February 2019

Manual IRENE Pro 4.7

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Title Manual IRENE Pro 4.7
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Contents

1 Introduction

Congratulations with your choice of IRENE Pro 4.7. IRENE Pro is the application for the analysis and simulation of gas distribution networks.

1.1 How to Use this Manual

In Chapter 2 of IRENE Pro , an explanation is given of how IRENE Pro works. This gives a quick insight into the operation of IRENE Pro. Each function is dealt with independently in the following chapters. Here are also highlighted sections:

> The highlighted sections show directly the steps needed to perform a function. Often, the function is known, but the question is where to find the function required. The highlighted sections give a direct answer.
>
> **The names of menus and buttons are shown in bold.**

1.2 New in IRENE Pro 4.7.0

IRENE Pro is continuously being developed. You, as a user, have great influence on this. The IRENE Pro team tries to include as many of your wishes as possible in the development.

PLEASE NOTE: IRENE Pro 4.7.0 uses an new upgraded XML definition for irene-files. Old irene-files can still be used without any problem. But once the file is saved with version 4.7, the file can no longer be used in previous versions of IRENE Pro.

In IRENE Pro 4.7.0, as compared with the previous version (4.6.3), the following requests from users have been incorporated:

- Background maps: New view options: Color, Soft tone, Dark grey, greyscale
- Background maps: Selected view option is saved as user setting.
- Assets dialog: Stable sort on columns in order of last sorted column to first selected column.
- Capacity calculation: Yellow marked warning message in both the calculation dialog and the status bar are clickable and will open a dialog with all warnings and error messages. Messages that are linked to a specific location, can be located in the grid view by a double click.
- Capacity calculation: In case of warnings and errors a more visible, yellow marked message is shown.
- Capacity calculation: warning messages for each station that has an inlet pressure less than the required inlet pressure.
- CML: Lay-out tab Stations has improved.
- Definitions – Gas: The net calorific value for a gas has been added to the gas definition. It is used to recalculate the consumption and capacity values in case a different gas is selected. For backward compatibility: in case the calorific value is unknown, the calorific value of the default gas is used. By default, the calorific value is 31,65 MJ/m^3, but can be changed via Settings – Default gas.
- Definitions – Gas: It is possible to create multiple gas definitions.
- Definitions – Networks: possible to select a different gas (if defined in the gas definitions). The demand and supply is automatically recalculated, based on the net calorific value of the gas.
- Dimensioning: Selection of design diameters is per material type.

- Settings – Units: Possibility to set the demands and supplies as energy instead of flow.
- Settings – Maps: Button “Update map index” has been moved from tab “Folders” to tab “Maps”.
- Settings – Default gas: the settings of the default gas can be changed. REMARK: It is saved as a user setting.
- Legend: the colours are automatically selected, such that they are optimal distinctive.
- Legend: For a continuous scale, the number of colours used, can be changed from minimal 6 to maximal 40 colours.
- Verify Network: verification if there are endpoints of pipelines within reach of twice the connection tolerance.
- Notes: A date field is added.
- Open: opening in read-only mode has been added. In case of any changes, the user is forced to save as a new file. Other users can still open the original for modification.
- Result presentations: themes flow and speed can be presented separately or combined.
- Status bar: shows a yellow marked message in case the network verification found some warnings and/or errors. By clicking on the message, the network verification dialog is opened.
- Status bar: shows a yellow marked message in case the calculation completed with warnings and/or errors. The message can be clicked, which will open a dialog containing all the messages.
- Tooltip: is shown even when the mouse is slightly beside the centre of the object.
- View: coordinate numbers are shown with thousands separators.

1.3 Demo Version

A demo version is available for free download at www.irenepro.com. With this demo version it is possible to complete a capacity calculation of a gas network which comprises of one network, a maximum of 50 pipelines and a maximum of one supply point.

If the calculation of a larger gas network is desired, a licence can be requested from Kiwa Technology

The table hereunder summarizes the differences between the demo version and the version of IRENE Pro with the most extended licence.

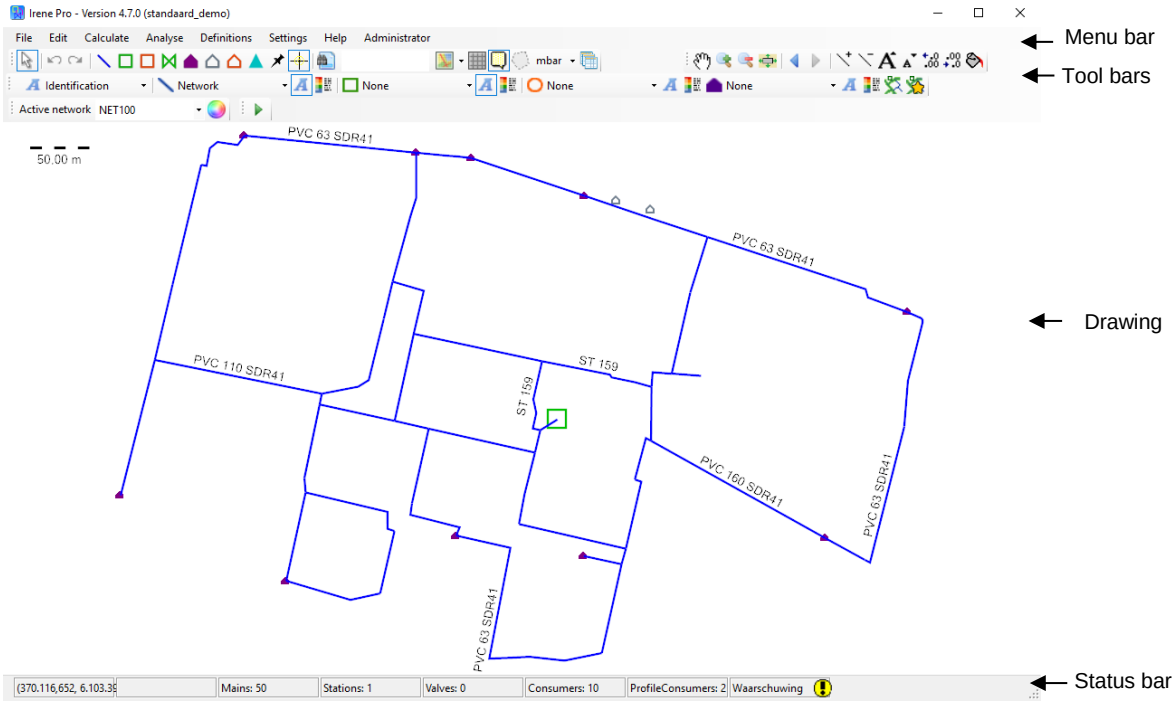
	Demo Version	Licensed Version
Modules	Capacity Calculation	Capacity Calculation, Dimensioning, Profile Calculation, CML, Green+, Operations
Network	1	Unlimited
Pipelines	50	Unlimited
Stations	1	Unlimited
Reporting	Limited	Complete
Calculation with Regulators	No	Yes
Use of online background maps	No	Yes

The most recent version of IRENE Pro, including this User’s Manual and the release notes, is available for download from the website www.irenepro.com.

The download and installation procedure is described in Annex VI.

2 IRENE Pro Basic Principles

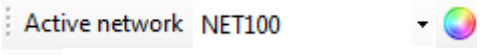
IRENE Pro works in a graphical environment. In the figure below, one or more networks are shown. These networks could have been imported from a GIS (XML-format), or drawn in by hand. Subsequently, it is possible to perform calculations and analyses using these networks. The results can then be shown graphically. Additionally, reports about the input data and the results can be generated in several ways.



The Button bar and the Toolbars are explained below. The menu bar and all the options are explained in the following chapters.

2.1 Toolbars

The toolbars can be found at the top of the screen. The toolbars for the selection of the network and displaying the results of the calculation can also be dragged to another part of the screen if required (e.g. the bottom of the screen).

Mouse selection mode	
Undo/redo	
Mouse drawing modes	
Search (drawing)	
View options: background maps, grid, etc.	
Open Assets dialog	
Active network selector	
Run standard calculation	
Mouse view modes (panning, zooming, fit view, etc.)	

Change object presentation settings

Show identification labels

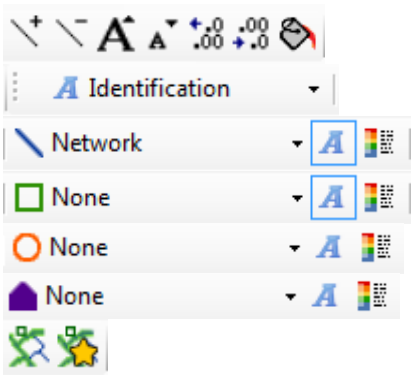
Result presentations pipes

Result presentations stations

Result presentations nodes

Result presentations consumers

Markings on/off and apply favourite markings



The “zoom” functions are cancelled with a click of the right mouse button. The “select” function then becomes active again.

For zooming in and out, the mouse wheel is used. Double click the mouse wheel for fit view.

The scale of the drawing is shown in the upper left of the window.

This automatically adjusts when zooming in and out. When the raster is visible the size of the raster matches the length of the scale.

2.2 Status bar

The status bar is shown at the bottom of the screen. It displays the statistics of the active network.

Calculation messages:

- Grey: no calculation results
- Green: calculation results
- Yellow: calculations results with warnings (click to see the warnings)
- Red: results invalid due to, for instance, modifications

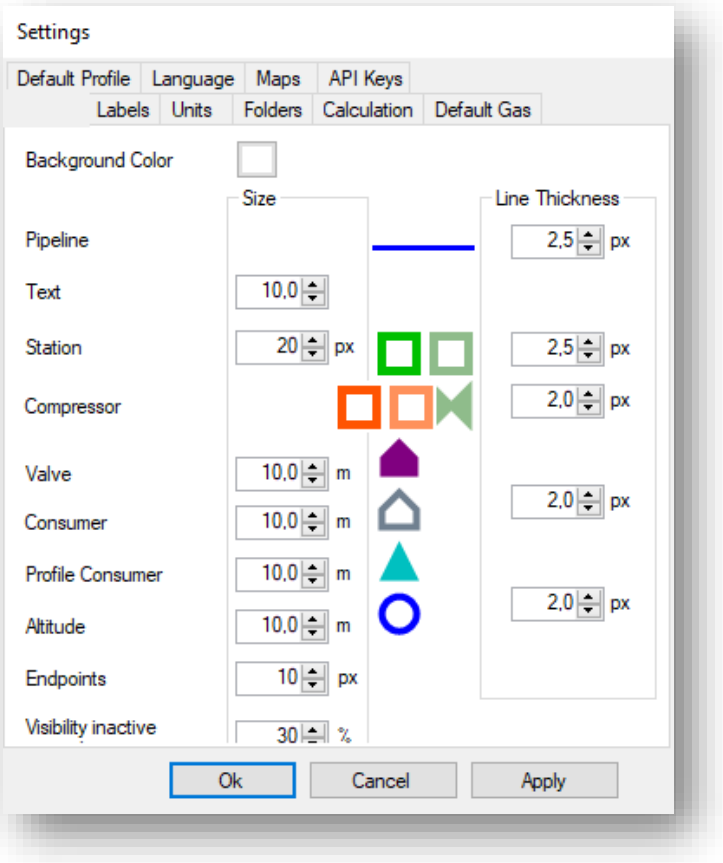
Information regarding the active network

Co-ordinates of mouse pointer

Messages from network checks (click to see)

2.3 Menu Settings

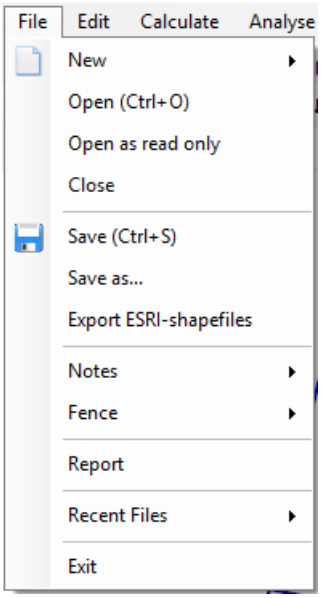
Through the menu **Settings** it's possible to alter a number of settings.



See chapter **Error! Reference source not found.** for details.

3 Working with Files and Reports

IRENE Pro uses XML files to exchange information with other Geographical Information Systems (GIS). IRENE also offers several reporting options. These are found under the **File** menu:



The different options are explained in detail below.

3.1 New / use template

With the option **New** the existing environment (all open networks) is closed and re-initialised (similar to Close). If you use the option **New - use template**, the new environment is initialized with the definitions for network, material and consumption of the chosen template. You can create your own templates by saving existing files as template, see §3.1.

Procedure:

- Select the **File** menu
- Click on **New - use template**.
- Select the template and click on **Ok**.

3.2 Open a File.

When **Open** (or **Ctrl**+**o**) is selected, the networks are opened from the *.irene files (XML). If you have already an environment with a network, you're asked if you want to close the existing environment. If you choose yes, the present networks are closed. If you choose not to close the existing environment, the contents of the file are added to the existing environment.

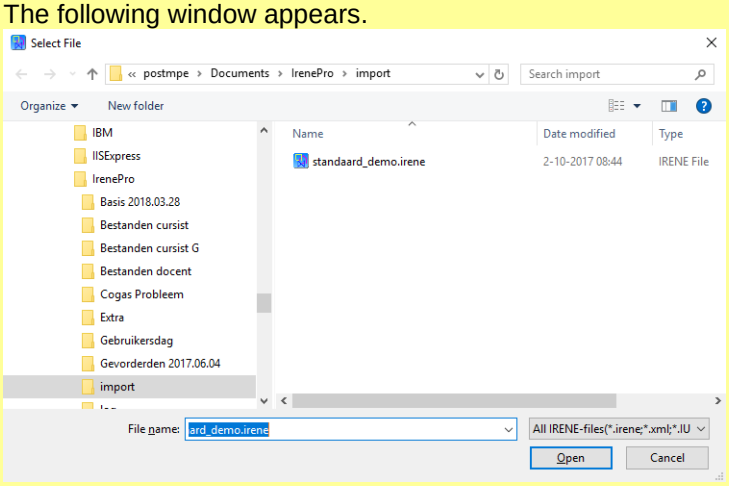
It is possible to import multiple files together. It is also possible to open different files after one another. The networks in these files are all imported in the same environment.

Tip
It is possible to open files by drag and drop them to IRENE Pro.

Tip
Key combination Ctrl+o opens the open file dialog.

Procedure for Opening Files:

- Select the **File** menu
- Click on **Open.**
  The following window appears.



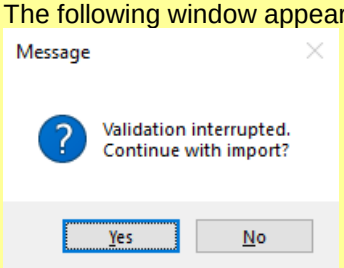
- Select the file and click on **Open**

When importing large networks, time can be saved during loading by interrupting the validation process.

Procedure for premature interruption of the XML validation process:

- Open a file (as described above).
- The following window appears.

- Press Cancel.
- The following window appears.



- Select **Yes.**

The networks in the files are opened and shown in the environment.

PLEASE NOTE: The interruption of the validation process is only without risk for further processing if the file has been found to be correct during an earlier validation.

PLEASE NOTE: There is no direct link between the opened files and the graphic environment. Changes which are made in the graphic environment will not be saved in the files which have been opened. If it is required that these changes are saved, then this must be done via the menu **Save** or **Save As.** The complete environment with all networks will then be saved in the first opened file, please refer to § 3.3.

A description of the XML- format is available for download from the website www.irenepro.com.

3.3 Save

All networks in the current environment are saved in a single XML file via the **File, Save** menu. This is the .irene file which was first opened (the name of the file is shown in the upper bar of IRENE Pro in brackets after the version number). In case you opened a read only file, you are asked for a new file name and/or location.

Tip
Key combination **Ctrl+s** also saves the file.

PLEASE NOTE: If multiple files have been opened, then all imported networks will be saved in the XML file which was opened first.

PLEASE NOTE: The results of calculations are included and also saved.

Procedure:

- Select the **File** menu
- Click on **Save**.
- The file which was originally opened will be overwritten.

3.4 Save As

Through the menu **File**, **Save As** the existing environment consisting of all the networks is saved in a user defined file and location.

After you have chosen **Save As**, multiple file types can be chosen, see the table below.

File type	Result
IRENE-file (*.irene)	The network is saved, including calculation results, in a standard IRENE-file (this is an XML file).
IRENE-file without calculation results (*.irene)	The network is saved without the results of the calculations.
IRENE-file as template (*.template)	A template file is made, based on the current environment. The template will contain all definitions (network definitions, material definitions, etc.), of the current environment. Objects, like pipelines and stations, are not saved in the template. The template can be used to initialize a new environment with all definitions, see §3.1. **PLEASE NOTE:** If multiple files have been opened, then the definitions of all imported networks will be saved in the template.

Image (*.png / *.jpg / *.bmp / *.gif)	The current screen display is saved as an image. There is a choice of four formats: PNG, JPG, BMP and GIF. When an image is saved, a location file is also generated[1]. With this file you can use the image as a raster layer in a GIS or, for example, as a background map in IRENE Pro.
Adobe Acrobat (*.pdf)	The current view is saved to a PDF file, together with the following information: date, filename, name of the calculator, remarks, calculation settings and legend of the selected result presentations.
DXF-file (*.dxf)	The current screen display is saved as a DXF file. This file can be opened with any program that supports the DXF format, enabling you to make a vector plot of the network. **PLEASE NOTE**: The background maps and gridlines are not saved to the DXF.

3.5 Export ESRI-Shapefiles

You can also export to ESRI-shapefiles. For each object (like pipes, stations and valves) files are made. These files can be viewed with any viewer that supports ESRI-shapefiles.

Procedure:

- Select the **File** menu.
- Click on **Export ESRI-Shapefiles.**
- Select a location for the files.
  PLEASE NOTE: Since multiple files are concerned, it is advisable to create a folder for the files.
- You will noticed as soon as the export is ready.

3.6 Notes / Save and import

If there are any notes present, they can be saved to a separate file. Saved notes files can be imported. The advantage is that all the notes can be reused with other .irene files.

Procedure:

Save notes:

- Add notes, see §6.1
- Select the **File** menu.
- Click on **Notes**, **Save.**
- Select a location and file name and save the notes.

Import notes

- Select the **File** menu.
- Click on **Notes**, **Import.**
- The previously saved Notes are imported.

