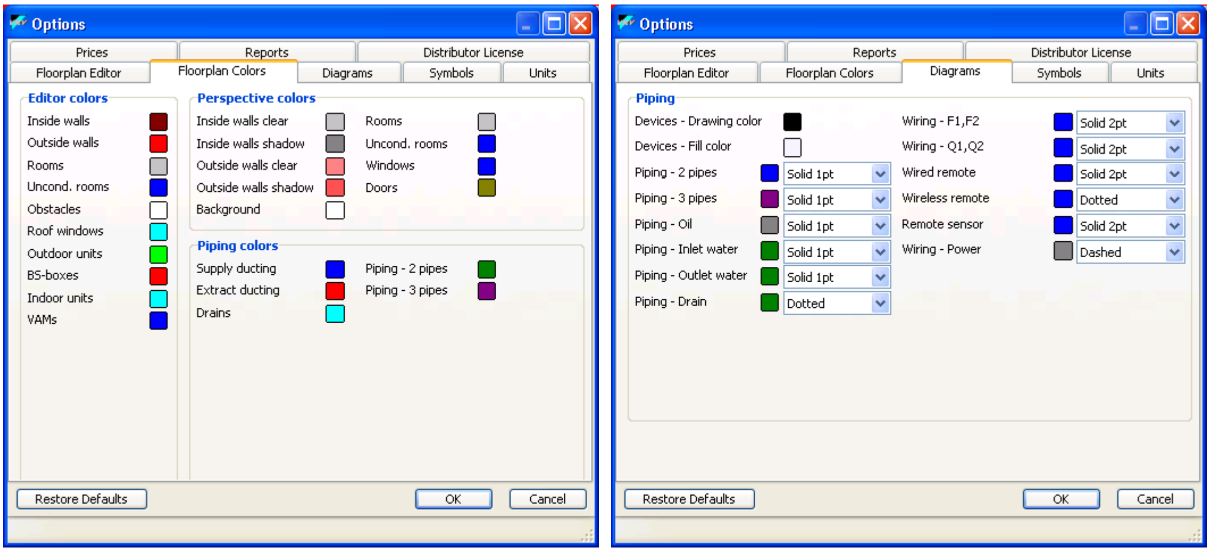


Figure 64: The VRVPro color setting schemes

2.10.10 Licensing

Without a VRVPro license, you will be able to use VRVPro for a maximum of 30 days. You will need a license to be able to use it for a longer period. To get a license, click the File menu and select the "***Licensing***" command. This brings up a window as shown in Figure 65.

To request a license, fill in you name, company and e-mail in the corresponding fields, then click the "***Make Request***" command. This produces a request string, as shown in the part containing the blue text. You now save this string by clicking the "***Save Request***" command, with which you save this string into a text file.

You then send this file per e-mail to the email address mentioned. Please make sure to fill in the subject of your e-mail (e.g. "VRVPro license request"). After a while you will receive an email with the reply string.

Start VRVPro, select the "Licensing" command again and click the "***Read Reply***" command in the licensing window. Select the file that has been sent to you. Finally click the "***Analyze Reply***" command. This will replace the status from "Unlicensed version" into a validity period, which is typically one year.

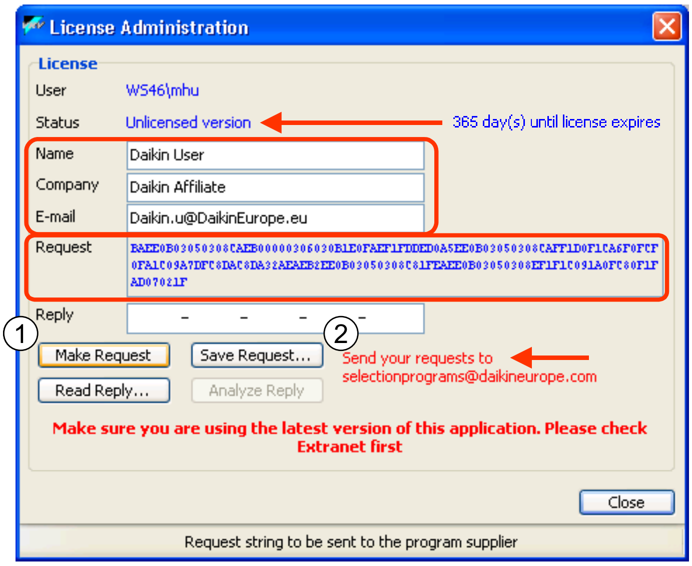


Figure 65: The licensing window

3 Selecting Air Conditioning Devices

This chapter explains how to dimension an air-conditioning system on a floor plan, how to design the piping (both refrigerant and drain piping) and what information you get from the diagrams. Before you can start dimensioning the devices, you must be sure that each conditioned room has a load filled in. You can do this by filling in the data manually, by defining a required load per m^2 or by performing a load calculation. The first two methods are explained in chapter 2 (see Figure 21 and Figure 43), the last one is explained in chapter 5, Performing a Load Calculation.

3.1 Selecting Indoor Units

To place an indoor unit in a room, select the indoor unit icon () and click in the room at the position you want to place it. VRVPro will now select an indoor unit from the family you selected in the building properties (see Figure 21). This indoor unit also covers the loads you entered manually (explicit loads) or calculated through the requirements per m2 and also defined in the building properties. The indoor unit in the "***Conference***" room in Figure 66 is a model 80 round flow indoor unit. The room edit window now contains the available capacities, next to the required loads.

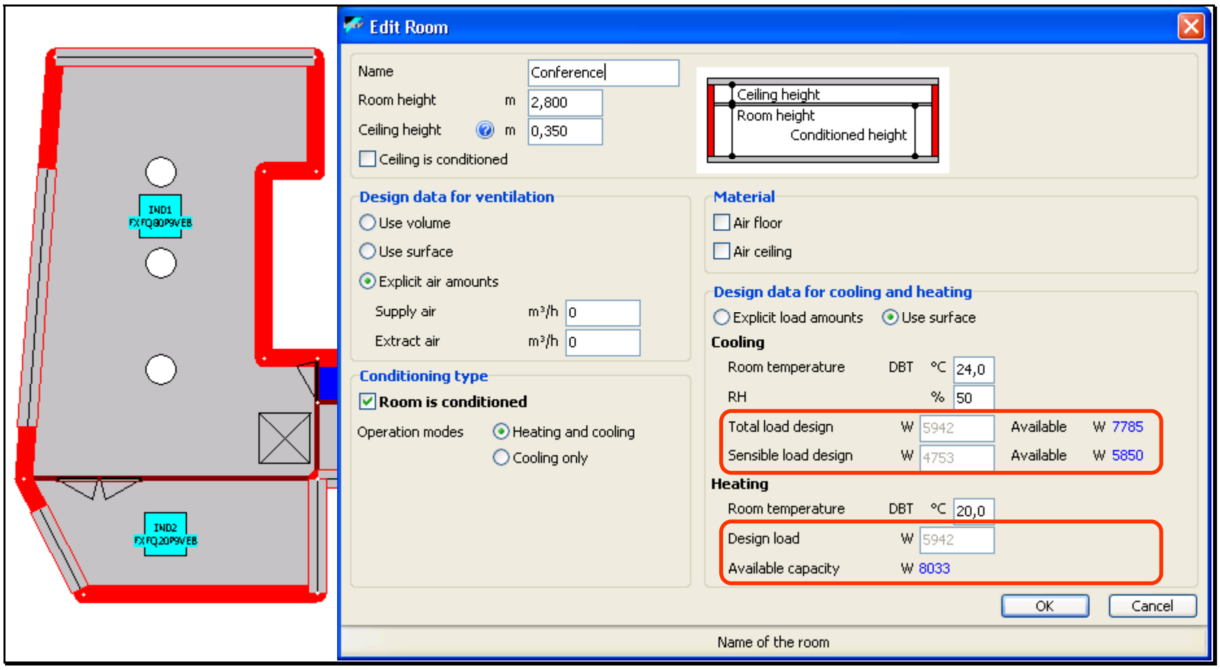


Figure 66: Placing an indoor unit in a room and covering the required loads

As the indoor unit is not yet connected to an outdoor unit, VRVPro uses the indoor unit capacities without taking corrections into account for piping lengths. So, the capacity results for now may be slightly larger than in the final solution.

Within a given family, VRVPro may not find an indoor unit that covers the loads in a room. In that case, it is not possible to show a model and VRVPro only displays the indoor unit name, as shown in Figure 67. You now have two options:

1. As some indoor unit families contain more models than other, changing the family may give a result. This is only conceivable if the family of the indoor unit is not important.
2. Adding more than one indoor unit in a room, until the indoor units cover the loads. This is probably the best solution. To do that, you have to keep placing indoor units in the room, until all indoor units get a model.

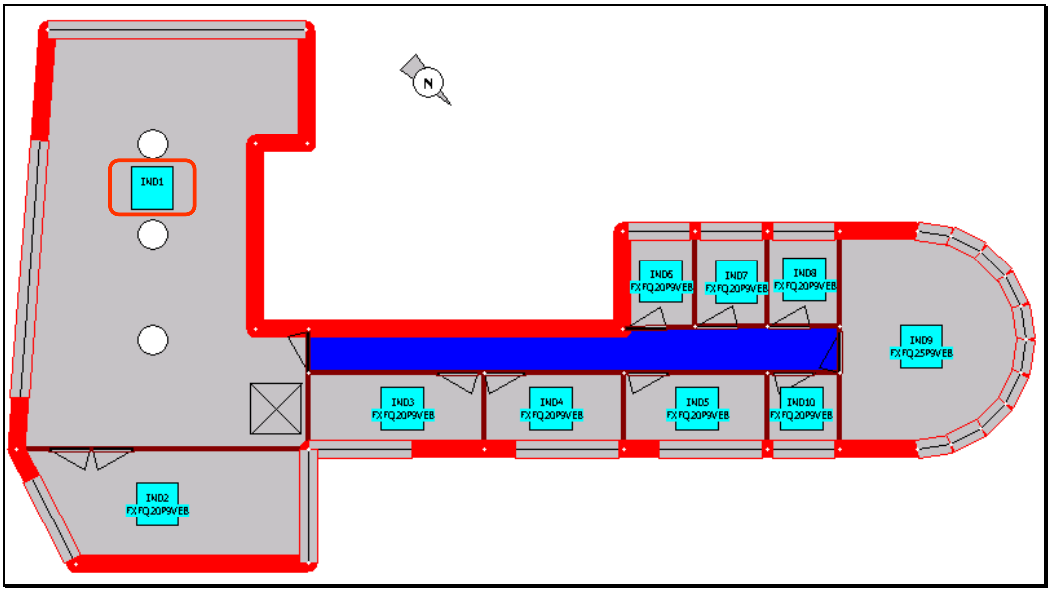


Figure 67: One indoor unit cannot cover the loads in the "Conference" room

You may also consider placing more than one indoor unit in a room to have a coverage that comes closer to the loads. In Figure 68, two model 32 indoor units deliver a capacity that comes closer to the loads than with one model 80 indoor unit as shown in Figure 66.

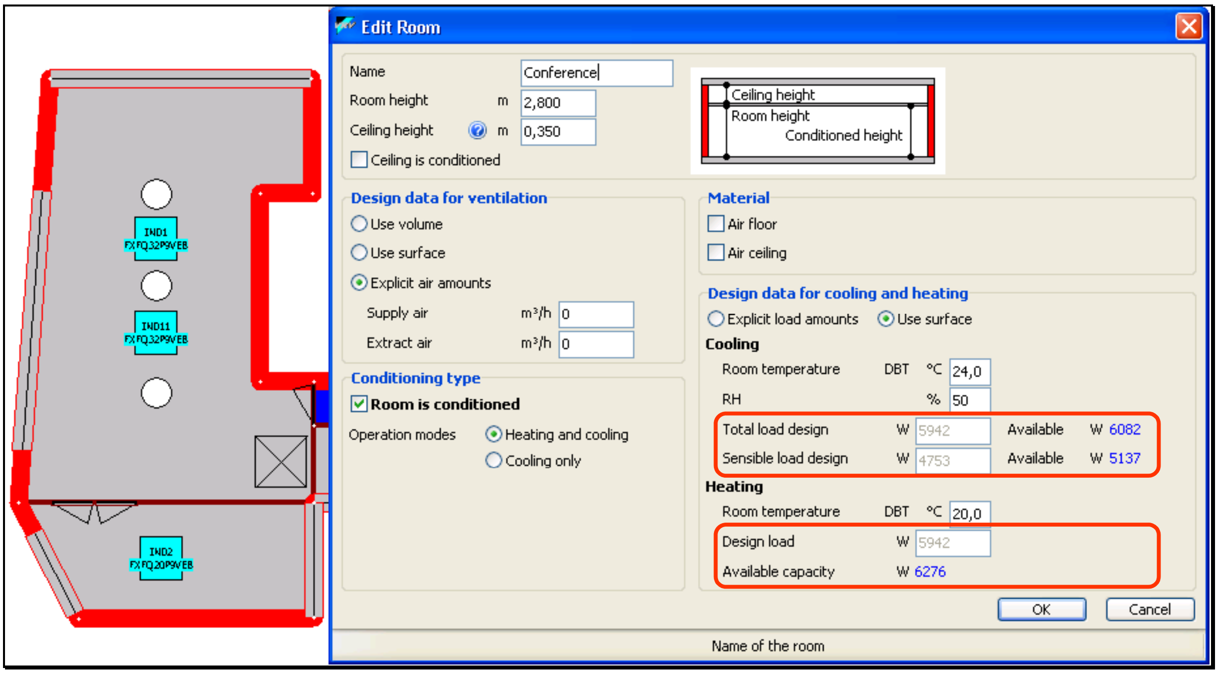


Figure 68: Using several indoor units to have a better load coverage and capacity distribution

VRVPro selects indoor units if they cover all loads that you have specified. If you set the sensible cool load to zero in Figure 68, VRVPro makes sure the indoor units only cover the total cool load and the heat load.

VRVPro also selects the smallest indoor units that cover the specified loads. If a room contains more than one indoor unit, VRVPro proceeds as follows:

- Divide the loads of the room by the number of indoor units in the room.
- Select the first indoor unit that covers these divided load values.
- The loads of the room are now reduced by the capacities covered by the first indoor unit and divided by the number of indoor units less 1 in the room. The process now repeats for the next

indoor unit. This results in a selection of indoor units that covers the loads in a closest possible way.

The situation becomes a bit more complicated if a room contains indoor units that are served by different outdoor units. Suppose a room contains 5 indoor units, 2 of which are served by outdoor unit A and the three other indoor units by outdoor unit B. VRVPro then uses the following selection strategy:

- Divide the room loads by 5 (the number of indoor units).
- Create two groups of indoor units: a group of 2 having to cover 2/5 of the loads and the other 3/5 of the loads.
- Select the indoor units of the first group as if the room only contains those two indoor units, but with loads that are 2/5 of the room.
- Select the indoor units of the second group as if the room only contains those three indoor units, but with loads that are 3/5 of the room.
- The extra capacity that would be available in the first group has no influence on the selection in the second group and vice versa.

The number of indoor units in a family is limited and the steps between indoor unit models may differ. VRVPro selects a larger model if the current model does not cover the loads, even if there is only a shortage of 1Watt. As the next model may be considerably larger, it would be interesting if VRVPro would keep the smaller model.

You can do this by defining a deviation percentage, which defines how much the capacities of the indoor unit may deviate from 100% coverage. In Figure 69 the deviation percentages have been set to -5%. This means that an indoor unit model remains selected if it covers at least 95% of the loads instead of at least 100%.

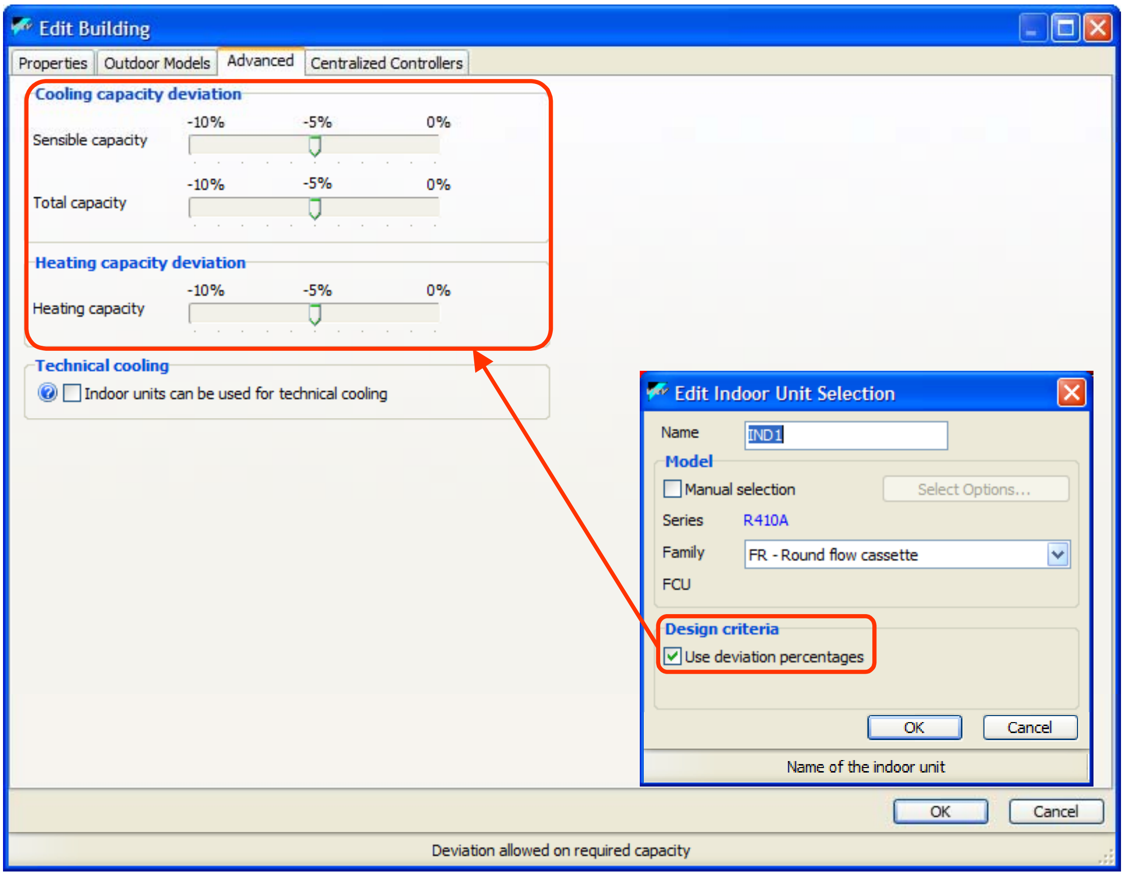


Figure 69: Setting a deviation percentage

By default, indoor units are selected according to the deviation settings in the building properties. You can prevent an indoor unit to use those deviations by unchecking the "***Use deviation percentages***" checkmark (see Figure 69) in its edit window (right click the indoor unit and select the edit command).

By default, the indoor unit model is selected automatically so that it covers the loads in a room. However, you can also select an indoor unit model manually. Figure 70 shows the indoor unit edit window, with the "***Manual selection***" checkmark checked. In that case, you can select the model name, independent of the loads to cover. The model will not change, even if the loads in a room would change. Note that room loads may change after a load calculation, due to all kinds of changes in a room, as explained in chapter 5. Therefore, manually selected indoor unit models may lead to an incorrectly dimensioned air-conditioning system.

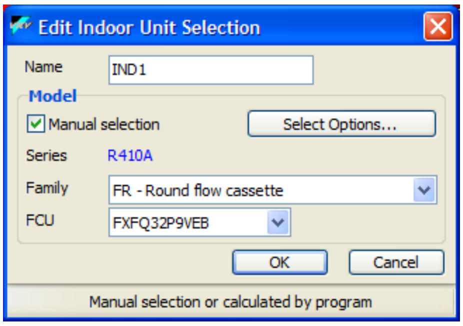


Figure 70: Manually selecting an indoor unit model

Within a room, VRVPro makes sure that all indoor units either are selected automatically or manually.

3.2 Drawing the Pipes

Before drawing a piping configuration on the floor plan, this section first explains a few important piping concepts, after which it illustrates two different piping configurations.

3.2.1 Piping Concepts

Depending on the selected outdoor unit (see section 0), you will need a different pipe design using different piping rules (see Figure 71):

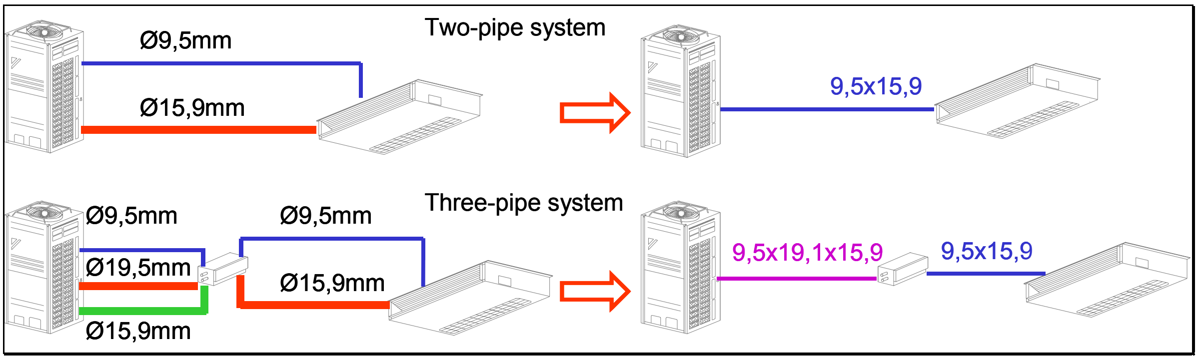


Figure 71: Schematic representation of two and three-pipe systems

- A two-pipe system (heat pump and cooling only outdoor unit) either cools or heats and uses two pipes to form a refrigerant circuit with its indoor units. The smallest pipe is a liquid pipe and the other is the gas pipe. The picture in the upper left corner shows a heat pump and the corresponding picture at the right how the two pipes are represented by one connection with both diameters marked above it.

- A three-pipe system (heat recovery outdoor unit) uses three pipes to an intermediate device, called a BS-box, which delivers cool or heat capacity to the indoor unit, depending on its demand. The BS-box connects to the outdoor unit with three pipes, allowing it to select heating or cooling capacity, whereas the BS-box connects to the indoor units using two-pipes, as is the case in a regular two-pipe system. The picture in the lower left corner shows a heat recovery system with a BS-box and the corresponding picture at the right how the three and two pipes are represented by one connection with the diameters marked above it.

Of course, an outdoor can serve more than one indoor unit. To connect them, you use refnets. There are two kinds of refnets (see Figure 72):

1. ***Joints*** connect 2 indoor units to an intermediate pipe or to the main pipe, which is the pipe coming from the outdoor unit to the first refnet.
2. ***Headers*** connect more than 2 indoor units, typically 4, 6 or 8 to an intermediate pipe or to the main pipe.

Figure 72: Use refnets to connect several indoor units

Figure 73 shows small piping schemes using joints (at the left) and headers (at the right). When using joints, several configurations are possible, depending on where you place the joints. The piping scheme at the left shows a tree-like configuration (indicated by ①) or a chain-like one (indicated by ②).

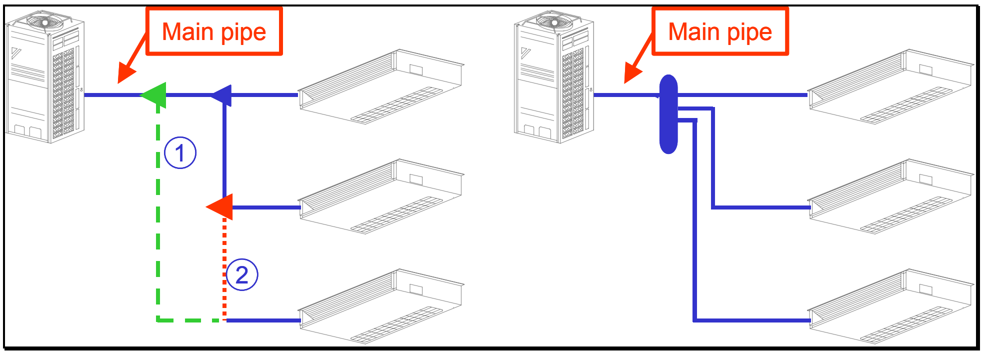


Figure 73: Small piping schemes using joints or headers

Generally speaking, a tree-like configuration is preferable to a linear one. In fact, the last indoor unit in a linear chain may not get the required capacity, due to losses in pipes that become too long. To prevent such situations, a piping configuration is subject to several piping rules, imposing different limits on a possible configuration.

The most important rules are:

- The main pipe has a maximum allowable length. If that length is exceeded, it is possible to extend it up to another maximum by increasing its diameters (gas and liquid pipes). This extended length is then the absolute maximum length.
- There is a limit on the distance of an indoor unit to the joint it is connected to.
- Another limit is the distance between the first joint (closest to the outdoor unit) and the last joint (closest to the indoor unit). If that maximum distance is exceeded, it is possible to extend it up to another maximum by increasing the diameters of all intermediate pipes (gas and liquid). That extended distance is then the absolute maximum distance.
- There is a limit on the distance difference between the closest (to the outdoor unit) and the furthest indoor units.

- There is a maximum height difference between indoor units and a maximum height for the outdoor unit above or below its indoor units.

The piping configuration for a VRV system may become really large. Checking all the rules that apply and trying to relief limits by sizing up pipe diameters may become a daunting task. So, VRVPro checks all those piping rules, sizes up diameters automatically and gives you a detailed explanation why. However, it does not solve a situation where the configuration hits absolute distance limits. In that case, VRVPro gives an error message and explains the limit(s).

In addition to the piping rules, you cannot freely intermix headers and joints (see Figure 74):
- When the first refnet is a joint, you can use other refnets after it.
- When the first refnet is a header, it is not possible to use any other refnet after it.
- In three-pipe systems, the BS-boxes play no role in those rules. So, if the first refnet is a header, it is not possible to use any refnet before or after the BS-boxes

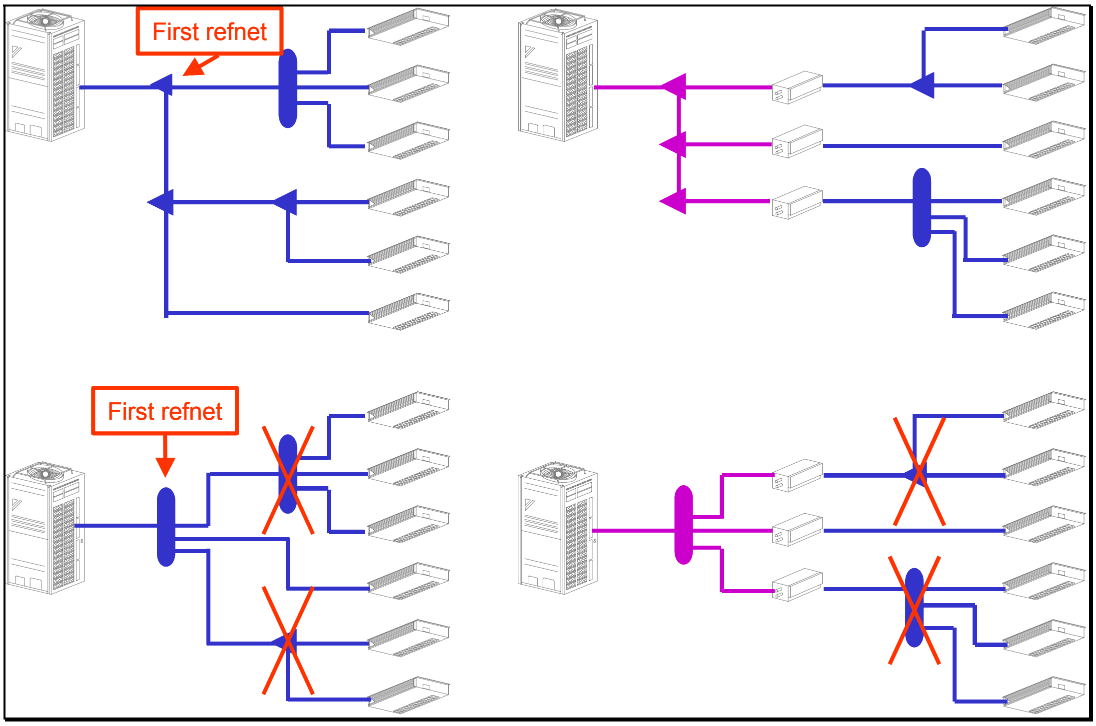
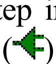


Figure 74: No refnets (joints or headers) after a (downstream) header

3.2.2 Defining a Two-pipe System

The first step in drawing the piping is placing the refnets (joints or headers). First select the refnet icon () and then click at a position in the floor plan where you want to place the refnet. VRVPro now brings up a window to specify the kind of refnet (joint or header) and it orientation, as shown in Figure 75:
- When selecting a header, a combo box appears, from which you have to select the number of connections. This combo box only shows the available connections.
- Once you selected an orientation, VRVPro will keep it for all next clicks on the floor plan, until you select the refnet icon () again.

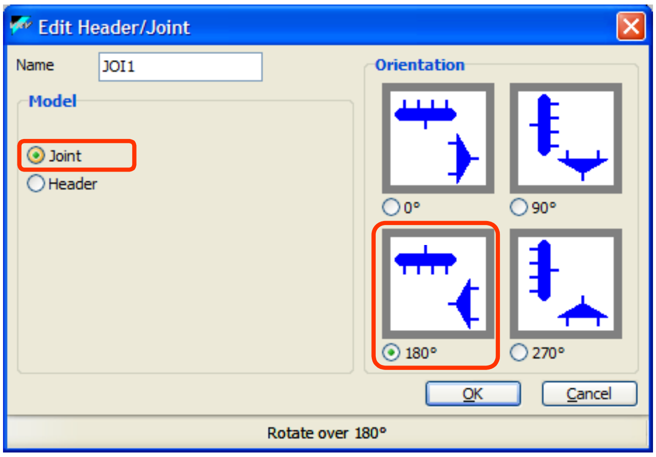


Figure 75: Defining the type and orientation of a refnet

Figure 76 shows a part of the floor plan, on which a few joints have been placed. It is important to place them in areas where you can mount them. In addition, you should also try to minimize the piping to avoid getting problem with one of the possible piping limitations:

- A joint has two incoming pipes. Place the joint such you minimize the lengths of the incoming pipes. By moving the refnet a bit more to the right in Figure 76, both incoming pipes become shorter.
- Depending on the selected indoor unit model, it is possible to rotate it or swap it. This is important, as indoor units have a connection at one side. By rotating the indoor unit Ind5 in Figure 76, you may gain about 1m of pipe.

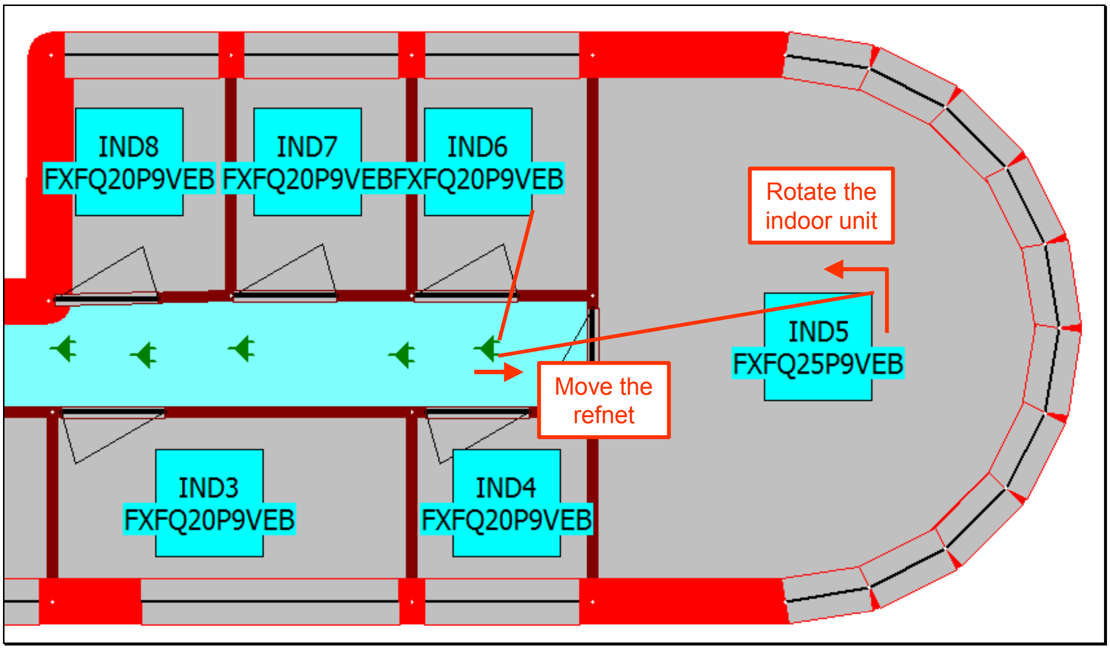


Figure 76: Placing joints and minimize the piping lengths

Although you may perform the actions above while connecting the pipes, VRVPro also contains pipe optimization functions. The best order to draw the piping is put the refnets at approximate good places, then to perform an optimization and finally refine the optimization.

The VRVPro drawing modes (see section 2.2 and Figure 24), offer two ways to draw the piping:

1. In modal drawing, the first step is selecting the piping icon (). Then you can connect an indoor unit to a refnet or a refnet to another refnet. The drawing is always from an output connection towards an input. You can keep on drawing, until you select the selection icon ().

2. In modeless drawing, you first have to select the element (indoor unit or refnet) from which you want to draw from, then select the piping icon (PIPE) and draw the connection.

Another problem is how to draw the pipes. Here also, VRVPro offers two possible ways, as shown in Figure 77: a horizontal-vertical connection and a straight connection.

By default, VRVPro draws horizontal-vertical connections. However, you can change this default by selecting the "***Options***" command in the File menu, which brings up the Options window. Uncheck the "***Horizontal/vertical drawing***" check mark to get straight connections by default.

However, you can also draw straight connections while in "***Horizontal/vertical drawing***" mode by pressing the Alt key while drawing. This key actually toggles the drawing mode: when in horizontal/vertical mode, pressing the Alt key will draw straight connections and when in straight mode, pressing the Alt key will draw horizontal/vertical connections.

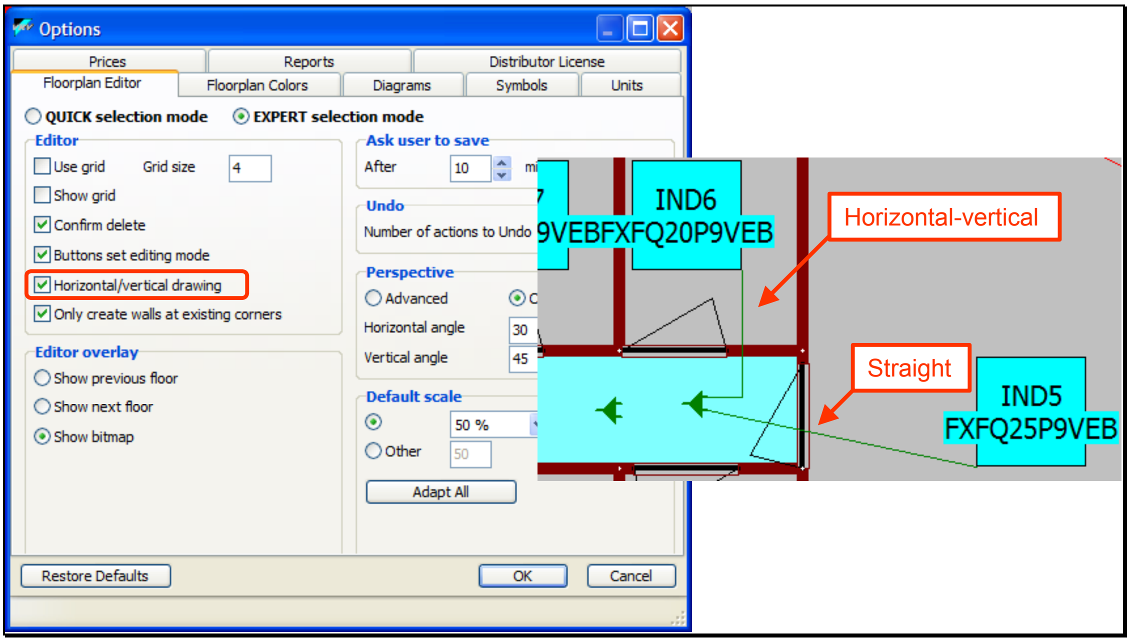


Figure 77: Drawing a pipe connection

When connecting an indoor unit to a joint, there are two incoming pipes. VRVPro chooses the connector that comes the closest, as shown in Figure 78:

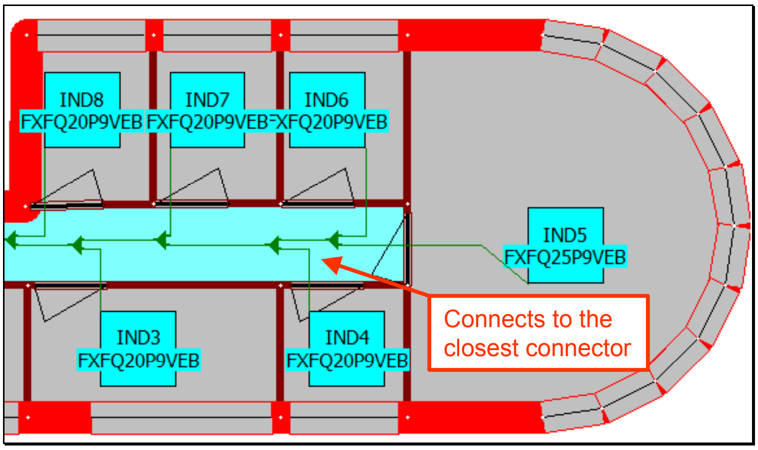


Figure 78: Connecting to the closest connection

However, the closest connector may not be that obvious. In the case of indoor unit Ind5, the connection point is lower than the joint connectors. So, when connecting Ind5 to the joint, VRVPro will use the lowest connector, as this one is the closest. In Figure 78, when an indoor unit is clearly above the joint, VRVPro will use the top connector, otherwise the bottom connector. Idem for situations where the indoor unit is clearly left or right vertically oriented joints. In case the connections are switched, right-click the joint and select the "***Swap connections***" command.

The piping can now be completed, up to the first joint, which is then connected to an outdoor unit. To place an outdoor unit, select the air-cooled outdoor unit icon ( ) or the water-cooled outdoor unit icon ( ) and click a position on the floor plan.

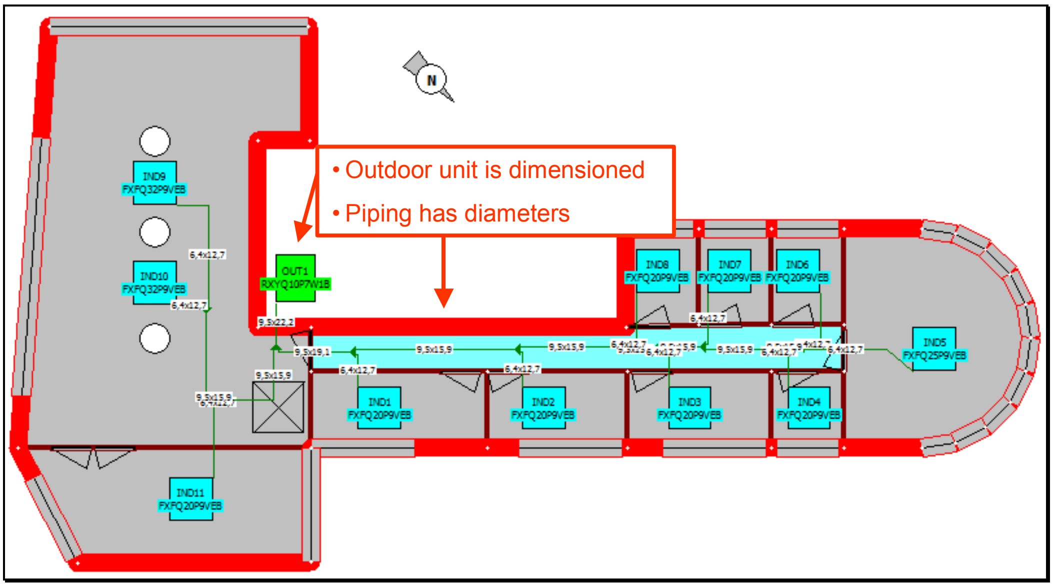


Figure 79: The completed piping for a 2-pipe system

As soon as you connect the first joint to the outdoor unit, VRVPro calculates the piping diameters, including a possible size-up of these diameters.