3.7 Import / Save Fence

If you have drawn a Fence (see §6.2.2), it's possible to save the shape and location of that Fence. After saving you can import and reuse this Fence again (import).

[1] As well as the image, an ESRI World file is created with the same name as the image, but with a different extension. This file contains the information of how the image should be positioned and scaled. For further information, please refer to: http://en.wikipedia.org/wiki/World_file

The Fence is saved as a .fence (which is a XML file). The file contains the coordinates of the corners of the Fence.

Procedure:

Save a Fence:

- Draw a Fence, see §6.2.2
- Select the **File** menu.
- Click on **Fence**, **Save.**
- Select a location and file name and save the Fence.

Import a Fence

- Select the **File** menu.
- Click on **Fence**, **Import.**
- The previously saved Fence is opened.

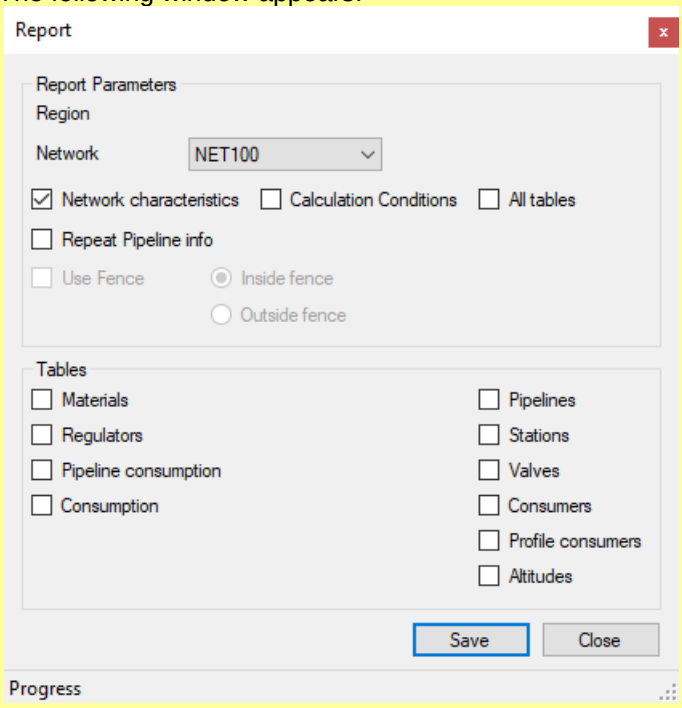
PLEASE NOTE: Any current Fence is replaced by the imported Fence.

3.8 Reporting

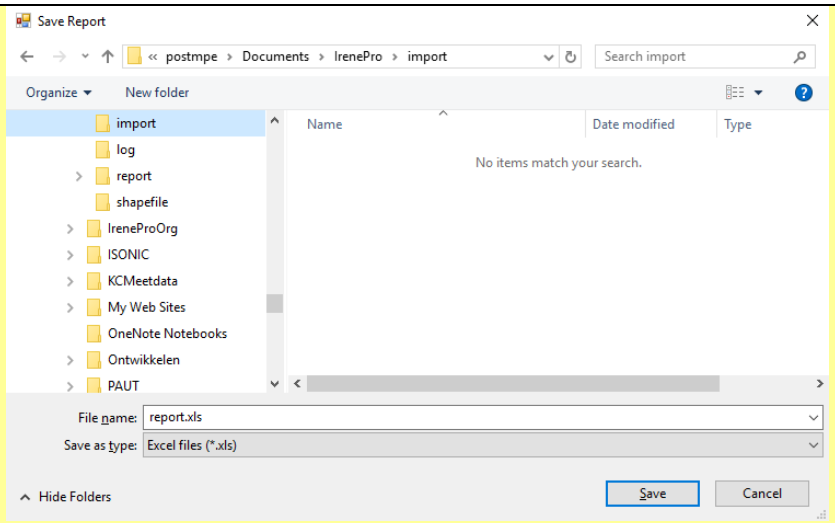
It is possible to generate a report of the network data and the available calculation results in Excel .

Procedure:

- Select the **File** menu
- Click on **Report**.
  The following window appears.



- If you have created a fence, you can choose to limit the report to the objects inside or outside the fence.
- Select the tables to be included in the report.
- Click **Save**
  The following window appears:



- Select a folder and file name and save the file
- If required, repeat the procedure for a report with a different selection.
- Click on **Close** to close this window.
- Open the report with Excel

3.8.1 Repeat pipeline info

A single pipeline can contain multiple consumers, each with its own consumption definition. In the report these are displayed as separate rows, without repeating the pipeline information. This generates some empty cells as shown in the picture below.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	IDX	ID	LENGTH [	STATE	YEAR	FLOW []	MATERIAL	VELOCITY	PRESSUR	PRESSUR	PRESSUR	CATEGOR	NUMBER
2	1	*	55,06672	In Service	2010	0	ST 108	0	0	0	0		
3	2	*	145,6899	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	11
4	3	*	46,85764	In Service	2010	0	PVC/CPE	0	0	0	0		
5	4	*	104,1108	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	1
6												IUF_2	3
7	5	*	111,4722	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	3
8	6	*	64,74784	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	3
9	7	*	32,15708	In Service	2010	0	PVC/CPE	0	0	0	0		
10	8	*	95,11098	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	2
11	9	*	65,09978	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	3
12												IUF_2	2
13	10	*	117,7889	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	5
14												IUF_2	2
15	11	*	143,9456	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	5
16												IUF_2	2
17	12	*	9,263637	In Service	2010	0	HZ 63	0	0	0	0		
18	13	*	64,87895	In Service	2010	0	HZ 63	0	0	0	0	IUF_2	4
19	14	*	63,3569	In Service	2010	0	HZ 63	0	0	0	0		
20	15	*	12,2048	In Service	2010	0	HZ 63	0	0	0	0		
21	16	*	91,48321	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	6
22	17	*	76,28189	In Service	2010	0	HZ 63	0	0	0	0	IUF_1	5

Figure 1: Table with pipe line information, after exporting without "Repeat pipeline info". Pipeline 4, 9, 10 and 11 contain multiple types of consumers. As a consequence, extra almost empty rows are visible

By selecting “Repeat pipeline info” the pipeline information is repeated on each row when a pipeline has multiple consumption definitions. Thus the empty cells are avoided and ensures there aren’t any white spaces. This can be convenient if you want to use the filter options Excel offers. See the picture below.
PLEASE NOTE: If you, for instance, totalize the pipeline length the pipelines with multiple consumers will be double counted.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	IDX	ID	LENGTH [	STATE	YEAR	FLOW []	MATERIAL	VELOCITY	PRESSUR	PRESSUR	PRESSUR	CATEGOR	NUMBER
2	1	*	55,06672	In Service	2010	0	ST 108	0	0	0	0		
3	2	*	145,6899	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	11
4	3	*	46,85764	In Service	2010	0	PVC/CPE	0	0	0	0		
5	4	*	104,1108	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	1
6	4	*	104,1108	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_2	3
7	5	*	111,4722	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	3
8	6	*	64,74784	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	3
9	7	*	32,15708	In Service	2010	0	PVC/CPE	0	0	0	0		
10	8	*	95,11098	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	2
11	9	*	65,09978	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	3
12	9	*	65,09978	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_2	2
13	10	*	117,7889	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	5
14	10	*	117,7889	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_2	2
15	11	*	143,9456	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	5
16	11	*	143,9456	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_2	2
17	12	*	9,263637	In Service	2010	0	HZ 63	0	0	0	0		
18	13	*	64,87895	In Service	2010	0	HZ 63	0	0	0	0	IUF_2	4
19	14	*	63,3569	In Service	2010	0	HZ 63	0	0	0	0		
20	15	*	12,2048	In Service	2010	0	HZ 63	0	0	0	0		
21	16	*	91,48321	In Service	2010	0	PVC/CPE	0	0	0	0	IUF_1	6

Figure 2: Same table as Figure 1, but now exported with "Repeat pipeline info". Pipeline 4, 9, 10 and 11 contain multiple types of users, and therefore show up on multiple rows, now without any empty cells, because all information is repeated on each line.

3.9 Recent Files

Here you can select to open one of the last six opened files.

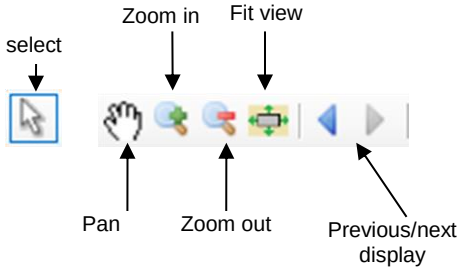
4 Display

The display can be changed in different ways. Zooming in, zooming out and panning are possible, the colours and the line widths can be altered too. It is also possible to show a background map and a raster.

4.1 Mouse Functions

The mouse is in selection mode by default. In this mode you can select any object by clicking it (left button), or open a context menu (right button). By holding the left button pressed and dragging, you can pan the drawing.

You can also select one of the specific mouse functions with the buttons on the button bar.:



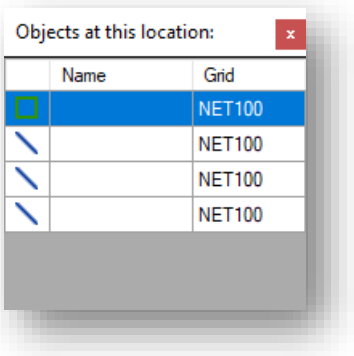
Click on the button to activate the function. Clicking with the right mouse button returns the mouse to its original function.

Scroll wheel: Zooming in and out can be done at all times using the scroll wheel of the mouse. Double clicking the scroll wheel causes a fit view. Scrolling while pressing shift or control will pan the drawing horizontal or vertical.

4.1.1 Selecting

By default the mouse is in selection mode. In this mode, objects can be selected and a Fence can be drawn (while pressing shft or alt). If you select an object with the right button, a specific context menu will open for that object. Standard mouse functions are:

- Selecting object by left clicking on it. A detail window will appear or
  If there are multiple (4 or more) objects close to each other, a selection menu will open:



  Click on one of the objects and the detail window will appear.
- Scroll wheel: zoom in and out.
- Ctrl + Scroll wheel: scroll image up and down.
- Shift + Scroll wheel: scroll image to the left or the right.
- Double click scroll wheel: a fit view is performed.

- Dragging with left mouse button pressed, pans the drawing.
- Dragging with left mouse button and shift pressed: fence selection.
- Alt + clicking left button creates a fence.
- Select an object with a right click of your mouse, opens a contextmenu with specific functions depending where you clicked.

4.1.2 Panning

With the pan function you shift the drawing on the display.

Procedure:

- Click on the Pan function (small hand) on the button bar.
- Click with the left mouse button in the drawing.
- Move the mouse whilst simultaneously holding down the left mouse button.
- When this has been completed you can reset the mouse to its original function with the right mouse button.

Note: Since panning can be performed in any mouse mode, just by dragging the mouse while holding the left mouse button, this function is a bit superfluous.

4.1.3 Zoom In

With the zoom in function you select a box for enlarging the drawing on the display.

Procedure:

- Click the Zoom In button (Magnifying glass with plus sign).
- Click with the left mouse button in the drawing and drag with the button held down simultaneously to draw a box over the area to be enlarged. The area will be enlarged to the size where everything which was selected in the box boundaries will still be visible.
- When this has been completed you can reset the mouse to its original function by clicking with the right mouse button.

4.1.4 Zoom Out

With the zoom out function you can shrink the drawing on the screen.

Procedure:

- Click the Zoom Out button (magnifying glass with minus sign). The drawing is reduced by a fixed factor
- Click the mouse button multiple times or in the drawing itself to zoom out further around the location of the mouse.
- When finished, you can reset the mouse to its original functions by clicking the right mouse button.

4.1.5 Fit View

Fit View enables the user to zoom in or out so that all of the networks fit precisely within the display. The mouse mode is not affected.

Procedure:

- Click on the Fit View function.
  The drawing is then zoomed in or out so that all of the networks are visible.

PLEASE NOTE: double clicking the scroll wheel will perform a fit view as well.

4.1.6 Previous /Next display

If multiple view functions have been used and the view has been changed, then using these buttons will go through the alternate views backwards and forwards.

Procedure:

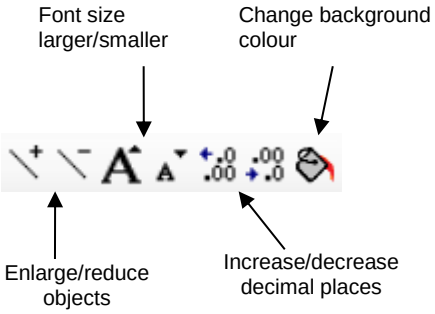
- Click on the arrow pointing left to return to the previous view.
- Click on the arrow pointing right to go to the next view.

4.2 Line Width, Colour and Other Display Options.

The presentation of the networks can be adapted to personal preferences. Beside the line width and size of objects, also the font size, the number of decimals and the background colour can be changed. These changes are temporarily, when performed by using the toolbar. Permanent change can be achieved via the **Settings** menu.

4.2.1 Changing the Display Using the Button Bar

Using the button bar it is possible to change the presentation directly. The button bar contains the following options:



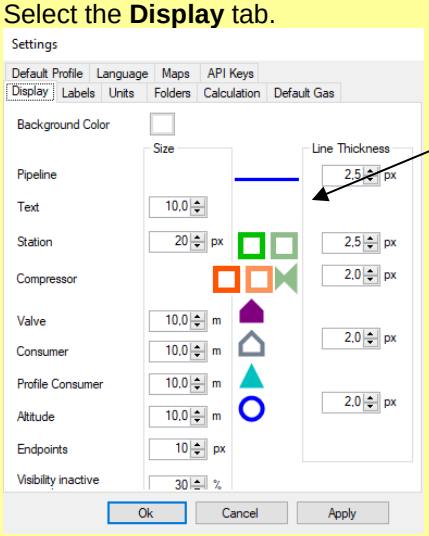
The changes are not saved when the file is closed. This means that the presentation will have the original settings when started again. If you want the change to be permanent, please use the **Settings** menu (see § 4.2.2).

4.2.2 Permanently Changing the Presentation using the Settings Menu.

The presentation changes made using the Settings menu are retained when IRENE Pro is closed. When the application is restarted, the presentation is initialised with these settings.

Procedure:

- Select the **Settings** menu.
- Select the **Display** tab.



Click on the object to select and set a different colour

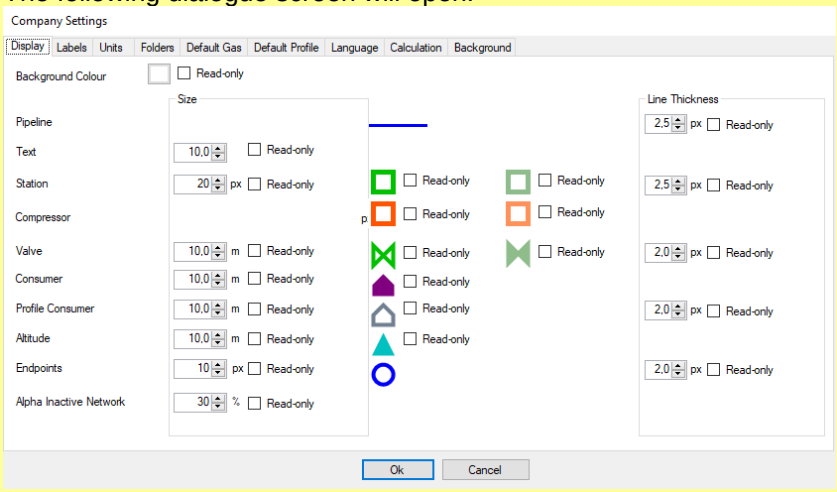
- Choose the desired background colour using Background Colour.
- Set the size and the line width for each object.
- Set the colour of an object by clicking on the picture of the object. A dialogue box will appear and you can select the desired colour. (With Stations and Valves you can select different colours for the closed and open status.)
- Choose the transparency of the inactive networks using Alpha Inactive Network (inactive networks are then shown with a lesser contrast than the active network).
- Click on **Ok** or **Apply** to save the settings.

4.2.3 Company settings

If you have a special Administrator license, you can create default values for all settings in the settings menu. These settings are loaded instead of the user settings every time the user starts IRENE Pro.

Procedure:

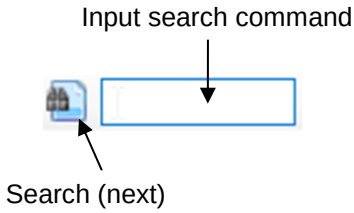
- Select **Administrator – Company settings**. (Only available with the proper license).
  The following dialogue screen will open:



- Choose on each tab the desired settings (if you check the **Read-only** boxes, the user will no longer be able to change that setting temporarily).
- Click on **Ok** to save the settings.
  The company settings are saved in the folder as designated in the Folders tab, at Company Settings. If you did not choose a location, IRENE Pro will default to the program directory in the Settings folder.
- Copy this folder to the same location for each user.

4.3 Search

IRENE Pro offers a search function for retrieving objects in the network.



There are three ways of searching:

- ID or Name
  Search on the unique identifier or the name of an object. You can fill in the whole name or a part of the name. The drawing is centred around the found object. By pressing the search button again, the next object that complies with your search string is searched.
- Postal code or address
  If you have an internet connection, you can also search on postal code or an address. The drawing is centred around the address point, if the address is known in Google.
  Note: this will only work, if you have set a valid API key for Google Maps, see §10.10.
- Coordinate
  You can also fill in a coordinate. The drawing is centred around the coordinate.

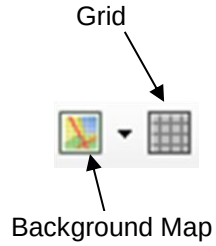
Procedure:

- Fill in the Name (or part thereof) of the object, or a coordinate (in accordance with the selected coordinate system)
- Click on Enter, alternatively, click on the button with the binoculars to the left of the search field.
- Click again on the button to search for the next object.

If the object, address or the co-ordinates have been found, then the drawing will be centred around the found location. In case an object has been found, the object is selected (marked in red).

4.4 Background Map and Grid

The background map and the grid can be activated using the following buttons:



The function can be deactivated by clicking the button again.

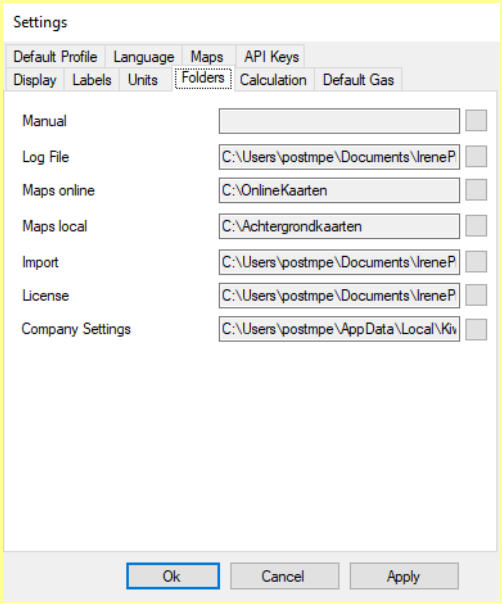
4.4.1 Providing the background maps

Background maps are not provided with IRENE Pro. There are two types of background maps possible:

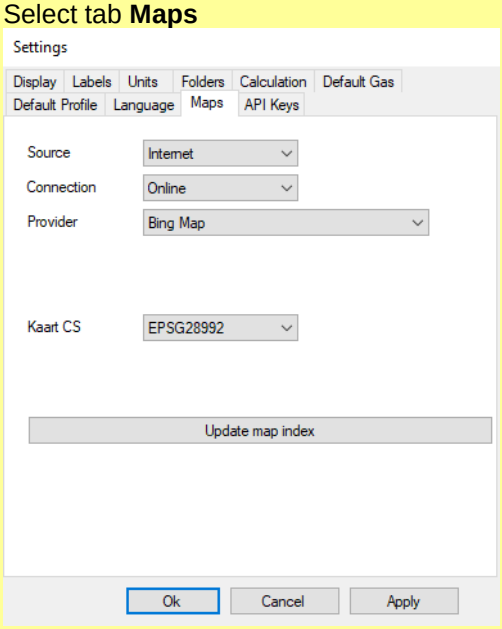
- **ESRI World files**
  Background maps with an ESRI world file can be used. It consists of image files (tiff, jpeg, bmp or png) and ESRI World Files with the same name but a different extension (tfw, jgw, bpw or pgw). These can be purchased separately from third party organisations.
- **Online maps**
  If you have a suitable IRENE Pro license, you can also use online maps from providers like Google Maps, Open Street Map or Bing Maps.

Procedure:

- Select the **Settings** menu
- Select the **Folders** tab**:**



- Select the location where the maps are stored:
  - **Maps online:** Location for caching maps that are downloaded from an internet provider
  - **Maps local:** location for stored maps in accordance with the ESRI world file system.
- Select tab **Maps**



- Set the **Source**:
  - **Local folder**: if you want to use ESRI worldfiles stored in a local folder
  - **Internet**: if you want to use maps from an internet provider. The maps are cached in the selected folder.
- If you have chosen **Internet**, than you have to set the following settings as well:
  - Set **Connection: Online** (if you select offline, only cached maps from a previous session are used).
  - Select a **Provider**

- **Map CS**: choose a coordinate system for the display (has to be the same as the one used for the ESRI Worldfiles).
- **Update map index:** in case you have added new ESRI worldfile maps to the folder, you will need to update the index (otherwise they aren't shown)
- Click on **Ok** or **Apply** to save the settings.

When everything is set up correctly, it is possible to turn the displaying of background maps on and off using the button  .
It is possible that the colours of the background map are too dominant. In that case you can set the Soft tone color, Dark Grey or Grey scale, using the drop down next to the button.

Procedure:
- Click on the arrow next to the button for showing back ground maps.
- In the drop down select one of the available options.

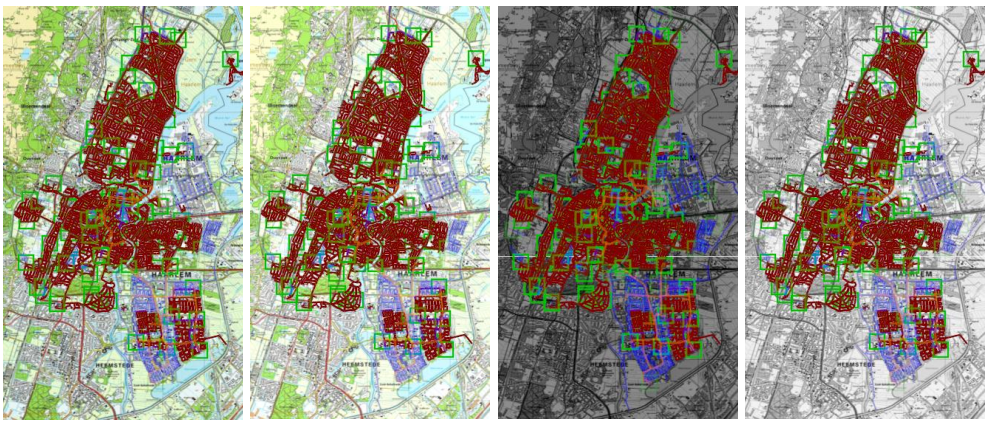


Figure 3: Display with background maps shown in Color, Soft tone color, Dark grey, and Grey scale.

PLEASE NOTE: After the selection of the Map folder, IRENE Pro creates an index file once (WorldFileIndex.xml), and places this in the map folder. If changes are made to the map, you have to update the index file:
- Select menu **Settings**
- Select tab **Maps**
- Press button **Update Map Index**

4.4.2 Grid

The grid can always be activated, even when no gas network is present. The grid is turned on and off using the  button.

Figure 4: View interface, at the left without grid, at the right with grid on.

The grid adapts – together with the scale ruler – while zooming in and out. The length of the ruler and the description matches the height and width of the grid cells.

4.5 Tooltip

When hoovering above an object, a text is shown with information about the object. This is a so called tooltip. The tooltip can be turned on or off using the button:

The information comprises the identification of the object, and, depending upon the type of object, some additional information (for instance, for pipelines the material and the diameter will be shown). The information is shown near the mouse pointer.

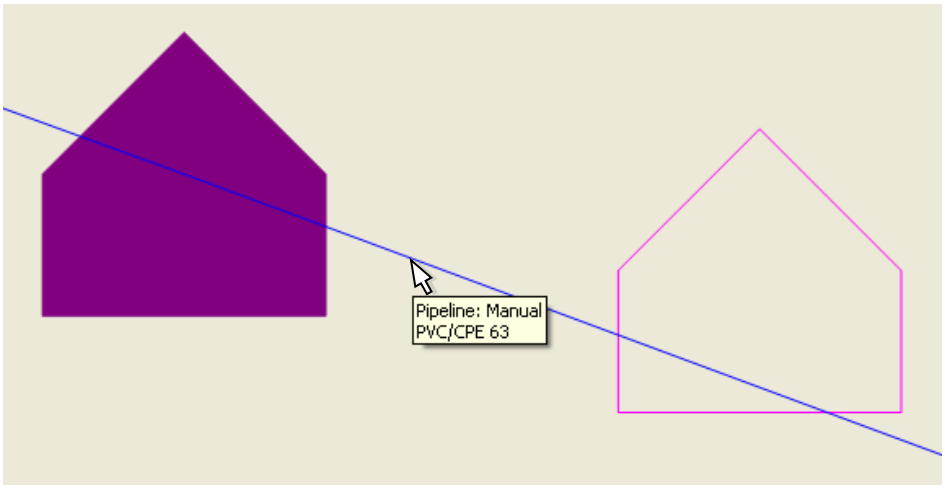


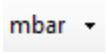
Figure 5: Tool tip near mouse cursor with information about the pipeline.

4.6 Selection on/off

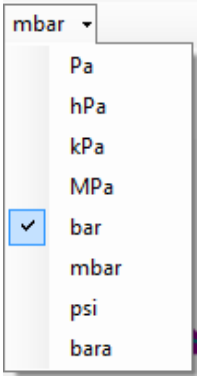
A fence can turned on and off using the following button:

4.7 Switching pressure unit

The following button enables you to switch between two pressure units:



By clicking once on the button the pressure unit changes to the pressure unit that the button indicates. To switch between other pressure units, click on the scroll down menu and select a different pressure unit.



4.8 Markings on/off

The following button enables you to turn markings on and off.

The marking of objects via the assets dialog is further explained in paragraph §6.3.5 and marking objects via marking definitions is explained in §9.9.

4.9 Copy screen

You can copy the current drawing to the clipboard, after which you can paste it as an image into a report or presentation.

Procedure:

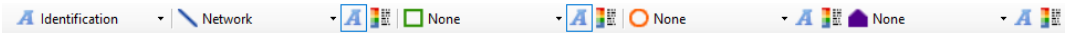
- Click on **Edit** and **Copy screen**

If you've made previously changes in the network, you will receive a warning stating that the Undo function can't be used to undo previous changes.

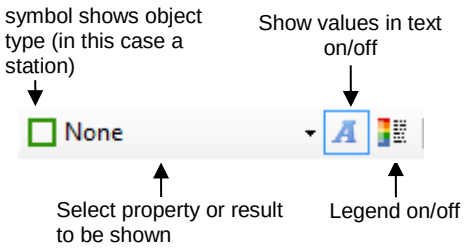
Tip
Use the key combination Ctrl + C to copy the current drawing to the clipboard.

5 Presentation of properties and results

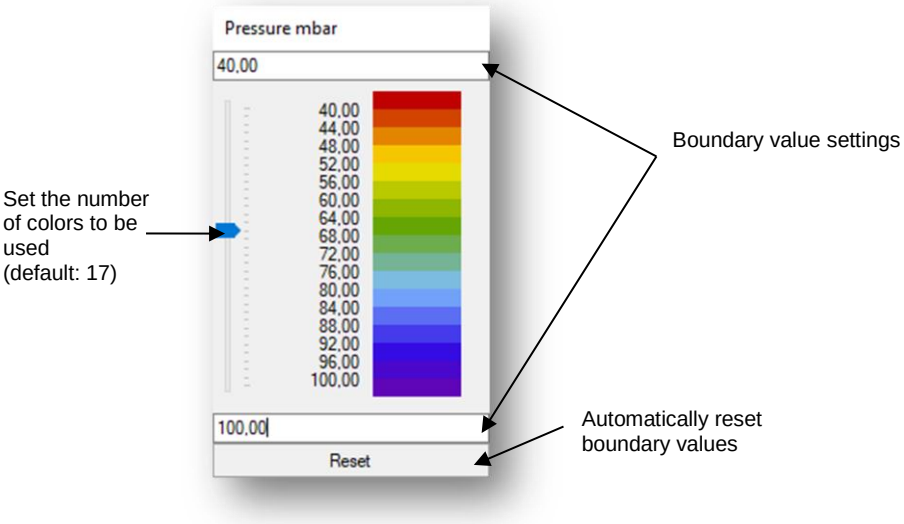
The properties and results is viewed with the assistance of the analyses toolbars. The four toolbars are shown below.



In the figure below, the general functioning of the toolbars is presented:



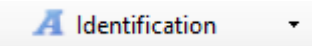
The legend can be turned on or off using the Legend button:  The legend shows the meaning of the colour scale. The upper and lower values for the colour scale are automatically set, but you can change both the minimum and maximum value.



The four toolbars are described in more detail in the following paragraphs.

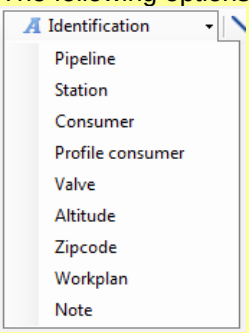
5.1 Identification Toolbar

The names of the objects are shown with the assistance of the Identification toolbar.

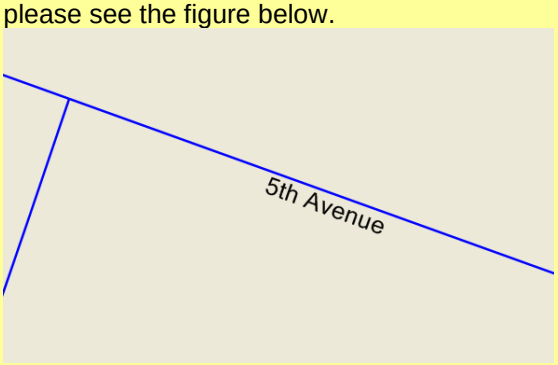


Procedure:

- Click on de **Identification** toolbar.
  The following options list is opened:

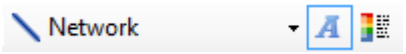


- Click (for example) on **Pipeline**
- The given name for the pipeline is now displayed next to the pipeline, please see the figure below.



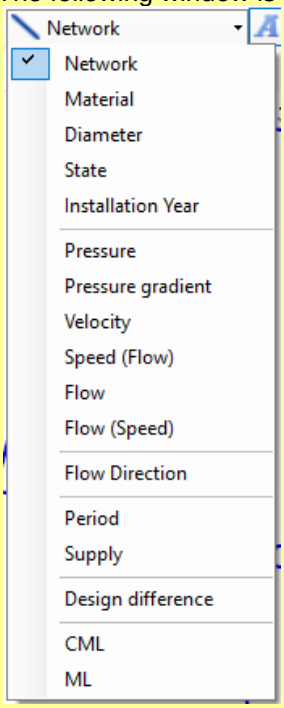
5.2 Pipeline Toolbar

The different calculation results are shown with the assistance of the Pipeline toolbar.

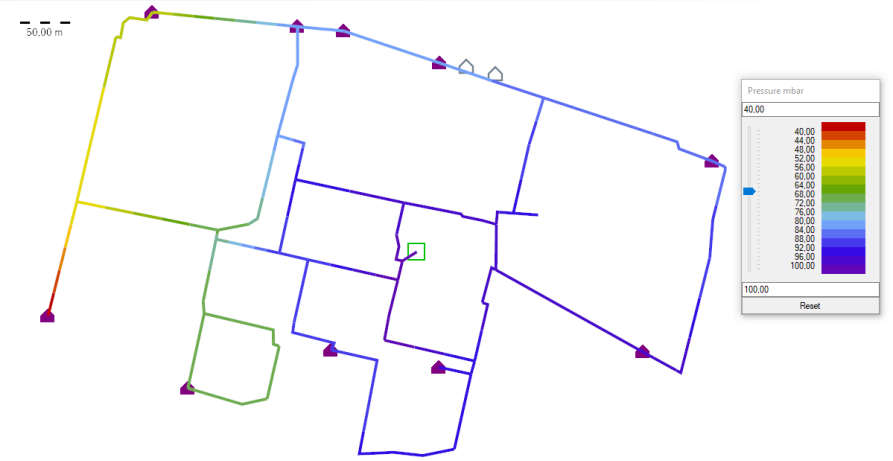


Procedure:

- Click on the **Pipeline** toolbar.
  The following window is opened:



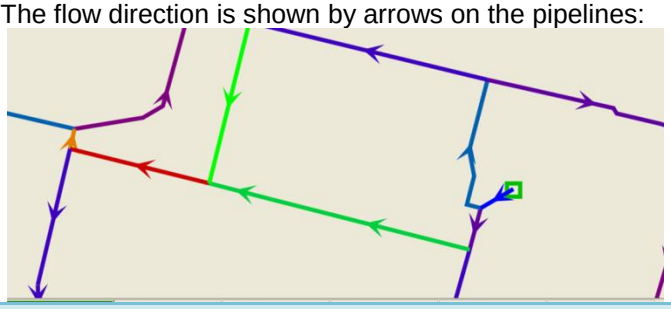
- Click (for example) on **Pressure** (after the completion of a capacity calculation).
  The following screen is shown:



  The distribution of the pressures in the network is shown on the screen.

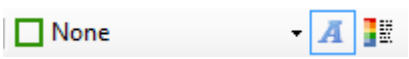
- The legend can be turned on or off by using the  button.
- The values can be turned on or off by using the  button.

Several items which can be selected in the above toolbar are described in more detail below.

Network	Shows each network in its own colour and the material names alongside the pipeline (if text is on).
Material	Shows the materials in colours and the names alongside the pipeline (if text is on).
Diameter	Shows the inner diameter in colours and the material names alongside the pipeline (if text is on).
State	The status of the pipelines by means of colours and text.
Installation year	The installation year by means of colours and values.
Pressure (isobars)	The calculated pressure distribution is shown by means of colours and text.
Pressure gradient	Calculated pressure loss per metre in colours and values.
Speed Speed (flow)	The maximum speed of the gas (operational conditions). The value for flow rate is shown between brackets.
Flow Flow (speed)	The calculated flow rates (normal conditions) are shown. The value for speed is shown as well between brackets.
Flow Direction	The flow direction is shown by arrows on the pipelines: 
Period	The transit time of the gas starting from the nearest supply point (in hours). The results are shown by means of colours and values. This is especially useful for analysis with third party (green) gas suppliers.
Supply	Shows the pipelines downstream of a selected station, supplier or pipeline. 1 means that all of the gas is supplied by the selected station, as 0.4 means that 40% of the gas is supplied by the selected station. Results are shown by means of colours and values.
Design difference	If a design calculation has been made, the difference between the current settings and the designed network is shown: the text shows both the current and the designed diameter are presented. The colours show if the diameter is increase, decreased or kept the same.
CML	Calculated CML (Customers Minutes Lost: chance on number of customers * minutes per year of no delivery) due to pipeline failure. Results are shown by means of colours and values. (Result of a CML calculation. CML calculations require a special license)
ML	Calculated ML (Minutes Lost: chance on minutes per year of no delivery) due to pipeline failure. Results are shown by means of colours and values. (Result of a CML calculation. CML calculations require a special license)

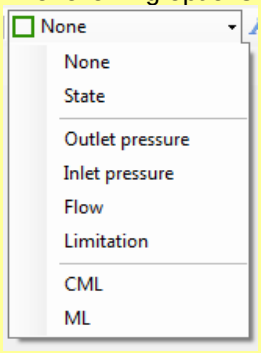
5.3 Station Toolbar

The different calculation results are shown with the assistance of the Station toolbar.

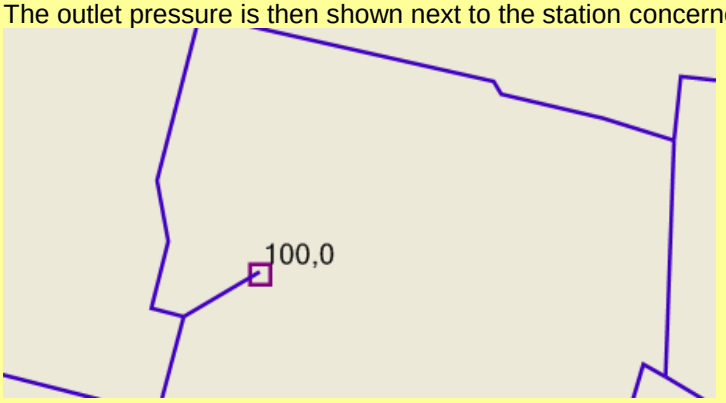


Procedure:

- Click on the **Stations** toolbar.
  The following options list is opened:



- Click (for example) on **Outlet pressure**.
  The stations are then coloured according to their outlet pressure.
- Next, click on  .
  The outlet pressure is then shown next to the station concerned.