It also dimensions the outdoor unit, according to the model pre-selection settings in the building properties (see Figure 21). Figure 79 shows the result of a completed piping, showing the pipe diameters for each pipe.

Depending on the settings in the editor palette (see Figure 57), VRVPro displays the pipe diameters and models for the joints. You may uncheck these to keep the floor plan clear.

After having connected the outdoor unit, you can start the piping optimization, by selecting the outdoor unit at the left of the main window. This displays the "Optimize Piping" command, as shown in Figure 80. Clicking it brings up a window with the possible optimizations:

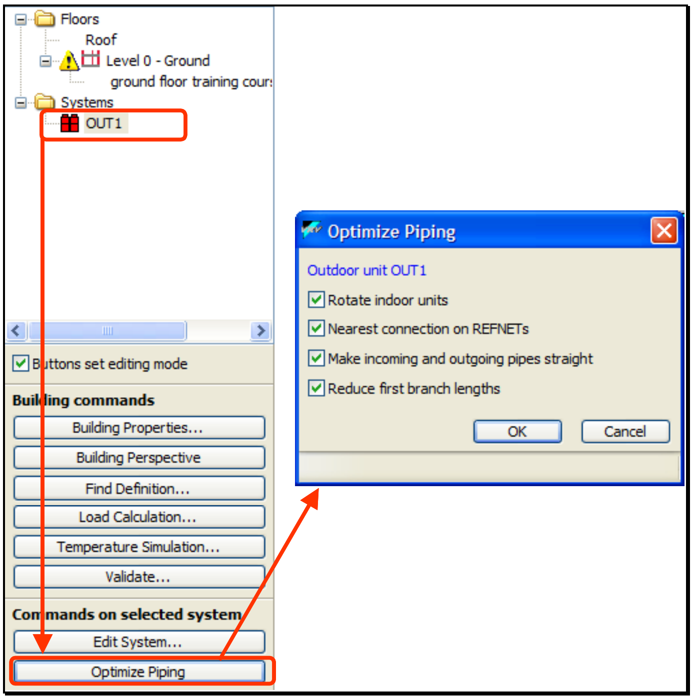


Figure 80: Optimize the piping connections

- "***Rotate indoor units***" will try to shorten the piping length by rotating the indoor unit. This is only possible for indoor unit models that can be rotated.
- "***Nearest connection on REFNETS***" will reconnect the pipes to the refnet to make sure connections are not crossing. For a joint, this is identical to the "***Swap connections***" command explained above.
- "***Make incoming and outgoing pipes straight***" removes bends in pipes going from an indoor unit to a joint, which will make more straight connections.
- "***Reduce first branch lengths***" will move the joint to the closest indoor unit, to reduce the length of the incoming pipes.

Figure 81 shows a part of the piping before and after a piping optimization. The part at the left indicates the elements that will be optimized and the part at the right gives the result.

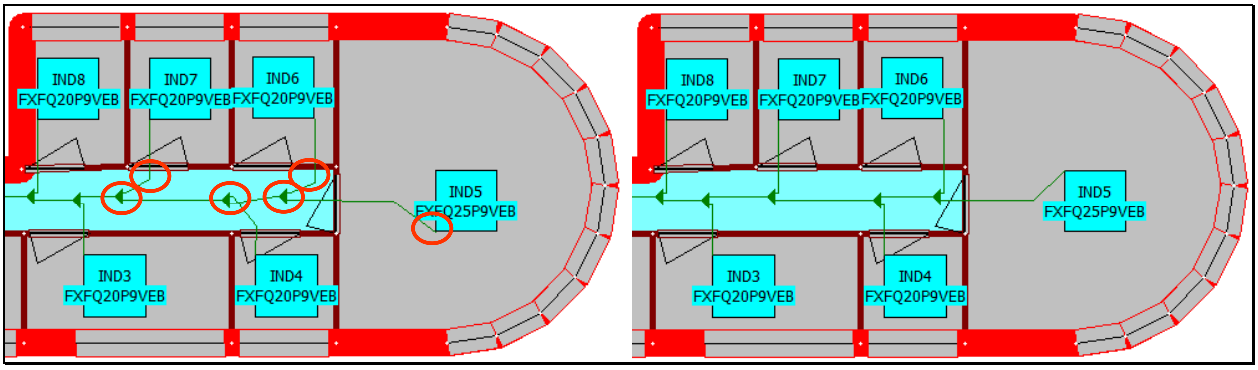


Figure 81: The result of piping optimization

It must be clear that piping optimization cannot solve all possible situations. In fact, even in the example of Figure 81, you may envision more intricate solutions, by slightly moving indoor units and combining this with rotations. Also, practical (building) constraints may require a quite different piping scheme. Anyway, the VRVPro optimizations perform many small improvements, which result in a shorter and cheaper piping scheme.

3.2.3 Defining a Three-pipe System

Figure 82 shows the piping of a three-pipe system, where you have to introduce BS-boxes between the indoor units and the outdoor unit.

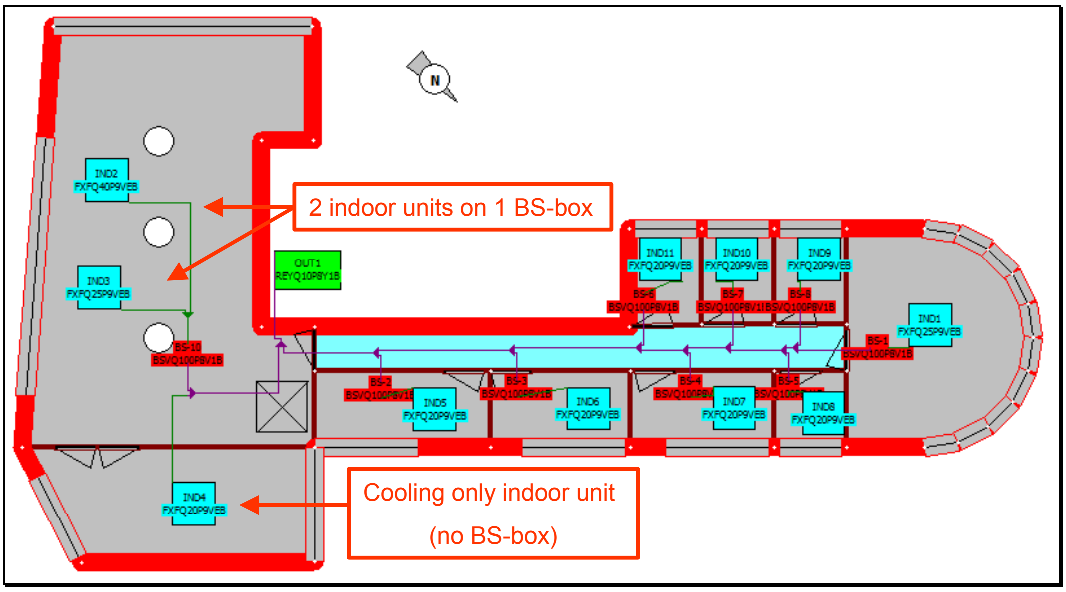


Figure 82: The piping for a three-pipe system

However, when connecting an indoor unit directly to the heat recovery outdoor unit, without having a BS-box in between, the indoor unit will cool only. VRVPro allows this, if the room does not have a heating load to cover. As explained in 3.2.1 and shown in Figure 74, a BS-box may also serve several indoor units. Figure 82 shows the floor plan with at complete three-pipe system, containing a cooling only indoor unit and a BS-box controlling two indoor units.

3.2.4 Defining a Service Shaft

Quite often, an outdoor unit is at a different level than its indoor units. An outdoor unit may be placed on a roof, for example. So, the piping possibly needs to cross several floors before reaching an outdoor unit. To cross a floor, you need a service shaft.

Figure 83 shows a part of Figure 79, in which the last pipe to the outdoor unit has been removed and a shaft has been placed in which the last pipe now disappears. The outdoor unit also has to disappear, as it will move to the roof.

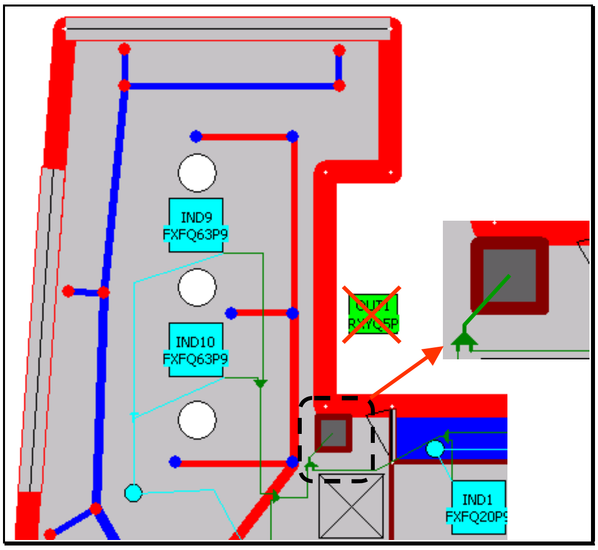


Figure 83: Inserting a service shaft

To add a shaft, select the service shaft icon () and click on the floor plan at the position you want to place it. VRVPro will than display a window to select a shaft. As this is the first shaft, this window will only show **"<*New Shaft*>"**. Select this entry to bring up a window to enter the name of the shaft. When clicking the OK button in that window, VRVPro places a shaft at the indicated position and with default dimensions (1m x 1m). You can change the size of the shaft by clicking on it with the right mouse button and select the "***Edit***" command. This brings up a window in which you can change the name of the shaft and its dimensions.

Figure 84 shows the three windows that appear when defining and editing a service shaft:

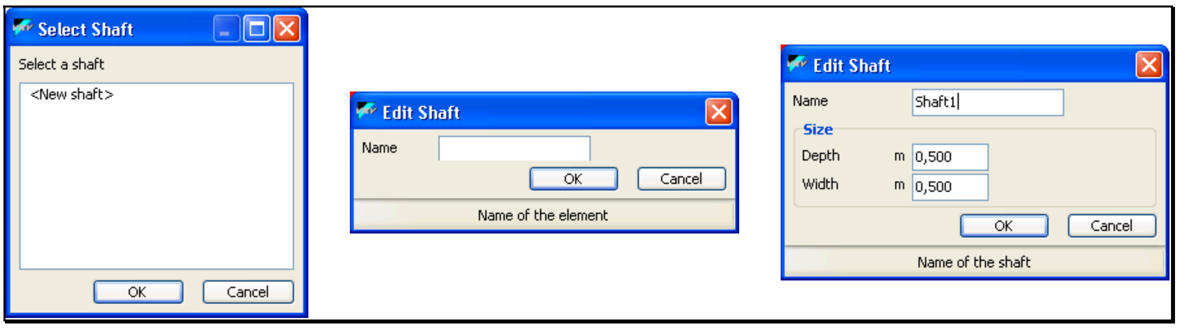


Figure 84: Defining and editing a service shaft

Once the service shaft has been placed and dimensioned, you can now connect the last joint to that shaft. This gives the result as shown in Figure 83.

A roof floor differs from a regular floor in that it only serves to put outdoor units on. It is a special case of a slanted roof. You can create one by double clicking the roof entry in the tree view. This brings up the "***Create Floor***" window, as explained in section 2.10.8 and shown in Figure 85:

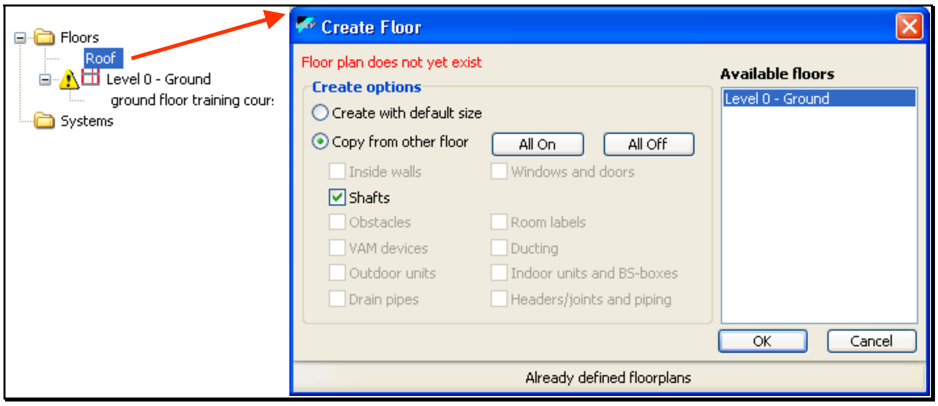


Figure 85: Creating a roof floor by copying it from the ground floor

When copying the roof floor from another floor, only the shafts can be copied. The shaft will also appear at the same position and with the same dimensions as on the ground floor.

Now you can add the outdoor unit on the roof. To connect the outdoor unit with the joint on the ground floor, connect the service shaft with the outdoor unit. This will bring up a window showing the names of the joints and headers that have been connected to that shaft, as shown in Figure 86, where there is only one joint to connect from:

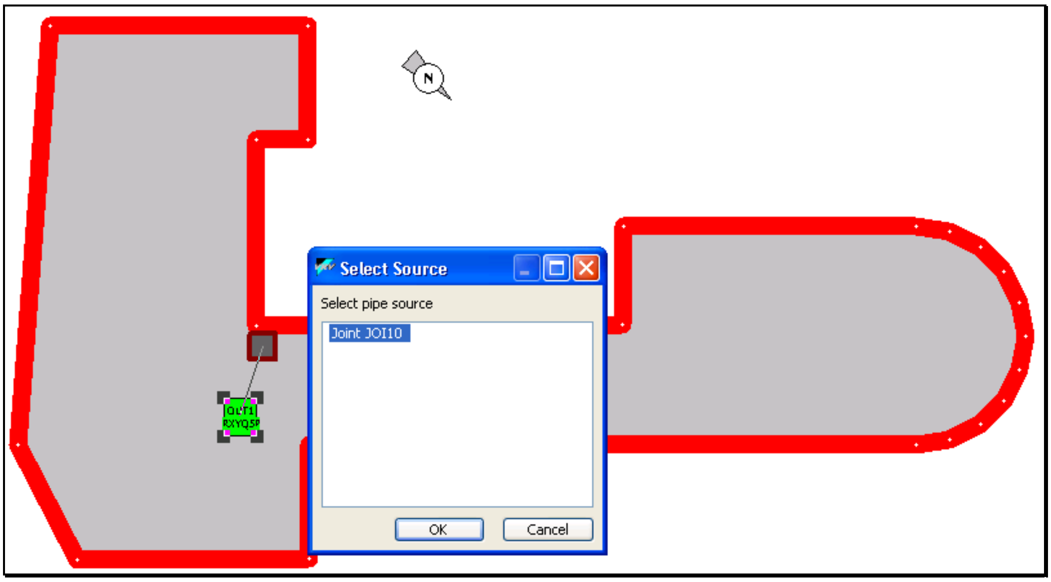


Figure 86: Adding an outdoor unit and connecting it with a pipe from a service shaft

The example above shows a situation where a floor has been copied from another floor, thereby including a shaft.

Suppose now, the ground floor contains a shaft ("***Service Shaft***") and you want to add the same shaft to an existing first floor. When you select the service shaft icon () and click on the floor plan, the "***Select Shaft***" window will appear, now containing the name "***Service Shaft***", as shown in Figure 87.

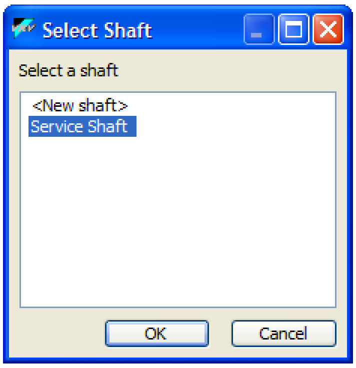


Figure 87: Selecting an existing shaft

Select that name to make sure the piping passes through the same shaft. When selecting an existing shaft, VRVPro uses a few conventions:

- If the shaft is on the floor that is used as a template floor (previous floor or next floor: see section 1.6.3), it uses the shaft dimensions from that floor.
- If there is no template floor or the template is a bitmap (see sections 1.6.1 and 1.6.2) and the shaft exists on the floor below, it uses the shaft dimensions from the floor below.
- In all other cases, VRVPro uses default shaft dimensions (1m x 1m).

Note that a same shaft may have different dimensions on different floors. On the higher floors, it may be smaller than on the lower floors. Note also that a shaft may appear at different positions on different floors. In fact, when the floor below has a false ceiling, the piping may first pass in that false ceiling and then appear in a shaft at a different position on the floor above. So, VRVPro does not align a shaft when you place it on a floor plan, as shown in Figure 88:

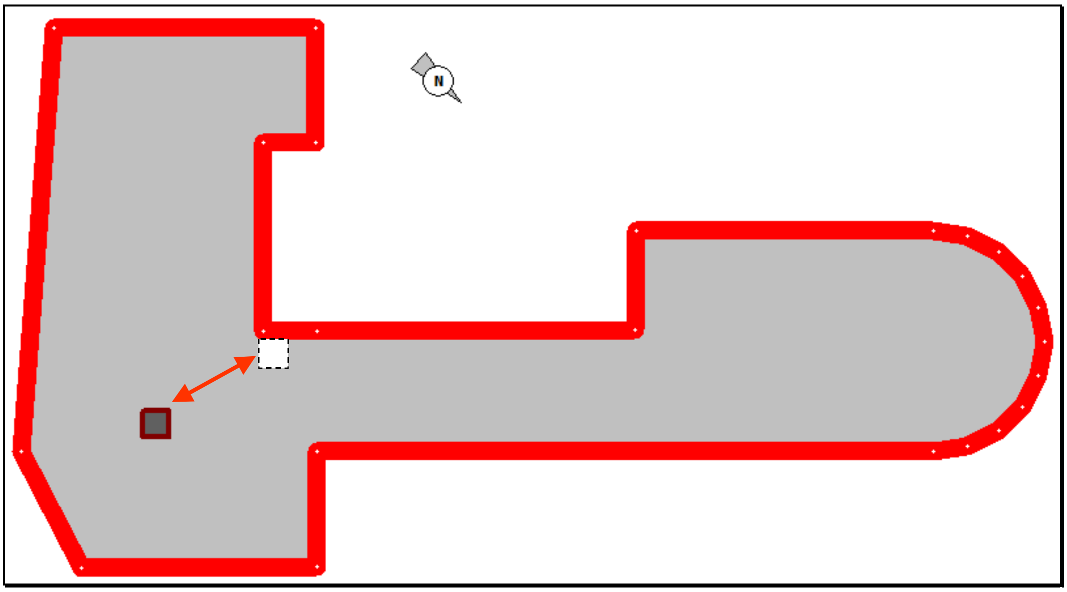


Figure 88: A manually placed shaft is not aligned with the other floors

However, it may be necessary to align a shaft on the same positions on the different floors. Clicking with the right mouse button on a shaft displays the menu commands "***Align with previous floor***" (except on the ground floor) and "***Align with next floor***" (except on the last floor). Note that aligning a shaft is an absolute action, that is, VRVPro does not take possible (internal) walls and obstacles into account.

3.3 *Selecting the Outdoor Units*

As explained in the previous section, an outdoor unit is selected as soon you place it on the floor plan and connect it with the first refnet. However, this selection is based on the device defaults, set in the "***Building Properties***" window. In case you want a different selection, you have to edit the outdoor unit, by right-clicking it and selecting the "Edit" command. The next sections explain the different parts of the outdoor unit window.

3.3.1 The Edit Outdoor Window

The Edit Outdoor Window consists of four tabs:

1. The system overview, showing the selection criteria and a tree view with the indoor units.
2. The piping diagram, explained in section 3.3.2
3. The wiring diagram, explained in section 3.3.3
4. A tab containing an overview of the indoor units connected to the outdoor unit.

Figure 89 shows the outdoor unit window for the two-pipe system shown in Figure 79:

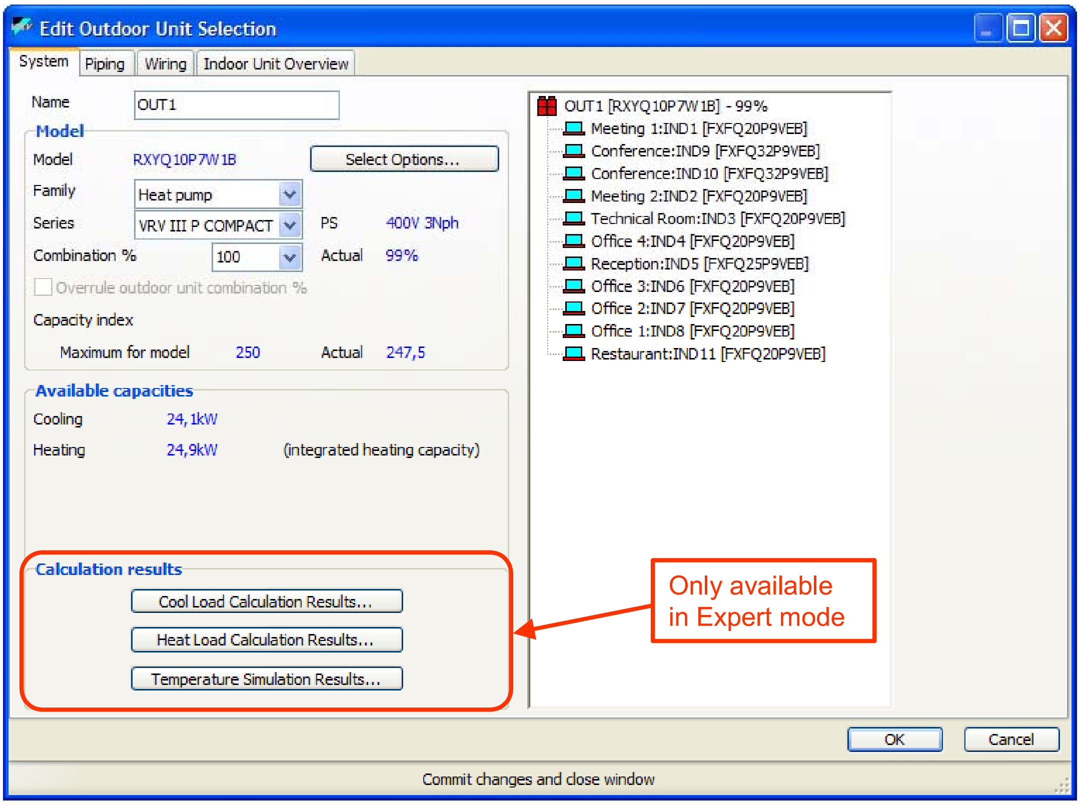


Figure 89: An outdoor system overview for a two-pipe system

The selected outdoor unit is a heat pump system and the connected indoor units maximum need 99% of the available capacity, which is smaller than the maximum allowed connection ratio of 100%.

An outdoor unit can only deliver 100% or less of its capacity. However, if all its indoor units are not operating at the same time, it is possible to connect more indoor units than the available 100%. Suppose an outdoor unit has indoor units connected to it for a total of 120% of its capacity. In case the indoor units would operate all at the same time, they surely will get less capacity than when the outdoor unit would have been connected up to 100%.

For offices, it is quite common to connect indoor units to an outdoor unit up to a connection ratio of 130%. When the indoor units have been selected manually (see section 3.1), they will get less capacity and may not cover the required load in the room. When the indoor units are automatically selected, VRVPro will make sure they always cover the required load. If necessary, VRVPro will increase the indoor unit model.

The calculation results at the bottom are only available in Expert mode (see section 1.3), where it is possible to perform a load calculation (see chapter 5, section 5.7.3) and a temperature simulation (see chapter 6).

Figure 90 shows the outdoor window for a three-pipe system, in which an indoor unit has been connected directly to the outdoor unit, as was the case on the floor plan in Figure 82:

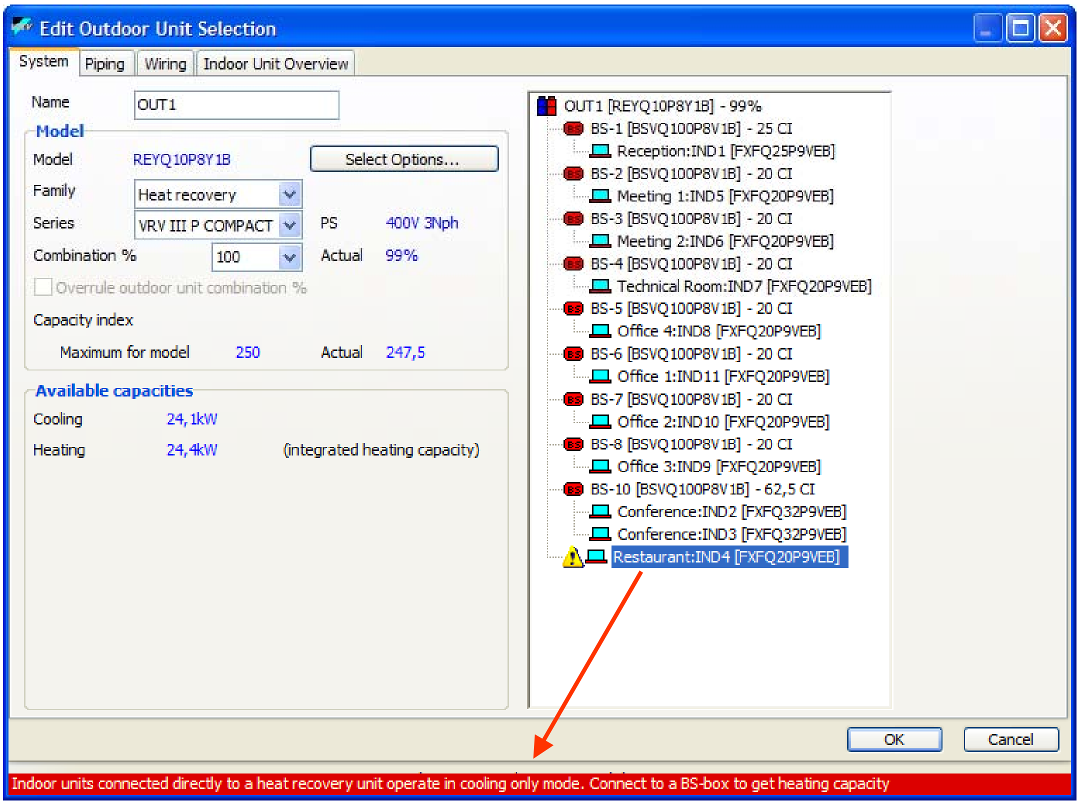


Figure 90: Displaying error messages or explaining special cases

Devices containing an error have a red cross in front of their name. Special cases get a yellow triangle. Clicking the device will show a message at the bottom of the window, explaining the problem or the special case.

Figure 91 shows the tab containing the indoor unit details. The icon at the start of each row indicates whether the indoor unit is an automatic or a manually selected one. The indoor unit on the last row is a manually selected one.

The list shows the model name, the required and covered capacities and the room the indoor unit belongs to. The small question mark at the top right opens a window explaining the column titles.

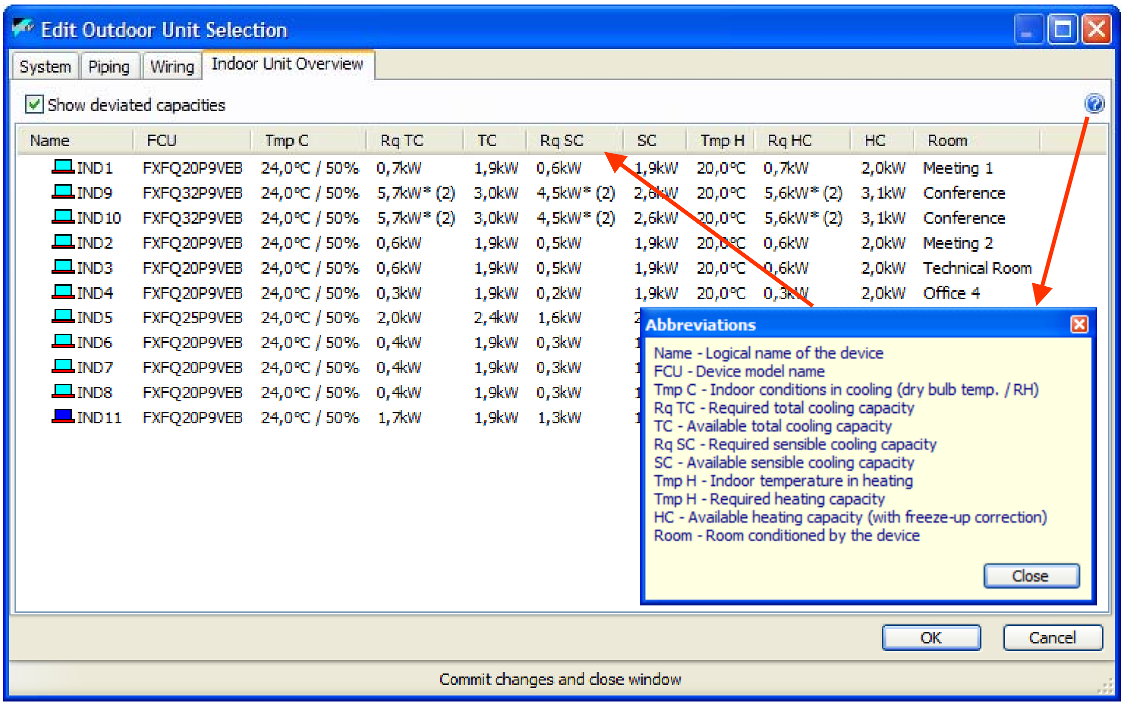


Figure 91: The list of indoor units with the selection details

When checking the "***Show deviated capacities***" checkmark, VRVPro shows the minimum required loads to cover. This is only important if the deviation percentage (see section 3.1 and Figure 69) differs from 0%.

3.3.2 The Piping Diagram

The piping diagram only appears if VRVPro could select an outdoor unit, calculate the pipe diameters and the refrigerant charge for the system, as shown in Figure 92:

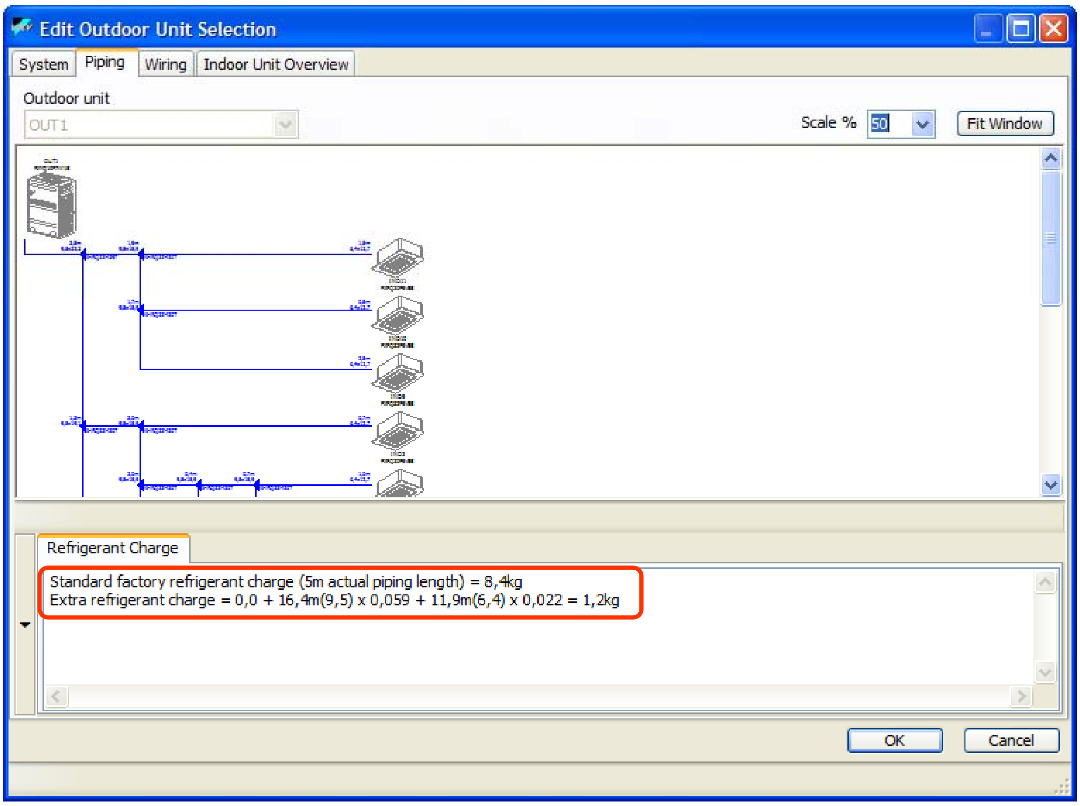


Figure 92: A piping diagram with the refrigerant charge

Figure 93 shows the piping diagrams from the floor plans in Figure 79 and Figure 82 respectively. A piping diagram shows many details of a system:

- It displays the indoor units, the BS-boxes and the outdoor unit, together with their name and model.
- It shows the refnets, together with their model names.
- It gives the diameters for all types of pipes (liquid, gas and discharge), together with the lengths of each piece of pipe.
- VRVPro shows diameters, which have a size-up to comply with one of the piping rules, in a different color as a visual feedback.

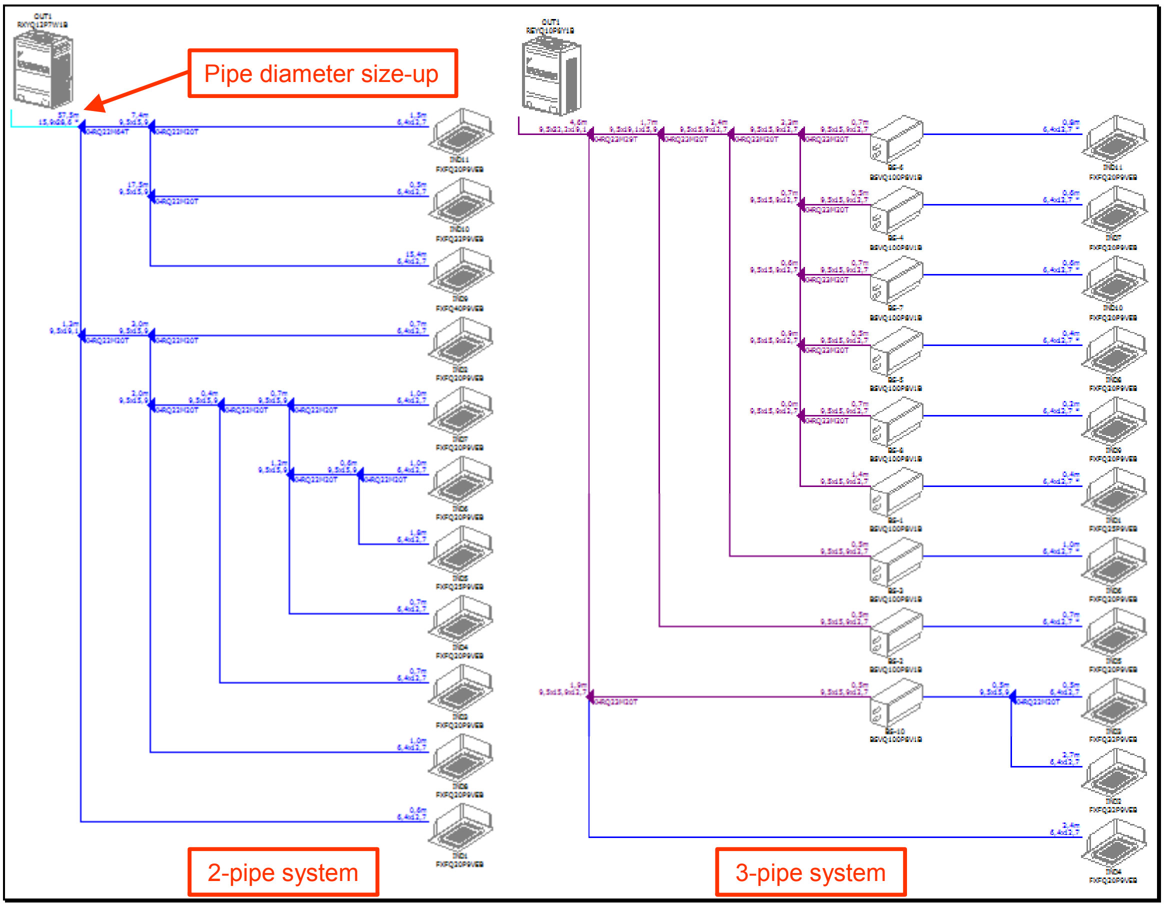


Figure 93: Examples of piping diagrams with refnets and diameters

The automatic selection of indoor units, outdoor units, BS-boxes, refnets and diameters may be a great bonus when using VRVPro. However, as there are many rules to follow, it may not be clear why VRVPro made a particular selection. For that reason, you can right-click any element on the piping diagram, which brings up a menu containing the "***Explain Selection***" command. Depending on the selected element, this command gives an extensive explanation of all the criteria used to select that element.

Figure 94 shows an explanation for the selection of a refnet. This is by far the shortest of the available explanations. With the exception of an outdoor unit, an explanation applies to the selected element and its output diameter.

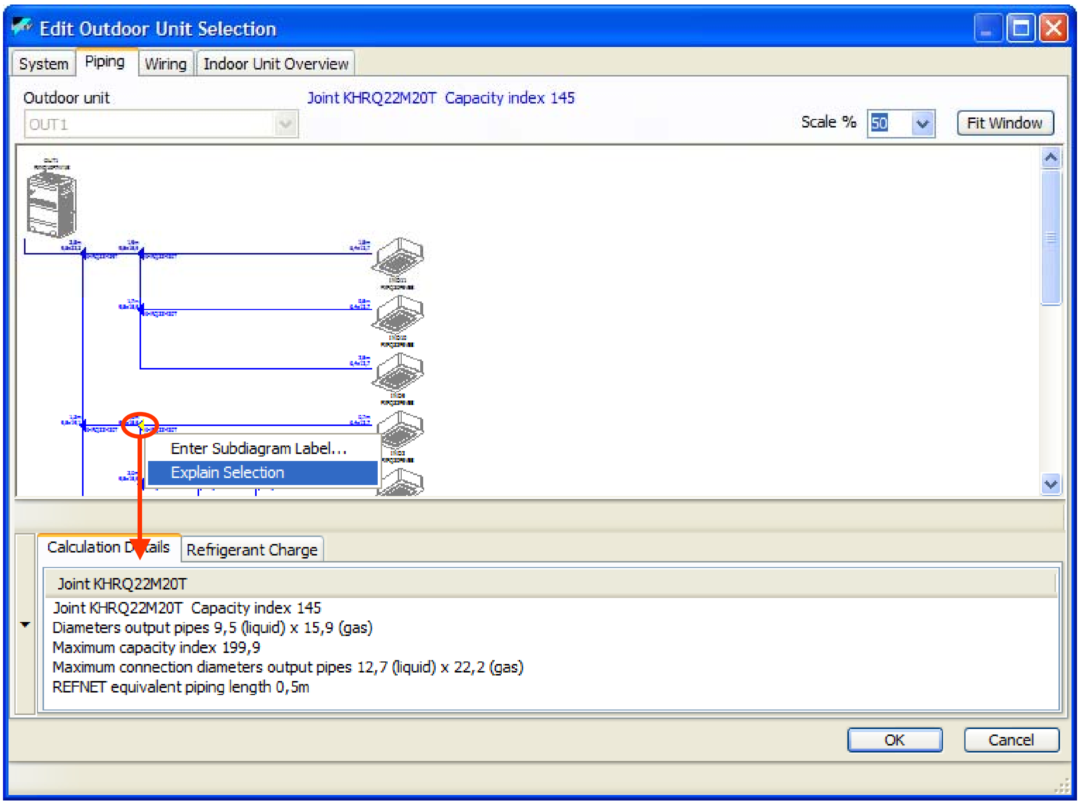


Figure 94: Explaining a selection in the piping diagram

The "***Enter Subdiagram Label***" command allows you inserting label in the piping diagram to cut it in smaller pieces when creating a report, as shown in Figure 95. You can enter a label of two letters used as a reference to the place where VRVPro must cut it. To remove the label, select the command again and enter an empty string.

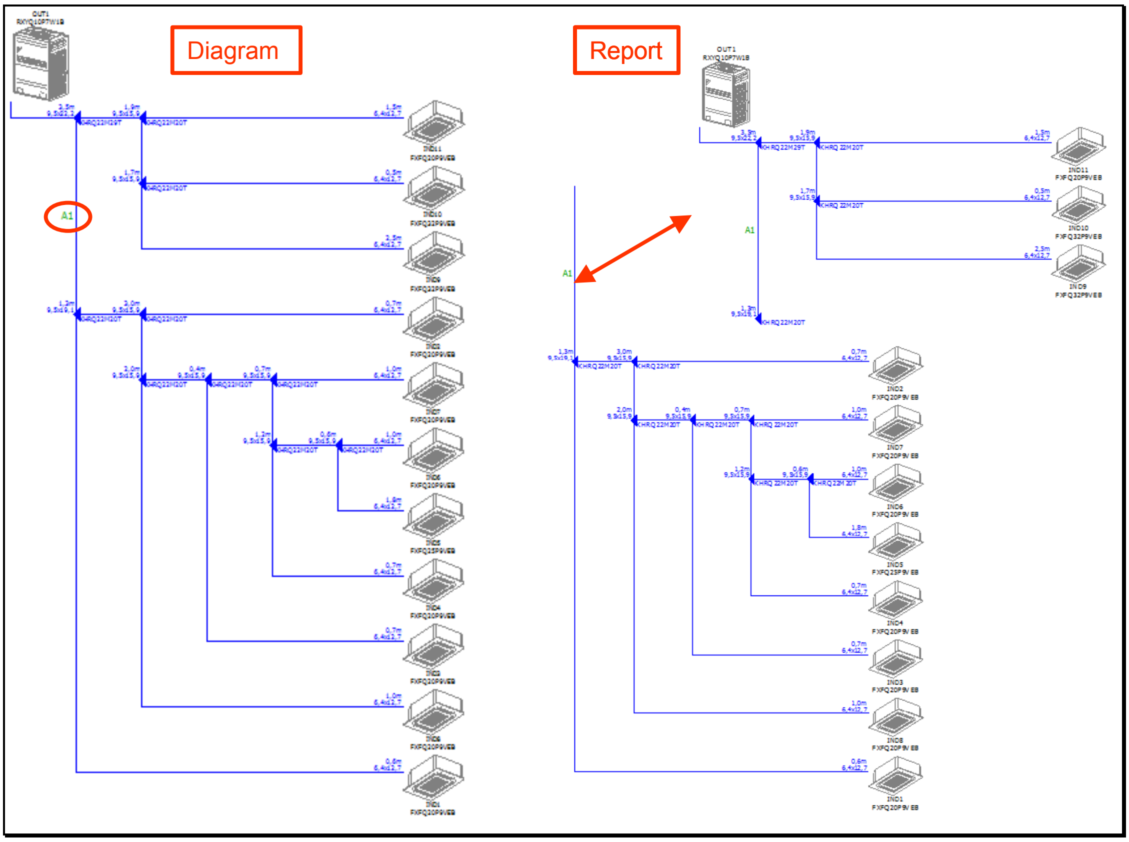


Figure 95: Cutting a piping diagram in pieces for reporting

3.3.3 The Wiring Diagram

Figure 96 shows the wiring diagrams of the systems in Figure 79 and Figure 82 respectively. By default, each indoor unit is connected to a remote controller.

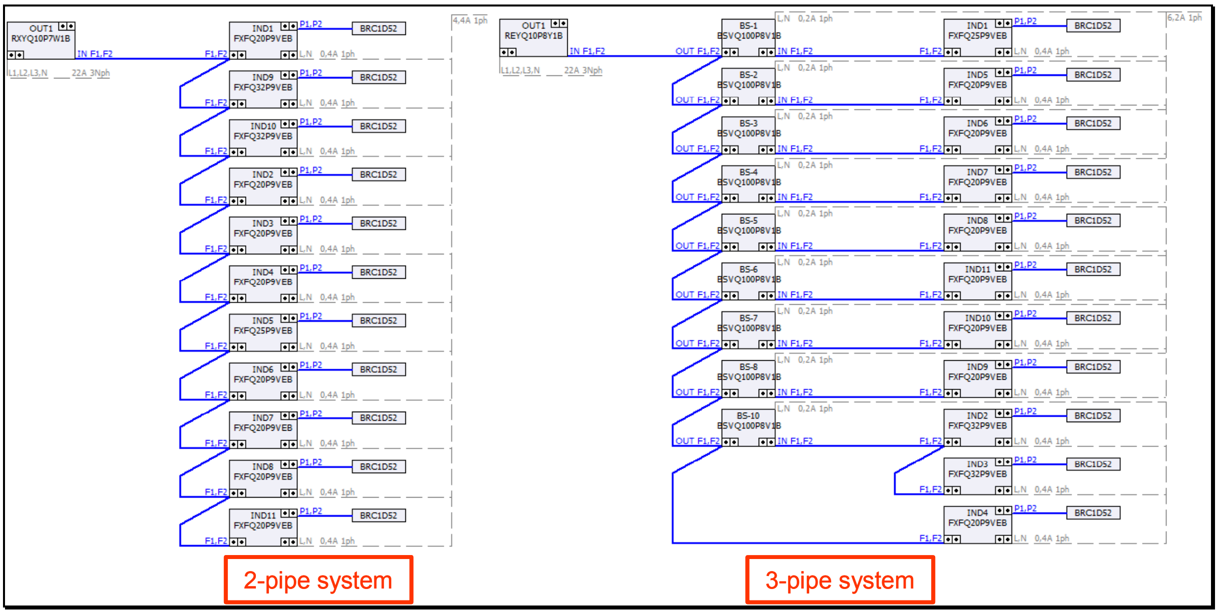


Figure 96: Examples of wiring diagrams

A remote controller may control one individual indoor unit, as shown in Figure 96. However, it is also possible to have one remote controller controlling several indoor units in the same room. In Figure 97, the room Conference contains two indoor units (Ind9 and Ind10), which must be controlled by a single remote controller. This is a two-step process:

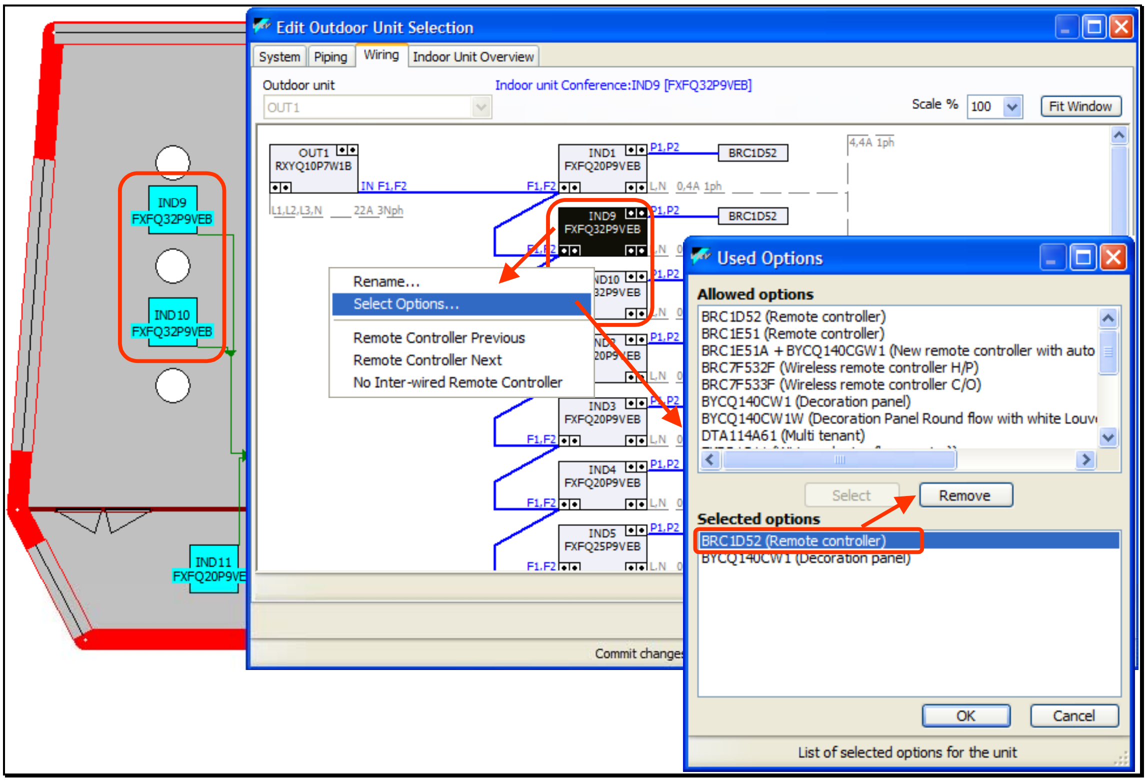


Figure 97: Removing a remote controller in a room

1. Right-click indoor unit Ind9 in the wiring diagram and select the "***Select Options***" command.

This brings up a window to select the options. Select the remote controller option and remove it. The indoor unit Ind9 no longer has a remote controller.

2. Right-click indoor unit Ind9 again and select the "***Remote Controller Next***" command, as shown in Figure 98. This connects indoor unit Ind9 to indoor unit Ind10, sharing its remote controller.

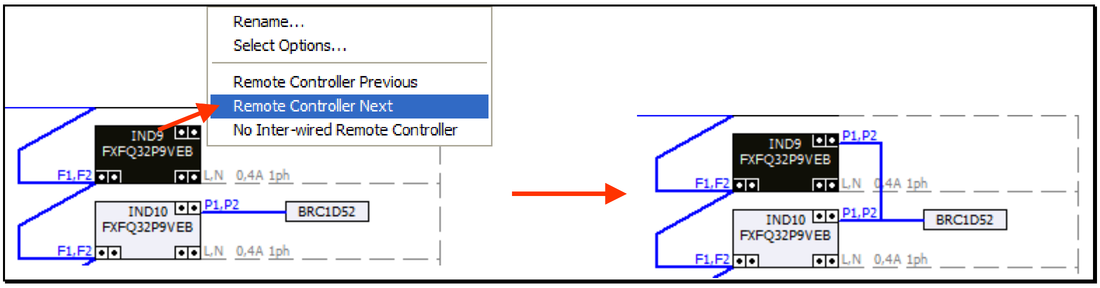


Figure 98: Sharing a remote controller between two indoor units

3.4 Drawing the Drain Piping

Drain piping is not part of dimensioning an air conditioning system, but it completes it. VRVPro does offer functions to draw the piping, but not to design it with pumps and other auxiliary devices. Instead, it assumes that you draw drainpipes from the indoor units to a drain point.

You place drain points by selecting the corresponding icon (H2O) and clicking at required positions on the floor plan. Then you select the drainpipe icon (H2O) to draw drainpipes from an indoor unit to a drain point. In modal drawing mode, you click the mouse on an indoor unit and while keeping the mouse button pressed, you move to the drain point. If you also keep the Alt key pressed, you draw a straight connection instead of a horizontal/vertical piping. Figure 99 at the left shows a drainpipe from indoor unit Ind9 to a drain point.

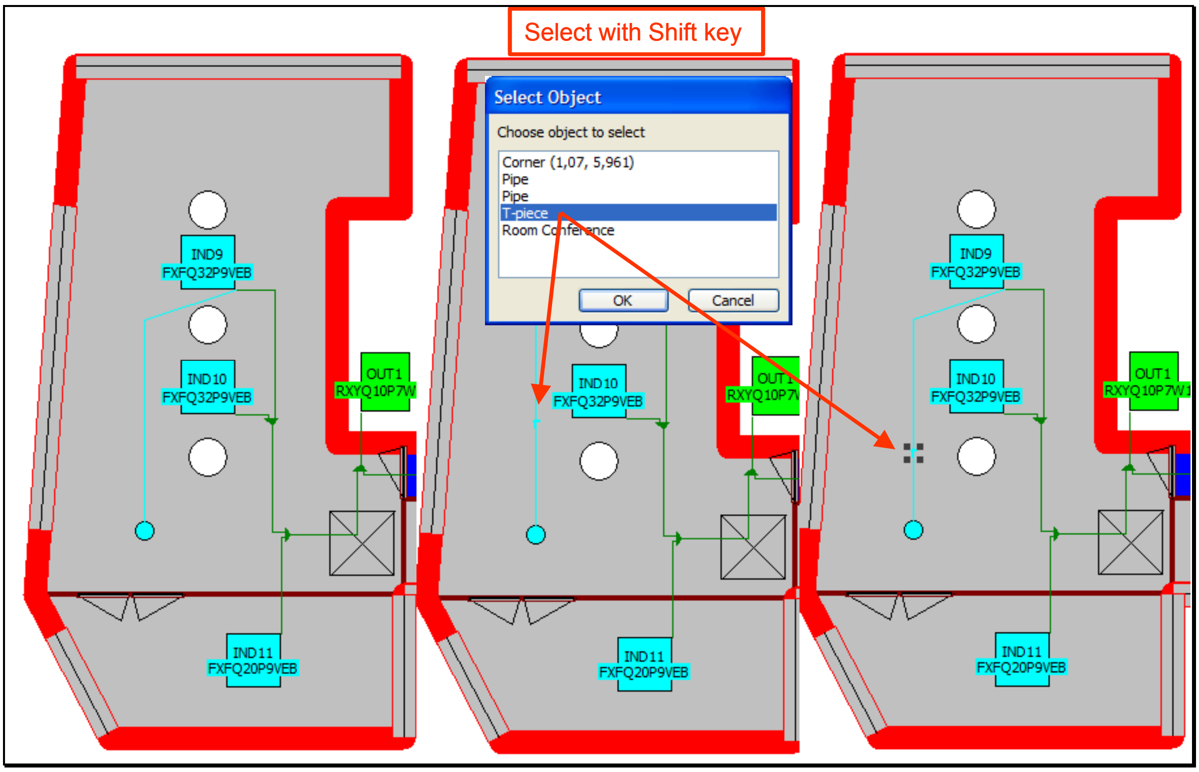


Figure 99: Drawing the drain pipes

On an existing drainpipe you can insert a T-joint by selecting its icon ( ) and clicking on a drainpipe piece. VRVPro will insert it in the middle of that pipe piece. Inserting a T-joint also inserts a corner point on the drainpipe. This may make it difficult to select.

When several elements come together in a small drawing place, you can click them while pressing the Shift key. This brings up a window with a list of elements that can be found on that place. Select the required element from that list to get the required element. Selecting the T-joint in Figure 99 selects it on the floor plan, allowing you to move it, if necessary.

By combining drain points and T-joints, you can draw the drainpipes for the project. Figure 100 shows a possible solution with three drain points.

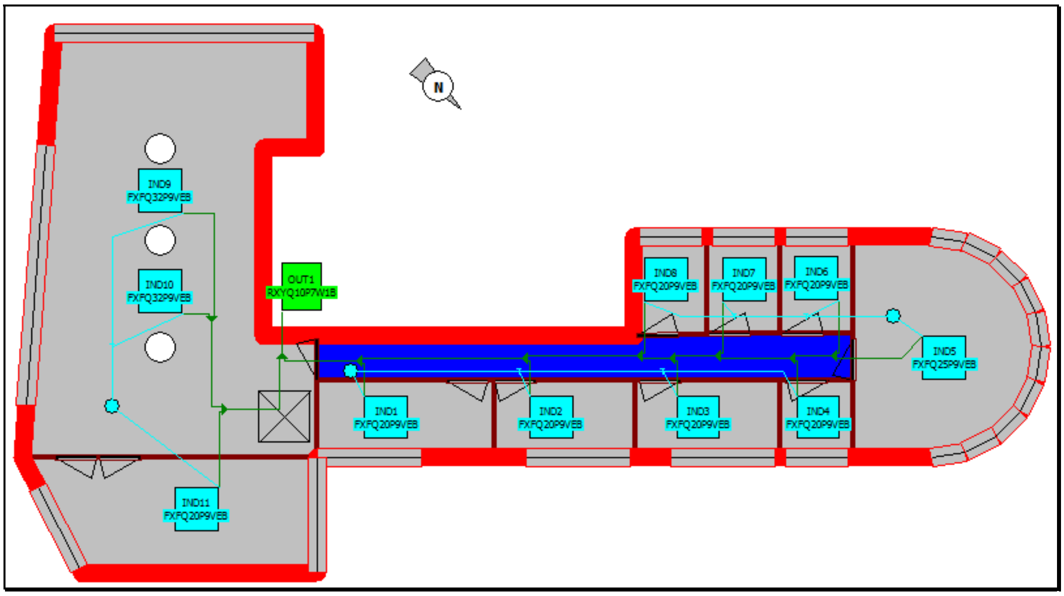


Figure 100: The floor plan with the completed drainpipes

You can right-click a drainpipe to straighten it vertically or horizontally, to insert a corner point or to edit it. You mainly edit a drainpipe to change its material or to change the default material in the company database, as shown in Figure 101.

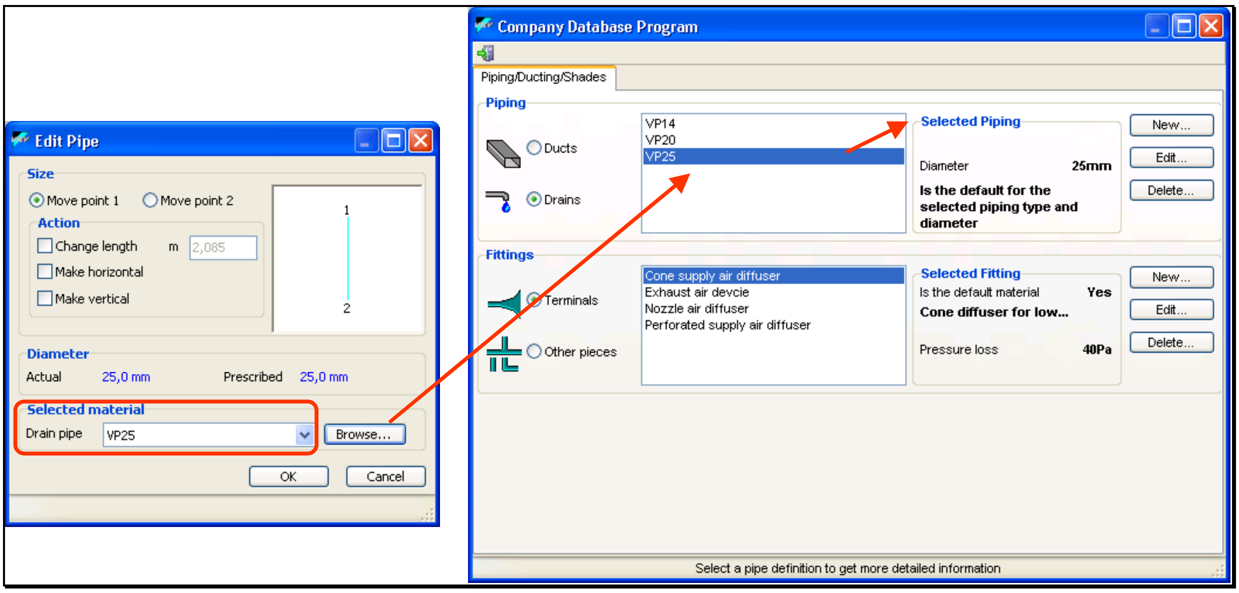


Figure 101: Changing the default material of a drainpipe

4 Designing a Ventilation Strategy

A building has many places through with ambient air may infiltrate: cracks, windows and doors. So, infiltration air is adding to the loads in a room. A good ventilation system reduces the infiltration in a room and also may reduce the required loads for the air-conditioning system. So, before dimensioning an air conditioning system, you should design a ventilation strategy.

Figure 102 shows how the air in a room is a blend of room air, infiltration and ventilation air. The resulting air may require less capacity to cool down or heat up, depending on the dimensioning of the ventilation system.

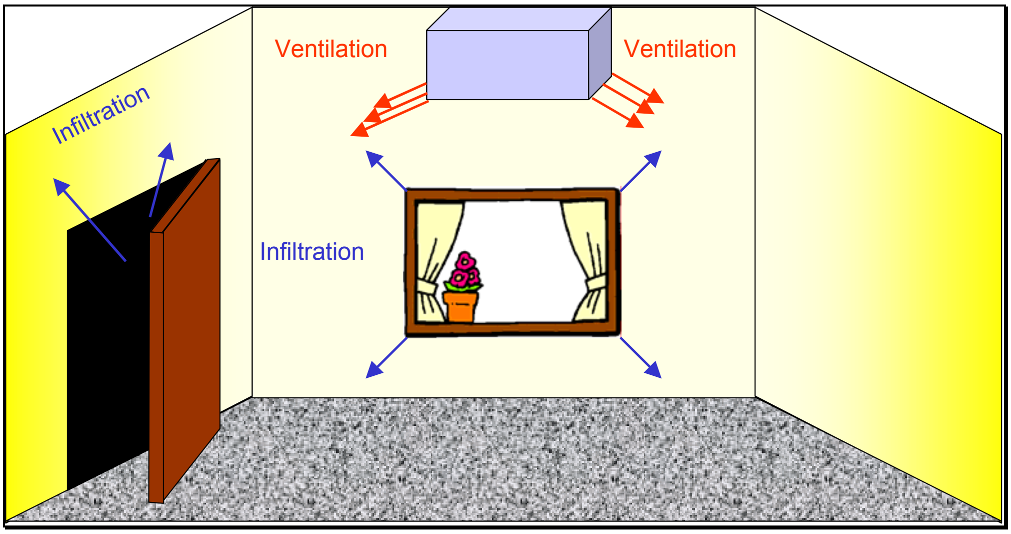


Figure 102: Air in a room is a blend of room air, infiltration air and ventilation air

In VRVPro Quick mode (see section 1.3), designing a ventilation system has no influence on the air conditioning system, as the required loads have been entered manually. In Expert mode, a ventilation system may have a considerable influence and VRVPro offers more possibilities too.

4.1 Installing a VAM or VKM Device in Quick Mode

A VAM or VKM device is a total heat recovery ventilation device. This means that it has a heat exchanger using the extracted warmer (cooler) air from a room to warm up (cool down) the ambient inlet air. So, a VAM or device has four duct connections, as shown in Figure 103. A VKM device in addition has a fan coil and possibly a humidifier:

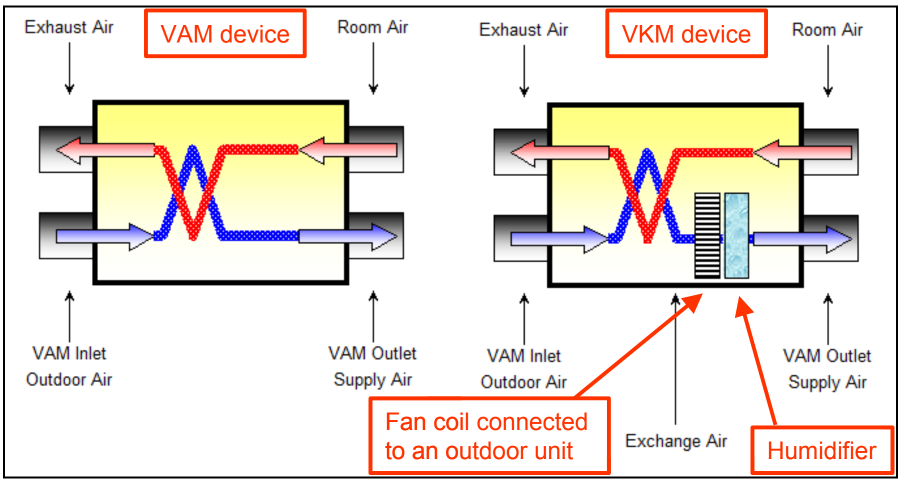


Figure 103: Schematic overview of a VAM and VKM device

Before selecting a VAM or VKM device, you must make sure a room has a required amount of ventilation air. You set the default in the "***Building Properties***" window, as shown in Figure 104:

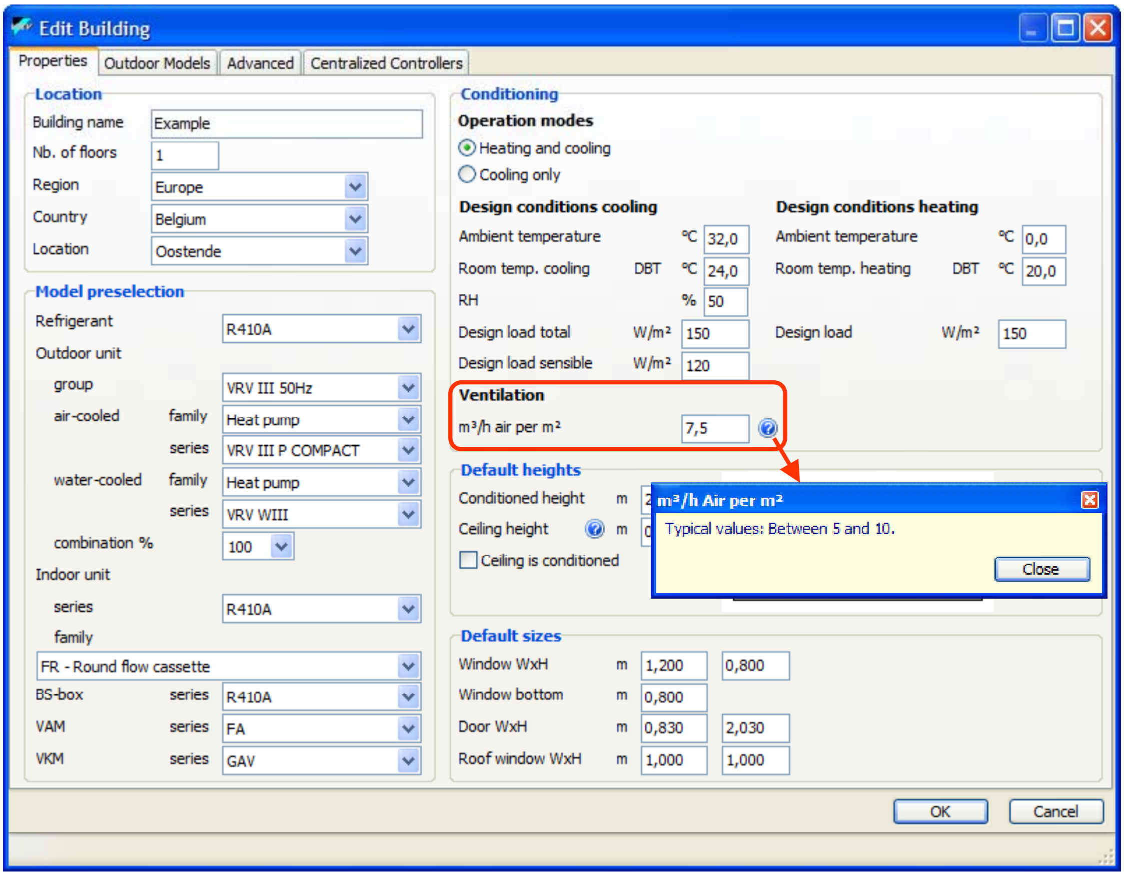


Figure 104: Defining the default amount of ventilation air

With this setting VRVPro can calculate the required amount of ventilation air, using the surface of the room, as shown in Figure 105:

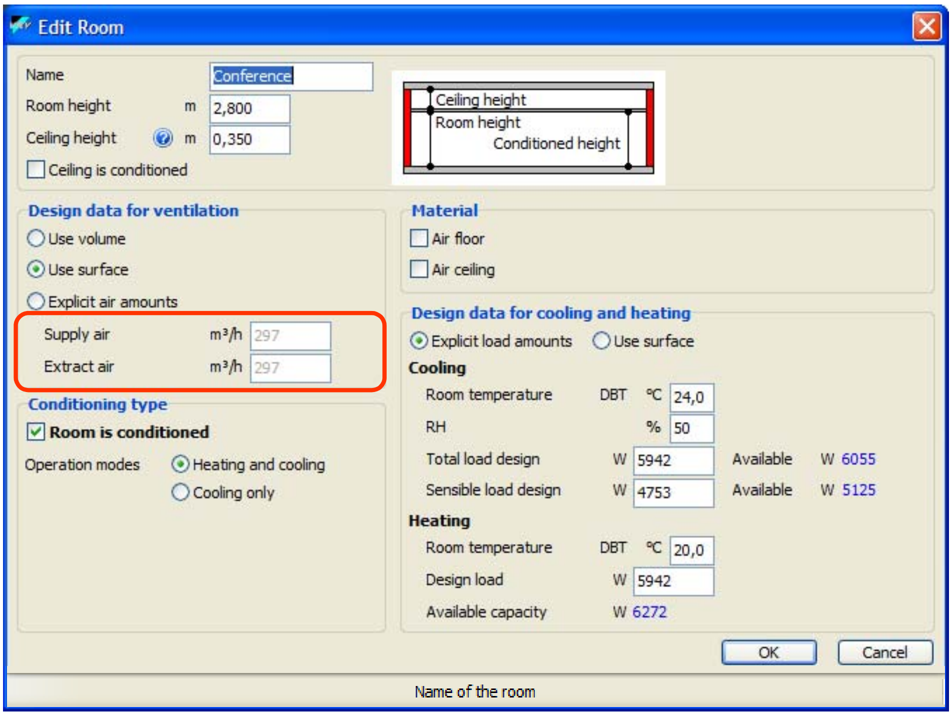


Figure 105: Using the default to calculate the required amount of ventilation air

Note that you can also overrule the calculated amount of air, by selecting the "***Explicit air amounts***" radio button, which allows you entering values instead of using the calculated ones.

To place a VAM or VKM in a room, select the corresponding VAM ( ) or VKM ( ) icon and click on the floor plan to place it. To define the rooms to serve, right-click the VAM or VKM device and select its "***Edit***" command. The first tab in this window shows the available rooms and the ones that you want to serve by this device. The VAM device in Figure 106 will serve two rooms, one of which is the master room. When you select a room in the served room, VRVPro selects it as a visual feedback.

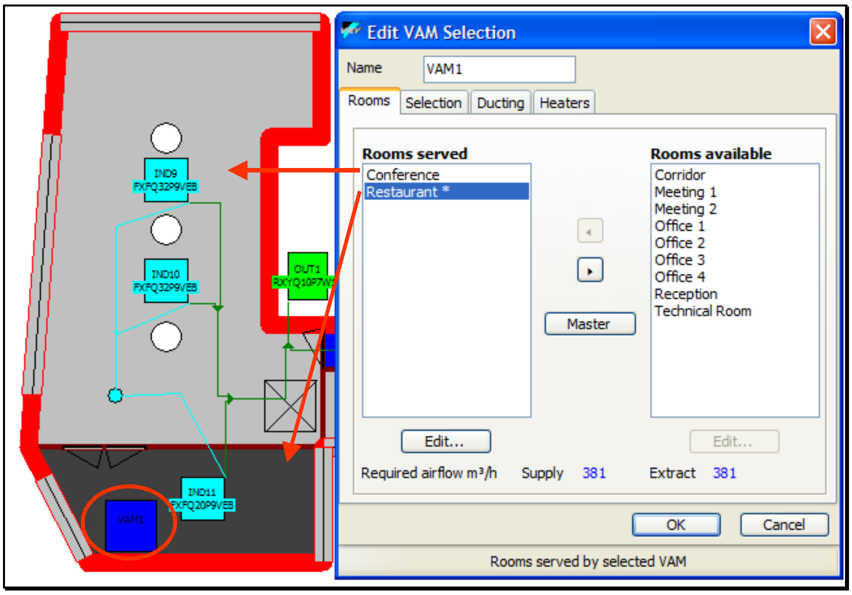


Figure 106: Selecting a VAM and associating its rooms

At the bottom of the VAM edit window you see the total air flow that this VAM will have to cover. With this information, it now becomes possible to select a VAM. Click on the second tab of the VAM edit window, possibly remove the models that must not be considered, select the required speed and click the "***Select***" command button, as shown in Figure 107. VRVPro will list the VAM devices that cover the required amount of ventilation air. The "***Allow freshup***" checkmark makes sure that the selected VAM uses a smaller extract speed than the supply speed.

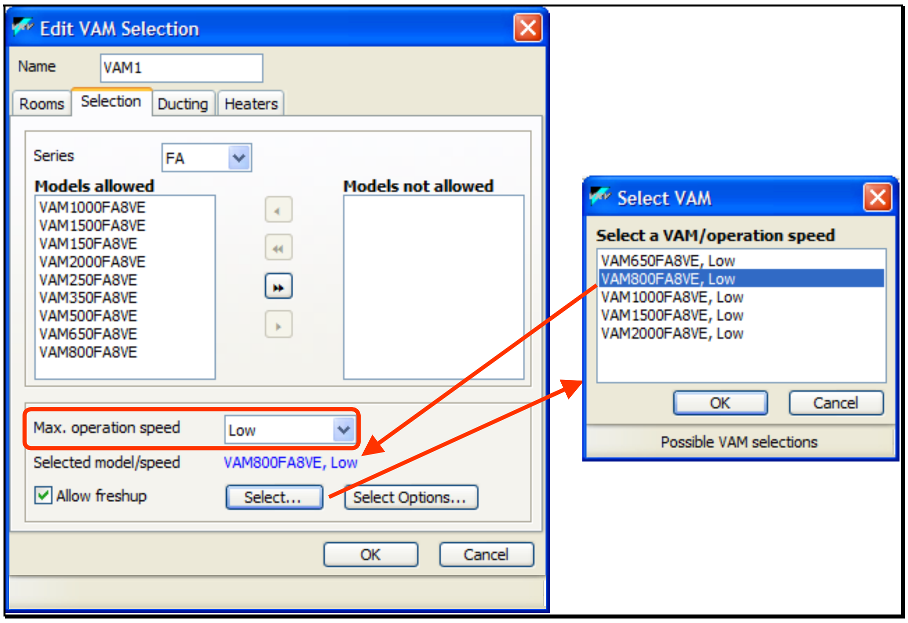


Figure 107: Selecting the VAM device

When a VAM or VKM device supplies warm air, uses a heat exchanger to cool down the extracted room air and to warm up the ambient inlet air. Cooling down air increases it relative humidity. If you cool down the air even more, the relative humidity reaches 100% and the vapor in the air turns into water. This would damage the heat exchanger or at least considerably reduce its efficiency. For that reason, the inlet air may have to be heated up by an inlet heater.

Although the air supplied by a VAM is heated up, the temperature of the supplied air may still be quite low. If necessary, the VAM outlet air may need a heater to provide a minimum supply temperature. Here is the difference between a VAM device and a VKM device: the latter uses a fan coil (i.e. an indoor unit) to extra heat up (or cool down) the supply air.
Figure 108 shows where the heaters are mounted on a VAM device and how this becomes visible on a psychrometric diagram.

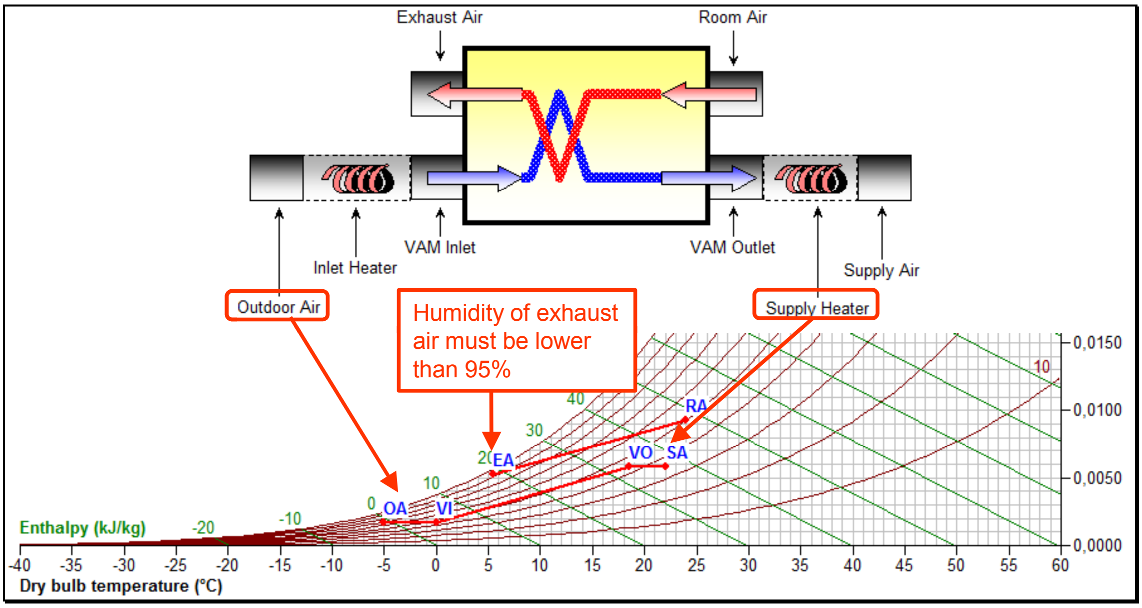


Figure 108: The use of heaters protect the heat exchanger and provide warm(er) ventilation air

VRVPro calculates the required heaters on both sides of a VAM device. However, the calculated required heater may not exist.

So, you may enter a more appropriate value for it, as shown in Figure 109:

- For a (worst case) ambient design temperature of –5^{0}C, the VAM device needs an inlet heater of 281Watt.
- You can enter a more appropriate heater, as for example a heater of 300Watt. This heater must be at least as large as the calculated one. The heater value you enter is used in a load calculation and in a temperature simulation. So, in Quick mode, this is not used, except for documentary purposes.
- To prevent damaging the heat exchanger, the inlet heater must be switched on for an ambient temperature of –3^{0}C or below.
- A minimum supply air temperature may also require a supply heater, which you can replace by an appropriate heater.

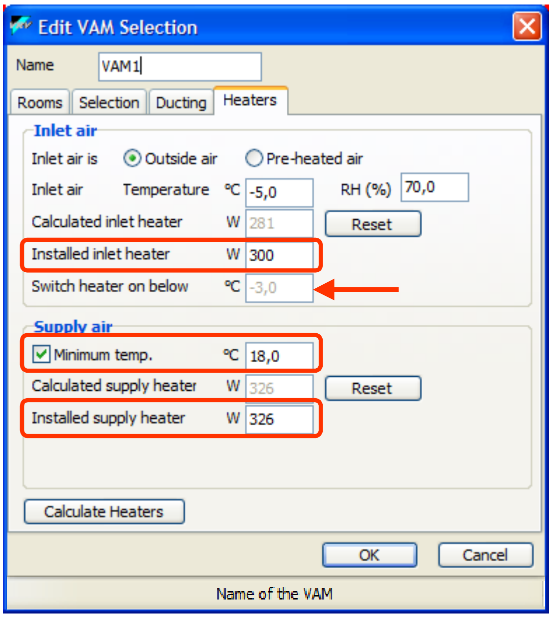


Figure 109: Calculating the heaters

The next step is drawing the ducts. Select the extracting duct icon () or the supply duct icon () and start drawing the ducts in the rooms. You can only end a duct in a room that is served by the VAM device. After you finished the extracting duct in the rooms, you can also draw an extracting duct from the VAM to a location outside the floor plan to extract the ambient air through an inlet duct. The same holds for the supply duct.