- The legend can be turned on or off by using the  button.

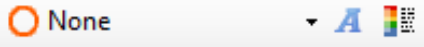
Several items which can be selected in the above toolbar are described in more detail below.

None	No results are shown.
State	The user provided status of the station (open or closed) is shown by means of colours and text.
Outlet pressure	The calculated outlet pressure of the station is shown by means of the colours and text.
Inlet pressure	The calculated inlet pressure of the station is shown by means of the colours and text (calculate all networks with option Use external demand).
Flow	The calculated flow rate of the stations is shown by means of colours and values.
Limitation	The calculated status of a station is shown using colours and text. There are four possible states: Open: Station delivers at the specified pressure. Limited to maximum: Station delivers at max. capacity (pressure at outlet is lower than the specified pressure). Limited to minimum: Station delivers at min. capacity (mostly 0, pressure at outlet is higher that the specified pressure) Closed: station is out of service (set by the user).

CML	Calculated CML (Customers Minutes Lost: chance on number of customers * minutes per year of no delivery) due to station failure. Results are shown by means of colours and values. (Result of a CML calculation. CML calculations require a special license)
ML	Calculated ML (Minutes Lost: chance on minutes per year of no delivery) due to station failure. Results are shown by means of colours and values. (Result of a CML calculation. CML calculations require a special license)

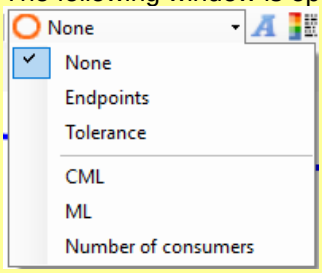
5.4 Endpoint Toolbar

The endpoints of the pipelines are shown with the assistance of the endpoint toolbar.

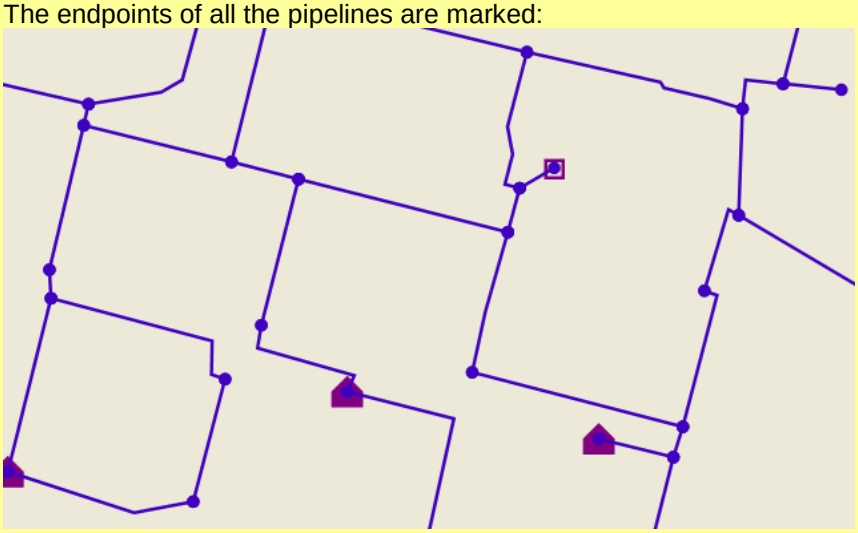


Procedure:

- Click on the **Endpoint** toolbar.
  The following window is opened:



- Click (for example) on **Endpoints**.
  The endpoints of all the pipelines are marked:



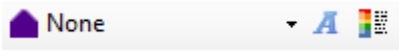
The items in the above toolbar are described in more detail below.

None	No results are shown.
Endpoints	All endpoints of pipelines are marked with a dot.
Tolerance	All endpoints of pipelines are marked with a circle at the size of the tolerance. **PLEASE NOTE:** Since the tolerance can be very small, also the circles can be very small and not be visible at a normal zoom level).
CML	Calculated CML (Customers Minutes Lost: chance on number of customers * minutes per year of no delivery) due to failures and/or weather conditions. Results are shown by

	means of colours and values. (Result of a CML calculation. CML calculations require a special license)
ML	Calculated ML (Minutes Lost: chance on minutes per year of no delivery) due to failures and/or weather conditions. Results are shown by means of colours and values. (Result of a CML calculation. CML calculations require a special license)
Number of customers	Number of customers that is assigned to the node for calculation purposes.

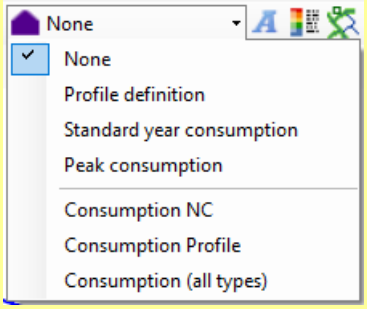
5.5 Consumer Toolbar

The properties and results of consumers are shown with the assistance of the consumer toolbar.

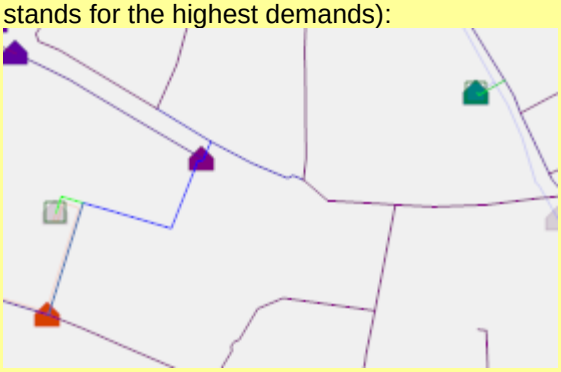


Procedure:

- Click on the **Endpoint** toolbar.
  The following window is opened:



- Click (for example) on **Consumption NC**.
  All consumers are coloured based on their calculated consumption (red stands for the highest demands):



The items in the above toolbar are described in more detail below.

None	No results are shown.
Profile definition	The profile definition of profile consumers is shown in colours and text.
Standard Annual Consumption	Standard Year Consumption of profile consumers is shown.
Peak Consumption	The demand at peak hours is shown.
Consumption NC	The calculated consumption for all node consumers is shown in colours and text.
Consumption Profile	The calculated consumption all profile consumers is shown in colours and text.

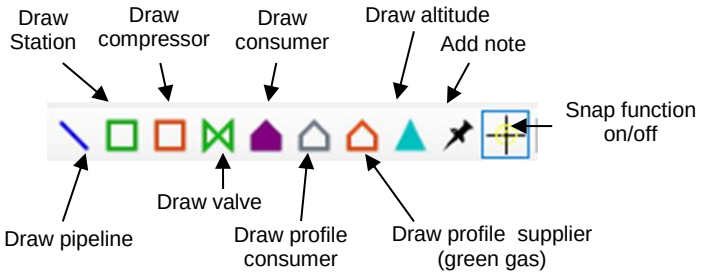
Consumption (all)	The calculated consumption for both node consumers and profile consumers is shown in colours and text.

6 Adapting Networks: add, modify and deleting objects

With IRENE Pro it is possible to adapt networks by adding objects, changing objects or removing objects. It is possible to do this directly in the drawing, or through the object lists.

6.1 Add an Object (Drawing)

To add new objects to a network, it is necessary to draw or place them. This is done using the **Drawing** toolbar:



PLEASE NOTE: Drawing a pipeline is only possible if the materials have been defined. Please refer to §9.2 as to how the definitions of materials can be added.

PLEASE NOTE: The drawing of a Profile Consumer / Supplier is only possible if consumer profiles are present, for example, if the import already contained consumer profiles. The creation of consumer profiles is only possible if the user has the appropriate license.

Procedure:

- Click in the button bar on the desired object to be drawn.
- Click in the drawing with the left mouse button at the location where the object is to be inserted. (With pipelines click multiple times for each intermediate point. Finish by clicking the right mouse button).
- Complete the Properties screen (please, see following paragraphs as well).
- Click on **Ok** to add the object.
- To end the drawing click with the right mouse button.

6.1.1 Snap

The Snap function can be turned on or off with the button shown below:

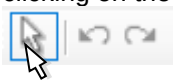
This is a help function for drawing. If the mouse pointer comes near an existing object, the mouse pointer will jump to this object. With pipelines this applies to both pipe ends. In the case of other objects the mouse pointer will jump to the location of the object (centre of the object). Use the snap function to ensure that the pipelines and the objects join together.

6.1.2 Zooming and Panning Whilst Drawing

Whilst drawing, you can still use of the zoom and pan functions. These do not end the drawing process. By clicking the right mouse button after zooming, the mouse will return to the drawing mode, and it is then possible to continue drawing.

6.2 Selecting and Changing Objects via the Drawing

It is possible to change the properties of existing objects. For this, the mouse must be set in the selection mode (this is also the default mode). This can be activated by clicking on the arrow in the menu bar:



To select an object, click with the left or right mouse button (single click). With the left mouse button, a dialogue box containing the properties is opened immediately so that these can be changed. With the right mouse button a menu is opened in which it is possible to select a certain action.

Procedure:

- Click the object to be changed with the left mouse button. (Alternatively, click with the right mouse button and choose **Features).**

The detail window with the properties of the pipeline will open.

- Change the properties and click on **Ok** or **Apply**.

6.2.1 Selecting from Multiple Objects in One Place

If there are multiple objects clustered in a small area, the desired object is not always immediately selected with a mouse click in that area. By further mouse clicks at the same location with the left mouse button you can cycle through the list of objects until the desired object is selected.

6.2.2 Fence Selection

With a Fence it is possible to select multiple objects and edit them at once. The editing is done in the Assets dialogue screen **Assets**. Please, see §6.3.

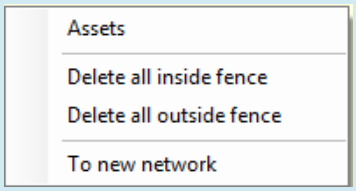
Procedure for drawing a Fence:

- Method 1: Rectangle fence
  Hold the shift key will dragging with the left mouse button pressed a rectangle.
- Method 2: Polyfence
  Whilst holding the Alt-key click with the left mouse button points to create a selection area.

Open the dialogue screen **Assets** for editing the objects. The lists will now only contain those objects that are completely within the fence (objects located at both sides of the border of the fence are not selected). For further instructions please refer to §6.3.

Tip

Click with the right mouse button in the Fence, and a menu opens with specific functions for the selection area:



This menu offers the following functions:

- **Assets**
  The Assets screen will appear.
- **Delete all inside fence**
  All objects in the active network, that are completely inside the fence, are removed.

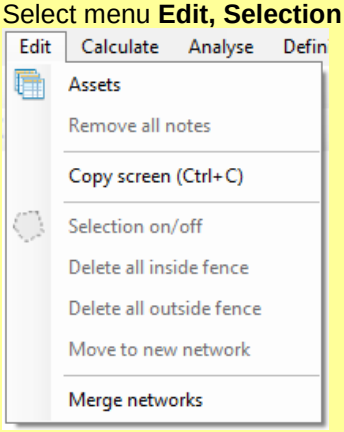
- **Delete all outside fence**
  All objects in the active network that are (partially) outside the fence shall be removed.
- **To new network**
  All objects in the active network within the fence are moved to a new network.

PLEASE NOTE: When the fence is used in combination with the assets lists, see §6.3, the lists are filtered and showing only objects that are completely inside the fence. It is still necessary to select the items in the lists themselves when editing the items in bulk, see §6.3.

PLEASE NOTE: The Fence remains active until a new Fence is drawn, or until the selection is deactivated.

Procedure for deactivate the Fence:

- Select menu **Edit, Selection on/off**.



Or use this button:

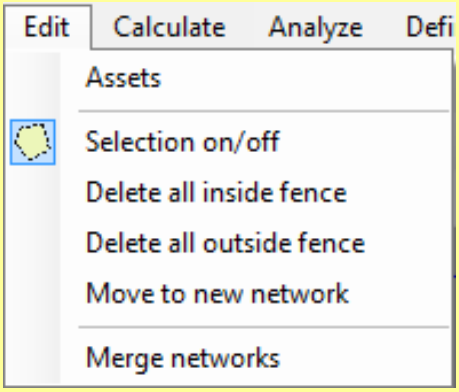
The Fence has been deactivated.

6.2.3 Delete objects inside/outside the fence

After drawing a fence all objects of the active network inside or outside the fence can be removed.

Procedure for deleting objects inside/outside the fence:

- Select menu **Edit,** and then **Delete all inside fence** or **Delete all outside fence**.



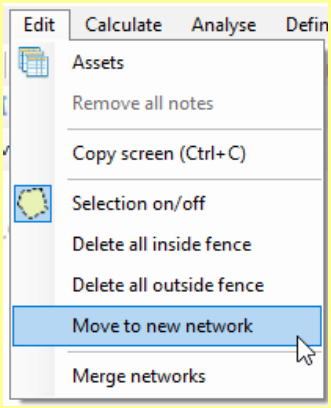
Tip
The functions **Delete all inside fence** and **Delete all outside fence** are also available in the menu when you click with the right mouse button in a fence.

6.2.4 Move to new network

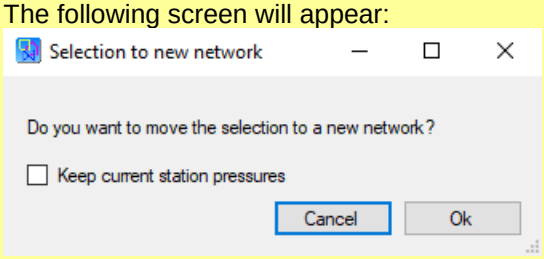
Once a fence is drawn, all objects in the active network inside the selection area can be moved to a new network.

Procedure for moving object to a new network:

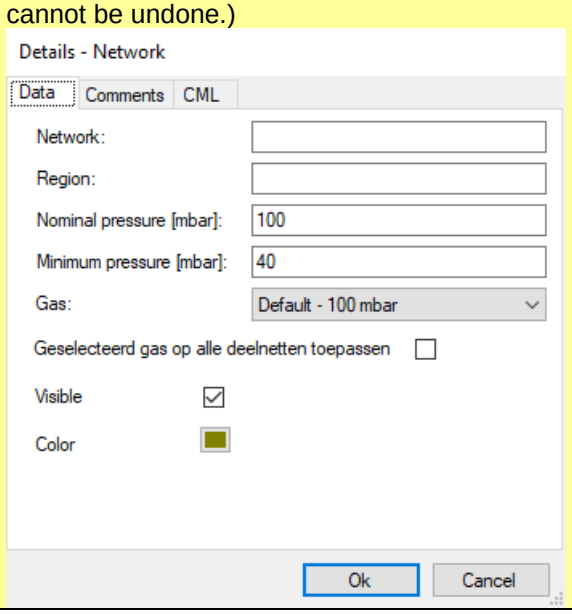
- Use context menu within fence or select menu **Edit,** and then **Move to new network**.



- The following screen will appear:



- If you don't want the Station Pressures to be adjusted to the nominal pressure (MOP) of the new network, check **Keep current station pressures**. Then press **Ok**.
- The following screen will appear:
  (if you have made previously changes you'll first receive a warning that this cannot be undone.)



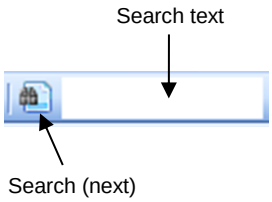
- Fill in all the properties of the new network.
- Then press **Ok**.

PLEASE NOTE: the station pressures are adjusted to the nominal pressure of the new network, unless **Keep current station pressures** was selected.

Tip
The function **Move to new network** shows up in a menu when you click with the right mouse button in a fence.

6.2.5 Search objects and locations

IRENE Pro has a search function, that can be used for searching objects or locations.



Objects can be found, based on their ID or name. Coordinates can be located as well. If you have a Google API Key and a internet connection, than you can search addresses as well (see §10.10 concerning the Google API Key).

Procedure:
- Type (part) of the name or ID, coordinate (according to the set coordinate system), or address (if you have set the Google API key).
- Click Enter or on the button next to the search field.
- For searching a following object that complies with the search, simply click once more on the button.

The drawing is centred around the found object or location. In case of an object, the object is selected and marked and its property dialog is opened.

6.2.6 Deleting Objects

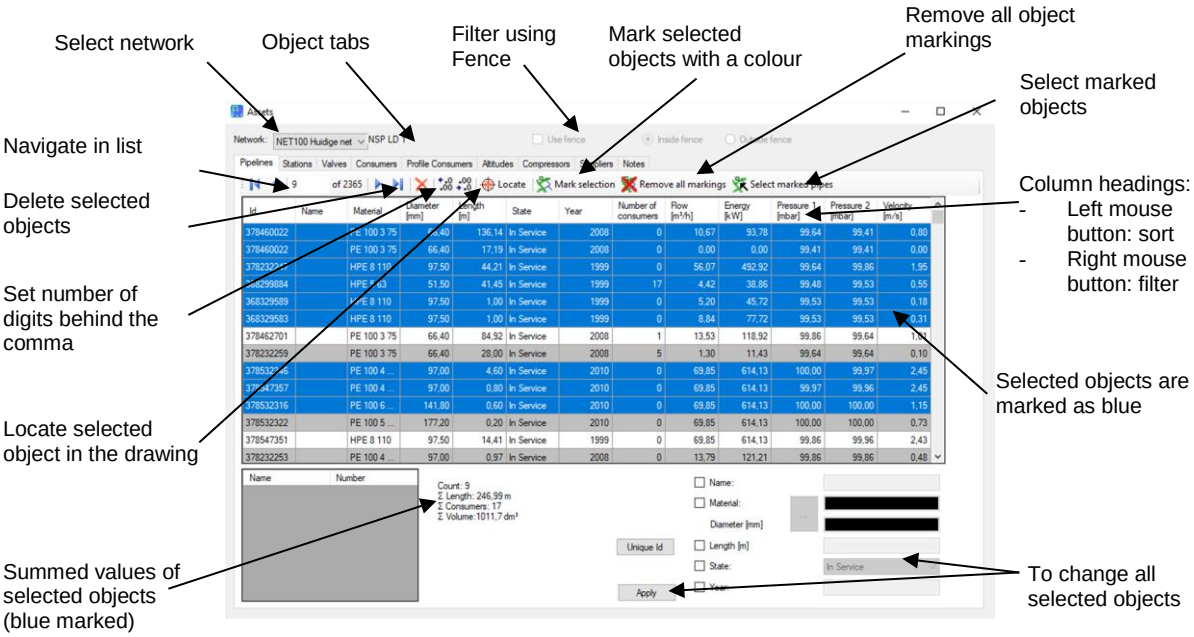
An object can be deleted via the drawing screen.