It is clear that the ducting should be such that there is a good air circulation in each room. Ideally, the supply air should be delivered close to windows and from the floor, where the extract air should be removed from the ceiling and at the opposite side of the supply air.

Figure 110 shows the ducting of the VAM device. Ducting without bends, T-joints and different kinds of end-pieces is not realistic. To make sure you take them into account, VRVPro automatically inserts such pieces. These are default pieces as defined in the company database. However, you can change them by more appropriate ones, by editing such a duct corner. You can also define a new duct piece in the company database and use that one.

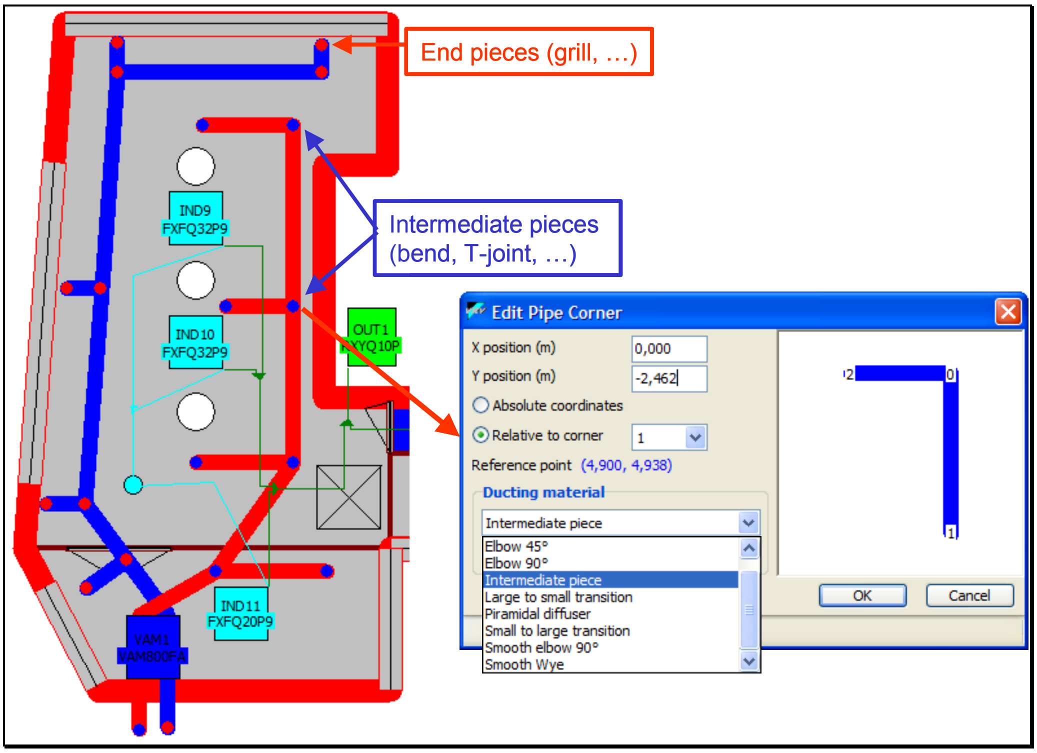


Figure 110: The ducting in a room, together with intermediate and end-pieces

When drawing the ducts, VRVPro assumes standard duct diameters, equal to the duct connections on the VAM device. In normal cases, these diameters are too large and have to be dimensioned.

In the ducting tab of the VAM edit window (see Figure 111), you can calculate the duct diameters. You can choose between round ducts and rectangular ones. For the latter, VRVPro always will calculate square sections, except if you want to place the ducts in the false ceiling. Only when a square duct becomes too large, VRVPro will calculate rectangular duct sections. For round ducts, VRVPro does not check the false ceiling height.

Once the diameters have been determined, you can now calculate the external static pressure (ESP). The design data (see Figure 111) have been used to select a VAM device and the maximum data are the ones that the VAM device maximally can deliver at the selected speed. The calculated ESP values must lie between the design values and the maximum values:

- If the calculated ESP is larger than the maximum values, the selected VAM will never been able to deliver enough ventilation air as it will be lost in friction and pressure drops.
- If the calculated ESP is larger than the design ESP, you should consider making the design values larger. However, in doing so, you should also reselect the VAM device to make sure it can deliver the required design external static pressure.

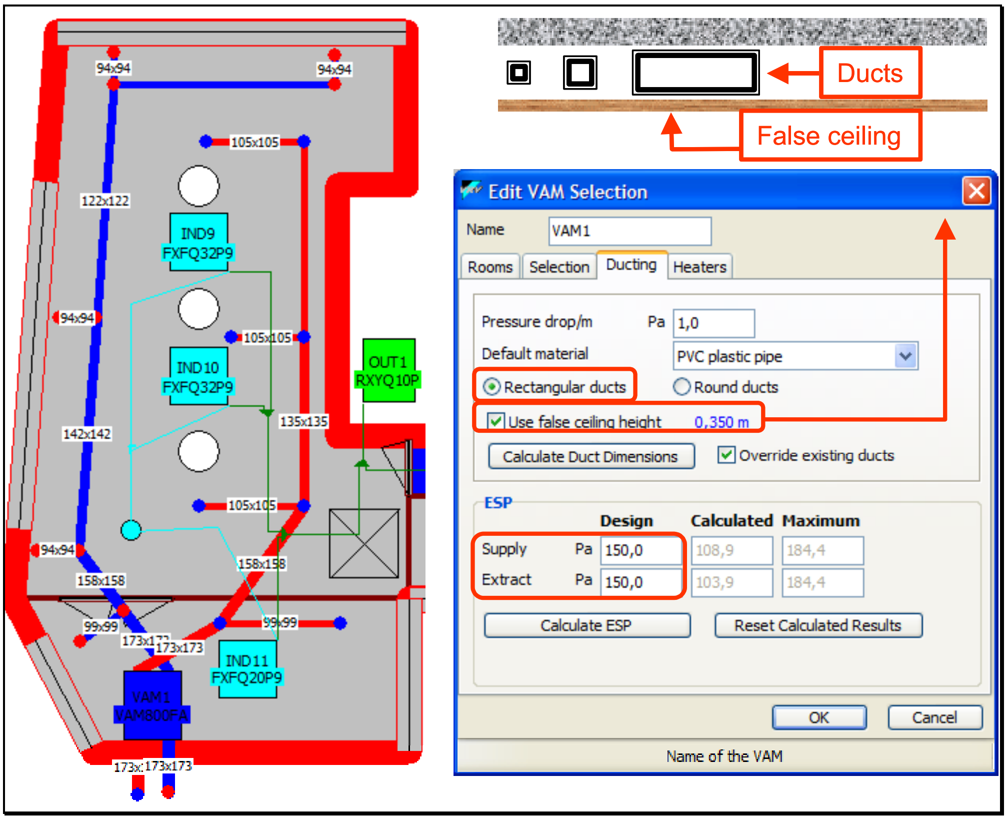


Figure 111: Calculating the duct diameters and the external static pressure

Figure 111 at the left shows the VAM device with its dimensioned ducting. By checking the duct diameters in the "***Editor Palette***" window (see Figure 57), VRVPro also shows the calculated diameters for each duct piece.

As the selected VAM (see Figure 107) uses a fresh-up operation, its supply speed will be larger than its extract speed. For equal length ducting, this means that the extract ESP will be lower than the supply ESP. In the case of drawn ducting, it is more difficult to check the lengths. However, reselecting the VAM without the fresh-up operation and recalculation the ESP will give a larger extract ESP value.

4.2 Ventilation in Expert Mode

VRVPro offers more ventilation possibilities in Expert mode, to allow you reducing the required loads by using a well-designed ventilation system. There are three sets of parameters that you can consider in the "***Building Properties***" window, as shown in Figure 112:

1. There are four different ways to specify the minimum amount of ventilation air in a room:
    a. Use volume: defines how many times per hour the air in the room must be replaced by fresh air.
    b. Use surface: defines the amount of fresh-air per m^2 of room surface. This is the value that you also can enter in Quick mode.
    c. Use persons: the company database contains many person definitions (see also Figure 119 in the next chapter 5, section 5.2). A person requires a minimum amount of fresh-air per hour. Depending on the number of persons in a room, VRVPro calculates the required

amount of fresh-air.

d. Explicit amount: you will have to enter an explicit amount of required ventilation air per room.

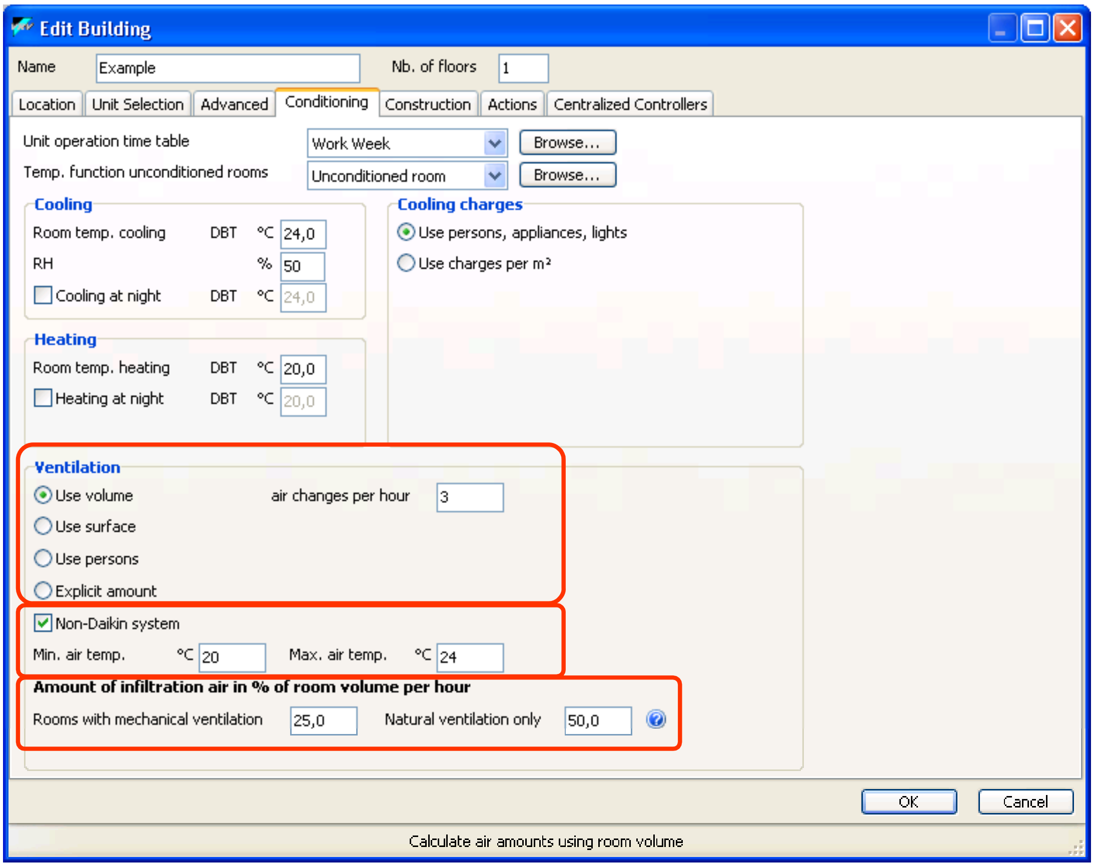


Figure 112: Ventilation parameters in the building properties window in Expert mode

2. Instead of a VAM or VKM device, the building may have been equipped with a central ventilation system. In that case, you enter the minimum and maximum temperature values for the supplied ventilation air. The central ventilation system makes sure the temperature values are within the given range by heating or cooling down the ambient air, if its temperature is outside the specified range. Figure 113 shows the principle of such a central ventilation system.

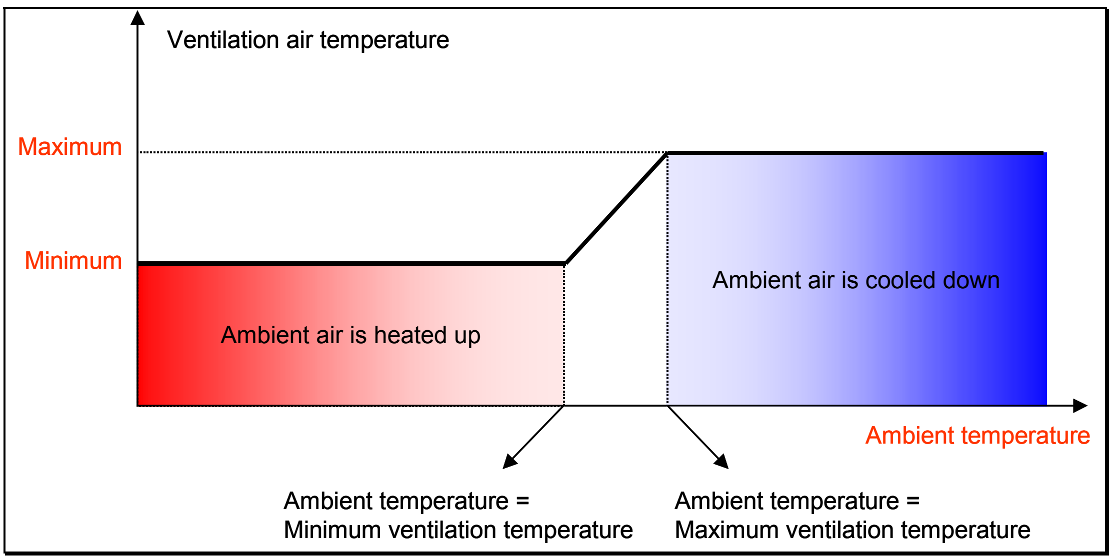


Figure 113: Defining a central ventilation system

3. As explained in the introduction of this chapter, the air in a room is a blend of room air, ventilation air and infiltration air. If there is no ventilation in a room, there will be much more infiltration. In fact, if a room does not have ventilation, a user will probably enter a door or a window to bring in fresh air. This way, the infiltration in a room may be up to 90% in a room. Even a user does not open a window, the infiltration in an old building is larger than in a new one, mainly due to cracks and leaks.

Having set these values, VRVPro will show a window to copy these properties to each room, as explained in section 1.4 and shown in Figure 11. In case you have defined a centralized ventilation system, VRVPro will now assume that this system has been installed in each room. If however, you want to install a VAM or VKM device in one or more rooms, as explained in the previous section, you will have to uncheck it for those rooms, as shown in Figure 114.

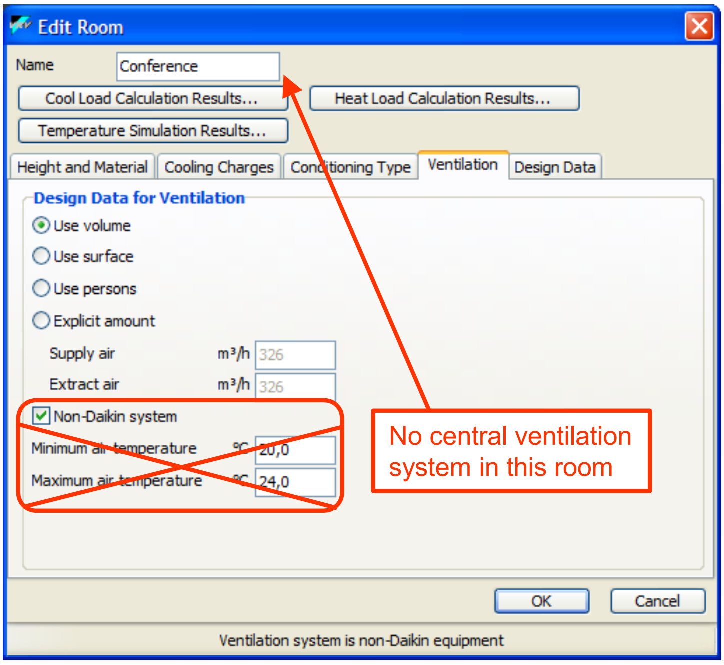


Figure 114: Overruling the building properties for ventilation

In case the building does not have a central ventilation system, the amount of ventilation air is used to calculate the infiltration air in the room. In case the room does not have a VAM or VKM device, ***both the ventilation air and the infiltration air are considered to be air at ambient conditions***.

In Expert mode, the selection of a VAM or VKM device is identical to the selection in Quick mode, including the dimensioning of the heaters, the ducts and the external static pressure. Figure 115 shows a room containing a VKM device and its ducting. This device has been dimensioned in the same way as the VAM device in the previous section. However, a VKM device needs to be connected to the piping of an outdoor unit. This required the insertion of an extra joint.

By connecting the VKM device to the outdoor unit, it also uses capacity of that unit, which in turn may need an increase of the size of the outdoor unit.

As both the VAM and the VKM provide ventilation air, which may reduce the loads in a room. If requested (see Figure 155) the load calculation takes this ventilation air into account, which may result in smaller loads and possibly smaller indoor units, which may reduce the size of the outdoor unit again.

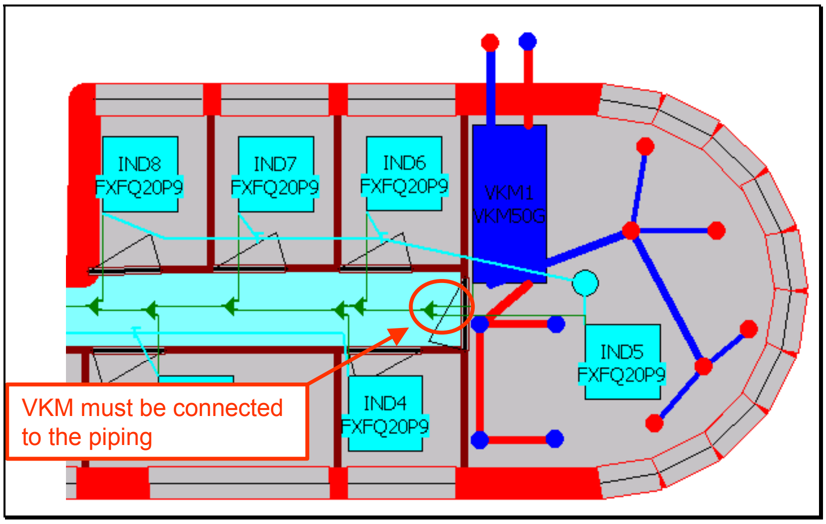


Figure 115: Adding a VKM to a room

The "***VAM Selection***" command in the "***Run***" sub menu of the Database menu allows you running a small VAM and VKM selection program, showing the selection results on a psychrometric diagram.

4.3 Ducted Indoor Units

Most indoor units provide their capacity to a room by directly blowing cooled or heated air into that room. However, there are indoor units allowing the use of a ducting to spread that air in a more uniform way. These units may also be used when a room is too small to install the indoor unit. In that case, you can install the indoor unit in another room, even an unconditioned room, and draw ducts to the room to serve.

Figure 116 shows an example of such a situation. To construct it, proceed as follows:

- Place the indoor unit in the room it has to serve.
- Select an indoor unit model that offers ducting. The models from the S-family are such indoor units.
- Move the indoor unit to the place where it will be installed. This is only possible for indoor units offering ducting. A dotted line will show to what room the indoor unit belongs.
- Draw the ducting from the indoor unit to the room. Note that it is not possible to dimension the ducting, as the indoor unit defines the duct size. Moreover, the indoor unit does not provide ventilation air, but cooled or warmed air from its fan coil.

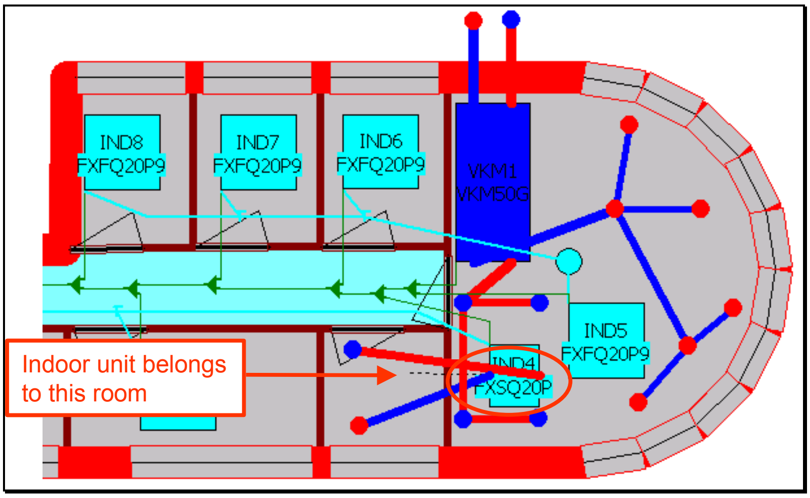


Figure 116: An indoor unit in another room and using ducting

5 Performing a Load Calculation

You can only perform a load calculation in Expert mode (see section 1.3) and before you can actually do this, you will have to fill in different data necessary to perform these calculations. This chapter both explains why these data are necessary and how you enter them in the different windows.

5.1 *Introducing Heat*

When you have to cool down a room, you must be conscious what heat is and where it is coming from. Without this knowledge, you will not be able to calculate the required cool load. This section explains the different kinds of heat and how they are related.

Air is a complex mixture of gases and water vapor. Its behavior depends on the temperature, the percentage of water vapor or relative humidity, and the pressure, which is a function of the altitude.

Within a given period of time (e.g. one hour), you can add or subtract heat to a given volume of air (e.g. one m^3). This heat is called the ***total*** heat, which splits up in ***sensible*** and ***latent*** heat:

- Sensible heat is the heat that you add or extract from the air by changing its temperature. A simple example is heating up the air using an electric heater.
- Latent heat is the heat that you add or extract from the air by changing its vapor percentage. When you are boiling water, the vapor dissipates in the air and adds latent heat.

You can use a psychrometric diagram to visualize the total heat necessary to change the air in a room from one point (P1) at a given temperature and relative humidity to another point (P2), as shown in Figure 117:

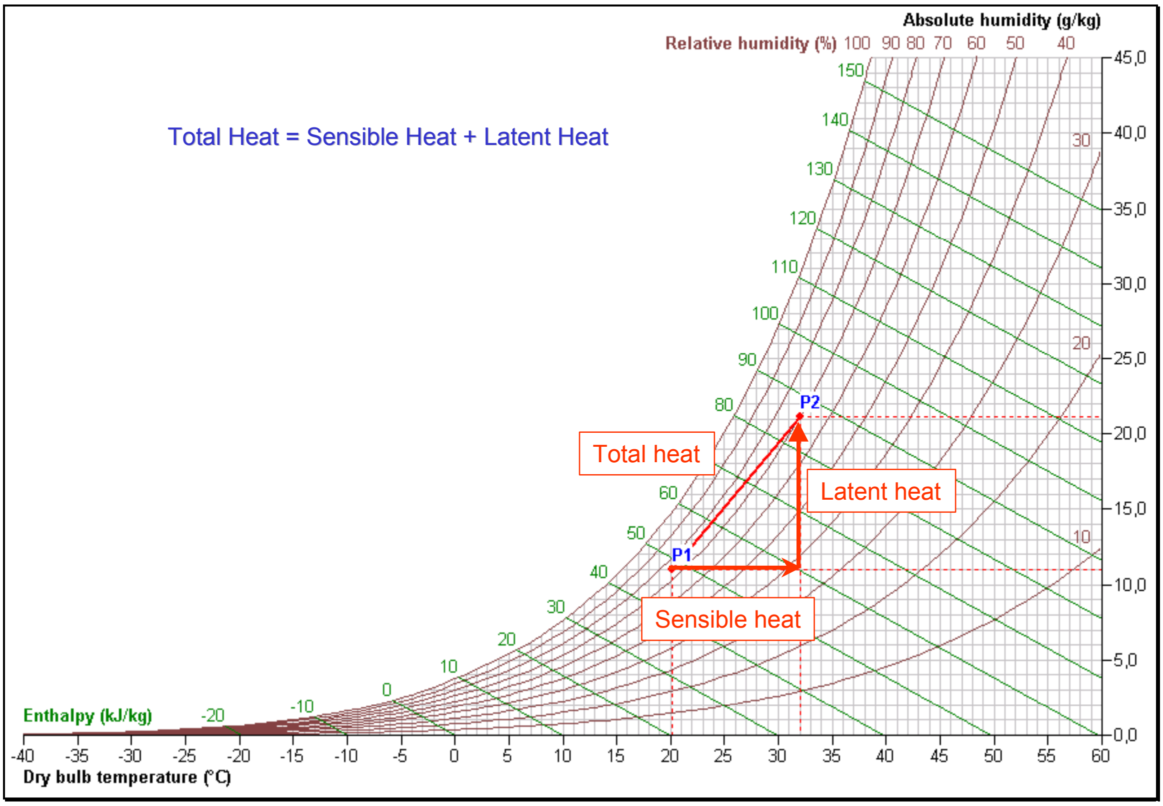


Figure 117: Visualization of total heat in terms of sensible and latent heat

The largest source of sensible heat is the sun. This celestial body only produces ***radiation*** heat, which does not heat up the air. In fact, when you get up higher in the air you get closer to the sun, but it gets colder instead of warmer. It is the earth that absorbs this radiation heat, accumulates it and also delivers it to the air through heat exchanging. This latter heat is called ***convection*** heat.

So, sensible heat is the sum of radiation heat and convection heat:

- Radiation heat always needs a body to absorb it and ***never heats up the air directly***.
- That body then delivers part of its absorbed heat as convection heat to the air through heat exchanging. The remaining heat is partially radiated (to be absorbed by other bodies) and is still accumulated. So, the delivery of absorbed heat is a function of time.

Figure 118 visualizes the sensible heat as a combination of radiation heat and convection heat.

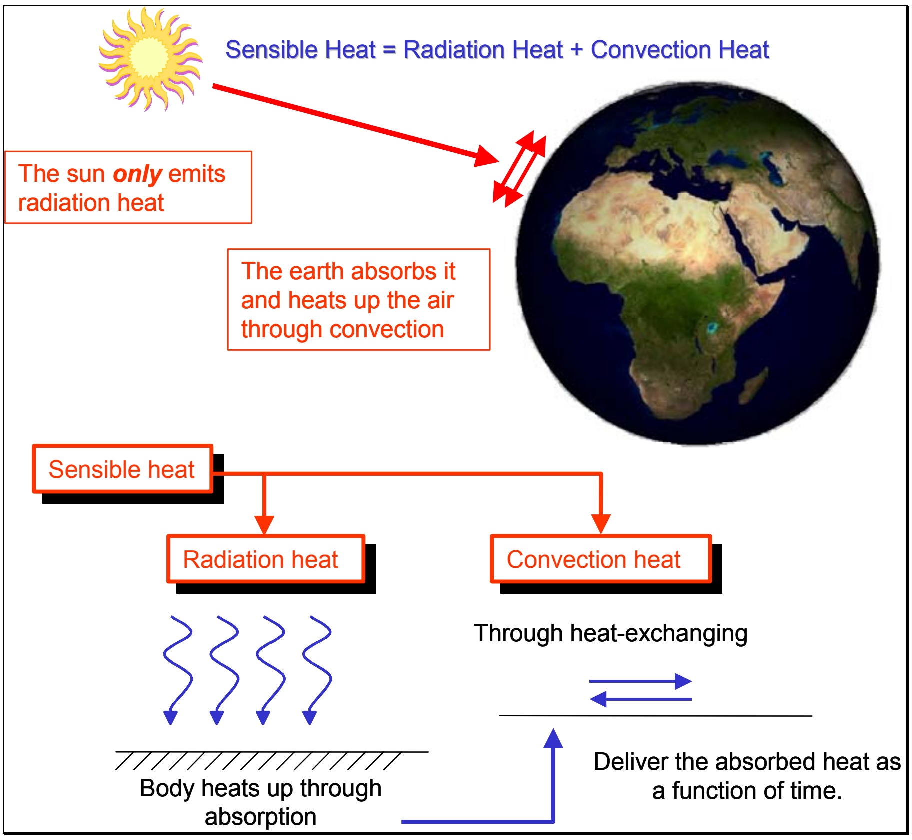


Figure 118: Definition of sensible heat in terms of radiation and convection heat

5.2 Heat Sources in a Room

In a room there are three kinds of bodies that produce heat: persons, appliances and lights:

- A person produces sensible heat, which is partially radiation heat and convection heat. The latter happens through exchanging the heat with the air surrounding the person. Heat exchange through convection becomes more effective if more air flows across the skin. There are two ways to increase the airflow: let the person move (walk or run) or use a ventilator to let the air move. Therefore, if a person produces 100Watt sensible heat, the amount of radiation is dependent on the velocity of the air around that person.
  A person also produces humidity through breathing and sweating. This puts water vapor in the air, which is latent heat.
- Appliances equally produce sensible heat, a combination of radiation heat and convection heat. Some appliances (e.g. a coffee machine) also produce humidity and so latent heat. Two elements affect the amount of heat delivered by appliances:

a. The appliance contains a ventilator or a fan. This creates a forced convection and increases the convection heat from that appliance.
b. The appliance is put under a hood. This probably will happen with food preparation equipment and removes most of the latent and convection heat of the appliance.

- Lights only produce sensible heat, which is partially radiation heat and convection heat. A part of the heat produced by lights may disappear in the false ceiling. The ***plenum factor*** defines this amount of heat and it is clear that this factor becomes larger for lights having ventilated fixtures. This heat loss does not contribute to the load in a room and must not be counted in the calculation.

Instead of you having to define different kinds of persons, appliances and lights, the company database (see section 1.2) already contains several standard (ASHRAE) definitions. Figure 119 summarizes the heat sources and shows the corresponding company database screens to add or change these definitions. For a person the company database also stores the required fresh air for that person type, both for smoking and non-smoking persons.

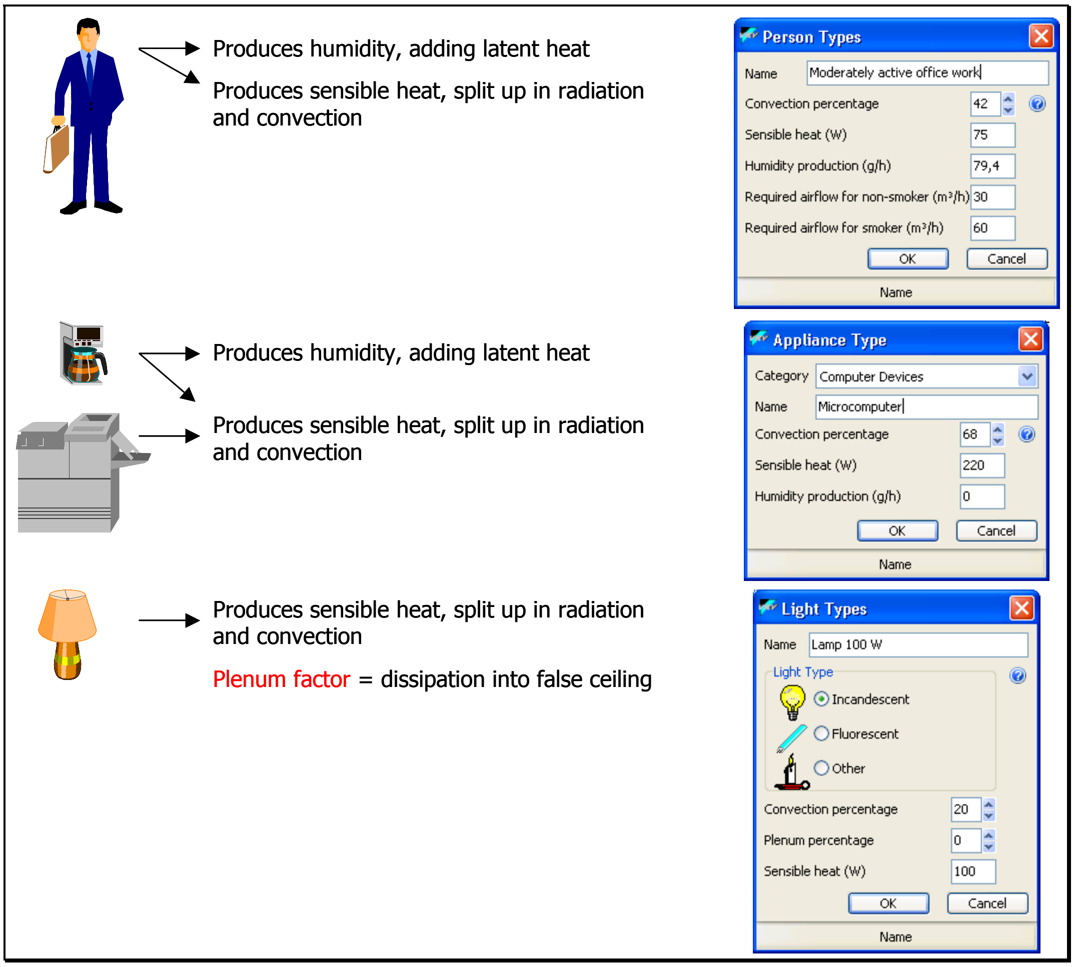


Figure 119: The heat sources in a room and how to define them in the company database

To use these heat sources in a room, you only have to refer to one of them in the company database and enter how many of them you want to use. However, heat sources are may only be present during a part of the day (e.g. people are present in a office during working hours). The presence (or activity) percentage of a heat source for each day of the week is called occupancy. The company database also contains a few occupancy definitions, an example of which is a workweek occupancy, as shown in Figure 120.

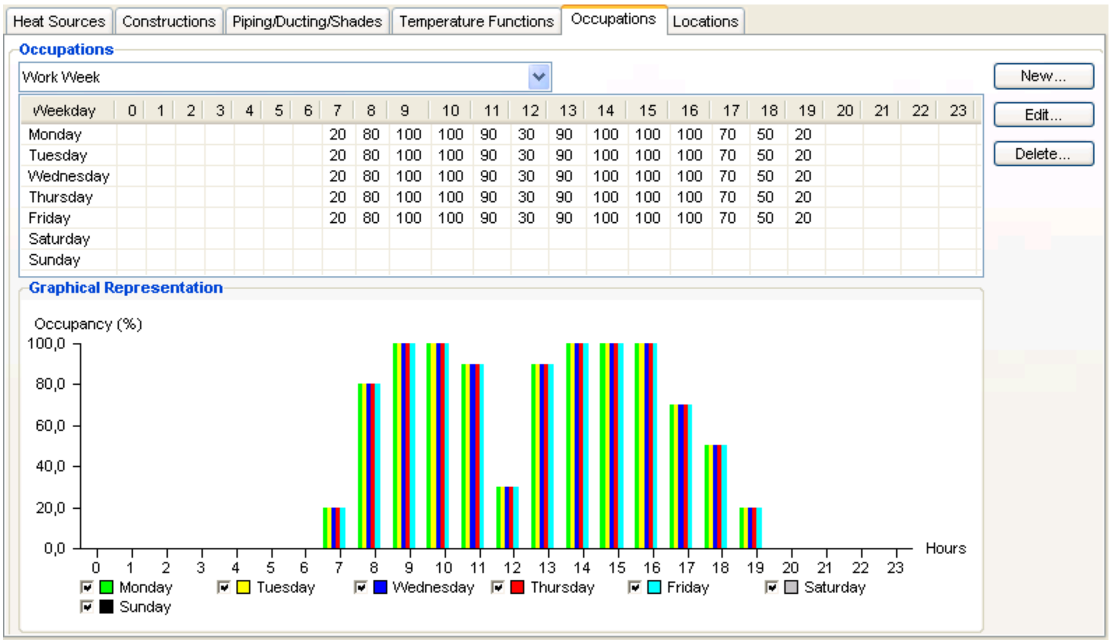


Figure 120: Definition of an occupancy

So, the cooling charges in a room refer to company database definitions. Figure 121 shows how to define 4 persons, who are office workers, present during a workweek. The Browse command indicated in the edit window activates the company database and shows the tab with the heat source definitions. The Browse command next to the occupation reference (time table) also activates the company database and shows the tab with the occupancy definitions.

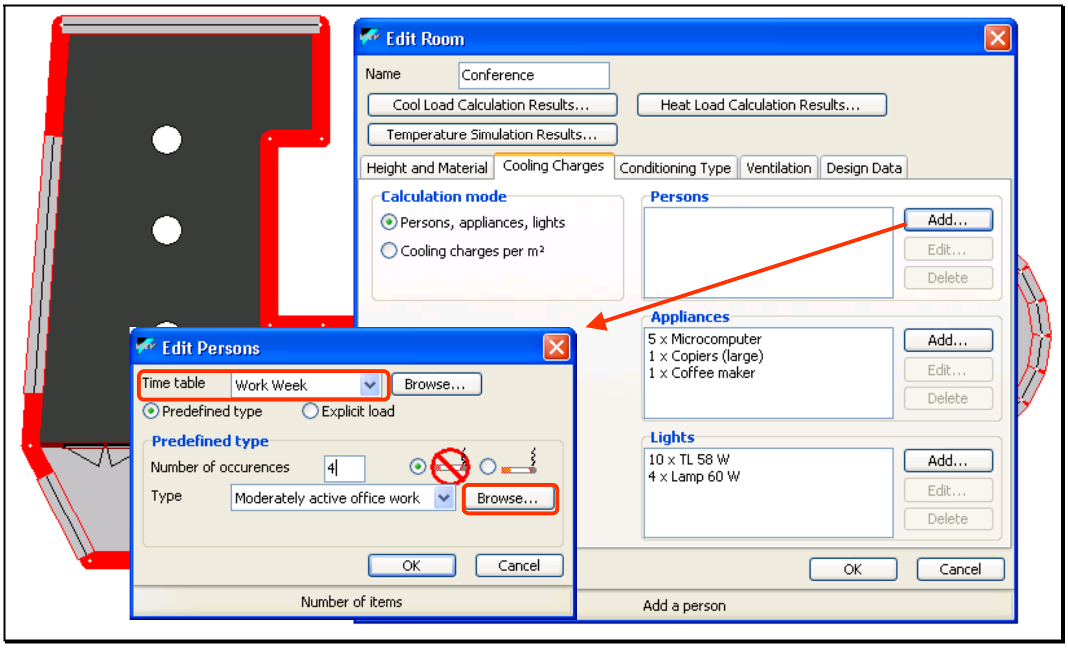


Figure 121: Defining explicit heat sources in a room

As it is not always possible to define the exact number of heat sources in a room, VRVPro offers several alternatives:

- Instead of defining loads in terms of predefined types, as shown in Figure 121, you can also define explicit loads. Figure 122 shows the two windows to enter persons in a room. The window at the left uses predefined person types ("moderately active office work") and the one at the right explicit loads. As these values may not be easy to load, VRVPro adds a question mark icon (), allowing you getting extra information, in most cases coming from ASHRAE.

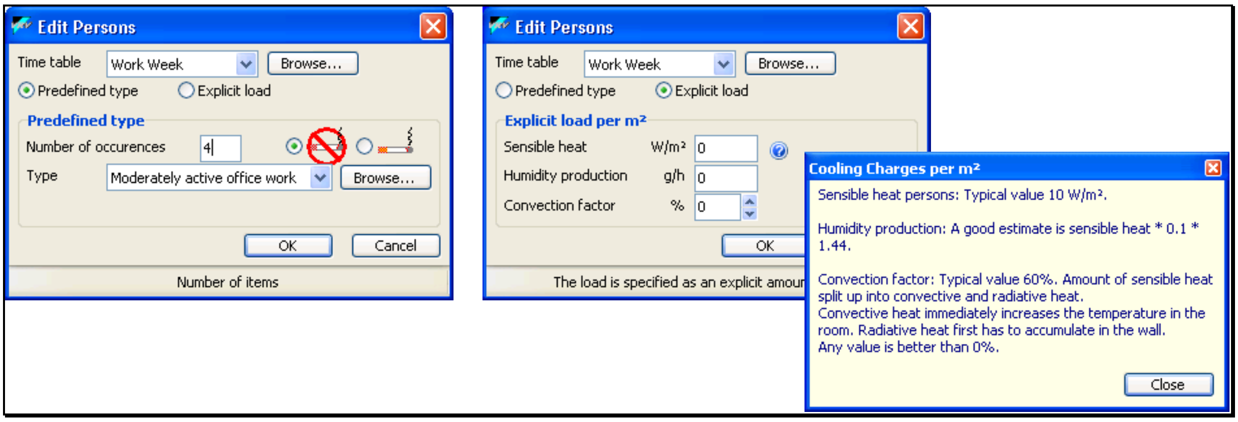


Figure 122: Defining persons in a room using predefined types or explicit loads

- Instead of entering explicit loads for each of the three heat sources, you can also enter these data for all heat sources at once, as shown in Figure 123. Note that it is important to understand the intended function of a room to enter realistic values. E.g. the heat sources in a restaurant, a theater or an office considerably differ.