Procedure:
- Select the object
- Press the **delete** key

Alternative procedure:
- Click on the object to be deleted using the right mouse button.
  A menu will open.
- Choose **Delete**.

6.3 Changing Objects via Lists

IRENE Pro also offers an overview of all objects via lists. Just as in the drawing it is possible to locate objects, change and delete them.

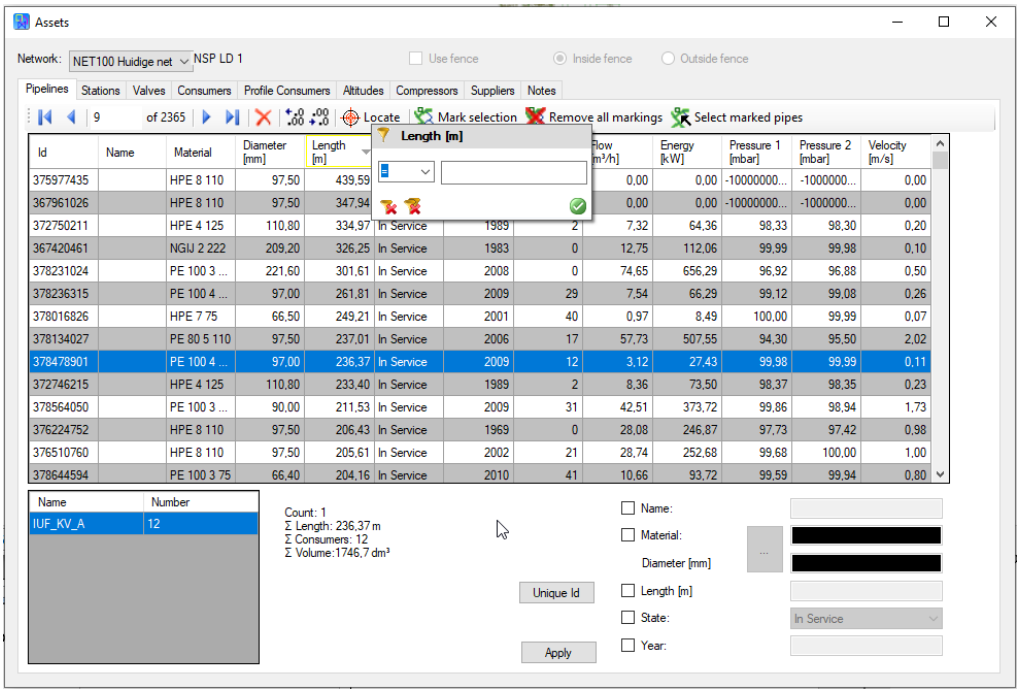


6.3.1 Searching asset list (Ctrl+f)

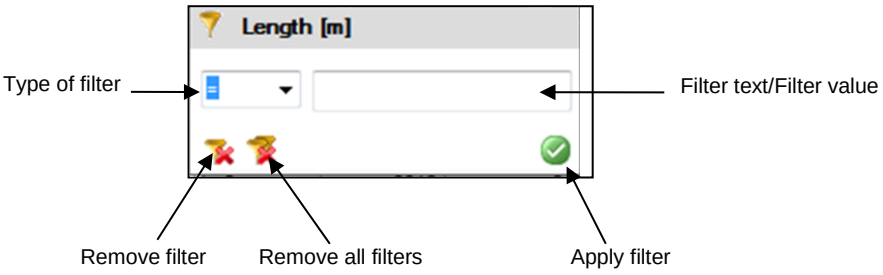
By pressing Ctrl+f the search window is displayed. Fill in a search text and press Find next. The first record that contains the search text in one of its fields is selected. By pressing Find next again the next record that complies to the search criteria is selected. Searching is case sensitive. The search string is searched in any part of the fields (so it does not have to be a complete word).

6.3.2 Filtering the assets list

The objects in the list can be filtered based on the properties in the displayed columns. A filter may be set for each column,. Setting is done by right clicking on the column header:



This opens a pop-up box where the filter can be defined and applied:



Once a filter value is entered, the filter is applied. The different types of filters will be explained below.

Filter type
The filter type indicates how the entered filter value is used for filtering the records in the column. Depending on the type of data in the column, you can choose from several options:

Filter types for text columns:

..xxx..	:	The data contains the filter text (the data may also contain more text in front or after the filter text).
xxx..	:	The text begins with the filter text.
..xxx	:	The text ends with the filter text.
=	:	The text is equal to the text filter.
<>	:	The text is not equal to the filter text.
=Ø	:	Field contains no text / is empty.
<> Ø	:	Field contains text / is not empty.

Filter types for numeric columns:

=	:	The value is equal to the filter value.
<>	:	The value is not equal to the filter value.
>	:	The value is larger than the filter value.
<	:	The value is less than the filter value.
>=	:	The value is larger than or equal to the filter value.

<= : The value is less than or equal to the filter value.
=Ø : Field contains no value / is empty.
<> Ø : Field contains a value / is not empty.

Filter types for Boolean columns (yes / no checkboxes):
= : The checkbox value is equal to the filter value.
=Ø : The checkbox is indeterminate.
<> Ø : The checkbox is not indeterminate.

Example:
In the following way, all steel pipes with an inner diameter of more than 101 mm can be found:

Filter settings material Column:

Type of filter	Filter value
xxx..	ST

Here is chosen to filter by text that begins with ST. This will display all materials with names starting with ST, e.g. STEEL.

Filter settings column diameter:

Type of filter	Filter value
>	0.101

Here is 0.101 set as a filter value instead of 101 because the column unit of the material is in meters.

6.3.3 Filtering the asset list based on a Fence

The Assets list can additionally be filtered based on a Fence. You can choose between the objects inside or outside the fence. For creating a Fence, please see §6.2.2.

6.3.4 Selecting Objects in the List

An object is selected simply by clicking on it. If multiple objects are required to be selected, then use the Control (Ctrl) and Shift key, as is standard in MS Windows. With the key combination Ctrl + a, the entire list is selected.

Each selected object is marked with a blue background in the list and marked red in the drawing.

6.3.5 Mark selected objects with a colour

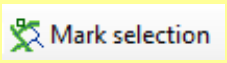
The selected objects can be marked with a chosen colour. Each selection can be marked with it's own colour.

REMARK: The markings remain visible, even when the Assets window is closed.

Use the button  to switch the visibility of the markings on/off.

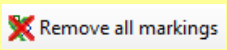
It is also possible to apply markings using marking definitions. The advantage is that the query is stored in the user settings and can be reused, see §9.9.

Procedure:

- Select the objects to be marked in the list.
- Click on the button 

- Select a colour in the colour picker and click on **Ok.**

Clear all markings:

- Click on the button 

6.3.6 Edit a Single Object

With a double mouse click on an object in the list, the details screen of the object is opened. The object properties can then be altered.

Procedure:

- Double click on the object to be altered.
- A details screen will open showing the properties of the object.
- Change the properties and click on **Ok** or **Apply.**

6.3.7 Edit Multiple Objects at Once

It is also possible to apply changes to multiple objects at once. This is achieved by using the menu at the bottom right of the screen. Only the properties selected (ticked) here will be changed. The remaining properties will retain their original values.

Procedure:

- Select the objects to be changed in the list
- Select (tick) at the bottom right of the screen the properties which need to be changed for all selected objects.
- Complete the new values.
- Click on **Apply**

6.3.8 Deleting Objects

One or more objects can be deleted by using the button:  .

Procedure:

- Select the list containing the objects which are to be deleted.
- Select in the list the object to be deleted.
- Click on:  .
- The selected objects will be deleted.

6.3.9 Copy objects from and to Excel

The selected objects in the Asset dialog can be copied and pasted to Excel or other program. It is also possible to copy a list with objects from Excel back to IRENE (for instance after modifications have been made).

Procedure:

- Select the list containing the objects which are to be copied.
- Select in the list the objects to be copied.
- Copy the list to the clipboard using Ctrl+c, or by using the context menu that appears when pressing the right mouse button.
- Go to Excel or another program
- Paste the selected objects by pressing Ctrl+v.

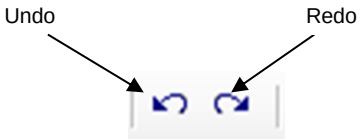
In a number of situations the data can be copied back to IRENE Pro. The preconditions are that the data contains exact the same columns in the same order as in the assets dialog.

The following objects can be copied back to IRENE Pro from Excel or a table in another program:

- Pipes
  Precondition is that the pipelines have to have an unique ID. When pasting a copied list of pipelines, the pipelines with the same ID are modified according to the paste information. After pasting, a message appears showing the number of modified pipelines. It is not possible to add new pipelines by pasting.
- Stations
  In case there is already a station present at the same coordinate, than the station will not be added, but the properties will be modified with the copied properties. Else the station will be added.
  From all the property fields, only the x and y coordinate (in accordance with the selected coordinate system) have to be filled. Other fields can be empty, but have to be present as column.
- Consumers
  Consumers are always added as new consumer. So if you want to replace the existing consumers, you will first have to remove all existing consumers. Both the consumption definition and the x- and y- coordinate (in accordance with the selected coordinate system) have to be filled. Other fields can be left empty, but have to be present as column.
- Profile consumers
  In case there is already a profile consumer with the same EAN code present, the existing profile consumer will be modified with the copied properties. Else the profile consumer will be added.
  From all the property fields, the EAN, Profile definition and the x and y coordinate (in accordance with the selected coordinate system) have to be filled. Other fields can be left empty, but have to be present as column.
- Altitudes
  In case there is already a altitude with the same ID present, the existing altitude will be modified with the copied properties. Else the altitude will be added. From all the property fields the x and y the x and y coordinate (in accordance with the selected coordinate system) have to be filled. Other fields can be left empty, but have to be present as column.

6.4 Undo Changes

With the Undo and Redo buttons it is possible to undo changes or to re-apply them.



Procedure:

- Click once or more on  to undo changes.
- Click once or more on  to reapply changes.

Tip
You can also undo changes by using the keyboard shortcut **Ctrl+z**.
With the keyboard shortcuts **Ctrl+y** or **Ctrl+Shift+z** you can reapply undone changes.

PLEASE NOTE: If there are no changes which to be undone or re-applied, then the relevant button is inactive (shown as grey).

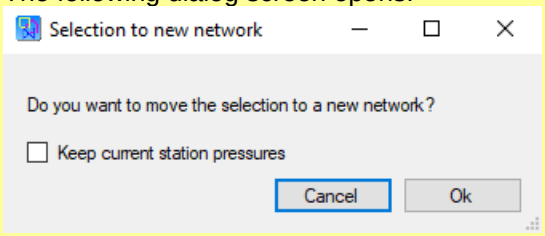
6.5 Move objects to a new network

Selected objects of the active network can be moved to a new network. By using a fence, you can select which objects are to be moved: all objects completely inside the fence are moved.
The function **Move to new network** is available both in the **Edit** menu and the context menu when clicking in the area on the right mouse button.

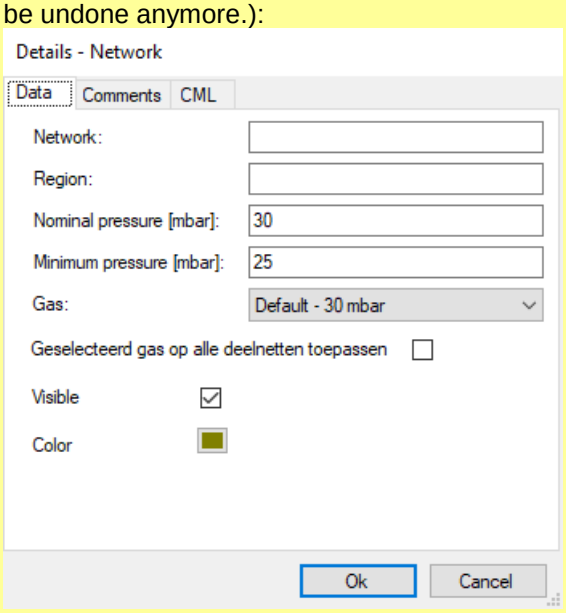
PLEASE NOTE: When performing this action, Undo will not be available anymore. This means that this action and all actions done before, cannot be reversed.

Procedure:

- Make a selection with by creating a Fence (see §6.2.2). All objects within the Fence are moved to the new network.
- Select menu **Edit - Move to new network**
  (or use right mouse button menu inside the fence).
- The following dialog screen opens:



- Station pressures will automatically change to the nominal pressure of the new network. If this is not what you want, check **Keep current station pressures**. Click **Ok.**
- The following dialogue screen opens
  (If you made some changes before, you will get a warning that they can't be undone anymore.):



- Complete all properties of the new network
- Click **Ok**.
  All objects within the Fence are moved to the new network.

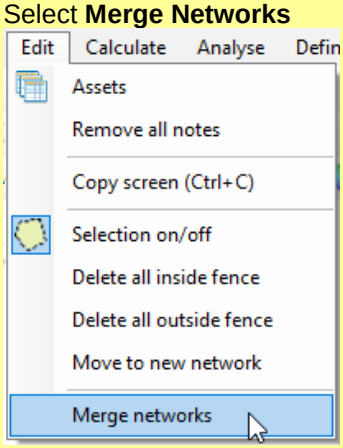
PLEASE NOTE: All station pressures are modified to the set nominal pressure of the new network, unless you had selected **Keep current station pressures.**

6.6 Merge Networks

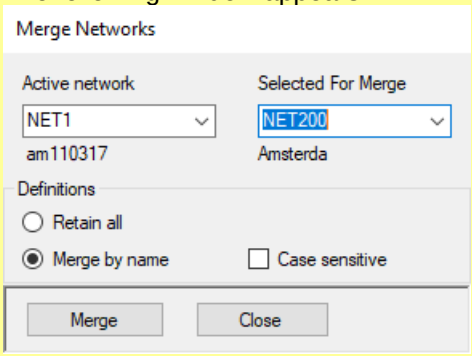
By using the function ‘Merge networks’, two separate networks can be merged as one network.

Procedure:

- Select menu **Edit**
- Select **Merge Networks**



- The following window appears:



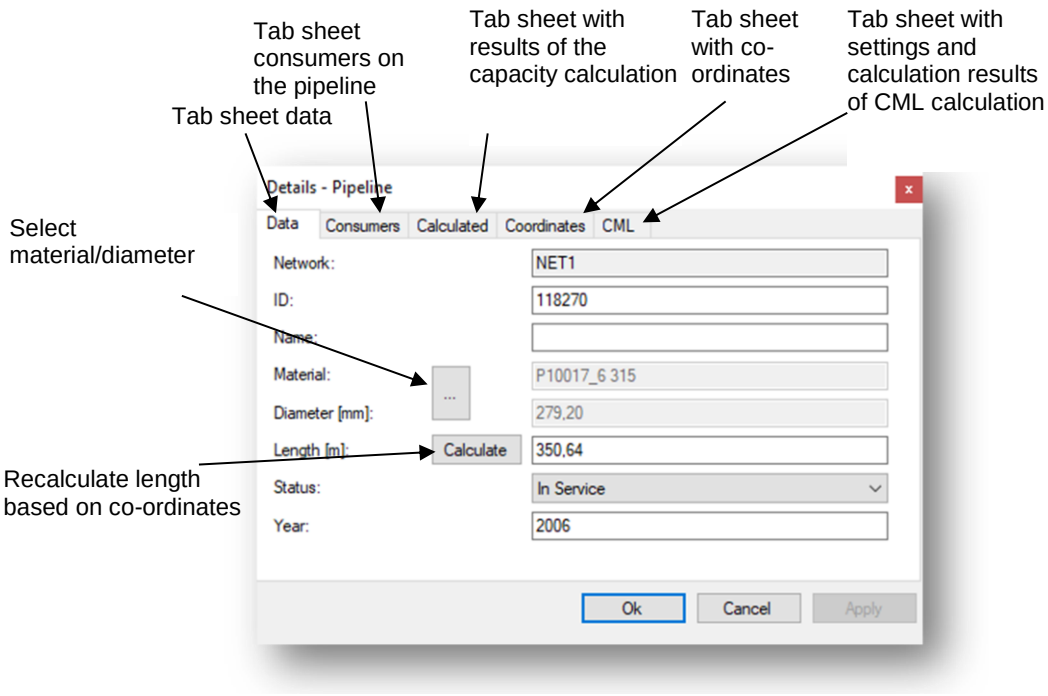
- Select under **Active network** the network required to be kept
- Select under **Selected for Merge** the network which is required to be merged with the Active network.
- Click on **Merge** and subsequently on **Close**.

Below is an overview of the definitions which can be selected for the merging of networks.

Definition	Consequence of “Merge networks”
Retain all	The set definitions of all components of both networks will be retained. Definitions with the same name will be given a new unique name.
Merge by name	The definitions with the same name in the network to be merged and the **Active network**, will be replaced by the definitions of the **Active network**
Case sensitive	If using ‘Merge by name’, the names of the definitions will be distinguished when containing different capitals and lower case characters.

6.7 Pipelines

By clicking on a pipeline a properties window will be opened that belongs to this pipeline. The same window also opens after drawing a pipeline.



The following properties are available:

Property	Meaning
Network name	Network to which the pipeline belongs. This cannot be changed.
ID	Identification of the pipeline (e.g. the ID from GIS).
Name	Alternative identification of the pipeline (e.g. street name)
Material	Name of the material/diameter definition. This can be selected with the button with the three dots.
Diameter	The inside diameter according to material/diameter definition.
Length	The length of the pipeline. Whilst drawing this will be calculated automatically. However, the length can also be entered manually. By clicking the **Calculate** button, the length is calculated and set on basis of the coordinates.
Status	The status of a pipeline is important for the calculations:
Year	Year of installation (only used as administrative feature, does not play a role in the calculation).