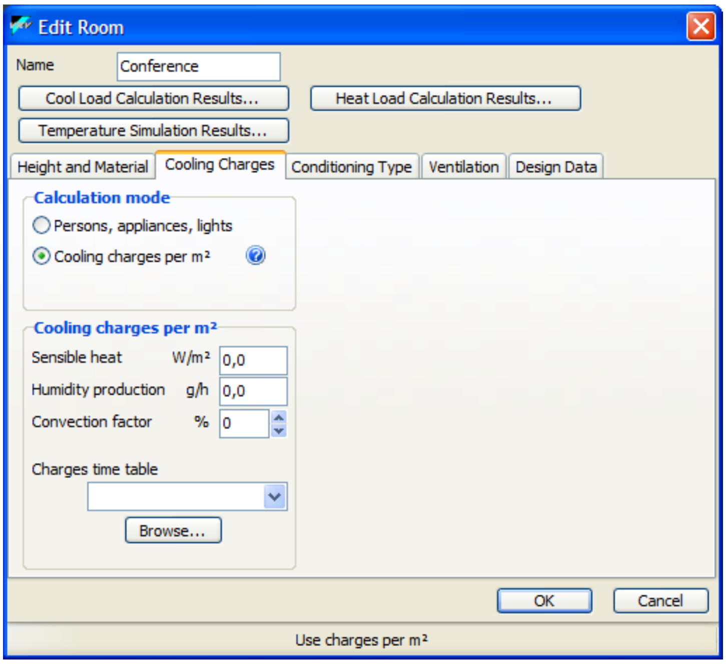


Figure 123: Defining explicit loads in a room for all heat sources at once

5.3 Decomposition of Sunlight

The sun altitude and azimuth depends on the geographical coordinates of the location. The company database contains more than 4500 locations. So, just select one in the building properties to use correct coordinates. From these data VRVPro calculates the sun positions and the direct and indirect (scattered through the air layers) sunlight for each hour of the year (see section 5.8).

Figure 124 graphically shows the sunlight on a wall. It consists of this direct and indirect sun radiation, together with the radiation resulting from the ground reflection. Before direct sunlight reaches a wall (or window), it may hit obstructions of different kinds, such as other buildings, trees and mountains. The direct sunlight that still shines through the obstructions hits the wall (or window) at a given angle, depending on the position of the sun and the inclination of the wall. Only the part of the sun radiation that is perpendicular to the wall has an influence on it.

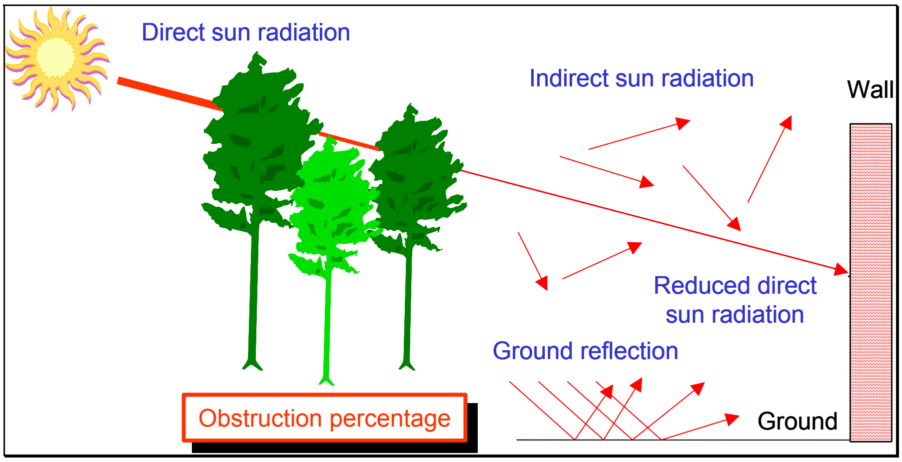


Figure 124: Direct sunlight reduced by obstructions

It is clear that obstructions differ in function of the direction and of the height. Figure 125 shows how to enter the obstruction percentage in each direction in the VRVPro floor edit window, as for instance trees may only obstruct the lower floors. The picture in the middle graphically shows the total obstruction percentage of that floor.

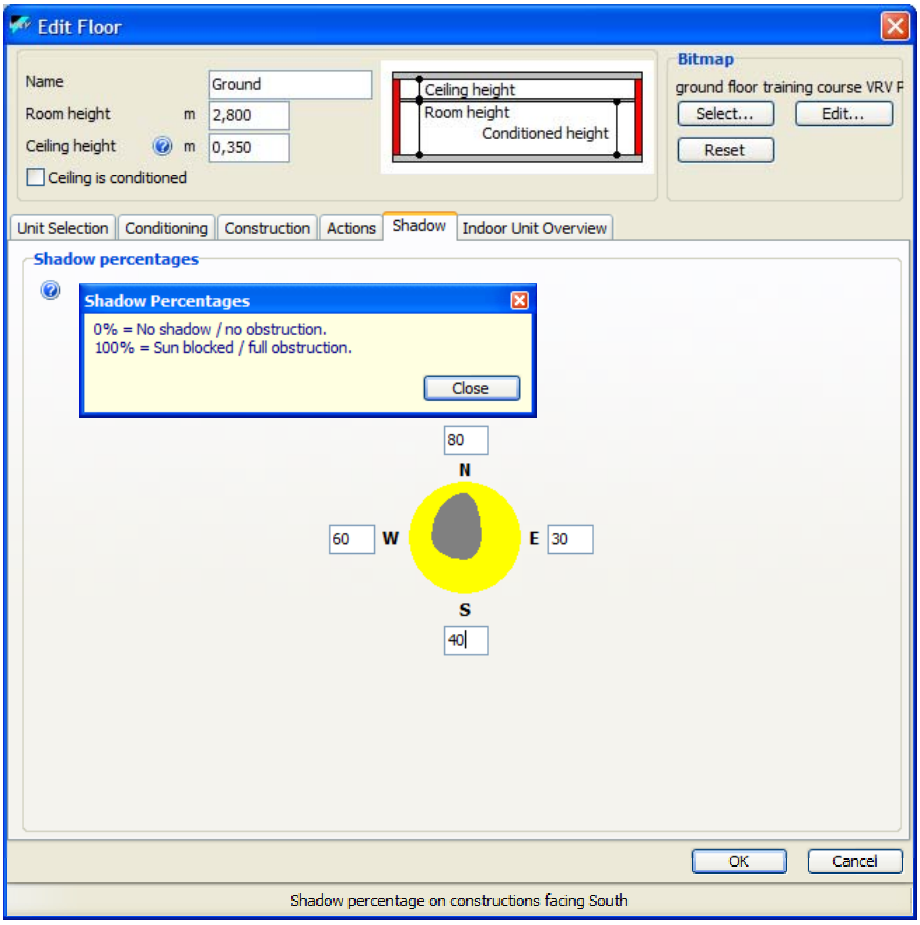


Figure 125: Defining obstruction percentages on a floor

The ground reflects the direct and indirect sun radiation, which gives the third element of the sun radiation. This reflection is dependent on the type of soil surrounding the building. VRVPro uses a constant ground reflection factor of 0.2. This value is based on a soil that has been partially hardened (by bitumen or concrete) around the building.

In contrast to direct sunlight, the radiation of indirect sunlight and ground reflection distribute equally in space. In fact, as there is daylight even with a sky completely covered by clouds, obstructions do not reduce indirect sunlight and ground reflection. This has important consequences on the orientation of walls (or windows), as shown in Figure 126:

- Vertical walls get halves of both radiation parts (as the radiation part pointing to the ground does not have any influence).
- Horizontal walls get a full indirect sun radiation, but no ground reflection radiation.
- Slanted walls get a combination of both, depending on the angle of the construction.

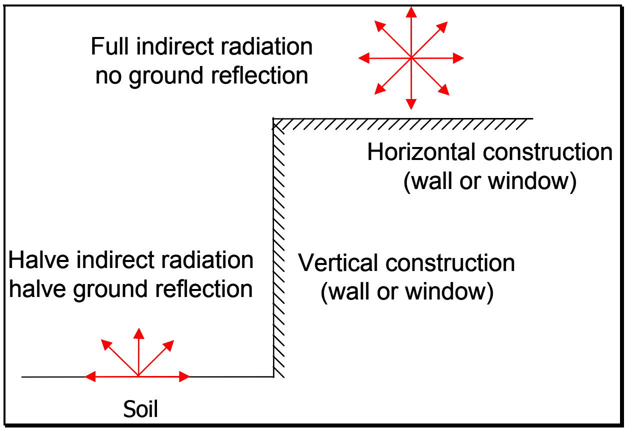


Figure 126: The radiation of ground reflection and indirect sunlight

5.4 The Sunlight on a Wall

As a wall is an opaque construction, it can only absorb and reflect the sun radiation by its exterior material (see Figure 127). From there on, the absorbed heat is accumulated and transmitted through the wall.

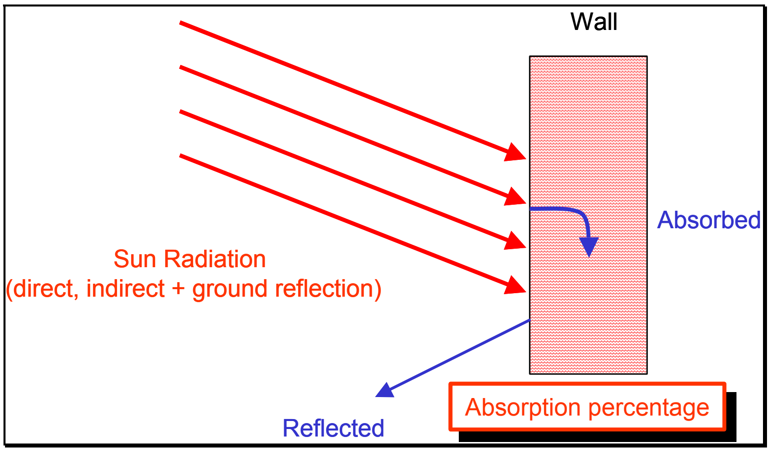


Figure 127: A wall absorbing the sun radiation

The material that absorbs the sun radiation the best is an ideal black body, which has 100% absorption. Real materials, of course, have absorption factors less than 100%. A simple rule of thumb is as follows:

- A white (or light) material has a low absorption percentage, typically between 20% and 40%.
- A black (or dark) material has a high absorption percentage, typically between 80% and 90%.
- Shiny metals have an absorption percentage of 10% to 30%. Old (and oxidized) metals have a higher percentage, between 50% and 90%, depending on the resulting color.

The wall accumulates the heat it absorbs and will deliver it to the room as a time-bound function.

The company database contains wall construction definitions. A part of the definition is the absorption percentage, which you can select by clicking on a color, as shown in Figure 128. Section 5.5 explains how to define a complete (wall) construction.

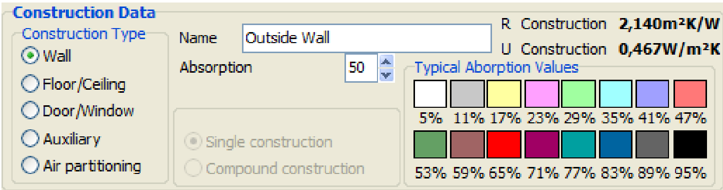


Figure 128: Defining the absorption percentage by picking a color

Although you can define your own constructions, you can also use the existing constructions from the company database. Figure 129 shows the three possible ways to select a wall construction:

1. Select default constructions in the "***Building Properties***" window, tab "***Construction***". The schematic overview shows the different kinds of wall, floor and ceiling constructions you can select.
2. Select default constructions in the floor properties window, tab "***Construction***". The schematic overview now only shows the possible constructions for one floor.
3. Right click a wall and select the edit window. At the bottom of this window, you can select the construction for that wall.

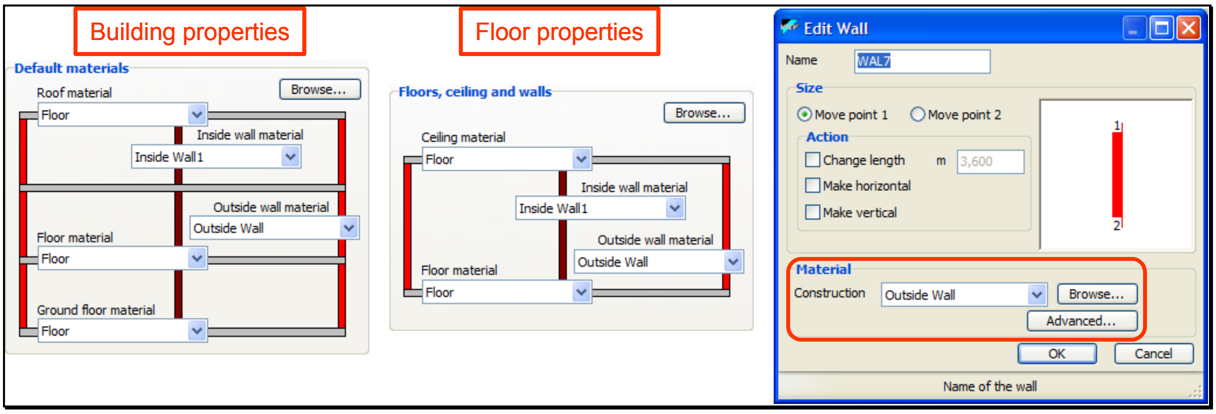


Figure 129: Selecting a (default) construction for a wall

The "***Browse***" command button in all three windows activates the company database to view the wall construction details (see next section).

5.5 A Wall Construction

A wall is a complex construction, which absorbs, accumulates and transfers heat. To manage this complexity, VRVPro not only offers existing constructions in its company database, but also allows you defining new ones in a simple way. This section first explains the different aspects of a wall construction and then shows how to define such a construction.

A wall construction consists of several layers of material. Each material layer has a conductance value (λ) and a thickness (d), giving a material layer resistance by dividing its thickness by its conductance value (d/λ). The resistance of the wall construction is then the sum of these material layer resistances. Figure 130 shows a wall-decomposition in material layers, each having their layer width.

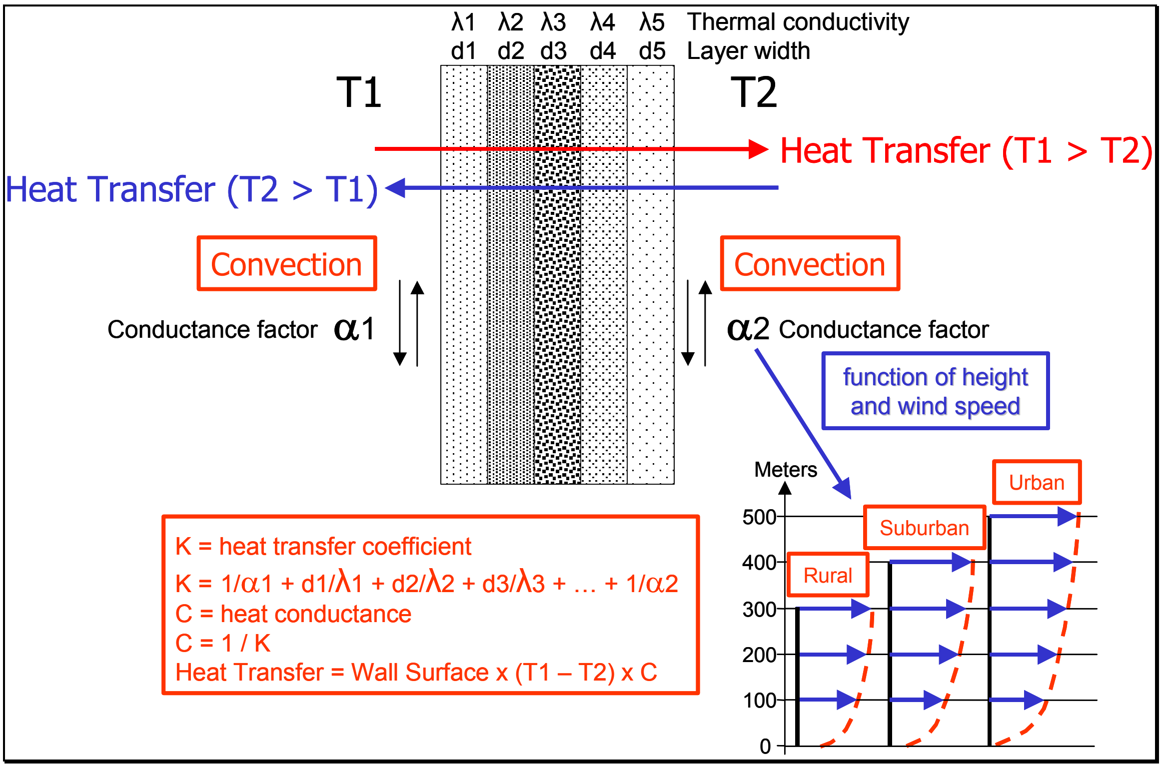


Figure 130: Heat transfer through a wall consisting of material layers

The reason why heat is transferred from one side of the wall to the other is convection. In fact, as for persons and appliances (see section 5.2), a wall exchanges heat with the air by convection. As a wall does not move, the airspeed (e.g. the wind, ventilation or simply by moving people) causes the convection, which gets larger with a larger airspeed. The surface conductance factor (α) defines the amount of convection heat a wall exchanges with the air surrounding it.

VRVPro allows you entering 8 different conductance factors in the "***Building Properties***" window tab Construction. Each value defines a particular kind of wall surface, as shown in Figure 131. The default values used are acceptable for most locations. For windy environments (e.g. a coastal region), it is better to use a higher surface conductance value for all outside values.

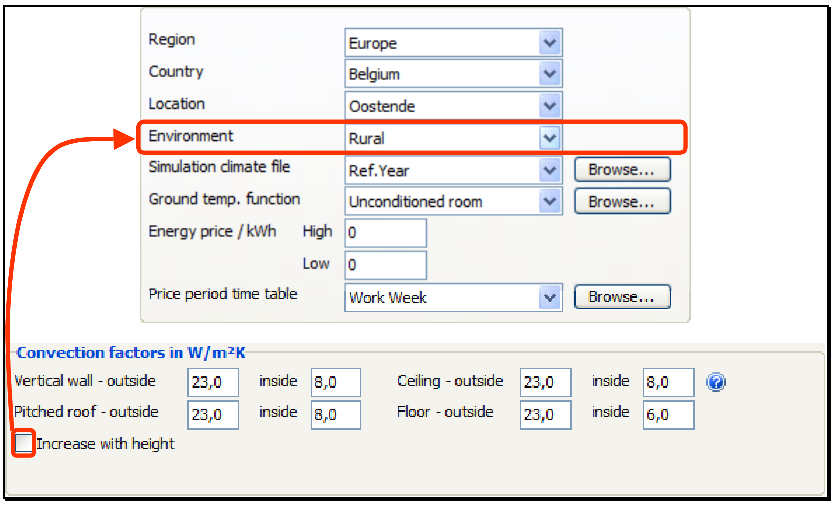


Figure 131: The 8 different surface conductance factors

You can also check the "***Increase with height***" checkmark. Together with what you filled in for the environment (see also Figure 130: rural, suburban or urban) in the building properties, VRVPro adapts these outside surface conductance values in function of the height.

Given the environment, the surface conductance factors, the different material layers, the wall surface and the temperature values at both sides of the wall, VRVPro can calculate the heat transfer through the wall. This value can be positive or negative, which defines the direction of the heat transfer. This method is simple, but not very accurate. In fact, it ignores two important aspects of walls: the absorption of sunlight radiation heat and capacity of a wall to accumulate heat.

Figure 132 shows all aspects of a wall to consider during a load calculation, but also during a temperature simulation (see chapter 6):

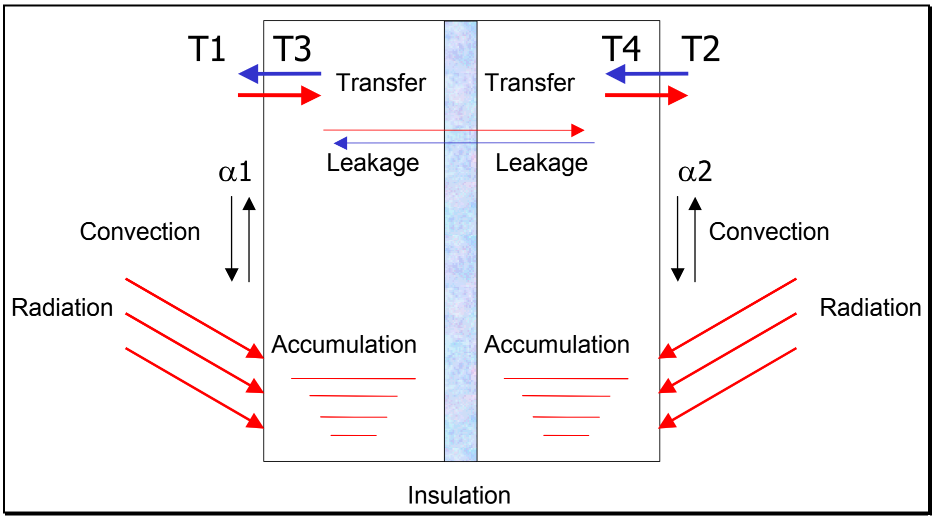


Figure 132: A complete wall construction definition

A wall construction has an accumulating capacity, possibly contains insulating material, takes radiation into account and exchanges heat with the air surrounding it using the surface conductance values. The parts at the left and at the right of the insulation have an accumulation capacity, which is calculated using the specific mass and specific heat of their composing materials.

The heat transfer through a wall now becomes a function of the time: a wall releases a part of the heat it has accumulated, while it also accumulates new heat. The simple heat transfer shown in Figure 130 now splits up in three transfers, as shown in Figure 132:

1. A transfer between T1 and T3. The direction is towards the smallest temperature value. This transfer uses the surface conductance value α1.
2. A transfer between T2 and T4. The direction is towards the smallest temperature value. This transfer uses the surface conductance value α2.
3. A leakage between T3 and T4. This leakage is another term for a heat transfer. The only difference is that it is an internal transfer.

In addition, a wall also has two accumulations, due to radiation:

1. Outside walls have the direct and indirect sun radiation, together with the ground reflection, as explained in section 5.4.
2. Inside walls get the radiation from persons, appliances, lights and sunlight coming in through the windows. VRVPro uses a standard absorption percentage of 50% for all internal walls and for the internal part of external walls.

VRVPro now uses the incoming radiation heat, the accumulated heat and the transferred heat and makes sure that both parts of the wall construction are in balance, that is, they cannot produce extra heat and heat cannot get lost.

The edit window of a wall construction (see Figure 129 at the right) contains a "***Browse***" command button to display the company database data about materials and constructions, as shown in Figure 133.

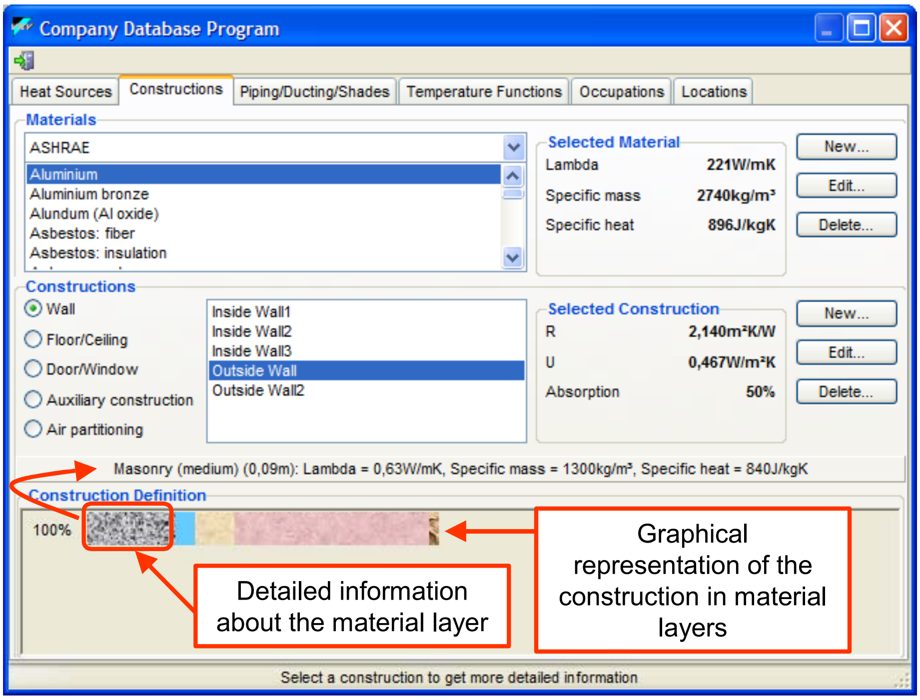


Figure 133: The company database window with materials and constructions

When selecting a wall construction from the list, the company database displays its properties at the right and a graphical representation of the material layers at the bottom:

- The resistance (R) and conductance (C) values do not take the surface conductance factors into account, as these constructions are defined independent of a building or a project.
- When moving the mouse cursor over the material layers, the detailed information about the selected layer appears.

Figure 134 shows the screen to create or edit a wall construction:

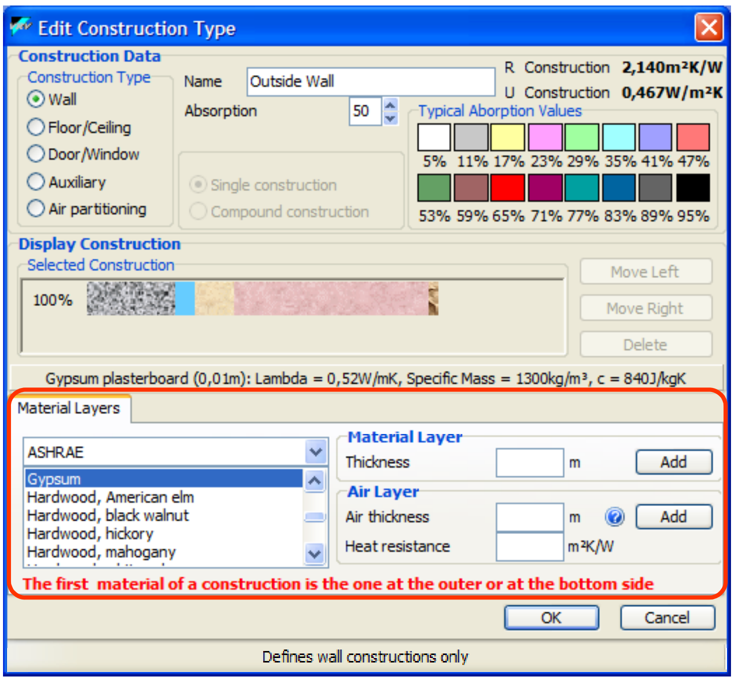


Figure 134: Editing a wall construction

To add material layers, you use the part at the bottom:

- Select a material in the list box at the left. Although there are a few material groups, the list per group can still be long. To get a faster selection, type the first letter of the material to jump to the first material name starting with that letter.
- Enter the thickness of the material layer and click the "Add" command button. VRVPro will add the layer to the graphical representation above and show the details of the selected material layer.

Some walls may use an air layer as an insulation layer. An air layer is special, as air moves and has a varying temperature and humidity. For an air layer, you have to enter its thickness (as for a regular material layer), but also its heat resistance. This value normally lies within the range of 0.18 (very good insulation) to 0.14 (good insulation), but degrades rapidly if that air moves, as shown in Figure 135.

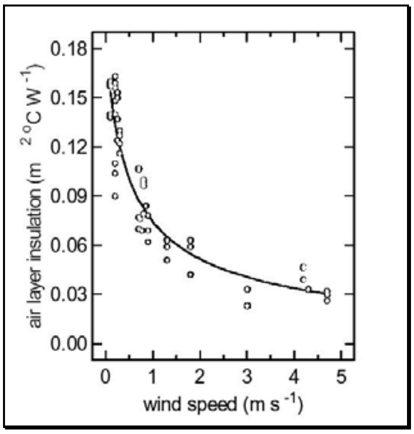


Figure 135: Heat resistance of air in function of its air speed

Humidity also has an influence on the insulating capacities or an air layer, but much less important.

The graphical representation in the middle of the construction definition window (see Figure 134) offers the same function as the construction overview window (see Figure 133): when moving the mouse cursor over a material layer, VRVPro displays the detailed information about that material layer. However, you can also click on a material layer, which then turns into a red rectangle, as shown in Figure 136. Now you can also move the selected material layer left and right or delete it.

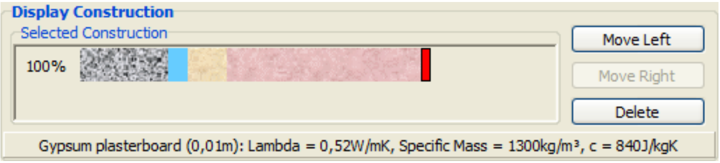


Figure 136: Moving and deleting material layers

The top part of the construction definition window (see Figure 134) allows you selecting the absorption percentage of the wall, as explained in section 5.5 and in Figure 127.

5.6 *The Sunlight through a Window*

A window is a transparent material, which will allow the sun radiation to come through, both directly and indirectly, as shown in Figure 137:

- When the sunlight radiation hits a window, a fraction of it is reflected and another fraction gets absorbed. The largest fraction, however, is transmitted. The sum of the three fractions (reflection, absorption and transmission) is 100%.
- The absorbed heat is transmitted again, partially at the inside and partially at the outside of the window. This is the indirectly transmitted heat. Therefore, the part of the sunlight coming into a room is its directly and indirectly transmitted part. For most windows the directly transmitted part is the largest one. So, the indirectly transmitted radiation will be relatively small.

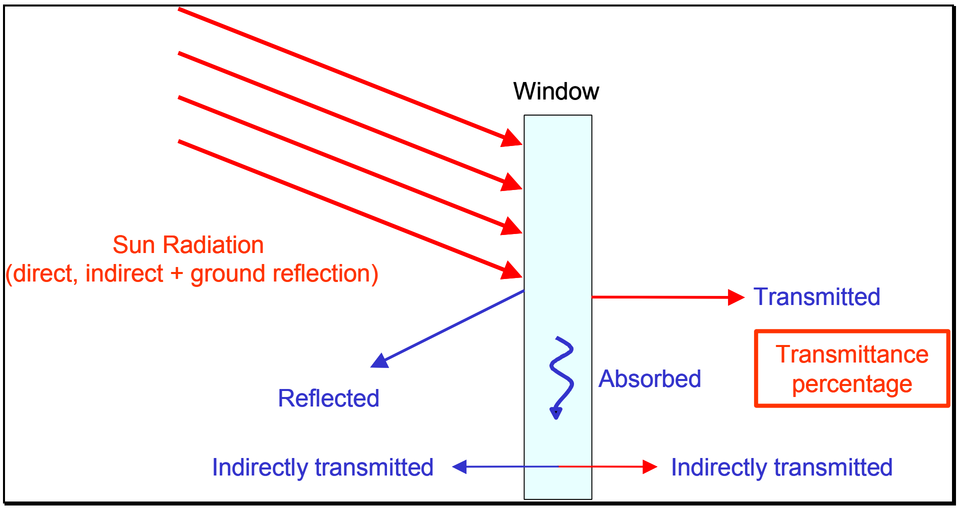


Figure 137: The transmission of sunlight through a window

Like a wall, a window is a construction, but a transparent one. So, it may also consist of several material layers, as for instance a double glazed window, e.g. consisting of two layers of glass with a gas between those layers (see also Figure 134). However, in addition to the material layers, you now have to define a solar ***transmittance percentage***, which is the combination of the directly and indirectly transmitted radiation. When defining a window construction, VRVPro displays this percentage, as shown in Figure 138:

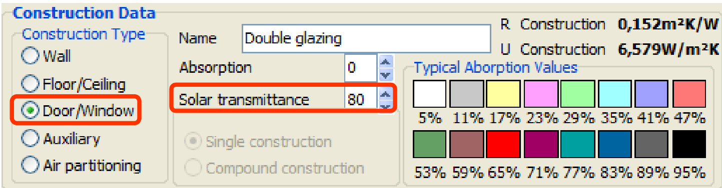


Figure 138: Defining a solar transmittance percentage for a window

Windows may also be covered by a shade (either at the inside or the outside) to keep the sun radiation out or at least attenuate it. VRVPro allows defining different kinds of shading, by using a shading factor, which reduces the sunlight that will be transmitted into the room.

Figure 139 combines the two kinds of shades into one drawing:

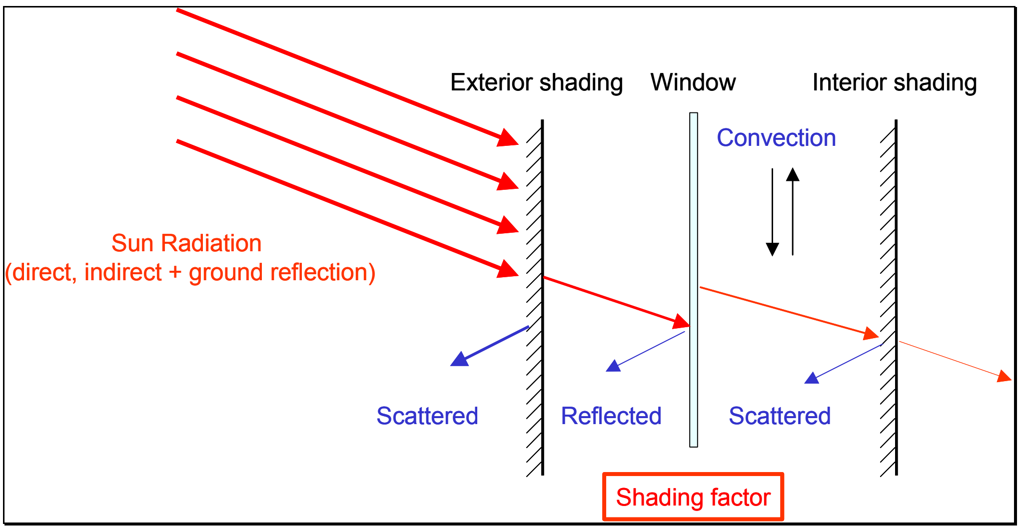


Figure 139: The use of shades attenuating the sun radiation through windows

When using an interior shading, the shade accumulates heat and provokes convection such that heat builds up between the window and the shade. This does not happen with exterior shades, as this heat would dissipate into the ambient air.

VRVPro offers a variety of shade definitions in its company database, both static and dynamic ones. A static shade is always closed and attenuates the sunlight. A dynamic shade closes when there is too much sun radiation or when there are persons present in the room or both, as shown in Figure 140:

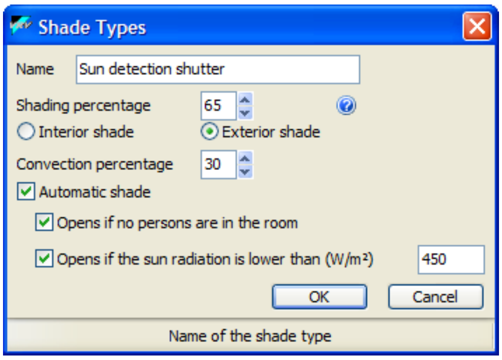


Figure 140: Defining a shade

When editing a window in a floor plan, you can select a shade for it. VRVPro displays windows having a shade with a thicker line either at the internal or external part of the window, as shown in Figure 141:

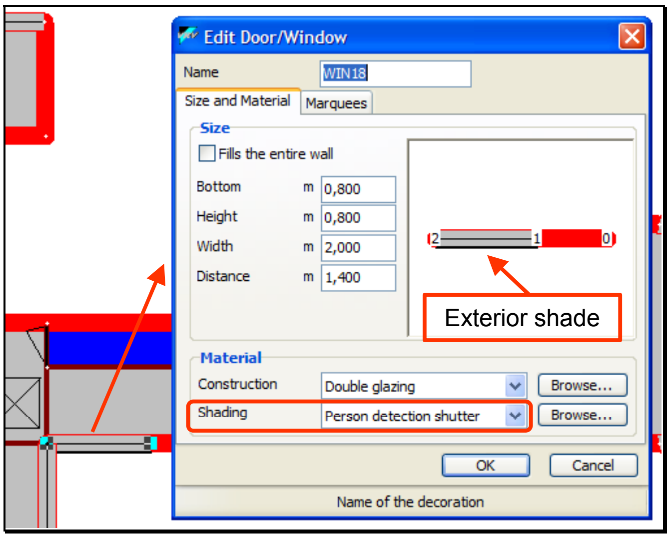


Figure 141: Adding a shade to a window in a floor plan

5.7 Load Calculations

The purpose of a load calculation is to calculate the required (maximum) load in each room, given the design temperature values. The elements to consider in a cool load calculation differ from those in a heat load calculation. The next sections explain both in detail.

5.7.1 Cool Load Calculations

The objective of a cool load calculation is to find the maximum cool load required in each room. Therefore, VRVPro has to consider the heat sources (persons, appliances, lights), the extra air (infiltration and ventilation), the walls, the windows and the sunlight, as shown in Figure 142:

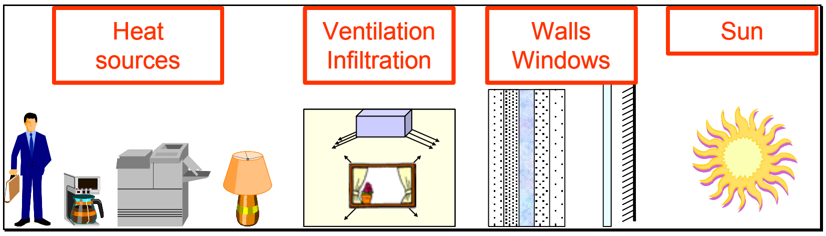


Figure 142: The elements considered during a cool load calculation

After having defined all sources that may produce heat in a room, you have to define the design indoor temperature you want to achieve in the room. The room edit window allows you entering these data for cooling and for heating (used in the next section), as shown in Figure 143:

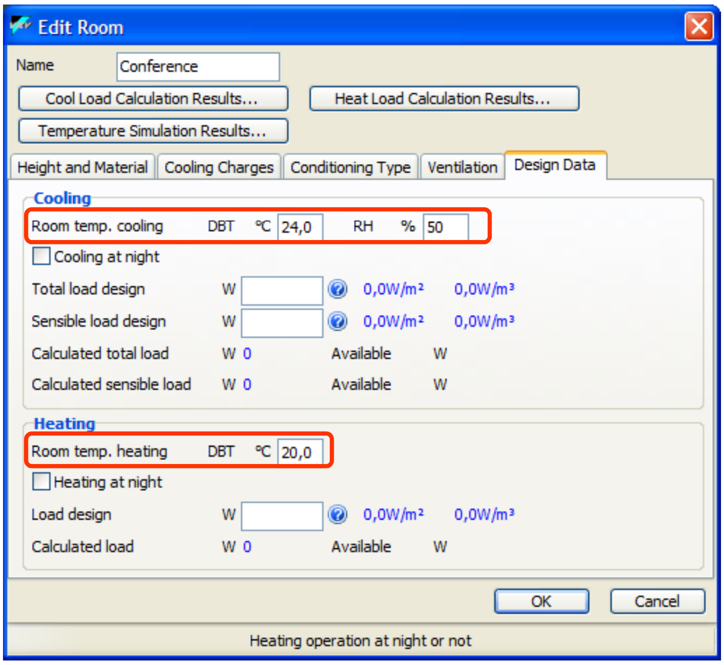


Figure 143: The design indoor temperature in a room

As the sun position changes during the daytime, its direct sunlight hits the walls of a building at different angles: rooms oriented east will get direct sunlight in the morning and no sunlight in the evening. So, VRVPro performs load calculations for different positions of the sun, while still using all elements mentioned Figure 142.

It will then keep the maximum of these results for each room, as shown in Figure 144. Consequently, the moment of the maximum required load in one room may differ from that of another room.

In addition to the sun data, VRVPro also needs the ambient temperature data, to calculate the heat transfer through the walls (see section 5.5 and Figure 132). It derives these data from a climate file, explained in section 5.8. By default, VRVPro uses 40 climate data, giving 40 load calculations to get the maximum from.

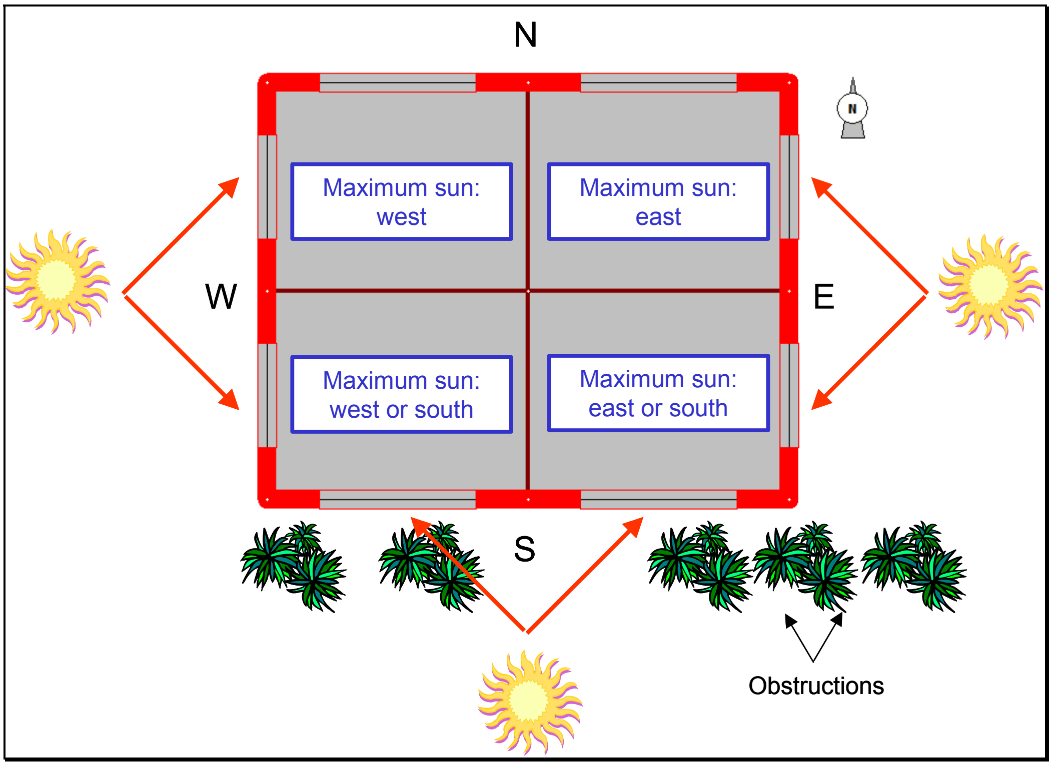


Figure 144: Effect of the sun position on the cool load calculation

As wall constructions accumulate heat (see section 5.5), they need an initial accumulation heat, before VRVPro can calculate the final cool load. So, it uses a two-step initialization method:

1. Define the wall temperature values through a simple heat transmission calculation, by using the conductance values of the materials, including the surface conductance factors. This gives a first value for the temperature values T3 and T4 (see Figure 132).
2. Calculate the heat accumulation in the walls, using the radiation heat and the 4 temperature values (see Figure 132: T1 is the ambient temperature, T2 is the room design temperature, T3 and T4 are the temperature values in the wall, calculated in the first step).

With these initialized values, the walls are recalculated a few times to make sure the accumulation has reached a balance. VRVPro can now perform the actual cool load calculation, which gives the required cool load to reach the design temperature in each room. This process repeats for each of the 40 climate data, mentioned above.

5.7.2 Heat Load Calculations

The objective of a heat load calculation is to find the maximum heat load required in each room. Therefore, VRVPro has to remove all heat sources (persons, appliances, lights), the walls, the windows and the sunlight, as shown in Figure 145:

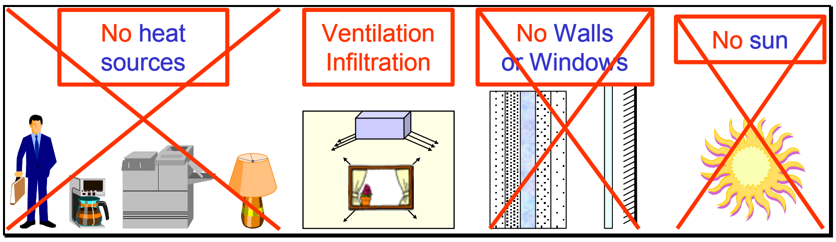


Figure 145: The elements considered during a heat load calculation

As for the cool load, VRVPro uses climate data to get ambient temperature data, as explained in 5.8. From these data, it only needs the temperature and the relative humidity to calculate the influence of the infiltration air and possibly also the ventilation air, if that one was produced using VAM or VKM devices (see chapter 4, Designing a Ventilation Strategy). By default, VRVPro uses 20 climate data, giving 20 load calculations to get the maximum required heat load from.

Although Figure 145 shows that a heat load calculation does not use heat sources, it considers appliances delivering a cooling capacity, such as open freezers. Such appliances use a ***negative sensible heat*** in their definition in the company database.

5.7.3 Load Calculation Results

After the load calculations, VRVPro fills in the required loads in each room. These are the maximum values found during the load calculations (see sections 5.7.1 and 5.7.2). VRVPro also keeps the individual results for each room and shows these in tabular form and in different graphs.

Figure 146 shows the tabular cool load calculation results for a room on a floor plan (click on the "***Cool calculation results***" command button in the "***Actions***" tab). The day and hour are not really relevant. In fact, these are selected records from a climate file, as explained in section 5.8.

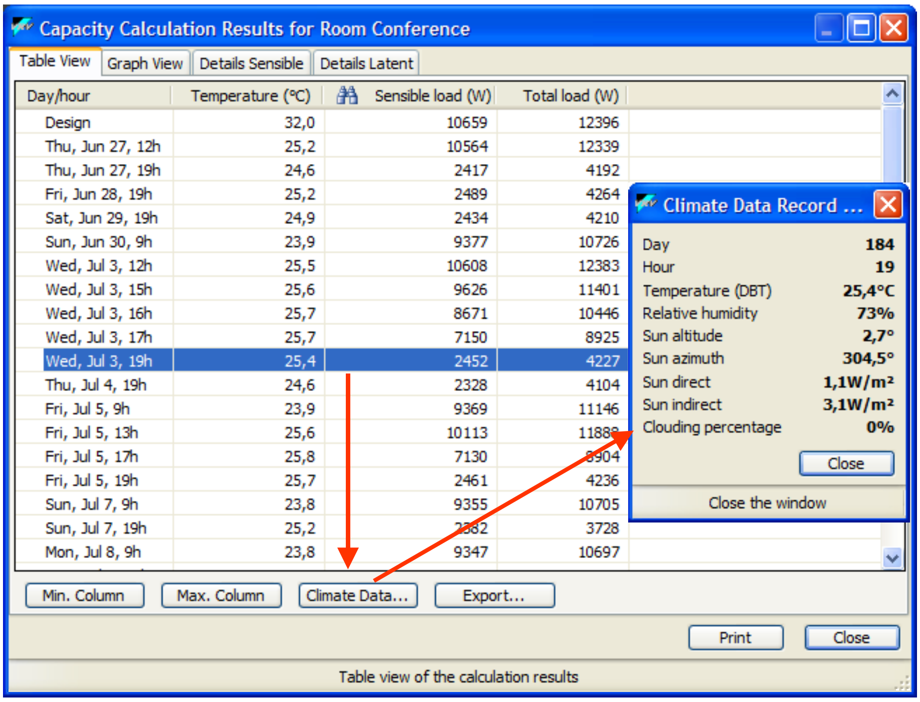


Figure 146: The cool load calculation results for a room

The values shown in the row "***Design***" are the maximum values found in the rows below. Each row only shows the load results. However, when selecting a row, the "***Climate Data***" command becomes available. Clicking on it gives all climate data for that particular record used for a load calculation.

This window also contains command buttons to find the minimum or maximum values in the selected column, that is, the one containing the binocular icon ( ). Click on a column in the title row to make it the selected one.

VRVPro also creates several graphical views of the load calculation data. Figure 147 gives an example of the sensible loads in a room. These are split up per heat source. Remark that in this example the accumulation heat in walls is an important factor.

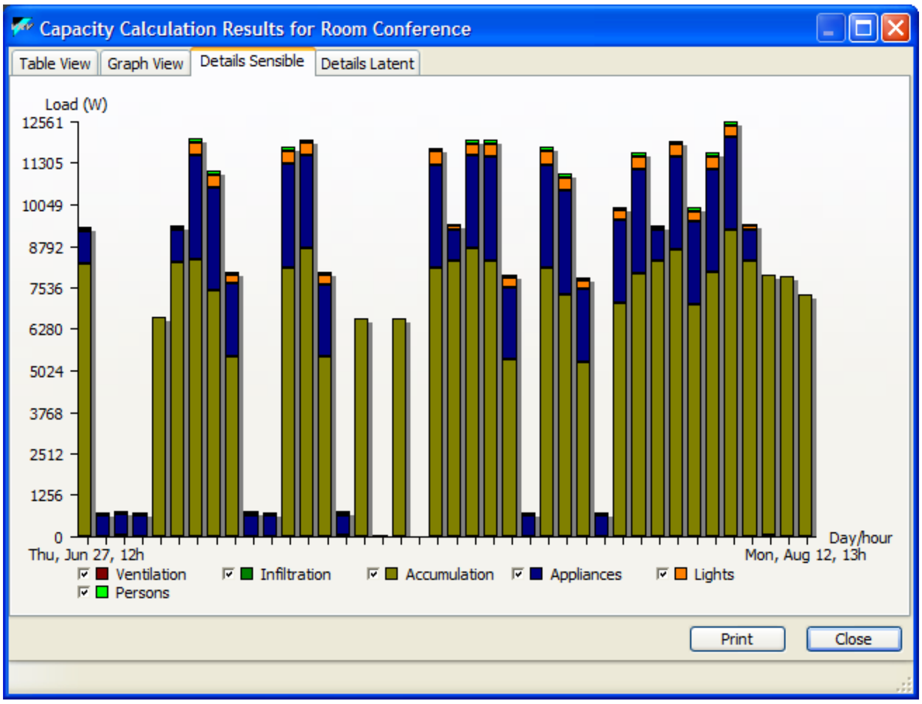


Figure 147: Sensible cool load results for a room, split up per heat source

In addition to the load calculation results in a room, VRVPro also calculates the accumulated values for a floor and the complete building, as shown in Figure 148.

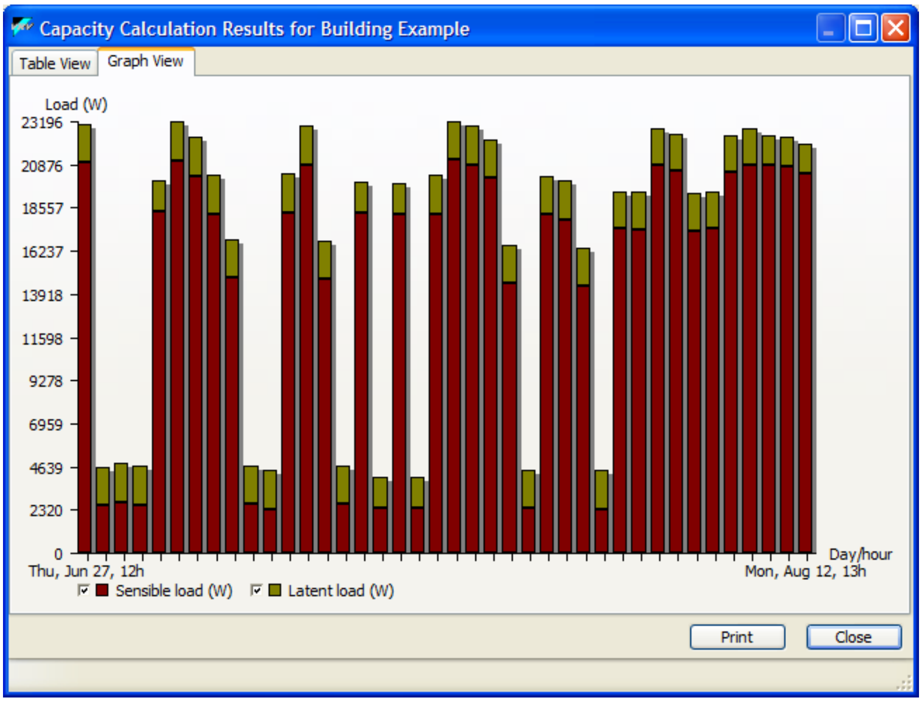


Figure 148: The cool load calculation results for the building

When you have selected indoor units on the floor plan and connected them to an outdoor unit, the outdoor unit window can now show the required capacities for each of the load calculation records, as shown in Figure 149.

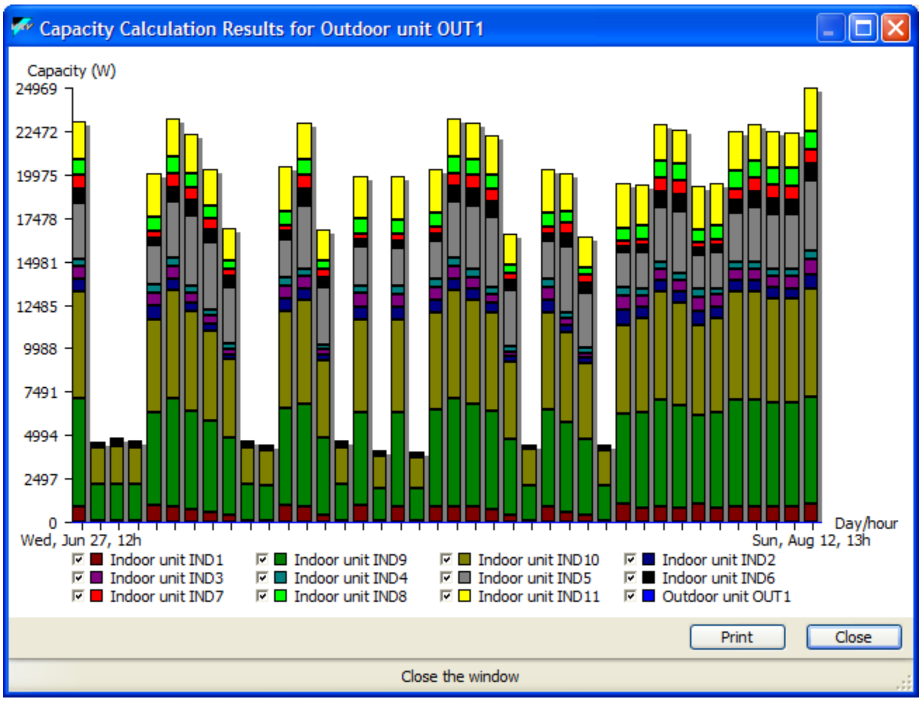


Figure 149: The individual indoor unit capacities for each calculated load

5.8 *Climate Files*

A temperature simulation file contains ambient data for 365 days and 24 hour per day, giving 8760 records. Each record contains the ambient temperature, the relative humidity, the sun position (altitude and azimuth), the direct and indirect sun radiation and the clouding. From this file, VRVPro derives the cool and heat load files, as explained further. These three files are climate files.

Climate files are referred to in the company database and associated to a location. Locations are organized in regions (continents), countries and locations (see Figure 150):

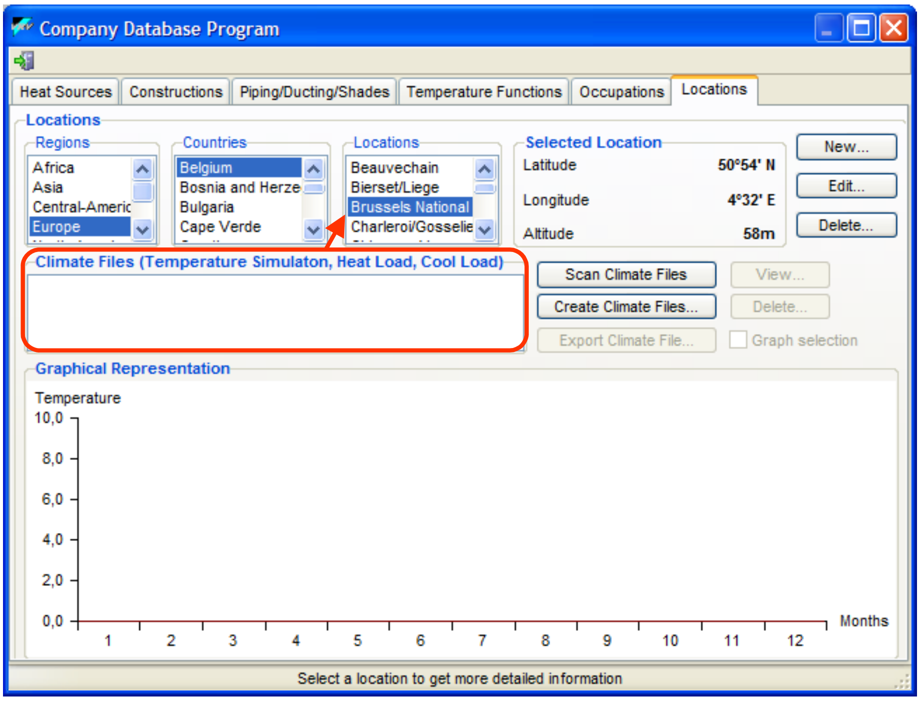


Figure 150: Climate files are associated to a location

The actual climate data are stored in files belonging to a subfolder ("***Climates***") of the VRVPro installation folder.

When you start a new VRVPro project and select the default company database (see section 2.1) The default company database does not contain references to climate files. However, you may have created climate files in previous projects. To load these in the new project, click the "***Scan Climate Files***" command button (see Figure 150). VRVPro will then scan the "***Climates***" subfolder and store references to all climate files it finds in that subfolder.

However, for that new project you may need climate files for a different location, for which there are no climate files available. In that case, you must create them, by clicking the "***Create Climate Files***" command button (see Figure 150). This brings up a window as shown in Figure 151:

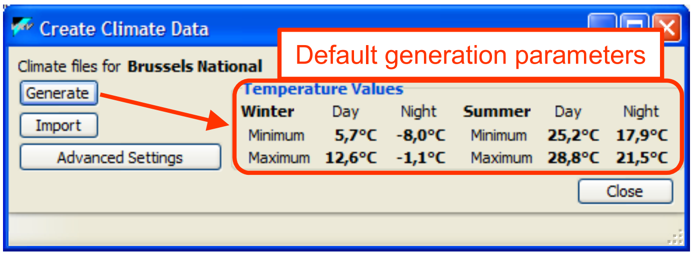


Figure 151: Default generation parameters associated to a location

There are two ways to create a temperature simulation file:

1. Generating a temperature simulation file. To generate climate data for a whole year, VRVPro uses 8 extreme temperature data, together with other data such as humidity and clouding, not shown in the simple window of Figure 151. After have produced the 8760 records, VRVPro saves the results in the temperature simulation file.
2. Importing a temperature simulation file. The local meteorological stations may provide climate data, which you can import, provided the file conforms to the required format, as explained in the table below:

- A climate line consists of 11 columns:
  1. ***The day of the year***. This column may contain values between 1 and 365. Climate files do not take leap years into account.
  2. ***The hour of the day***. This column may contain values between 0 and 23.
  3. ***The dry bulb temperature***, expressed in °C.
  4. ***The relative humidity***, expressed in %. Theoretically, these values may range from 0% to 100%. In practice, however, it is more likely to see values between 30% and 100%.
  5. ***The sun altitude***, expressed in ° (degrees). These values may range from –90° to + 90°. Negative values mean that the sun is below the horizon and may be replaced by zero (or an empty cell).
  6. ***The sun azimuth***, expressed in ° (degrees). These values may range from 0° (North) to 360° (North again). So, East is 90°, South is 180° and West is 270°. It is also possible to enter negative values. If so, add 360° to that value to get the positive azimuth value.
  7. ***The direct sunlight***, expressed in W/m^2. Remark that direct sunlight is only available for a positive sun altitude (the sun has to be above the horizon to produce direct sunlight) ***and*** if there is less than 100% clouding.
  8. ***The indirect sunlight***, expressed in W/m^2. Remark that direct sun light is only available for a positive sun altitude. In contrast to the direct sunlight, there is always an indirect sunlight for a positive sun altitude (otherwise it would stay night if the sky is covered by clouds).
  9. ***The wind speed***, expressed in m/s. This column may remain empty, as the software currently does not take wind speeds into account.
  10. ***The wind direction***, expressed in ° (degrees). These values may range from 0° (North) to 360° (North again). So, East is 90°, south is 180° and west is 270°. This column may remain empty, as the software currently does not take wind directions into account.
  11. ***The clouding***, expressed in %.

- A complete climate file contains 8762 lines.
  - The first line contain the following titles: "Day", "Hour", "DBT", "RH", "Sun altitude", "Sun azimuth", "Sun direct", "Sun indirect", "Wind speed", "Wind direction" and "Clouding". These titles are checked when importing a climate file. However, they are not case sensitive. So, "day", "DAY" and "Day" are all considered a correct title.
  - The second line contains the dimensions for the data. Although this line must be present, it is skipped when importing the data.
  - 8760 (365 days x 24 hours) lines with data.
- When preparing a climate file from a meteorological institute, the following conventions may have been used:
  - The clouding data may have been given in octets (0, 1/8 covered, 2/8 covered, … 8/8 covered). These data have to be converted into percentages:
    - ∴ 0/8 -> 0%
    - ∴ 1/8 -> 12.5%
    - ∴ 2/8 -> 25%
    - ∴ 3/8 -> 37.5%
    - ∴ 4/8 -> 50%
    - ∴ 5/8 -> 67.5%
    - ∴ 6/8 -> 75%
    - ∴ 7/8 -> 87.5%
    - ∴ 8/8 -> 100%
  - The clouding data may have been given in wording: sky clear (SKC) means 0 clouding, few means 1/8 to 2/8 covered, scattered (SCT) means 3/8 to 4/8 covered, broken (BKN) means 5/8 to 7/8 covered and overcast (OVC) means a completely covered sky. These data have to be converted into percentages:
    - ∴ SKC -> 0%
    - ∴ FEW -> 20%
    - ∴ SCT -> 45%
    - ∴ BKN -> 75%
    - ∴ OVC -> 100%
  - The data may only be available per 3 hours (data for the hours 0, 3, 6, 9, 12, 15, 18 and 21) or per 6 hours. When importing a file with missing hours, the software will calculate interpolating values to create a complete climate file. ***When importing a file with missing days, the software will issue an error message, without importing the file***. However, when the missing days are at the end of the file, the file will be imported, as the remaining records are consecutive.
  - The software assumes that the direct sun light data have taken the clouding attenuation into account.

The table below shows an excerpt from a climate file for the first two days of a year. Empty cells are equal to the value zero. The software to import a climate file accepts both an empty cell and a value zero. The colors used have no meaning, except making the table more readable. This table should be exported to a comma separated (CSV) file to import it.

Day	Hour	DBT	RH	Sun altitude	Sun azimuth	Sun direct	Sun indirect	Wind speed	Wind direction	Clouding
		°C	%	° (-90 to +90)	° (0-360)	W/m^2	W/m^2	m/s	° (0-360)	%
1	0	-3.0	84	-60.91	18.99					100
1	1	-2.7	87	-55.97	43.81					100
1	2	-2.3	89	-48.42	62.77					100
1	3	-2.0	92	-39.57	77.56					100
1	4	-2.0	89	-30.23	89.98					100
1	5	-2.0	87	-20.88	101.25					100
1	6	-2.0	84	-11.88	112.15					100
1	7	-1.7	84	-3.55	123.27					100
1	8	-1.3	85	3.74	134.98		13.8			100
1	9	-1.0	85	9.63	147.55		53.1			100
1	10	-0.7	79	13.72	161.01	145.9	63.4			8
1	11	-0.3	72	15.67	175.13	192.9	73.6			
1	12	0.0	66	15.29	189.44	186.0	72.7			
1	13	0.0	68	12.63	203.39	138.1	65.1			
1	14	0.0	70	7.93	216.57	37.7	28.2			42
1	15	0.0	72	1.54	228.85	0.2	0.5			42

Once the temperature simulation file is available, VRVPro uses these data to look up 40 records with the highest ambient temperature and largest sun radiation in the four major wind directions to create a cool load file. It equally looks for 20 records with the lowest ambient temperature to create a heat load file.

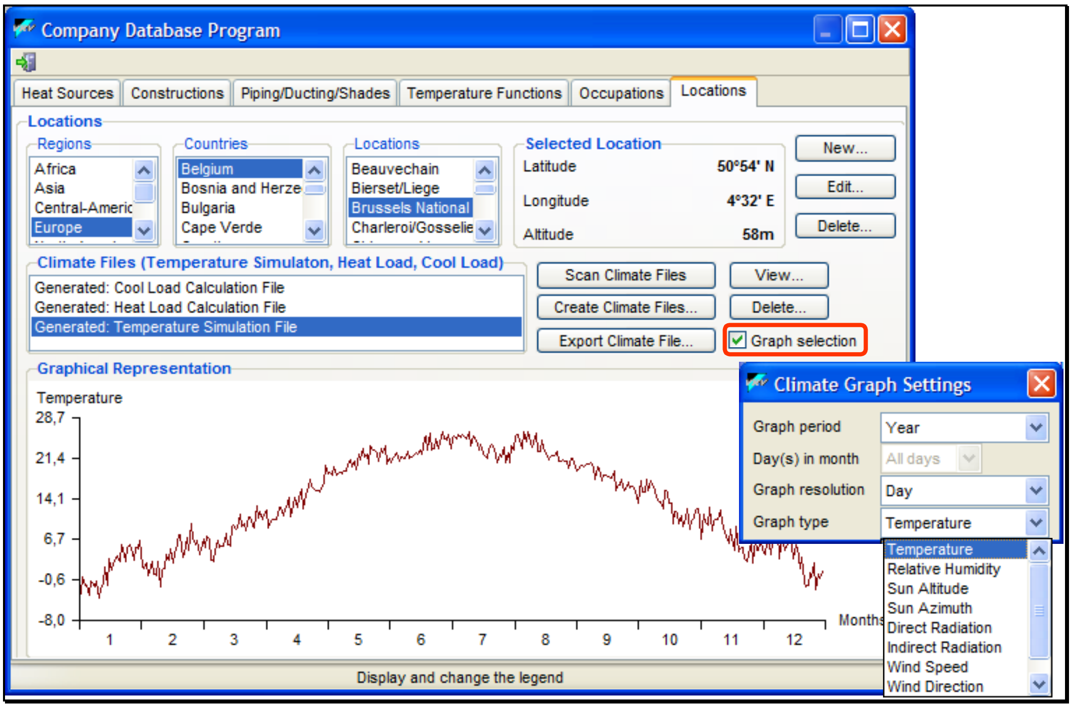


Figure 152: Viewing a temperature simulation file

It then loads the data and shows them in the lower part of the window, as shown in Figure 152: By checking the "***Graph Selection***" check mark, a window comes up allowing you to select other graphs, other resolutions and other periods.

The locations tab of the company database contains three other command buttons:

1. The "***View***" command button allows you viewing the data in tabular form.
2. With the "***Delete***" command button, you remove the file and the reference to the file in the company database.
3. The "***Export Climate File***" command button allows you exporting a climate file in a csv-format so that you can use it e.g. in an Excel application.

Instead of using the defaults to create the climate files, you can also click the "***Advanced Settings***" command button in Figure 151 to display a window as shown in Figure 153. This window allows you editing the extreme ambient temperature data, but also the humidity and clouding. In addition, you can also define rain seasons (e.g. a monsoon period), during which the humidity and clouding gets an extra boost.

The heat and cool load settings in the middle of the window in Figure 153 define the months to look up, as the coldest hours to use for heating are in the winter and the hottest in the summer. You can also select the total number of records required for a cool load and for a heat load. For the heat load settings, you can also enter a maximum ambient temperature. VRVPro will not consider records with ambient temperature values higher than the given one, when deriving a heat load calculation file.

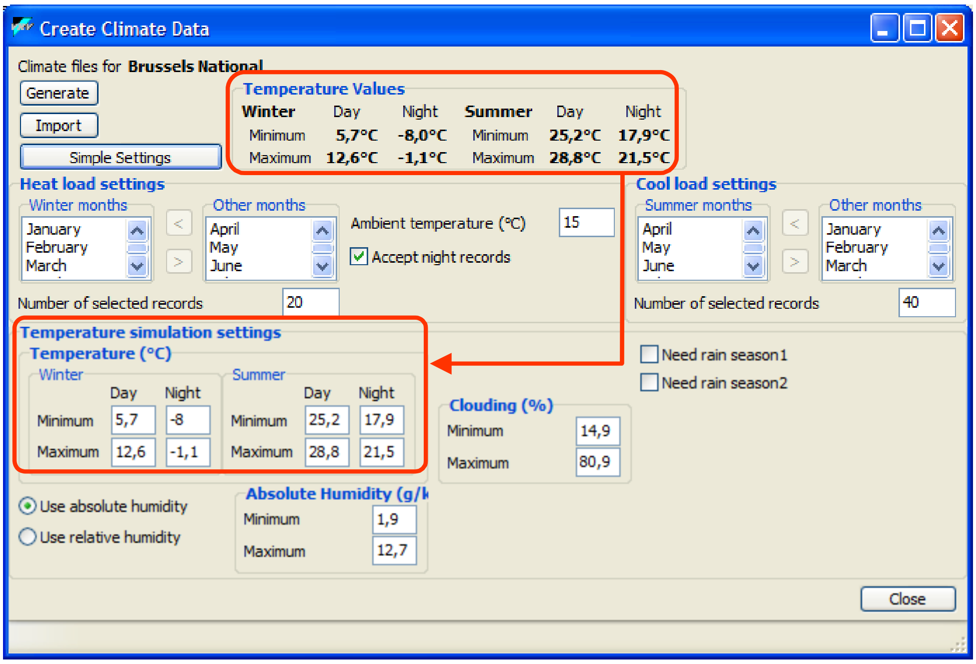


Figure 153: Advanced generation parameters and load derivation settings

Once you have the climate data ready, you have to use them in your project. You do this by selecting the temperature simulation file in the "***Building Properties***" window (see Figure 154). VRVPro automatically find the associated cool and heat load files.

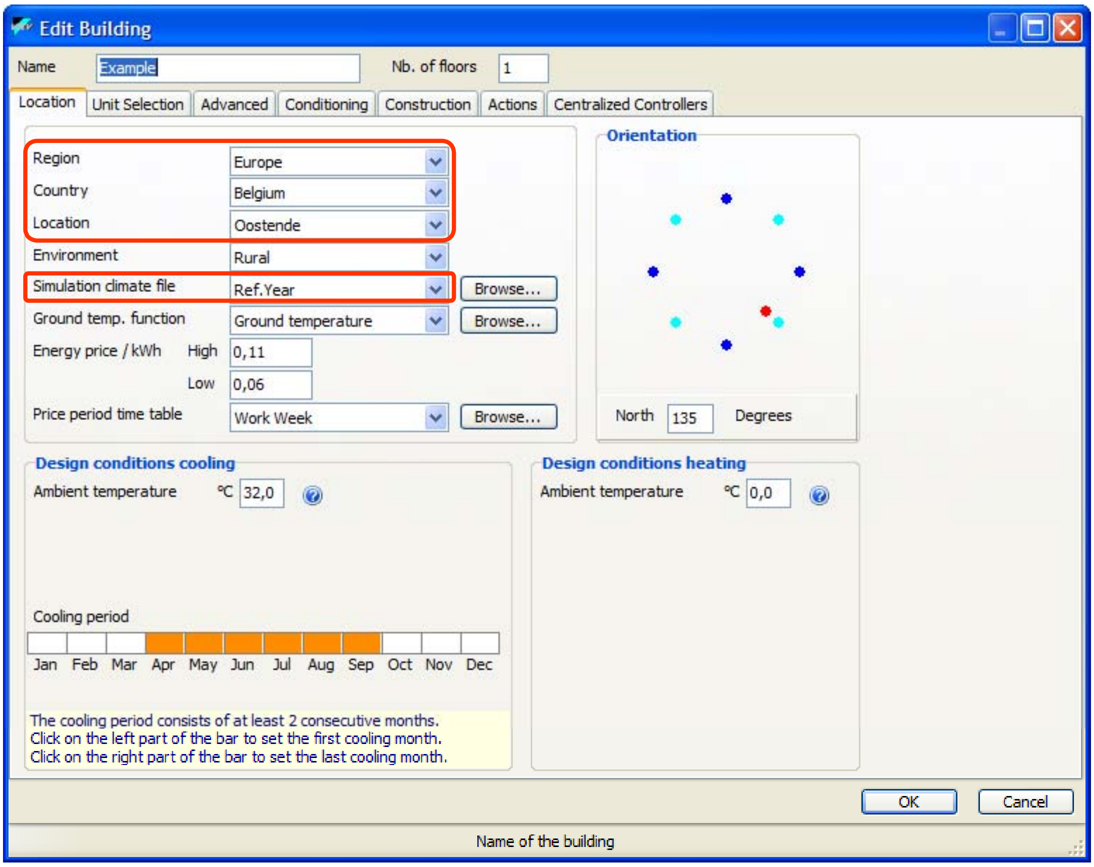


Figure 154: Using the climate files in project

With all this is place, you can now perform the cool and heat load calculation. Select the command "***Load Calculation***" from the Building menu. This brings up a window, as shown in Figure 155.

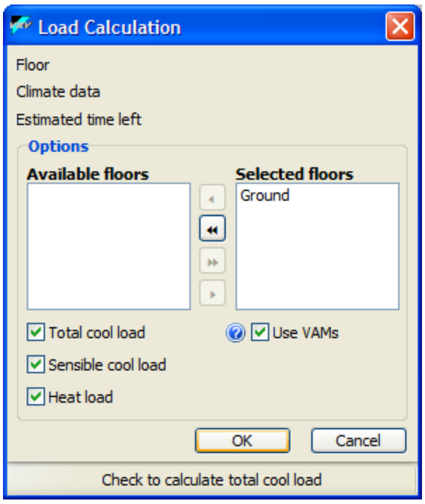


Figure 155: Starting the load calculation

You can perform a load calculation on the selected floors. By checking the relevant checkmarks, VRVPro calculates the total cool load, the sensible cool load and the heat load for each room on the selected floors.

If you have designed a ventilation system with VAM or VKM devices – both are using total heat exchangers – you can decide to take the reclaimed cooling or heating into account during the load calculation. This may considerably reduce the required load in the rooms. If there is no ventilation system, checking the "***Use VAMS***" checkmark has no influence on the calculations.

5.9 Special Constructions

In addition to the constructions explained in chapter 2, VRVPro also offers additional constructions, which are only available in Expert mode or have a special effect in Expert mode. This section explains them in detail.

5.9.1 Compound Constructions

A compound construction consists of a combination of different constructions. An example is a framed window, consisting of a wooden frame and a double glazed window.

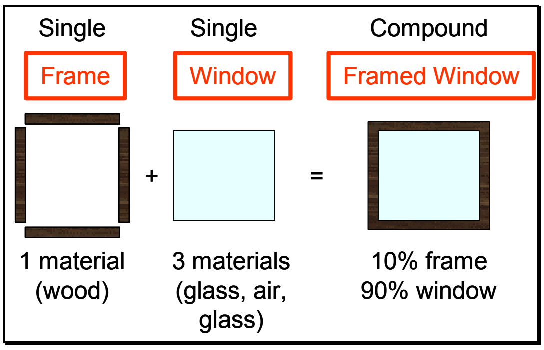


Figure 156: A compound construction

A single construction may consist of one or several material layers, as explained for a wall construction (see section 5.5 and Figure 134). A compound construction consists of percentages of single constructions. The company database offers the possibility to define auxiliary constructions that you can use to build compound constructions. This allows you to differentiate between constructions directly used in a building and others making up a compound construction. However, it is possible to use any construction as part of a compound construction.

The company database visualizes a compound construction as a list of its single constructions and displays the material layers for each of these single constructions, as shown in Figure 157:

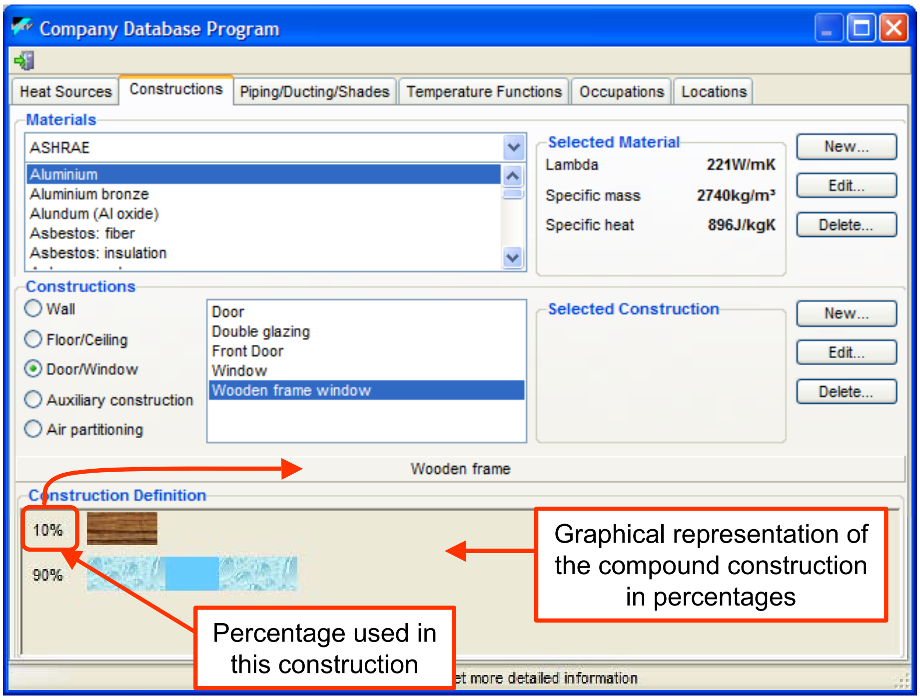


Figure 157: Viewing a compound construction

Moving the mouse cursor over the percentage displays the name of the construction and moving over a material layer shows the material layer details, as explained in Figure 133.

Figure 158 shows the window to enter a new compound construction:

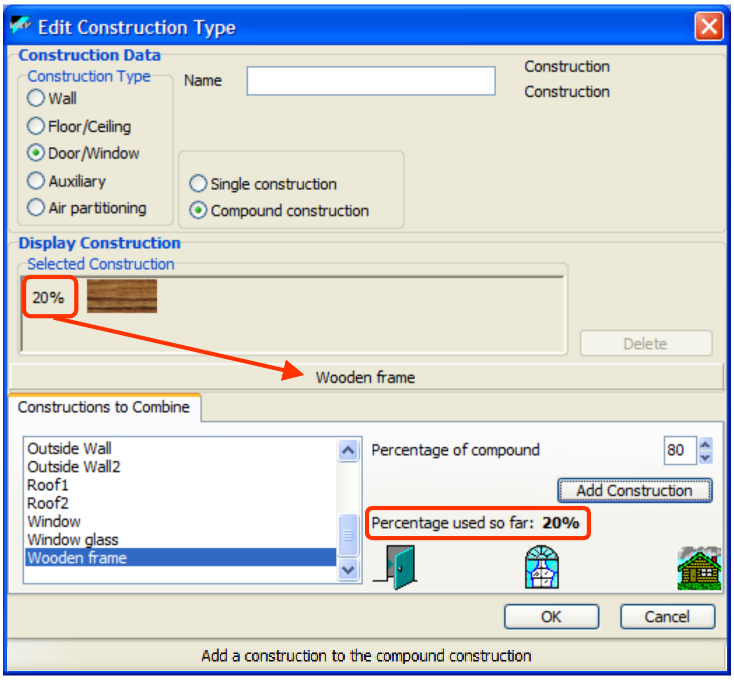


Figure 158: Defining a compound construction

- Select the "***Compound construction***" radio button to change the window to enter percentages of single constructions.
- Select the single construction, enter the required percentage and click the "***Add Construction***"

command button. The single construction is now added to the graphical representation.