Status	**Relation to the calculation**
In use	Pipelines with this status are always incorporated in the calculation
Projected	Pipelines with this status are only incorporated in the calculation as indicted by calculation settings.
In design	The diameter of these pipelines is designed in the dimensioning calculation. In the capacity calculation these pipelines are not incorporated.
Out of use	These pipelines are never incorporated in the calculation.

6.7.1 *Drawing of Pipelines*

Procedure for drawing pipelines:

- Click on the button with the pipeline symbol in the menu bar:

- Draw the pipeline by clicking points with the left mouse button.
- Close drawing of the pipeline with the right mouse button.

The details screen for pipelines appears.

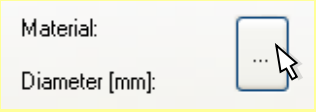
- Fill in the properties of the pipeline (for Materials/Diameter and Consumption please refer to the paragraphs below).
- Click on **Ok** to add the pipeline.

6.7.2 *Material/Diameter Selection*

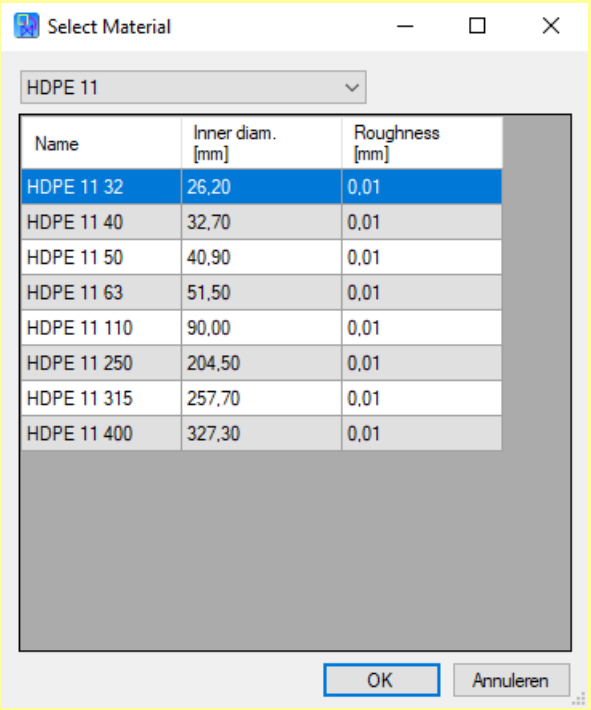
The material/diameter combinations are pre-defined with their own properties (please refer to §9.2 for an explanation). In order to select a material/diameter definition for a pipeline, you open the material selection screen by using the … button.

Procedure:

- Click on the button with the three dots:



- The screen for the selection of the material-diameter definition will open.



- Select the material in the top window.
- Select the desired diameter from the list.
- Click on **Ok**.

The screen will close.

- Click on **Ok** or **Apply** in the properties screen of the pipeline.

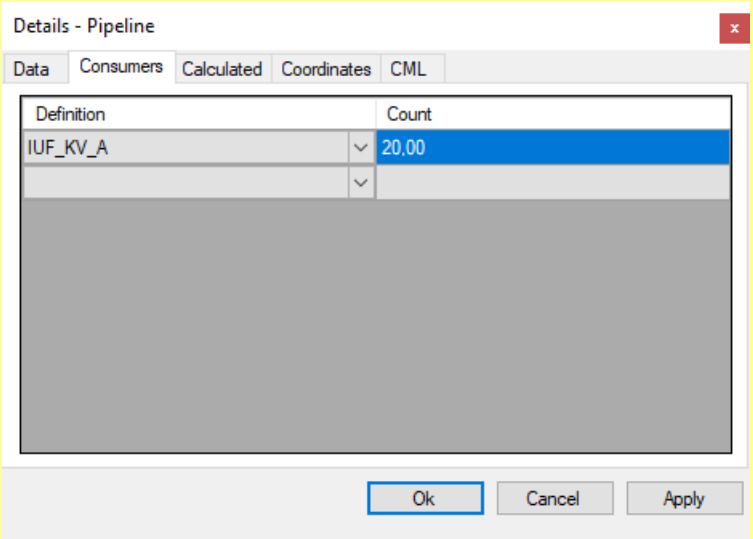
6.7.3 *Editing Pipeline Consumption*

Under the tab sheet **Consumers,** the consumer data of the pipeline can be changed.

Procedure for adding a consumer:

- Open the properties screen of the pipeline

- Select the tab sheet Consumers:



- Select the row needing editing
  (the bottom row (empty row) is to add a consumer)
- Select a consumer definition and number of consumers
- To delete a consumer, select the row and click on **Delete**.

6.7.4 Extending a pipeline

A pipeline can be extended by adding an extra pipe length.

Procedure:

- Click on the pipeline to be extended using the right mouse button. Please do this at the end of the pipeline that needs to be extended.

A menu opens.

- Select **Extend**
- Draw the extra pipe length using the left mouse button and clicking the desired route point on the drawing.
- Finalize by clicking the right mouse button.

The length of the pipeline is automatically adjusted taking into account the added piece. If the original length was entered manually (and not calculated on basis of the coordinates), the added length is derived from the co-ordinates, but scaled proportionally. .

6.7.5 Splitting a Pipeline

A pipeline can be split into two pipelines. This may be necessary when placing a shut-off valve or an extra branch, for example.

Procedure:

- Click with the right mouse button on the location where the pipeline needs to be split.

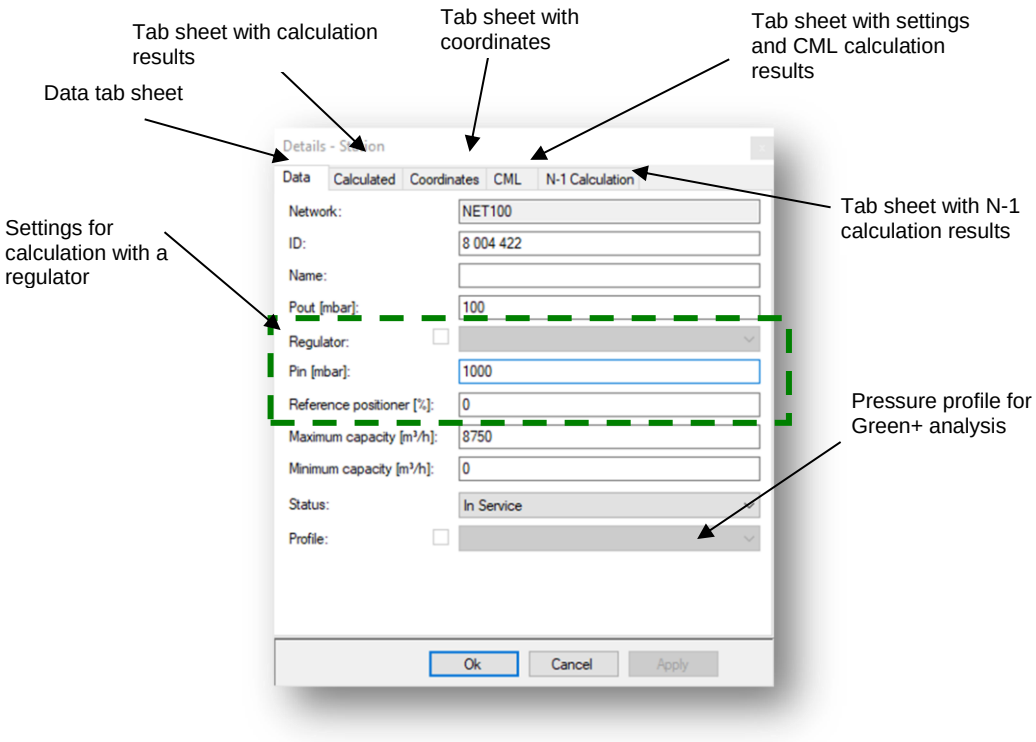
A menu opens.

- Select **Split**

The pipeline will now be split. If there was consumption on the pipeline, this will be split between the two new pipelines. This may lead to a fraction of consumers on a pipeline (e.g. 1.5 consumers). If this is undesirable, this should be corrected manually in the new pipelines. The length will also be divided pro rata. The length of the new pipelines will thus be derived from the given length of the original pipeline and not necessarily from the co-ordinates..

6.8 Stations

The properties screen of a station can be opened by clicking on the station. The same screen is opened when a station is added.



The following properties are available:

Property	Meaning
Network name	Network to which the station belongs. This cannot be changed.
ID	Identification of the station.
Name	Alternative identification of the station.
Outlet pressure	Pressure with which the station feeds the network.
Regulator	For calculation with a regulator (this is only possible when the regulator definitions are available).
Inlet pressure	User defined inlet pressure of the station. This is only relevant for calculations with regulators.
Reference valve setting	Set reference valve stem position, only relevant for calculations with regulators.
Maximum capacity	The maximum capacity to which a station is limited. (When calculating with 'Use limiting' option on, the station will not exceed this maximum capacity)
Minimum capacity	The minimum capacity to which a station is limited. When calculating with 'Use limiting' option on, the station will deliver at least this minimum capacity)
Status	Status of the station: **Status** / **Relation to the calculation** In use / Station will be incorporated in the calculation Out of use / Station will not be incorporated in the calculations
Profile	Pressure profile for Green+ analysis.

6.8.1 Adding a Station

Procedure:

- Click on the button with the Station symbol in the menu bar.

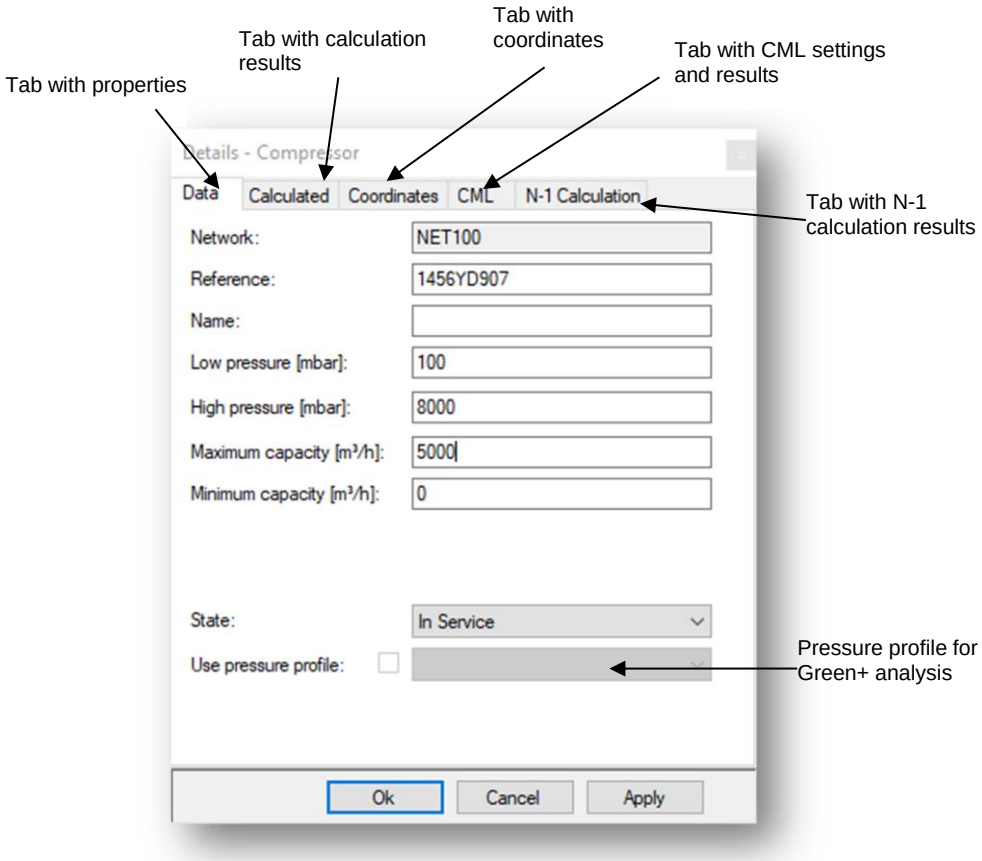
- Click in the drawing on the location where the station needs to be placed. **PLEASE NOTE:** a station must be placed at the end point of a pipeline (please use the Snap-function).

The details screen of the station opens.

- Complete the properties of the station and click on **Ok**. The station appears in the drawing.

6.8.2 Compressors

A compressor is a special “station”. It can govern the pressure by sucking gas out of the network. By clicking on a compressor the property dialog is displayed. The same dialog is shown when adding a compressor.



The following properties are available:

Property	Meaning
Network name	Network to which the station belongs. This cannot be changed.
Reference	Identification of the compressor (for instance the ID in a GIS)
Name	Identification of the station.
Low pressure	Pressure governed by the compressor
High pressure	Pressure at the outlet of the compressor.
Maximum capacity	The maximum capacity to which a compressor is limited.

	(When calculating with 'Use limiting' option on, the compressor will not exceed this maximum capacity)
Minimum capacity	The minimum capacity to which a compressor is limited. When calculating with 'Use limiting' option on, the compressor will at least draw this minimum capacity form the network)
Status	Status of the compressor : **Status** / **Relation to the calculation** In use / Compressor will be part of the calculations Out of use / Compressor will not be incorporated in the calculation
Profile	Pressure profile for Green+ analasys

6.8.3 Add a compressor

Procedure:

- Click on the button with the Station symbol in the menu bar.

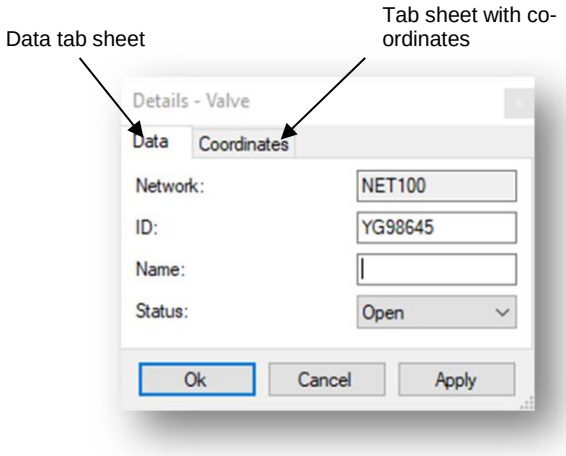
- Click in the drawing on the location where the compressor needs to be placed.
  PLEASE NOTE: a compressor must be placed at the end point of a pipeline (please use the Snap-function).

The details screen of the compressor opens.

- Complete the properties of the compressor and click on **Ok**. The compressor appears in the drawing.

6.9 Shut-off Valves

By clicking on a shut-off valve, the properties screen of that shut-off valve is opened. The same screen is also opened when a shut-off valve is added.



The following properties are available:

Property	Meaning
Network	Network to which the shut-off valve belongs. This cannot be changed.
ID	Identification of the shut-off valve (for instance GIS ID).
Name	Alternative identification of the shut-off valve.
Status	Status of the shut-off valve: **Status** / **Relation to the calculation** Open / Pipelines on both sides are connected. Closed / Pipelines on both sides are un- connected.

6.9.1 Add a Shut-Off Valve

Procedure:

- Click on the button with the shut-off valve symbol in the menu bar.

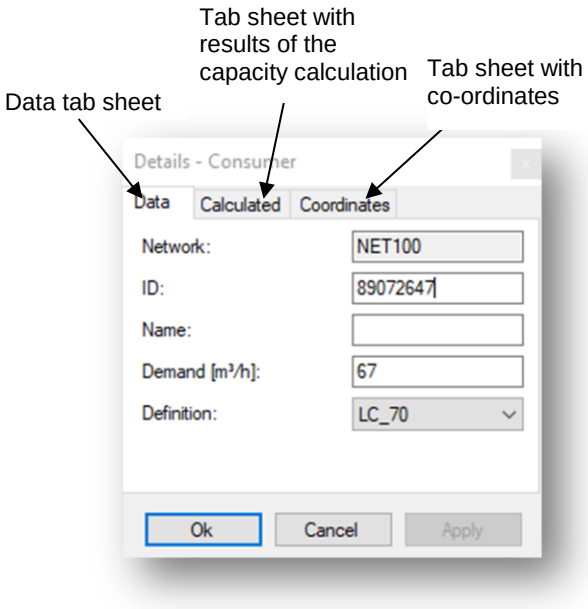
- Click in the drawing on the location where the shut-off valve needs to be placed.
  PLEASE NOTE: a shut-off valve must be placed at the end point of a pipeline (please use the Snap-function).

The properties screen opens

- Complete the properties of the shut-off valve and click on **Ok**. The shut-off valve appears in the drawing.

6.10 Consumer

By clicking on a consumer the properties screen of that consumer is opened. The same screen also opens when a consumer is added.



The following properties are available:

Property	Meaning
Network	Network to which the consumer belongs. This cannot be changed.
ID	Identification of the consumer (for instance GIS ID)
Name	Alternative identification of the consumer.
Consumption	Peak consumption of the consumer. In case of a negative value, the consumer will act as a supplier and the colour will change to green.
Definition	Consumption Definition (describes the temperature dependency of the consumption).

6.10.1 Adding a Consumer

Procedure:

- Click on the button for **Consumer** in the Menu Bar (shaded house):

- Click on the location in the drawing where the new Consumer needs to be placed.
  PLEASE NOTE: A Consumer needs to be placed exactly at a end point of a pipeline in order to be incorporated in the calculation (please use the snap function). The order of drawing is not important; the pipeline can also be added later.