- Moving the mouse cursor over the percentage gives the construction name. If you move the cursor over a material layer, you get the material details, as in the overview window.
- The sum of all percentages must give 100%. So, the company database displays the percentage used so far as well as the remaining percentage to assign to a construction to complete the compound construction.

5.9.2 Other Side of an External Wall

The other side of an external wall is its outside part, which is normally exposed to ambient conditions, where it may get sunlight, depending on its orientation and slope. However, this is not always the case, as shown in Figure 159, where another building has covers the selected wall.

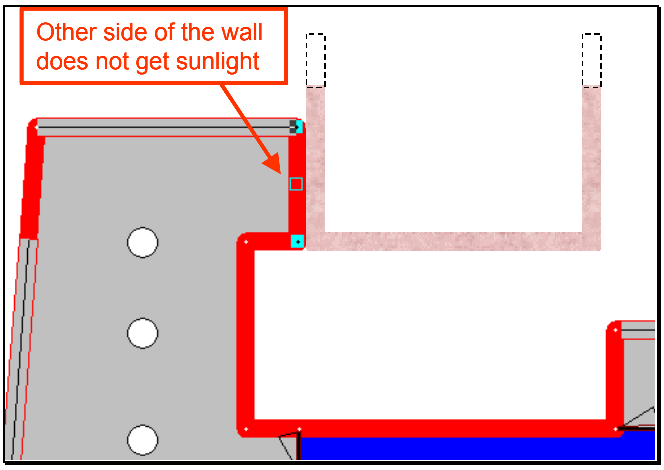


Figure 159: Other side of the wall is not default ambient

The other side of that wall is no longer exposed to the ambient conditions and may even have to be defined as having another construction. To change the default conditions of an external wall, right click the wall and select the "***Edit***" command. In the wall edit window, click the "***Advanced***" command button. This brings up a window as shown at the right of Figure 160:

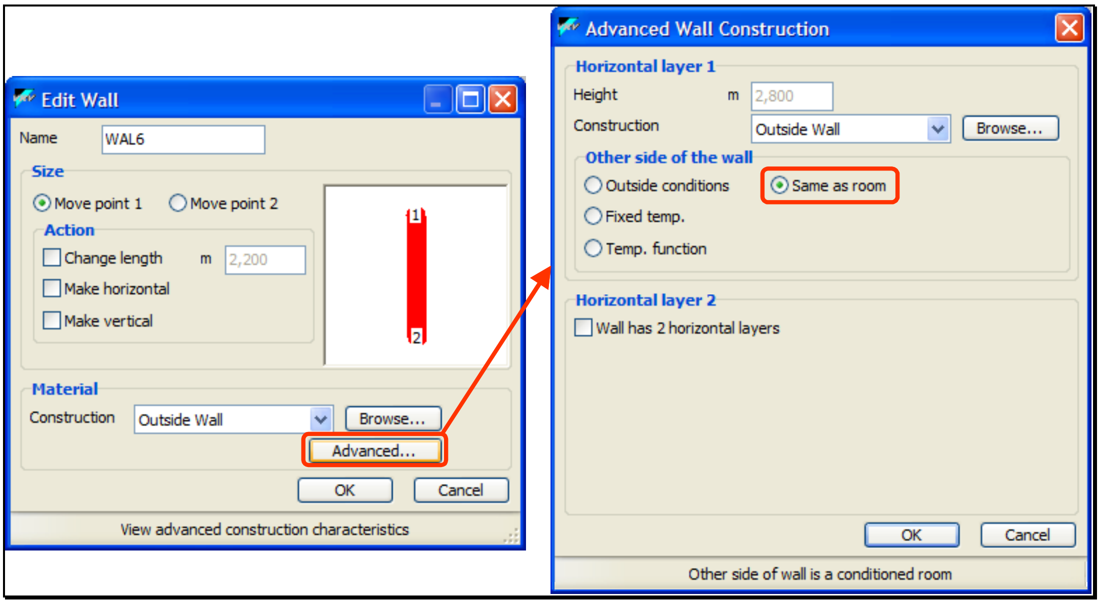


Figure 160: Defining the conditions at the other side of the wall

VRVPro offers four possible conditions at the other side of an external wall:

1. Outside conditions are the default conditions, where the sunlight may hit the wall.
2. If you use the same as room conditions, the temperature at both sides of the wall are identical and there will be no heat transfer through that wall.
3. When selecting fixed temperature, you can enter a temperature value, which will be used to calculate the heat transfer through the wall.
4. If you select a temperature function, the temperature at the other side of the wall varies as a linear function of the ambient temperature. Temperature functions are defined in the company database and need four temperature values: the minimum and maximum ambient temperature values and the corresponding required temperature values. Figure 161 shows an example of such a temperature function.

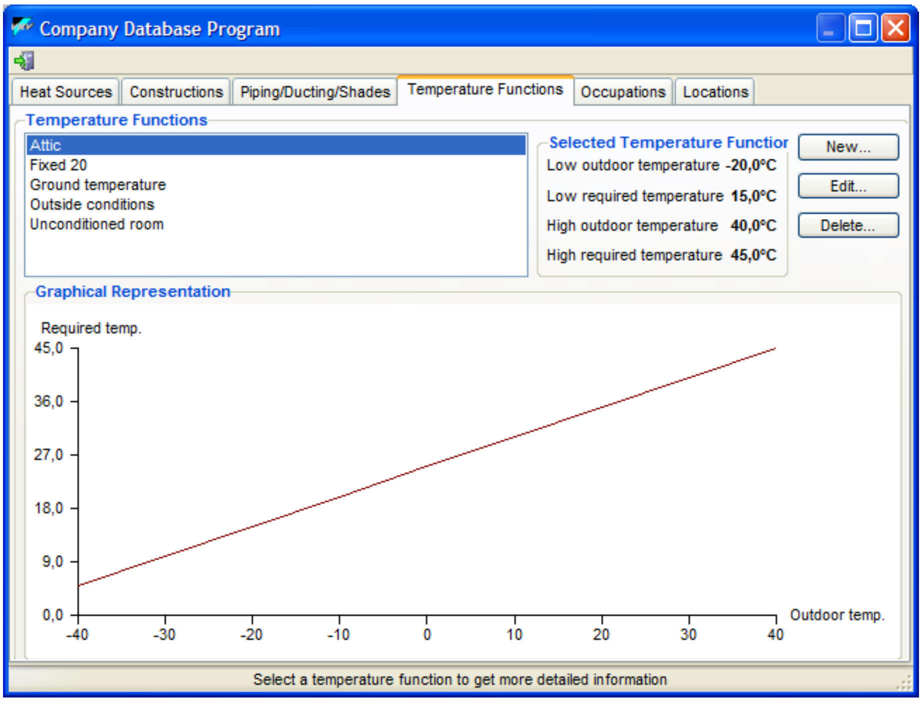


Figure 161: Definition of a temperature function

5.9.3 Composed Walls

A wall may consist of two different parts, as shown in Figure 162. As walls may contain windows and doors, it would be difficult to define such a wall as a compound construction, consisting of percentages of single constructions (see section 5.9.1).

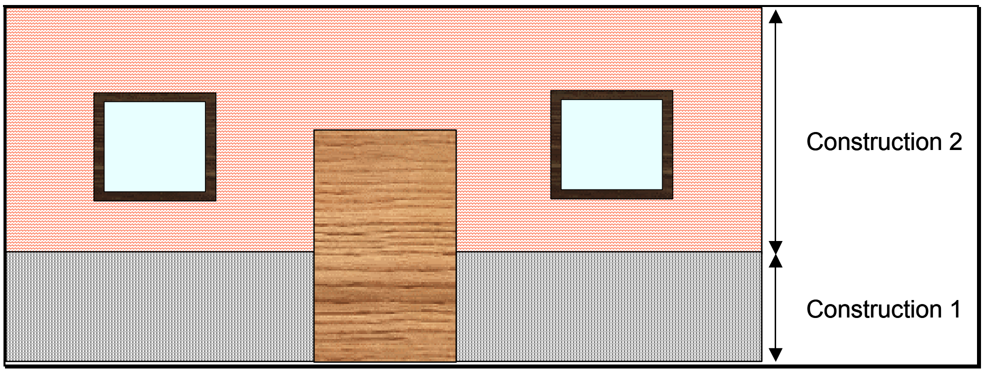


Figure 162: A composed wall, consisting of two constructions

To define a composed wall, right click the wall and select the "***Edit***" command. In the wall edit window, click the "***Advanced***" command button. This brings up a window as shown at the right of Figure 163:

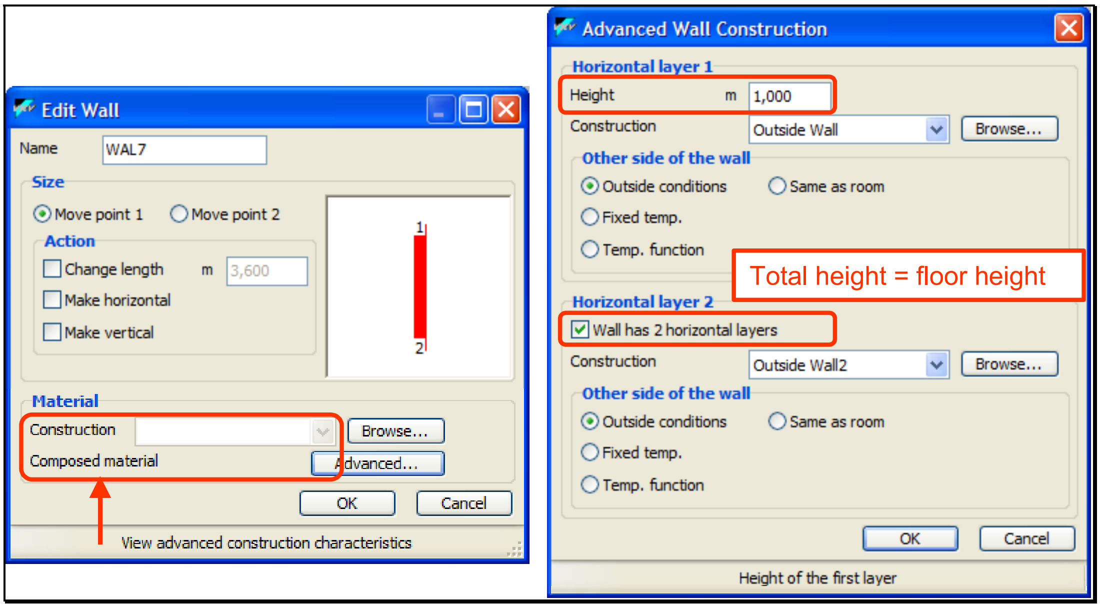


Figure 163: Advanced settings for a combined wall

- Check the "***Wall has 2 horizontal layers***" and select the construction for the second layer.
- Enter the height of the first layer. The height of the second layer is the difference between the floor height and the height of the first layer.
- Select the construction for the second horizontal layer.

As the wall now consists of two constructions, its edit window no longer shows any construction. It only mentions that the wall consist of a composed material.

5.9.4 Window Marquees

In Expert mode, a window may contain marquees on three sides (left, right and top). These may be of any length and at any angle ranging from 90^0 (perpendicular to the window) to 45^0 (slanted to the window). As marquees are constructed at the outside part of the wall, all the heat they may transfer or accumulate does not contribute to the rooms in the building. However, they may partially cover a window, thereby blocking a part of the indirect and direct sun radiation, as shown in Figure 164.

To define marquees on a window, right click it and select the "***Edit***" command. In the window that comes up, select the "***Marquees***" tab. For each side (left, right and top), you can enter a length and an angle. The small pictures at the right show how the marquees look like. To demonstrate this, the marquee at the right side of the window in Figure 164 has an angle of 60^0.

VRVPro also offer a visual feedback by showing how the shadow of a marquee blocks a part of the window. The percentage blocked depends on the position of the sun and VRVPro takes it into account during the cool load calculation (see section 5.7.1) and the temperature simulation (see chapter 6). In Figure 164 and for the selected sun position, the three marquees only let pass 29% of the indirect and 25% of the direct sunlight. VRVPro also displays the percentages per side to illustrate what marquee has the largest influence.

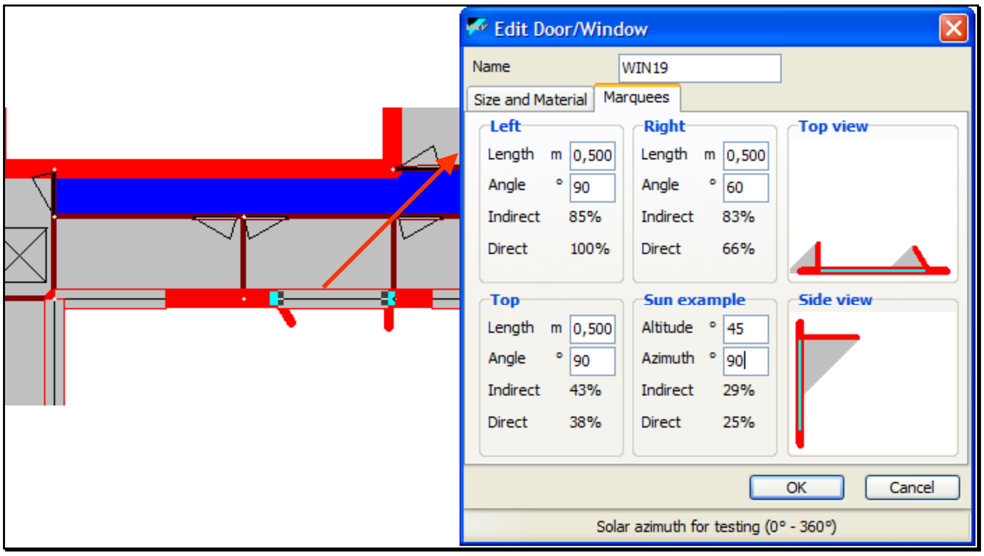


Figure 164: Defining marquees on a window

5.9.5 Rooflines

A roofline defines the top line of a slanted roof. The slanted sides of the roof may cut a part of the walls of the top floor. Before explaining how to draw a roofline, Figure 165 shows the edit window of a roofline, containing a schematic overview of its parameters:

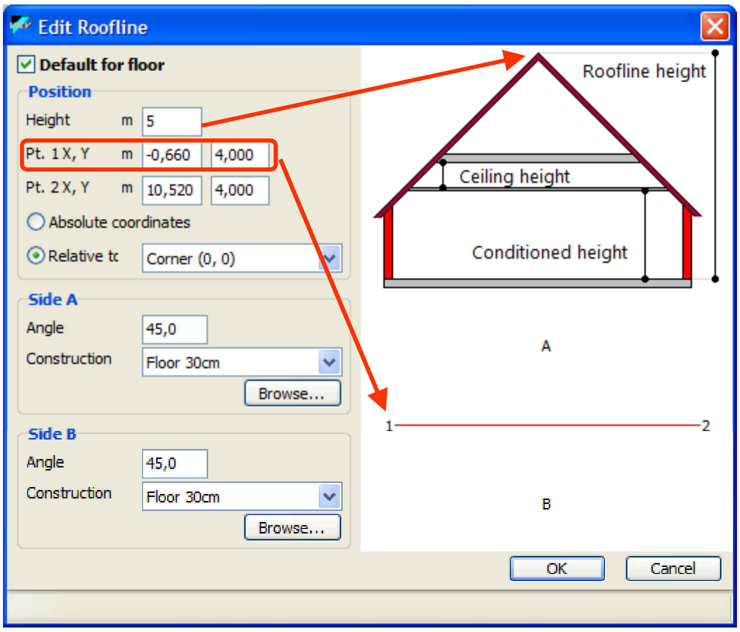


Figure 165: The roofline edit window

- You can change the height of the roof.
- Both sides of the roof may use a different slope angle.
- Depending on the slope angle on both sides and the roof height, the roof cuts the vertical walls of the floor, as shown in the small picture in Figure 165. A slope may vary from 0^0 (a flat roof) up to 65^0 (a very steep roof).
- Both roof sides may consist of a different construction.

To draw a roofline, select its icon ( ) and draw a line on the floor plan. Depending on how you draw that roofline, the height of the roof and its slope angle on both sides, the roof may cut the vertical floor plan walls differently, as shown in Figure 166. Note that the length of the roofline has no influence on the result, only its angle. As the roofline edit window has its "***Default for floor***" checkmark checked in Figure 165, VRVPro applies the roof to all rooms on that floor.

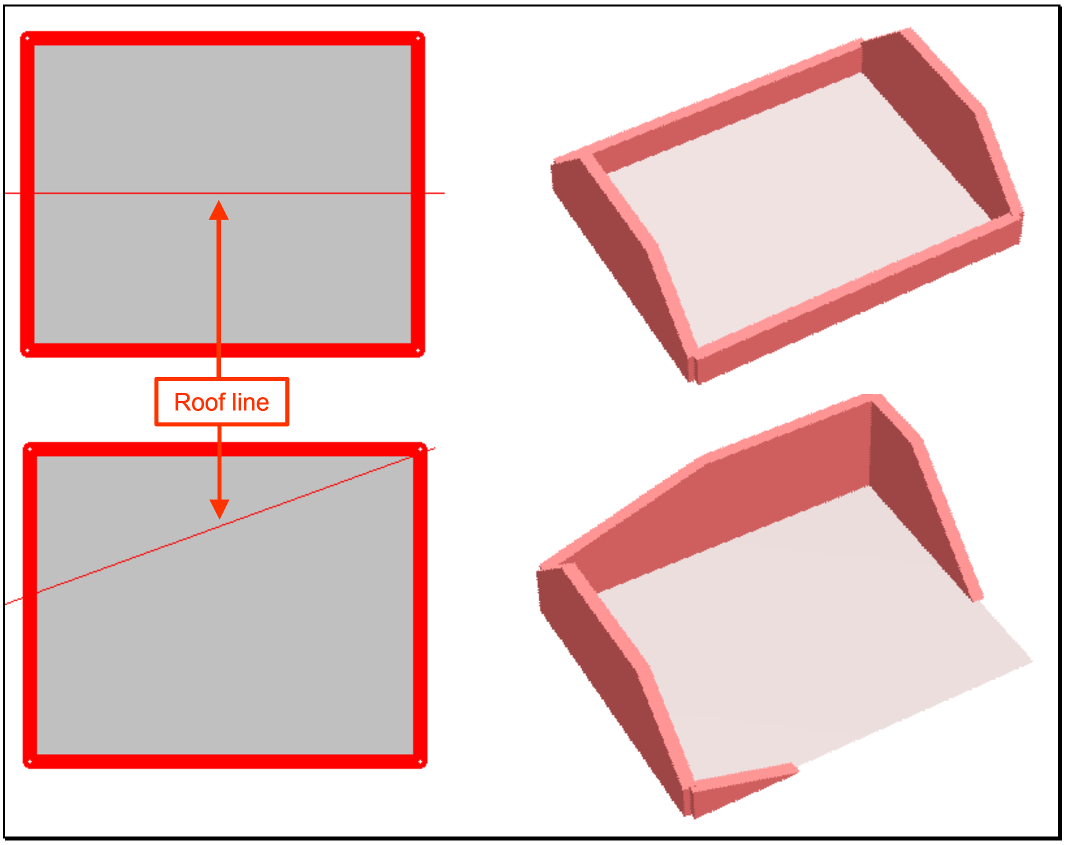


Figure 166: Drawing a roofline on a floor plan and its effect on the floor walls

The situation becomes a bit more complicated if the floor plan consists of several rooms and you only want to apply the roof to one room, as shown in Figure 167:

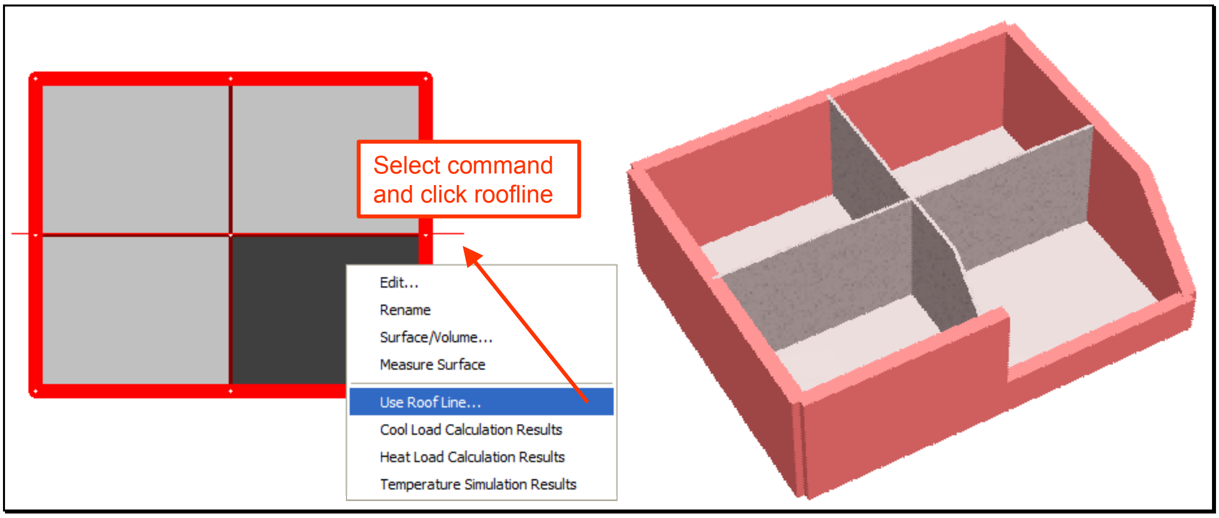


Figure 167: Constraining a roof to a room

- First uncheck the "***Default for floor***" checkmark in the roofline edit window. Although the roofline is still drawn on the floor plan, VRVPro no longer applies it. A perspective view of the floor plan only shows the vertical walls on the floor.
- Right click the room to which you want to apply the roofline, select the "***Use Roofline***" command and click on the roofline. This associates the roofline to that room.

- Repeat this process for all rooms that apply.
- If you selected a wrong room and associated it by mistake, you can right click it again and select the "***Unuse Roofline***" command, which only appears in the menu for rooms associated to a roofline.

A floor plan may contain different rooflines, but a room can only use one of them. Figure 168 shows a floor plan with two rooflines, each having a different roof height and orientation.

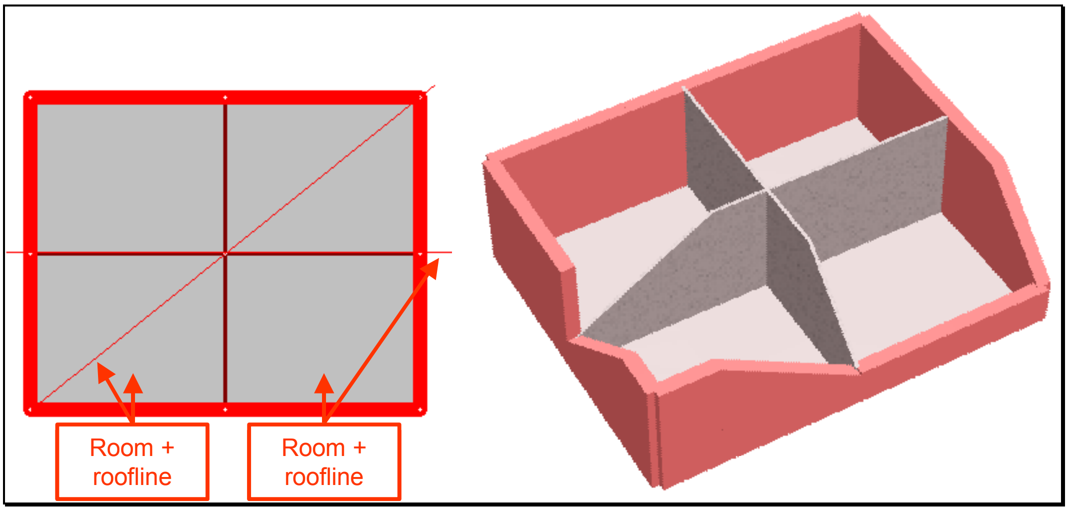


Figure 168: A floor plan with two rooflines, associated to two rooms

A roof may also contain roof windows. To draw it, select the roof window icon () and place the window on the floor plan, as shown in Figure 169:

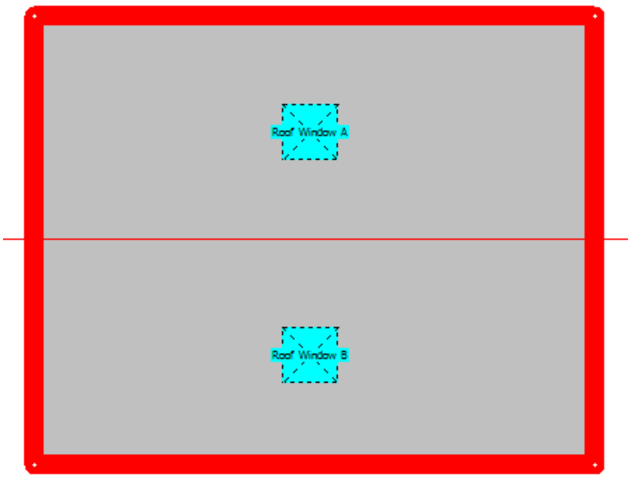


Figure 169: A roof with two roof windows

The edit window of a roof window allows entering its dimensions (height and width) and to select its construction and shade.

6 Performing a Temperature Simulation

As the load calculations, temperature simulations are only possible in Expert mode. As explained in the previous chapters, after you have drawn the floor plan, you start with the design of a ventilation strategy, after which you perform a load calculation to benefit from the ventilation devices. Once you have the required loads, you can select the air-conditioning devices. When all devices have been selected, the floor plan is ready for a temperature simulation. However, during all those steps, many may go wrong. A few examples:

- If you forget an important load in a room, the load calculations may give results that are too small.
- You may forget to connect an indoor unit to an outdoor unit.

This chapter first explains how to perform validation checks and then explains temperature simulation, while showing results. It concludes with the use of centralized controllers and the production of reports.

6.1 Validation Checks

In the VRVPro Expert mode, there are many items to take care about. So, it is quite possible to forget a few or to make mistakes. VRVPro offers a validation function, allowing you to detect problems in a building. Select the "***Validate***" command in the Building menu to bring up a window, as shown in Figure 170:

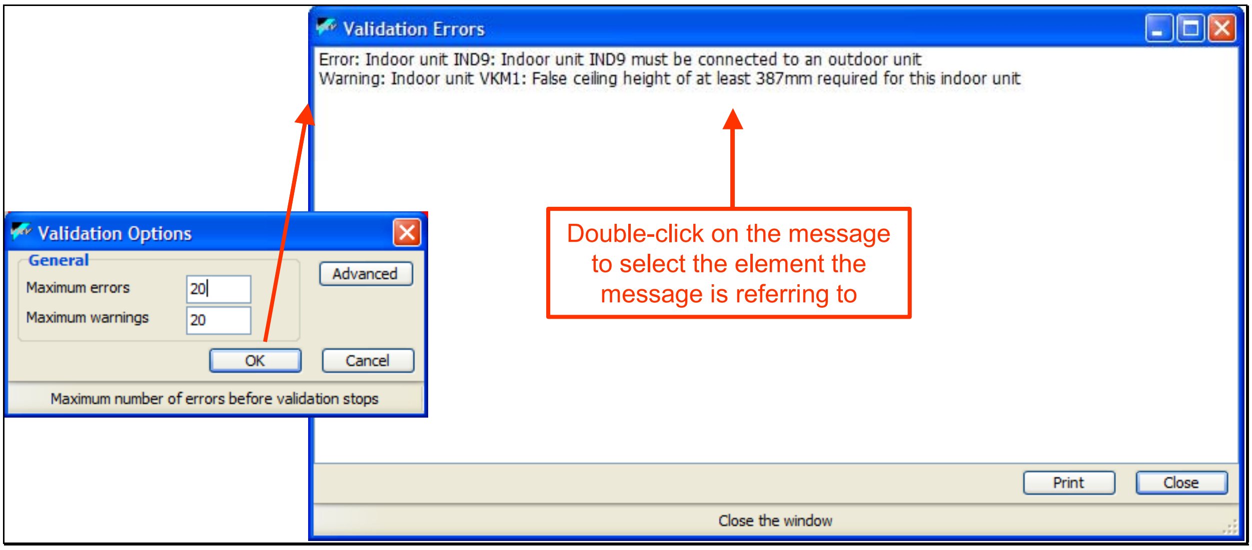


Figure 170: Validation the building using standard validation checks

When clicking the OK button, VRVPro starts its validation and lists the problems it found in a validation window. Double-click a message to select the element it is referring to in the floor plan.

VRVPro discerns between errors and warnings. An error message prevents you creating reports, as the building contains inadmissible problems. An example is the first message in Figure 170. Warnings, on the other hand, are used to indicate potential problems. You may take them into account, but you may also ignore it. An example is the second message in Figure 170.

In addition to the standard validations, you can also perform a more in depth validation. Before starting the validation, you can click the "***Advanced***" command button in the validation window. This creates a larger window showing a whole list of possible user checks, as shown in Figure 171. These checks allow you finding problem areas in rooms, that you otherwise would find by checking room per room.

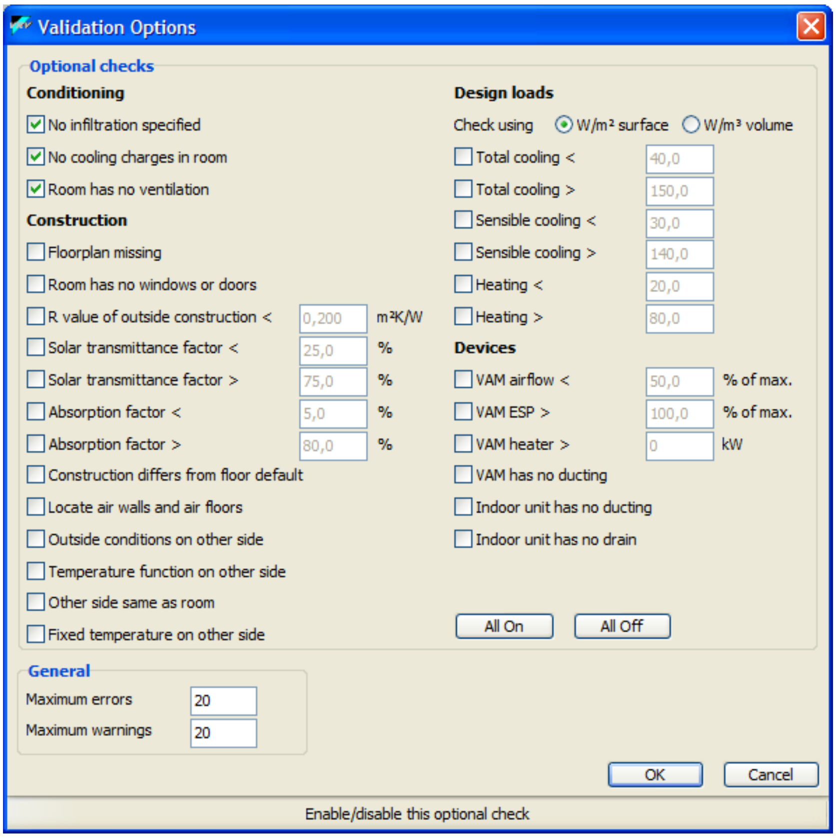


Figure 171: The full validation window in Expert mode

Just select the extra checks to perform and click the OK button. For some checks you also will need additional data. When you select for instance a minimum total cooling load, you must enter a value (or accept the default value). Figure 172 shows the results of a validation with the extra checks selected in Figure 171. The results show that this floor plan was not completed before performing a load calculation.

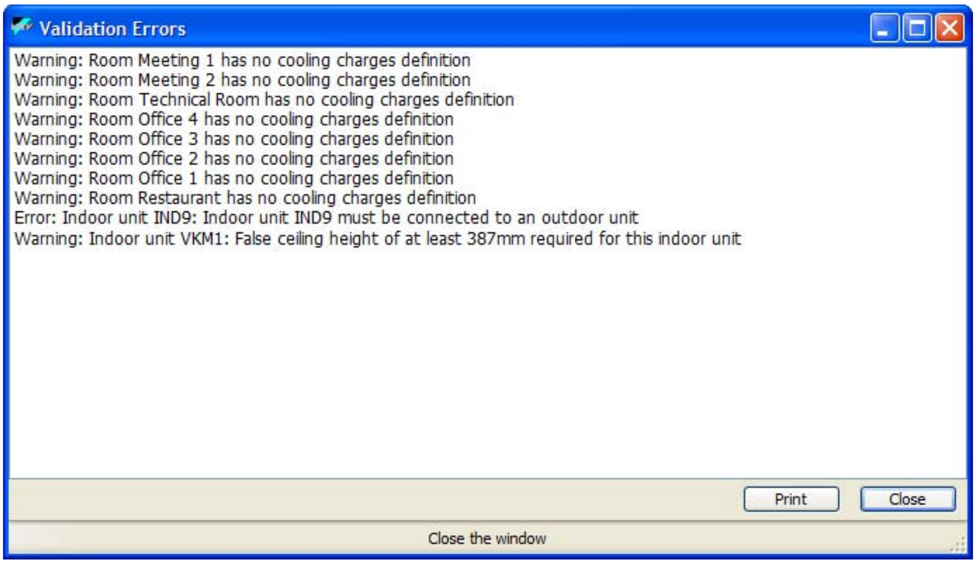


Figure 172: The validation window showing some extra checks

Although it is possible to select all user checks, it is not a good idea to do so. In fact, a building may contain many exceptions or special cases. Performing all user checks would result in a long list of messages. It is better to select a few user checks and concentrate on specific problems.

6.2 Temperature Simulations

A temperature simulation is comparable to a load calculation, but has three important differences:

1. It uses all heat sources, sun data, infiltration air and ventilation air. This is a combination of what is used in the cool and heat load calculations. It also takes the occupancy definitions (see Figure 120) into account, both for the heat sources and for the devices.
2. It adds the delivered capacities of the indoor units, VAM devices and VKM devices. These counter-act the heat sources and sun data.
3. It performs calculations per hour and for a whole year (in total 8760 hours). In addition, the results of one hour are used for the next hour. This is especially important for the accumulated heat in walls and for the mixing of the room air with infiltration air and ventilation air.

Of all the devices, a heat pump outdoor unit needs some special treatment. In fact, when heat pump operates in cooling mode, all its indoor units only cool. If the room would need heating capacity, these indoor units can only ventilate the air. This does not provide any capacity to the room.

So, a heat pump outdoor unit uses a cooling period, during which is operates in cooling mode only. Outside this period, it operates in heating mode. To define such a cooling period, the first tab in the "***Building Properties***" window shows the months in a year. You can select the months during which the heat pump outdoor unit must cool, as shown in Figure 173. The month's order changes (see the bottom of Figure 173) when you select a location in the Southern Hemisphere:

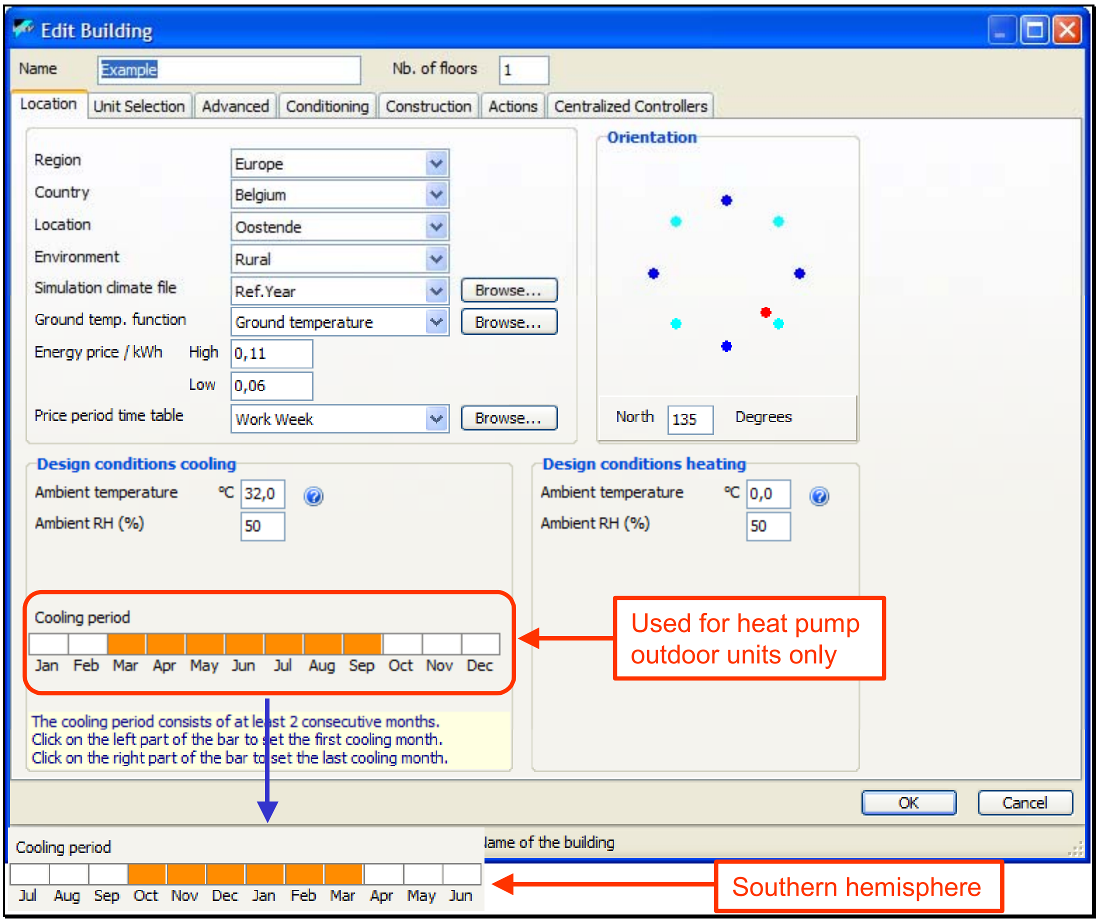


Figure 173: Defining the operation mode of heat pump outdoor units

After correcting possible validation errors and setting the cooling period, you can now start the temperature simulation. Select the "***Temperature Simulation***" command in the Building menu. This brings up a window, shown in Figure 174 and similar to the load calculation window.

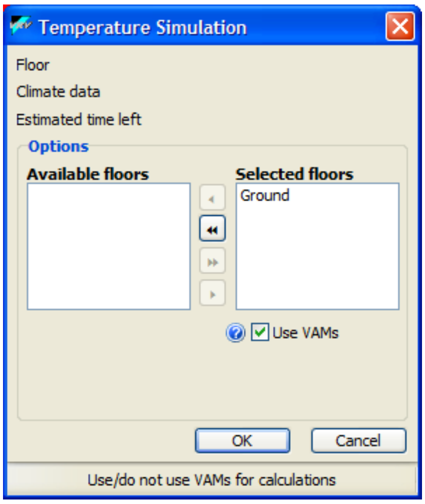


Figure 174: The temperature simulation window

A temperature simulation simulates the temperature and humidity evolution in a room. To make the results more realistic, you should define when the air-conditioning system should work. Although it may work day and night, it is more probable that it only works during the working hours. You can define this by selecting an occupancy definition for the indoor units. For a given date and hour, a value larger than zero in such definition means that the indoor units are operating. A value zero means that the indoor units are not operating and that the temperature in the room may freely evaluate.