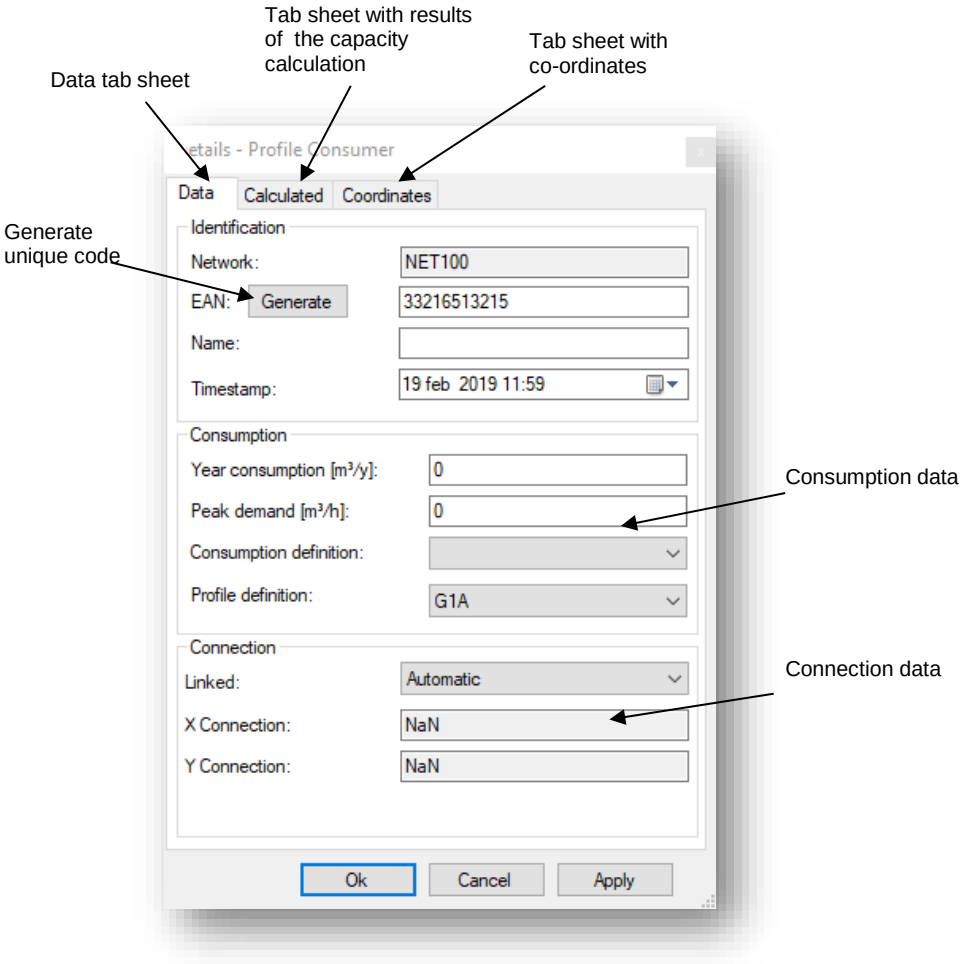
The Properties screen opens.

- Complete the properties of the consumer and click on **Ok.** The Consumer then appears in the drawing.

6.11 Profile Consumer

By clicking on a profile consumer, the properties screen of the profile consumer is opened. The same screen also opens when a profile consumer is added.

PLEASE NOTE: This option is only available if the user has a License for profile consumption calculations. A minimum of one consumption profile needs to be defined before a profile consumer can be added.



The following properties are available:

Property	Meaning
Network	Network to which the consumer belongs. This cannot be changed.
EAN	Required and has to be unique: EAN (ID) of the consumer. With the button **Generate** a unique “EAN” can be generated (only available when adding a new profile consumer).

Name	Can be used to give the consumer a comprehensive name.
Timestamp	Validity date of the consumer consumption (administrative feature, this has no influence on the calculations)
Annual Consumption	Standardized annual consumption In case of a negative value, the consumer is automatically turned into a profile supplier. Choose whether you want to use this value or Peak demand.
Peak demand	Peak demand (to be used during the standard capacity calculation) . In case of a negative value, the consumer is automatically turned into a profile supplier. Choose whether you want to use this value or Annual Consumption.
Consumption Definition	The consumption definition used for the profile consumer during a standard capacity calculation.
Profile	Required : The profile to be used during profile calculations or Green+ calculations.
Connection status:	Method of the determination of the point of connection to the network:

Status	Relation to Calculation
Automatic	Connection is automatically generated to the nearest pipeline.
Via Pipeline	Connection is made to the pipeline identified by Pipeline ID.

X-Connection	X coordinate for the point where the connection to the pipeline is. (calculated, cannot be changed**).**
Y-Connection	Y coordinate for the point where the connection to the pipeline is. (calculated, cannot be changed**).**
Pipeline ID:	Identification (Name) of the pipeline to which the consumption needs to be linked. (Only available when Connection status = **Via Pipeline** is selected).

6.11.1 Add Profile Consumer

Procedure:

- Click on the button for Profile Consumer in the toolbar (house outline):

- Click on the location in the drawing where the consumer should be placed. This can be in a random location. IRENE locates the nearest pipeline when calculating.

The properties screen then opens.

- Complete the properties of the profile consumer and click on **Ok.** The profile consumer appears in the drawing.

6.12 Green Gas Supplier

A green gas supplier is a special way of simulation of non-pressure regulated supply: A supplier supplies a fixed amount of gas. This type of supply can be modelled in several ways:

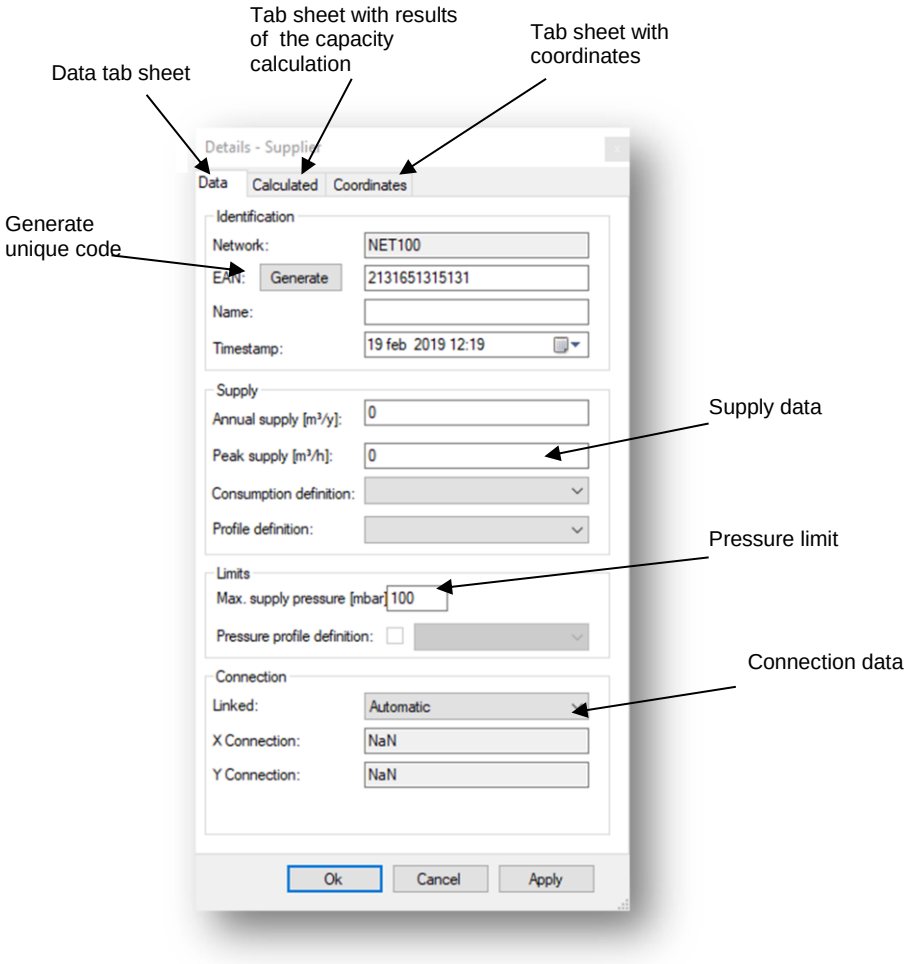
- Profile supplier
  This is a specific IRENE Pro object to simulate supply. It works just like the profile consumer, except that it supplies gas instead of consuming it. (If you draw a profile consumer with a negative consumption, IRENE Pro will automatically recognize it as a profile supplier).

  PLEASE, NOTE: This option is only available if you have a licens for profile calculations or Green+ analysis. Also at least one flow profile has to be

defined before a profile supplier can be added.

- Negative consumer
  Add a consumer with a negative gas consumption. For instance, if the supplier supplies 2000 m^3_n/h, fill in -2000 m^3_n/h as peak consumption. The supplier is shown in green.
- Limited Station
  This option requires calculations with the limitation option. Add a station and set the supplier's supply as the minimum capacity. Use the same value or a slightly higher value for the maximum capacity.

In case of a profile supplier, the following property dialog is available:



The following properties are available:

Property	Meaning
Network	Network to which the consumer belongs. This cannot be changed.
EAN	Required and has to be unique: EAN (ID) of the consumer. With the button **Generate** a unique "EAN" can be generated (only available when adding a new consumer).
Name	Identification of the consumer, for instance an address.
Timestamp	Validity date of the consumer consumption (administrative feature, this has no influence on the calculations)

Annual supply	Standardized annual consumption. Choose whether you want to use this value or Peak Supply.
Peak supply	Peak supply. Choose whether you want to use this value or Annual Supply.
Consumption Definition	The consumption definition used for the profile consumer during he standard capacity calculation.
Profile	Required : The profile to be used during profile calculation or Green+ calculation.
Max. supply pressure	Pressure limit at which the supplier is allowed to supply. The calculation will limit the supply when this limit is exceeded.
Pressure Profile	Profile for the pressure limit.
Connection status:	Method for determination of the connection to the network:

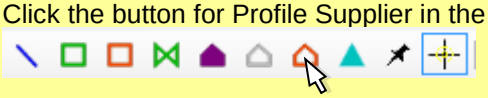
Status	Relation to Calculation
Automatic	Connection is automatically generated to the nearest pipeline.
Via Pipeline	Connection is made to the pipeline identified by Pipeline ID.

X-Connection	X coordinate for the point where the connection to the pipeline is. (calculated, cannot be changed**).**
Y-Connection	Y coordinate for the point where the connection to the pipeline is. (calculated, cannot be changed**).**
Pipeline ID:	Identification (Name) of the pipeline to which the consumption needs to be linked. (Only available when Connection status = **Via Pipeline** is selected).

6.12.1 Add a Profile Supplier

Procedure:

- Click the button for Profile Supplier in the toolbar (house outline):



- Click the location in the drawing where the supplier should be placed. This can be in a random location. IRENE locates the nearest pipeline when calculating.

The properties dialog opens.

- Complete the properties of the profile supplier and click **Ok.** The profile consumer appears in the drawing.

6.12.2 Alternative 1: Negative consumer

Procedure:

- Click the button for consumer:

- Click in the drawing where the supplier is located. For a normal consumer this has to be at the end of a pipeline.
  PLEASE NOTE: a consumer has to be placed at the end of a pipeline (use the Snap-function).

The properties dialog shows up:

- Set the suppliers supply as a negative value for the consumption(peak- or year) . Click on **Ok**. The supplier is presented as a green coloured house.

6.12.3 Alternative 2: Limited Station

Procedure:

- Click on the station button.

- Click in the drawing where the supplier is localized.
  PLEASE NOTE: a station has to be placed at the end of a pipeline (use the Snap-function).

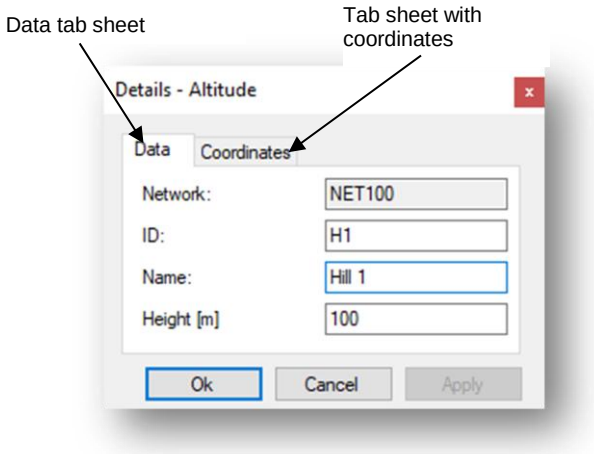
The properties dialog shows up:

- Set the suppliers supply as the minimal capacity. Use the same value (or somewhat more) for the maximal capacity. Click on **Ok**.

PLEASE NOTE: This will only work when the calculations are performed with the 'Use limiting' option.

6.13 Altitude Markers

Altitude differences can be shown in the network in the altitude menu. These must be placed at the end point of a pipeline. The properties of the marker are shown when clicking on an altitude marker. The same screen opens when a new altitude marker is added.



The following properties are available:

Property	Meaning
Network	Network to which the altitude marker belongs. This cannot be changed.
Name	Identification of the altitude marker.
Altitude	Altitude difference relative to the reference plane. At low pressures, natural gas is lighter than air. As a consequence the network pressure will increase at a higher altitude. This pressure gain is caculated in the capacity calculation. Mind that this is only relevant for relatively low pressures (< 200 mbar).

6.13.1 Add an Altitude Marker

Procedure:

- Click on the button with the altitude symbol in the toolbar (triangle):

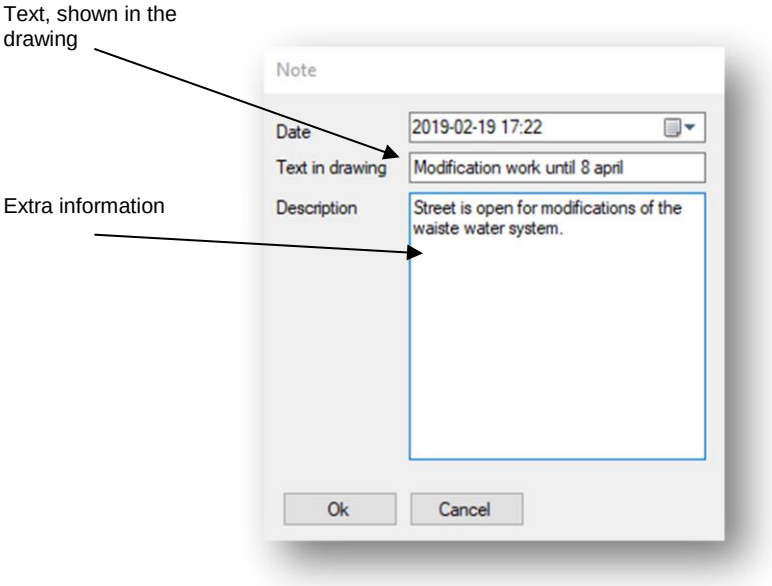
- Click the location where the altitude marker needs to be placed.
  PLEASE NOTE: An altitude marker must be placed on the end point of a pipeline (please use the snap function).
  PLEASE NOTE: The checkbox for **Altitude** must be checked in the window with the calculation settings.

The properties screen opens.

- Please complete the properties and click on **Ok.**

6.14 Text notes

Text notes can be placed at any place. They don't have any influence on the calculations. You can use them for adding notes at specific locations. The properties of the text note are shown when clicking on the pin sign. The same screen opens when a new text note is added.



The following properties are available:

Property	Meaning
Text in drawing	Text that is also displayed in the drawing (if this is selected in the presentation options)
Description	Text, only shown by selecting the text node (in the properties screen).

6.14.1 Add a Text note

Procedure:

- Click on the text note button (with pin symbol) in the toolbar:

- Click the location in the drawing where you want to place the text note.

The properties screen opens.

- Please complete the properties and click on **Ok.**

6.14.2 Save / import notes

Text notes can be saved in a separate file for later use. The saved notes can be imported into any project.

Procedure:

- Choose **File – Notes – Save**
  A file explorer window opens.
- Select the location and name and press Save.
  The file is saved as a .notes file.

Import notes

- Select menu **File – Notes – Import**
  A file explorer window opens.
- Select the file you want to import and press **Open**.
  All text notes are added to the current project.

6.14.3 Remove (all) notes

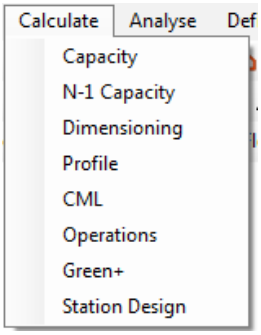
A text note can be removed by selecting the note and pressing delete key. It is also possible to remove all text notes.

Procedure:
ATTENTION: this procedure cannot be undone. Save the text notes first, see §6.14.2

- Select menu **Edit – Remove all notes**

7 Calculations

IRENE Pro 4 is a software programme which performs specialized calculations on a gas distribution network. Click in the main menu on **Calculate.** Seven possible calculation options are given (and a beta version of Station Design). In the demo version only the Capacity calculation can be used, which is the basic pressure calculation.



The seven calculation methods are described in the following paragraphs.

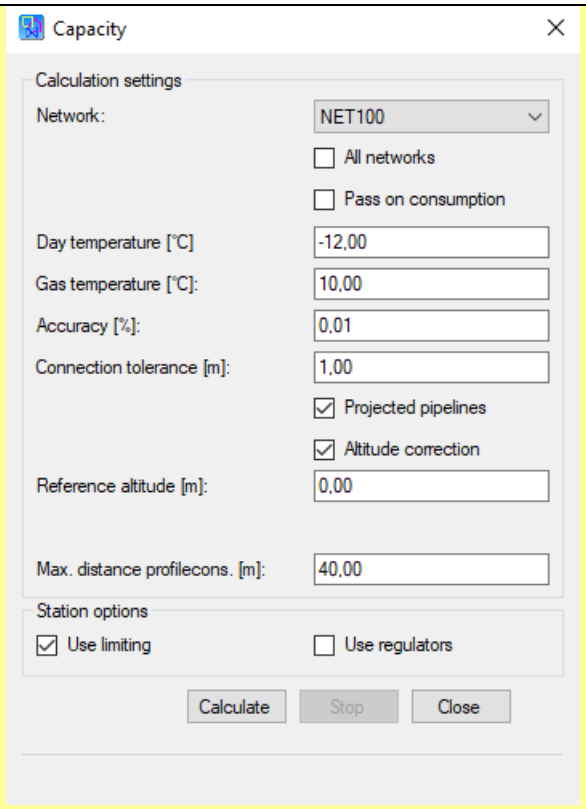
7.1 Capacity Calculation

A capacity calculation calculates the pressure distribution and the flow in the network, on the basis of the specified consumption and calculation settings. You can start the calculation with the Capacity calculation dialog, but also with the quick button:

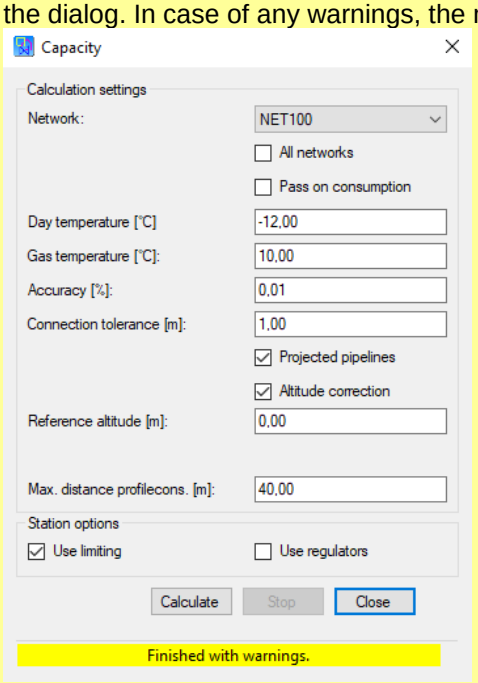
The calculation is carried out with the last used settings. If you want to change the settings, then you will have to calculate using the calculation dialog, see below.