By doing so, the temperature in a room may drop or rise too much. You can prevent this by defining night temperature setback values, as shown in Figure 175 at the right. When the temperature drops lower than 16^{0}C or rises more than 32^{0}C, the air-conditioning will switch on to make sure these limits are taken into account.

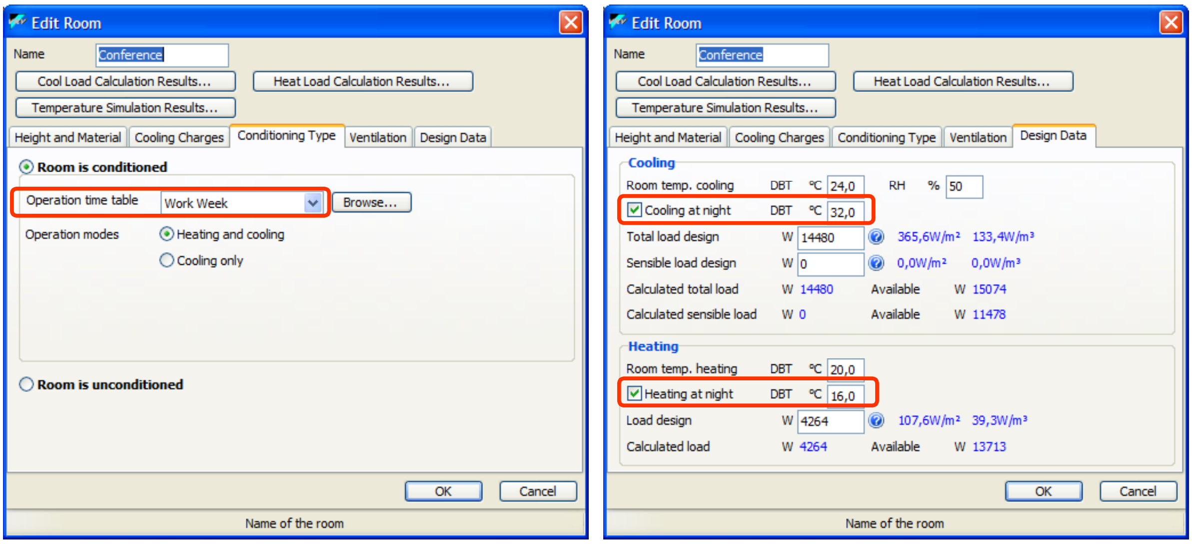


Figure 175: Useful settings for the temperature simulation

Performing a temperature simulation takes more time than a load calculation, as VRVPro calculates results for 8760 climate records and this for each floor. On an average computer, this may take 30 seconds to several minutes, depending on the size of the project. During these calculations, VRVPro creates simulation data for each room and stores them in separate files for later evaluation.

6.3 Temperature Simulation Results

As for the load calculation results, you can get the temperature simulation results for a room, a floor, the building and the outdoor units, by clicking the "***Temperature Simulation Results***" command button in the corresponding edit or properties windows. However, graphs with 8760 results are too dense to analyze results. So, temperature simulation result graphs have two periods that you can select, where one of these periods is the active one for which the data are shown.

Figure 176 shows such a graph containing a "***Cooling***" and a "***Heating***" period. These names have no particular meaning, as you can slide both periods over any part of the year. The idea was to have two periods between which you can compare easily just by activating one and then the other.

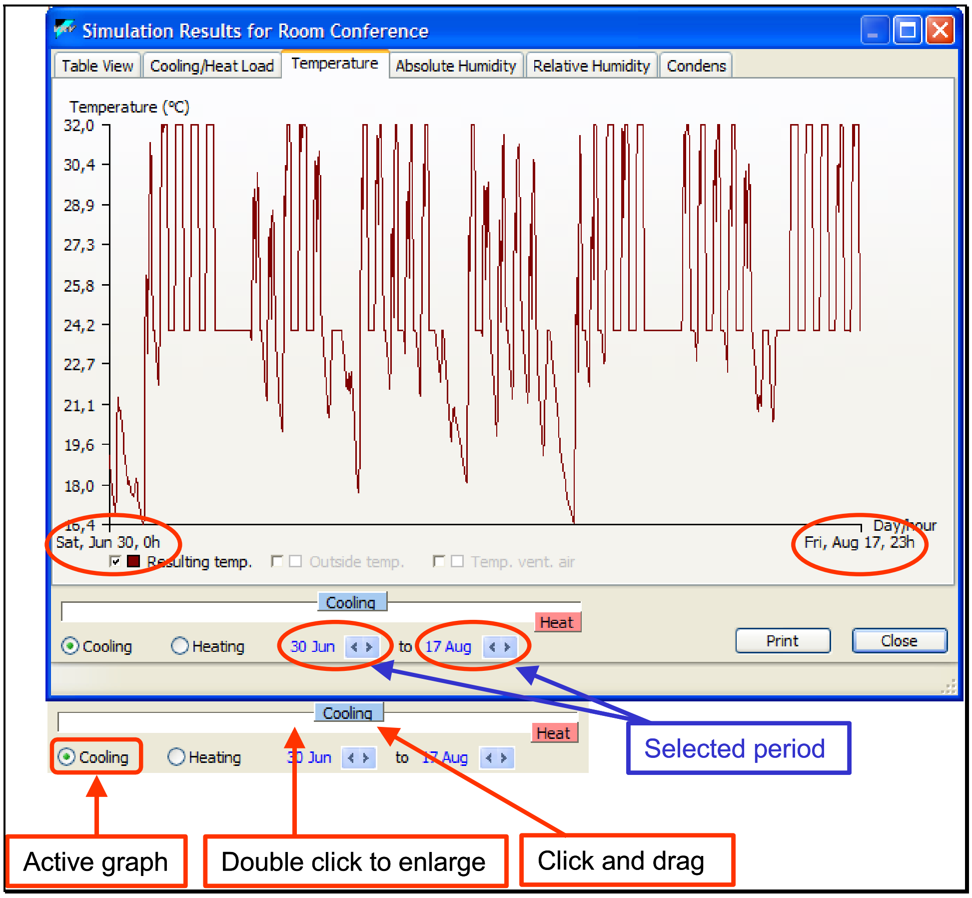


Figure 176: Temperature values in a room as a result of a temperature simulation

You move the (active) period by clicking on it and while keeping the mouse pressed, drag it along the line. The date values below the line give the start and end dates of the period. If you want to enlarge a period, just double click at the left of it. To reduce it to one day, double-click at the right of it. You can also adjust a period by clicking the arrows at the right of the dates.

In the graph of Figure 176, the cooling period is active and ranges from 30 June up to 17 August. The graph shows the evolution of the temperature in the room "***Conference***". It clearly shows that the temperature during the days (working days and hours) is fixed at 24^0C, where at some nights it is topped off at 32^0C. Other nights (and weekends) the temperature drops during the hours the air-conditioning system is not operating.

The graph data are also available in tabular form. A table contains 8760 rows, which makes it difficult to locate some numerical values within the active period. For that reason, VRVPro adds an icon to the left of the tabular data, if the dates are within the cooling or the heating periods. If both periods overlap, VRVPro uses a third icon. Figure 177 gives an example of the tabular view with icons at the left. This part shows a few hours of the cooling period and several hours of overlapping cooling and heating periods.

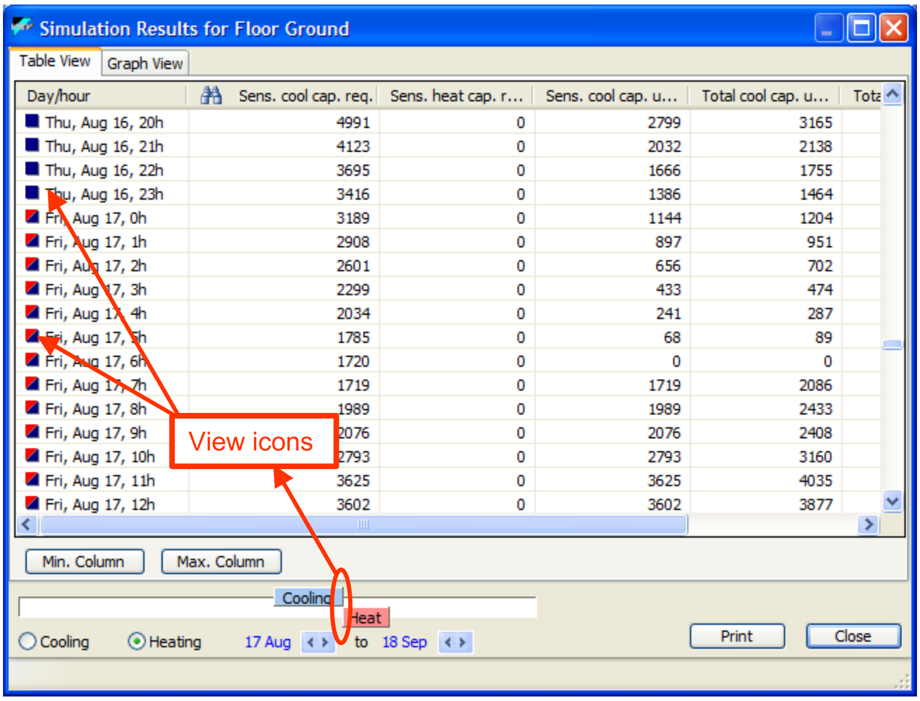


Figure 177: Using icons in the tabular forms to indicate the cooling and heating periods

For some graphs, you may need to see the whole year. For example to get the yearly load graph for the outdoor unit, use one period and enlarge it over the whole year, as shown in Figure 178:

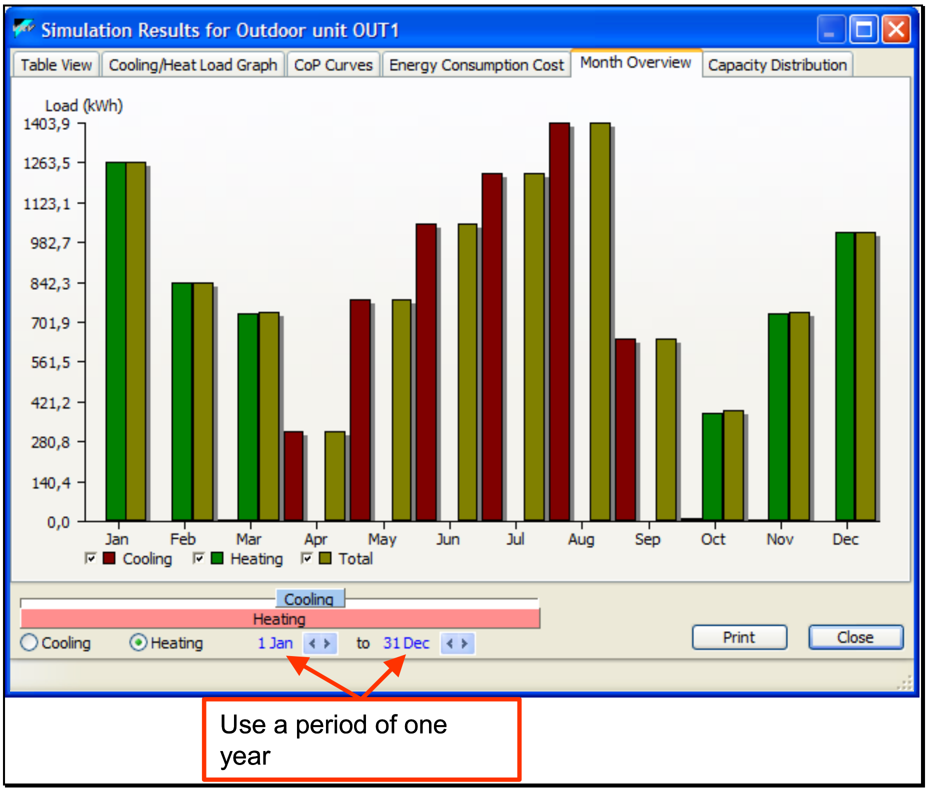


Figure 178: Yearly load results for an outdoor unit

Figure 179 gives another example of an interesting yearly overview are the EER and COP values (both are the ratio between the delivered capacity and the power input required). These are only given for hours the outdoor unit is operating. Given these individual COP and EER, VRVPro calculates the seasonal COP and EER values.

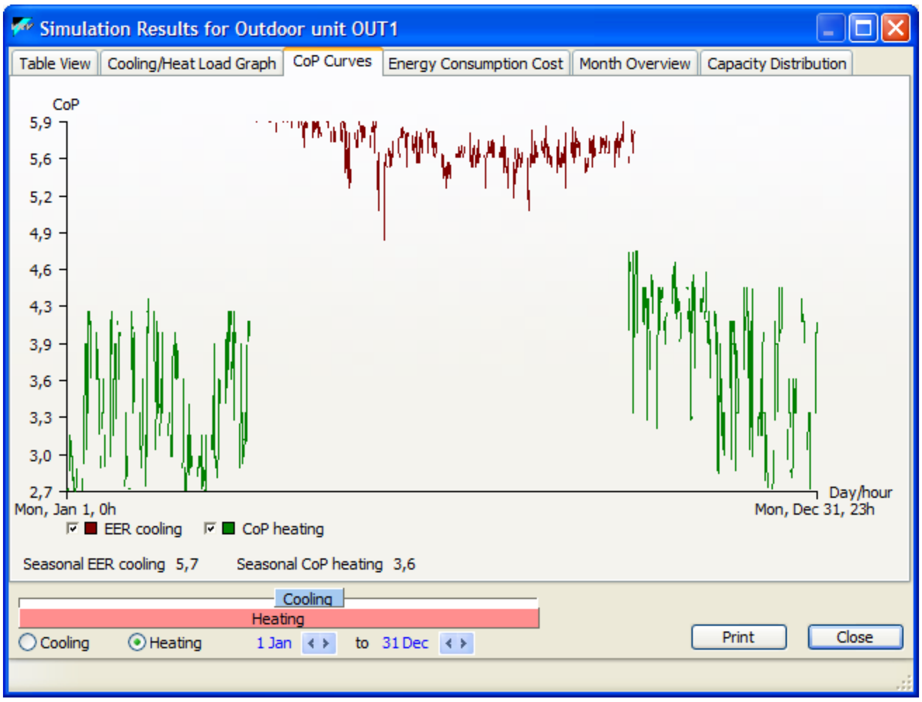


Figure 179: Yearly COP and EER curves for an outdoor unit

For some rooms, interpreting temperature simulation results may become difficult, as too many elements play a role. In those cases, it is always advisable to simplify the room data until the results become comprehensible and explainable. This will give you a deep knowledge of your building and its rooms.

6.4 Centralized Controllers

To define the centralized controllers, open the "***Building Properties***" window and click the "***Centralized Controllers***" tab. VRVPro handles centralized controllers in exactly the same way as in Xpress (see Figure 180):

- You select a centralized controller from the list at the top of the window.
- VRVPro then draws that controller and its sub controllers in the part below. It automatically connects outdoor units to it, up to a maximum defined by the centralized controller.
- If there are more outdoor units than can be connected to a single centralized controller, VRVPro adds another one, up to all outdoor units are connected.
- In addition to centralized controllers, you can also select a management system from the list at the right side of the window.
- The list at the bottom right lists the outdoor units and four special buttons:
  - : Allows moving up an outdoor unit in the list. If the list only contains one outdoor unit, there is no point in moving it up.
  - : Allows moving down an outdoor unit in the list. If the list only contains one outdoor unit, there is no point in moving it down.
  - : Splits up a group of outdoor units into two groups.
  - : Allows selecting a different centralized controller for the selected outdoor unit.

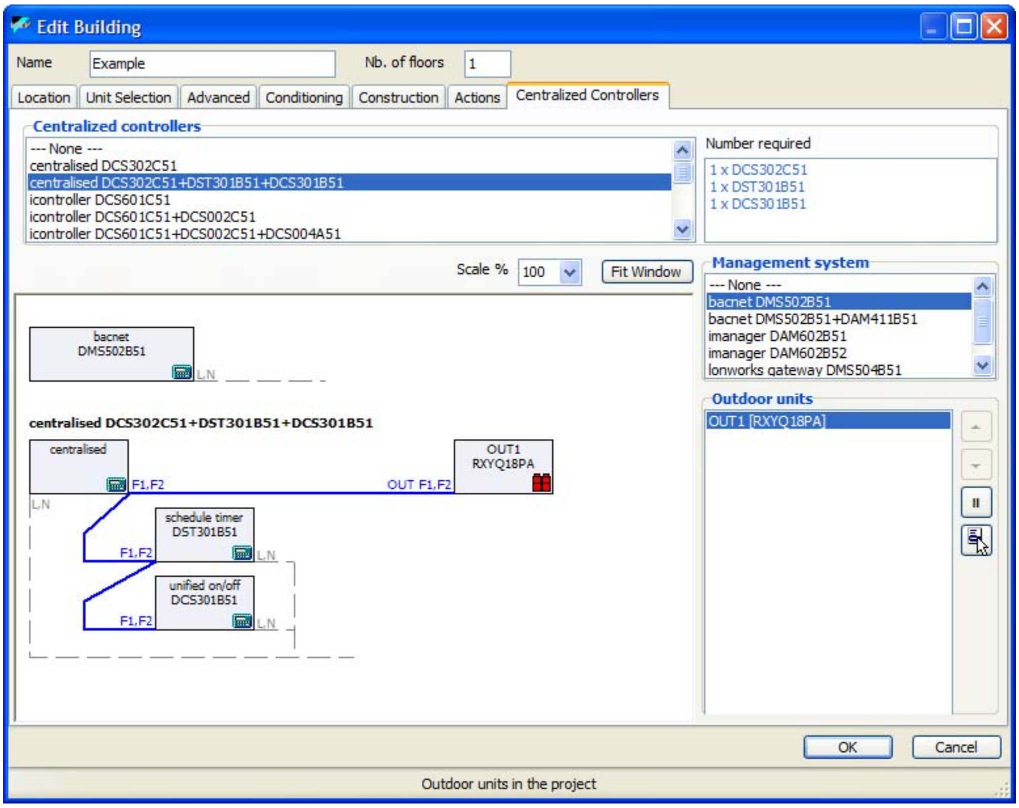


Figure 180: Adding centralized controllers to the systems

The actions of the last two buttons are illustrated in Figure 181:

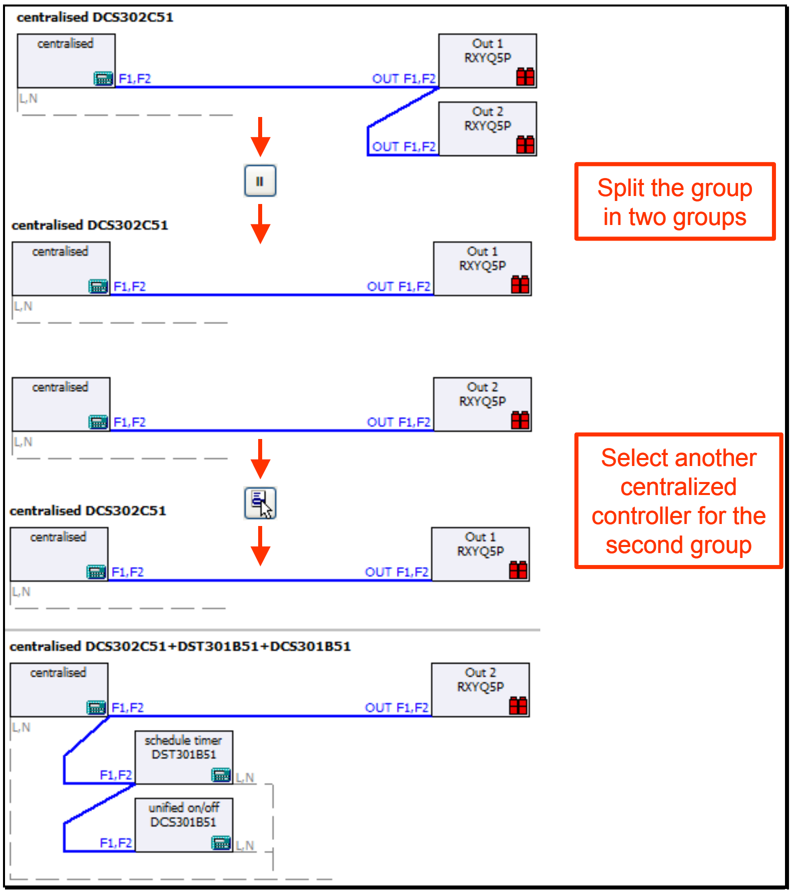


Figure 181: Defining different centralized controllers on groups of outdoor units

6.5 Reporting

VRVPro offers different kinds of reports. The next sections explain them in more detail.

6.5.1 The MSWord Report

VRVPro can produce very large MSWord reports, containing a lot of data gathered during the drawing, the load calculations, the device selections and the temperature simulations. Figure 182 shows the window that VRVPro brings up when selecting the "***Document***" command in the "***Reports***" sub menu of the building menu.

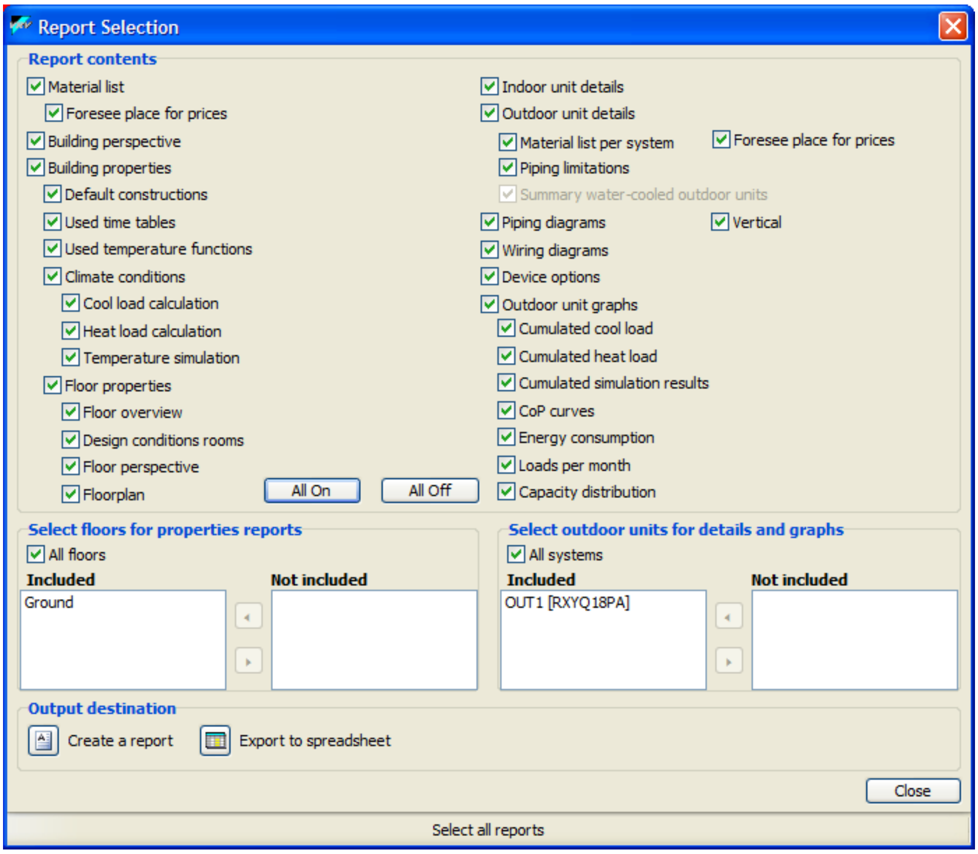


Figure 182: The VRVPro MSWord report window

This window is organized in several sections containing tabular overviews, such as material lists, and tables with overviews of devices. It also contains sections to get the floor plans (both the two-dimensional and the perspective view). Other sections allow you to produce the piping diagrams, wiring diagrams and several outdoor unit graphs. You can decide to include the information for all floors or only for a selection of floors, for all outdoor units or for a selection of outdoor units.

When you click the "Create a report" command button, VRVPro first will perform a validation. If this validation succeeds, it will create the report. However, if VRVPro finds errors, it will prevent you making a report. First you will have to correct those errors.

VRVPro creates an MSWord report with a page break between each section. For a small project, this may result is more pages than necessary. In such cases, you should remove some extra page breaks to get a more condense report. Figure 183 gives an example of a report. Although the pages are rather iconic, many parts of the report are recognizable as pictures and graphs appearing in full in this document.

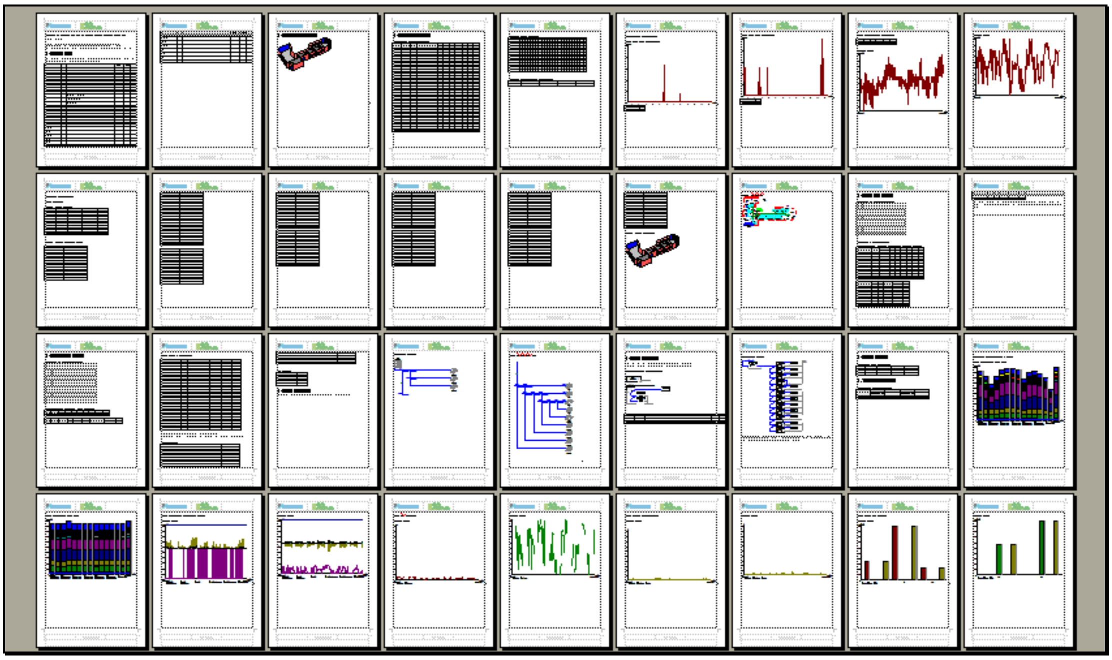


Figure 183: An iconic overview of a VRVPro document report

6.5.2 The Floor Plan as AutoCAD File

When selecting the "***Floorplan View***" command in the "***Reports***" sub menu of the building menu, VRVPro brings up a window as shown in Figure 184. In this screen you can select the floor plans you want to export, the folder in which to produce the AutoCAD files and the prefix that each filename will get. Note that the exported floor plans will only show the elements that you have selected via the "***Editor Palette***" window (see Figure 57).

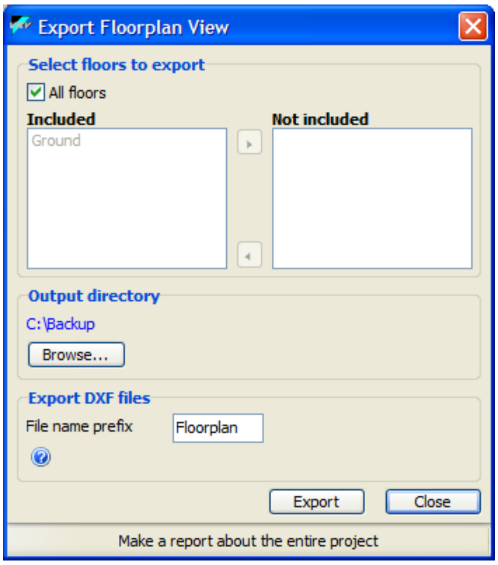


Figure 184: Exporting floor plans in AutoCAD

When clicking the "***Export***" command button, VRVPro will export all floor plans in dxf format. In addition to the floor plan, VRVPro will also add a scale line of 5m to allow scaling the drawing once you load it into AutoCAD. Figure 185 gives an example of a floor plan exported as dxf file.

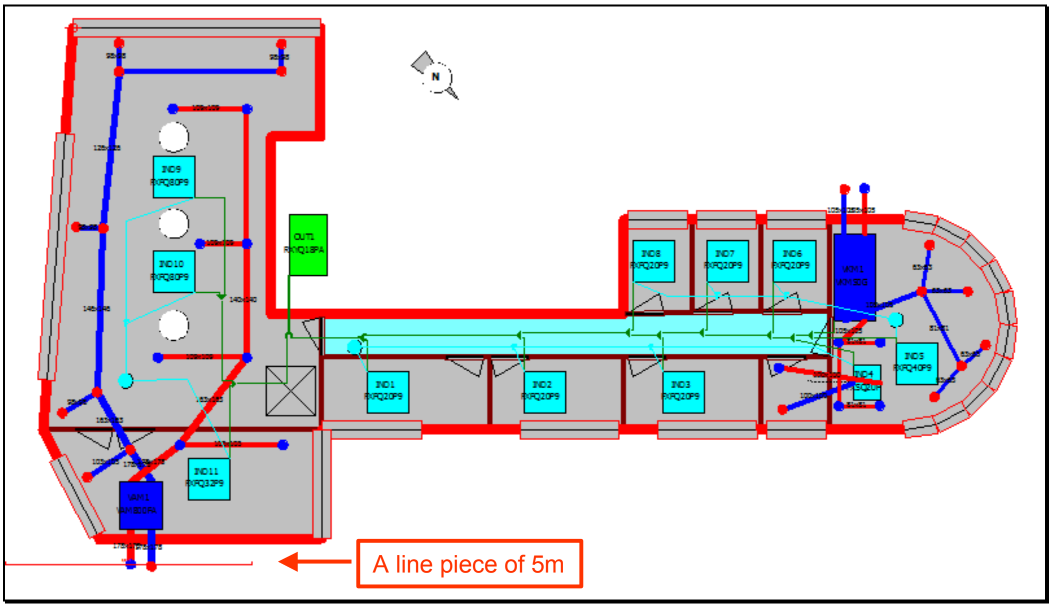


Figure 185: Example of a floor plan exported as AutoCAD file

6.5.3 The Floor Plan Piping as AutoCAD Layer

When selecting the "***Piping Diagram***" command in the "***Reports***" sub menu of the building menu, a similar window comes up as shown in Figure 184, but the file name prefix is now set to "***floor***". When clicking the "***Export***" command button, VRVPro will only export the devices on a floor plan and connected with piping, as shown in Figure 186. The purpose of this export is to allow you sending these data to the developer of the original AutoCAD file that you used as a template, as explained in section 1.6.2.

In addition to a scale line of 5m, as in the floor plan export, this AutoCAD file also contains a reference point allowing the exact positioning of this layer over the other layers in the AutoCAD file.

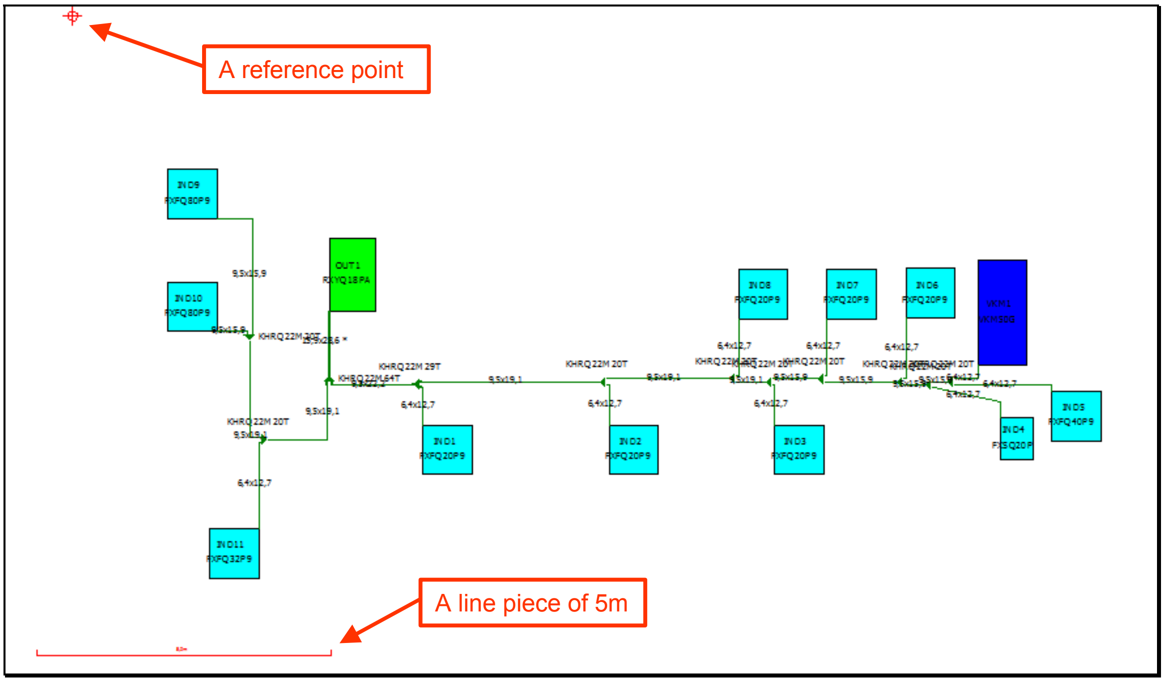


Figure 186: The floor plan piping, exported as an AutoCAD layer.

6.5.4 The Piping and Wiring Diagrams as AutoCAD Files

The "***Export Diagrams***" command in the "***Reports***" sub menu of the building menu brings up a window to select a folder name, similar to the other export commands, in which VRVPro will export the piping and wiring diagrams for each outdoor unit.

In addition to the diagrams, VRVPro also add some small tabular form containing outdoor unit data from the project, as shown in Figure 187:

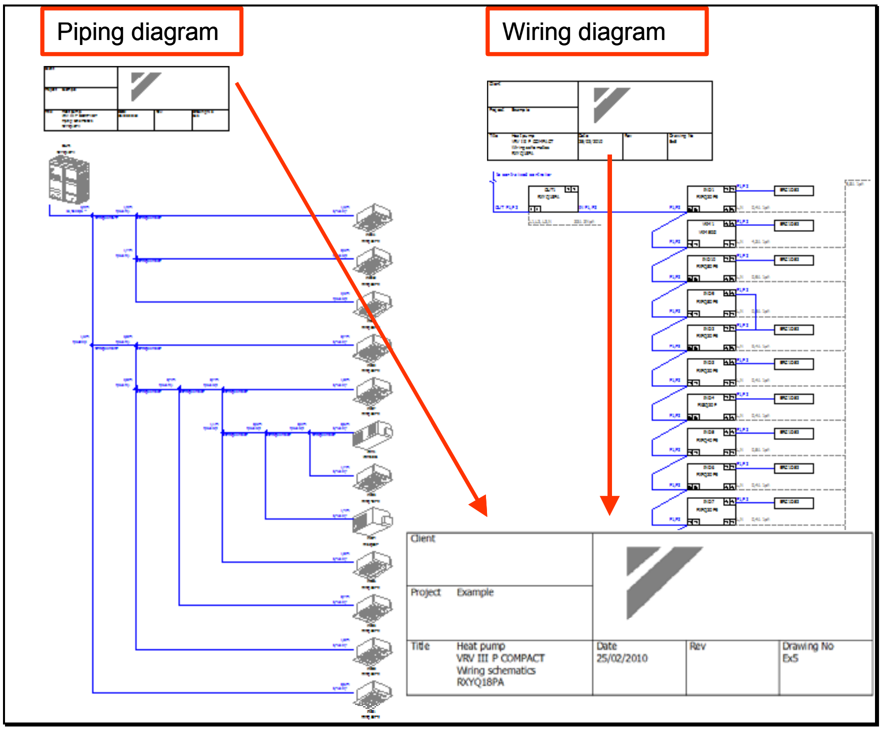


Figure 187: AutoCAD export of a piping and wiring diagram

6.6 *Getting Data From Other Projects*

As explained in section 1.2, the company database is part of the VRVPro executable program. When releasing a new version, it is possible that the company database it contains may have been extended with several new definitions. You may also want to recuperate construction definitions from existing projects.

The "***Update Definitions***" command in the Database menu brings up a window as shown in Figure 188. It contains two tabs:

1. The "***Company Database***" tab (see Figure 188 at the left) allows copying the selected data from the company database in the VRVPro executable program into your project. From then on, you can use those new definitions. Note, for example, that loading the "***current location***" resets all parameters used to produce a climate file (see section 5.8) to the original data.
2. The "***User defined constructions***" tab allows you scanning all VRVPro project files to look for user-defined constructions. After you selected a folder from where to start, click the "***Scan***" command button. VRVPro will now look for all project files (fpe files) in the selected folder and all its sub folders. It opens each of these files, looks for user-defined constructions and puts them in the "***Do not import***" list. After the scan, you can select the required constructions and click on the button to move them in the "***Import***" list. You now can click the "***Import***" command to import constructions in your project.

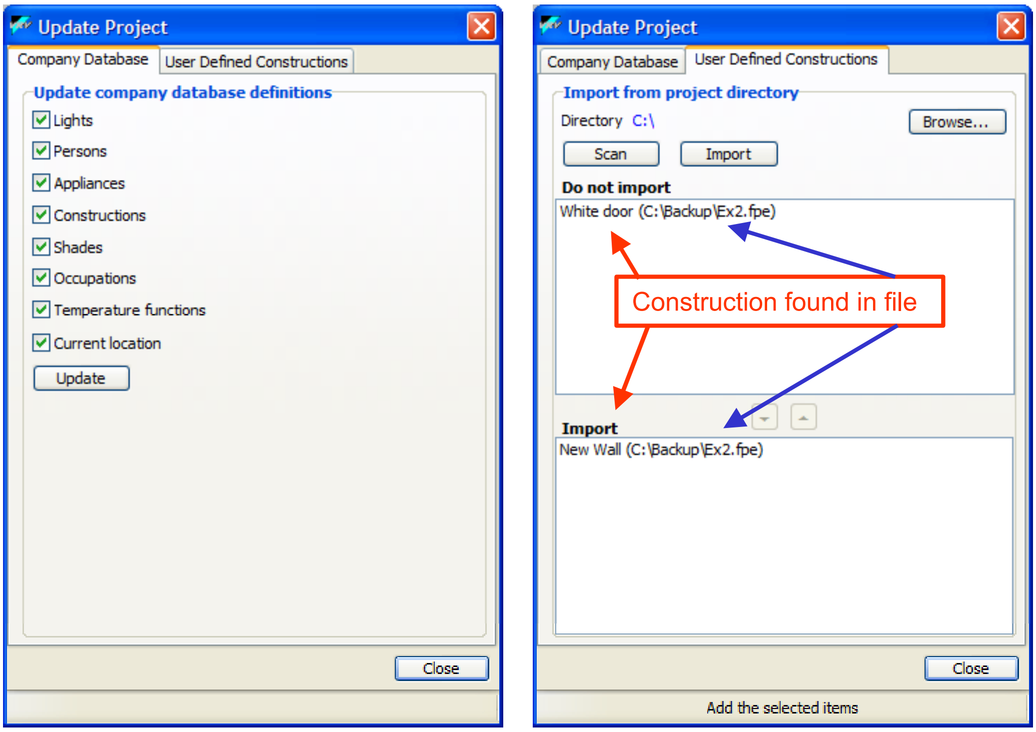


Figure 188: Updating project data from different sources