Procedure:

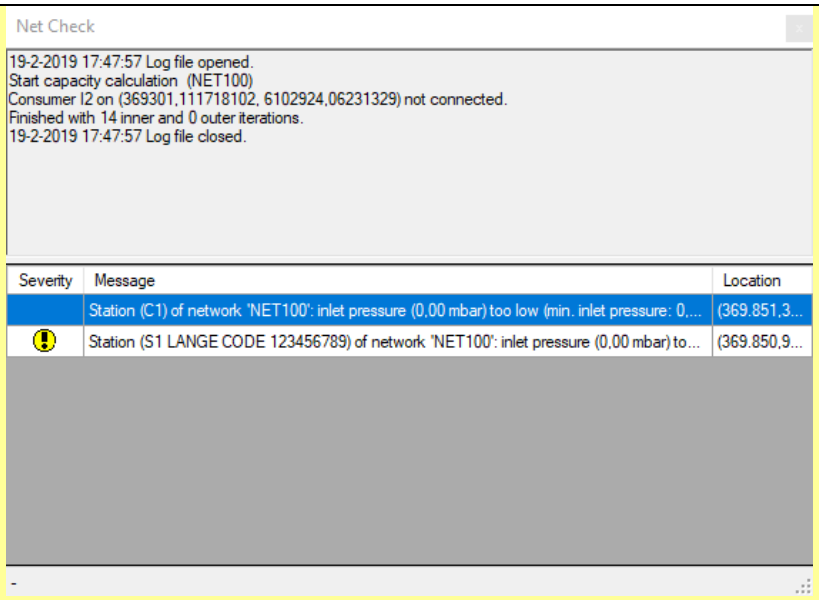
- Select the menu **Calculation**
- Click on **Capacity**
  The following window opens:



- Complete the calculation settings (please see below for an explanation)
- Click on **Calculate**.
  The progress can be followed by the messages at the bottom of the dialog.
- When the calculation has finished, a message is shown at the bottom of the dialog. In case of any warnings, the message is marked yellow.



- Click on the messag at the bottom to see the log and any warnings or errors:



- Any warnings or errors related to objects can be localized by double clicking on the message.

The calculation can take time with larger networks. If it is desired to cancel the procedure in the meantime, then the **Stop** button can be clicked.

Meaning of the Parameters.

Parameter	Meaning/Function
Network	The selected network (effective only if All Networks is not ticked)
All Networks	If ticked, then all the networks will be calculated, starting with the networks with the lowest pressures.
Pass On Consumption	The calculated consumption of a network is passed on to the network which feeds the Station (if All Networks is not ticked, any existing old calculation results are used to define the consumption of the lower pressure networks!).
Day Temperature	Mean day temperature on which the gas consumption is based.
Gas Temperature	The temperature of the gas in the pipeline.
Accuracy	The accuracy with which the pressures are calculated. The accuracy is given as a percentage of the maximum allowable pressure loss.
Connection Tolerance	The maximum distance between pipelines ends to the objects to be joined to them (e.g. other pipelines, stations, valves, consumers and altitude markers), which are considered as hydraulically connected. (Can only be set via the Settings menu, see §2.3.)
Projected Pipelines	If ticked, projected pipelines are included in the calculation as well.
Altitude correction	If ticked, the calculation is carried out using the correction for altitude.
Reference Altitude	Reference level for the altitude from which the ascent pressure gain is determined
Max. Distance Profile Consumer	Maximum distance for a profile consumer from a pipeline, onto which they can be automatically connected (maximum length of the connection pipeline).

Use limiting (Station Options)	If ticked, the calculation is performed taking into account the parameters Maximum capacity and Minimum capacity of the stations.
Use regulators (Station Options)	If ticked, the calculation is performed with the control characteristic of the regulator present in the stations, if one is present (please refer to Appendix IV for details).

Progress of the Capacity Calculation
During the capacity calculation, the progress is shown in the bottom of the window. The term 'Iterations' shows how many times the calculation process has completed an iteration. Here, the set accuracy is decisive. The calculation is stopped when the error in the pressure imbalance over all the meshes is smaller than the accuracy specified.

After completion of the calculation it is possible that it is indicated that a loose network section was present. These are one or more pipelines which are not connected to a supply point (station).
Any other erroneous conditions are also given in the status bar. The user can also view these messages and an overview of the capacity calculation progress in the log file (**Analyse** menu, **View Log**).

7.2 n-1 calculation

With n-1 all possible situations with one station in failure are calculated. The result is a table with the following information:

- The capacity and name of the station that failed.
- Reference Min. Pressure
  The minimal pressure under normal conditions at the location where the pressure will be lowest due to the station failure, see Min. pressure.
- Min. Pressure
  The lowest pressure of all the pressures that have changed due to the station failure. NOTE: this is not necessarily the lowest pressure in the network, because only locations where the pressure has changed due to the station failure are considered.
- Summed connected load
  pre-defined consumption of all consumers that are not supplied if the station fails. (For node consumers, this can be split according to the consumption definition)
- Summed Consumption
  Summed calculated consumption of all consumers that are not supplied if the station fails. (For node consumers, this can be split according to the consumption definition)
- Station calculated capacities
  The calculated amount of gas that each station has to supply, due to the failing station.

Each row represents a calculation result for the failure of one specific station. By selecting a row the calculation is selected. The calculation results presented in the drawing belong to the selected row. This is also true for the calculate values shown in the assets dialog. However, when a different row (calculation) is selected, the user has to reopen the assets dialog to see the changed values.

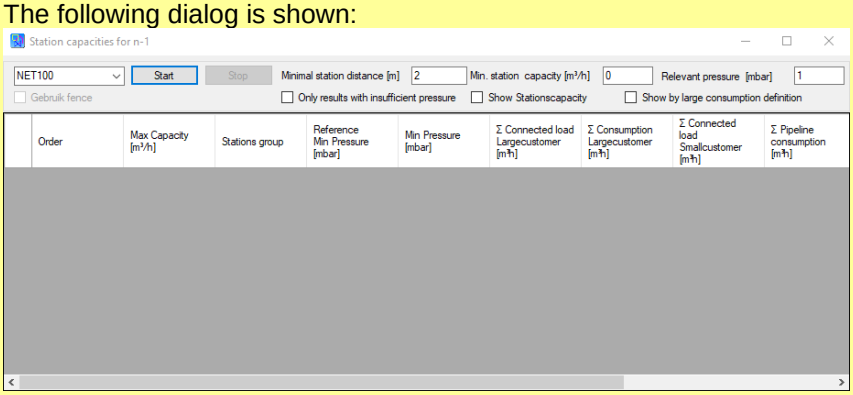
PLEASE NOTE: the calculation settings of the last calculation are used. To change the calculation settings, use the capacity calculation dialog.

PLEASE NOTE: The calculation can take a long time if there are many stations. However, the calculation is smart: it starts by calculating the most important stations (stations with the highest maximal capacity). So you can stop the calculation in prematurely. The results of the calculated stations will be available.

PLEASE NOTE: Pass-on consumption will not work. You can therefore only calculate low pressure distribution networks and not the supplying transport networks.

Procedure:

- Select the menu **Calculate – N-1 capacity**.
  The following dialog is shown:



- Select the prefered network
- Set the **Minimal station distance** (stations that are within this distance will be considered as one station)
- Set the **Min. Station capacity** (stations with a lower maximal capacity will not be calculated)
- Press **Start** to start the calculations.

The results are presented in a table. By selecting a row, the corresponding calculation results can be shown. The table can be copied to excel for futher analysis.

The dialog gives several options for the calculation and for the result table. Below an explanation of each option:

Calculation parameter	Meaning
Active network	The selected network that will be calculated (be carefull that All networks is not selected in the capacity calculation settings).
Start	Starts the calculation.
Stop	The calculation is stopped, the calculated results are available. The calculation starts with the stations with the largest maximal capacity.
Minimal station distance	Stations with a lower distance between each other will be considered as one station. This is important if stations contain multiple feeds that are modelled as separate “stations”.
Min. station capacity	Only stations and stationgroups with a higher maximum capacity are calculated. This can be useful if the network contains a lot of small stations that are used for just a few consumers.

Beside the calculation parameters, there are some parameters that determine how the results are presented in the result table.

Setting	Meaning
Relevant pressure	The result table will only show values where, due to the failing station, the pressure drop is equal or larger than the set value.
Only results with insufficient pressure	When selected, the table will only show values for situations where the pressure is insufficient.

Show station capacity	When selected, the calculated capacity of each station is shown (be careful: each station has its own column, so the table can become quite large).
Show by large consumption definition	When selected, the summed demand for node consumers with insufficient pressure, is split per consumption definition.

7.3 Dimensioning

The Dimensioning calculation determines the minimum pipeline diameters in a network. This is completed for the pipelines with the status 'Design'. These pipelines do have a routing already, but the material and diameter are still to be specified. The Dimensioning calculation specifies which diameters are necessary, based upon the calculated pressures and the minimum network pressure.

There are two dimensioning options available.

1. Standard
   With the standard calculation the pipeline diameters are specified on the basis of a failure free situation (all stations working correctly).
2. n-1 situation
   This method indicates the pipeline diameters on the basis of a failure situation in which a maximum of one station is out of service.

In both cases the status of the stations, which are manually set as out of service by the user, remains unchanged.

The dimensioning occurs on the basis of the gas consumption at a given outside temperature (the design temperature, and possibly also the 'n-1' temperature). The outside temperature for the failure-free situation (design situation) shall in principle be lower than the outside temperature for the failure situation ('n-1' temperature).

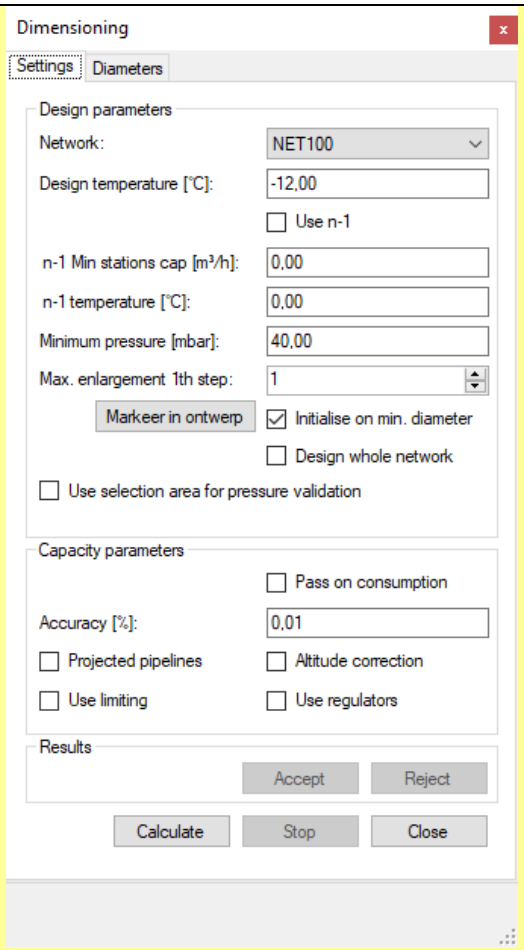
The dimensioning takes place in such a way that nowhere in the network the pressure at the given temperatures is less than a specified lower limit for this network. Furthermore, the aim is to distribute pressure gradient as evenly as possible over the network.

PLEASE NOTE: see appendix V for additional background information.

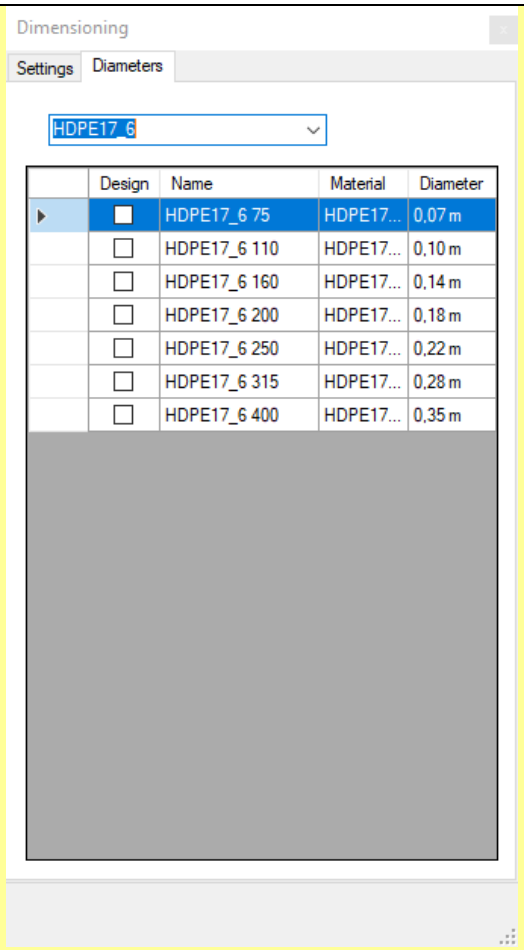
The following steps are to be executed when dimensioning a network.

Procedure:

- Draw or open an existing network.
- Set the status of each pipeline to be dimensioned to 'in design' (if you want to dimension the complete network you can use the button 'All in design' in the Dimensioning window).
- Choose **Dimensioning** in the menu **Calculation**.
  The following window appears:



- Select the **Diameters** tab:



- Select the material that is to be used for the calculations
- Select the diameters that are to be used in the dimensioning calculation. (the list shows the pre-defined materials, see §9.2)
- Go back to the **Settings** tab.
- Choose the desired calculation settings. (see below for a description of the different possibilities).
- Click on **Calculate**.

The calculation can take some time, especially in the case of larger networks. The calculation can be stopped before completion by clicking the **Stop** button.

When the dimensioning is completed according to the message in the status bar, the dimensioning window can be closed and the results can be viewed in the same manner as for a standard capacity calculation.

If required, the diameters are made definitive by opening the dimensioning window and clicking on '**Accept'**. All designed pipelines will now have the status 'In Service' with the new material/diameter.

The dimensioning can be undone by opening the dimensioning window and clicking on Reject. The state will be reset as it was before the last calculation.

Meaning of the Parameters.

Parameter	Meaning/Function
Network	The selected network
Design temperature	Minimum temperature on which the network design is based.

Apply n-1	Perform calculation according to the n-1 method: the network is designed in such a way that at the n-1 temperature the pressure is still sufficient when one of the stations fails.
n-1 Min stations cap	The n-1 calculation is only applied for stations with the same or larger capacity than the set minimal n-1 station capacity.
n-1 temperature	Temperature for the n-1 calculations.
Minimum pressure	Minimum allowable pressure under design conditions and if applicable, the n-1 conditions.
Max. enlargement 1st step	The dimensioning method for failure-free conditions consists of multiple steps. In the first step the best diameter for all pipelines (in design) is estimated (based upon an estimate on the basis of the pressures at the smallest or original diameter). The parameter limits the number of sizes with which the diameter in the first step may be increased. The parameter may be set to 0, in which case the first step is skipped (in the following steps the size will only increase by 1 size.)
Initialise min. diameter	When selected, the minimum diameter available out of the selected range is used as starting point for all pipelines. If not selected, the current diameter of each pipeline is used as a starting point and will only increase (if necessary).
All in design	When selected, the state of all of the pipelines is set to 'In Design'.
Use selection area for pressure validation	When selected, the pressure will only be validated within the fence (otherwise the pressure in the whole network will be validated). This is only applicable if a fence is created, see §6.2.2.
Pass on consumption	When selected, the calculated consumption from a network is transferred to the supplying networks, via the stations. First the demands of all networks is calculated at the selected temperature and n-1 temperature before the dimensioning is started.
Accuracy	The accuracy with which the pressures are calculated. The accuracy is given as a percentage of the maximum allowable pressure loss (see network definition, §9.1).
Projected Pipelines	If selected, projected pipelines are taken into account as if they are present.
Altitude correction	If ticked, the altitude correction is included in the calculation.
Use limiting	If ticked, the stations are limited to their set capacities.
Use Regulators	If ticked, the control characteristic of the regulator in the stations, if present, is included in the calculation
Accept	Accept the calculation result of the dimensioning calculation: all pipelines are given the calculated diameter and the status 'In Service'.
Reject	The network is reset to the original state as it was before the last calculation.
Stop	Stops a running calculation.
Calculate	Calculate the diameter of pipelines with status 'In design'. After a successful calculation all pipelines with the status 'In Design' have the appropriate material/diameter.

Comment: To ensure that the gas network meets the criterion of supply pressure at higher temperatures than the design temperature or the n-1 temperature, the gas demand should decrease with an increasing outside temperature.

Comment: The design temperature is always set lower than the ‘n-1’ temperature. Otherwise it would only be necessary to complete dimensioning under failure conditions.

Comment: If ‘Initialise at minimum diameter ’ is not ticked, the dimensioning is started using the already present diameters of the relevant ‘in design’ pipelines as starting point.

Error Messages

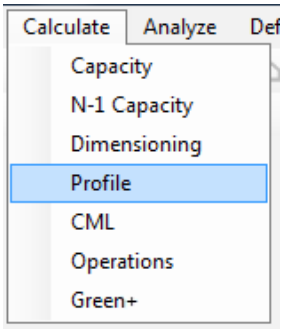
Assuming that the network is constructed in such a way that a capacity calculation can be carried out error-free, there are five reasons why the dimensioning may not be successful:

1	There are no pipelines designated for dimensioning (no pipelines with the status ‘In Design’).
2	There are no material/diameters selected for dimensioning.
3	Even when the largest available diameters are applied under failure-free conditions, there remain locations in the network where the pressure is too low. **PLEASE NOTE:** In large networks this can be caused by a location that is not involved in the part of the network that has to be designed. Please, use a fence to limit the pressure check to the relevant area.
4	Even when the largest available diameters are applied under conditions with one or more failure conditions, there remain locations in the network where the pressure is too low. See also note at previous item.

7.4 Profile Calculation

With the Profile Calculation module it is possible to carry out capacity calculations of the gas network over a specified period on an hourly basis. For a useful calculation profile consumers should be present in the gas network, otherwise the same calculation result will be generated for each hour. The associated profile definitions must also be present together with their data for the appropriate period.

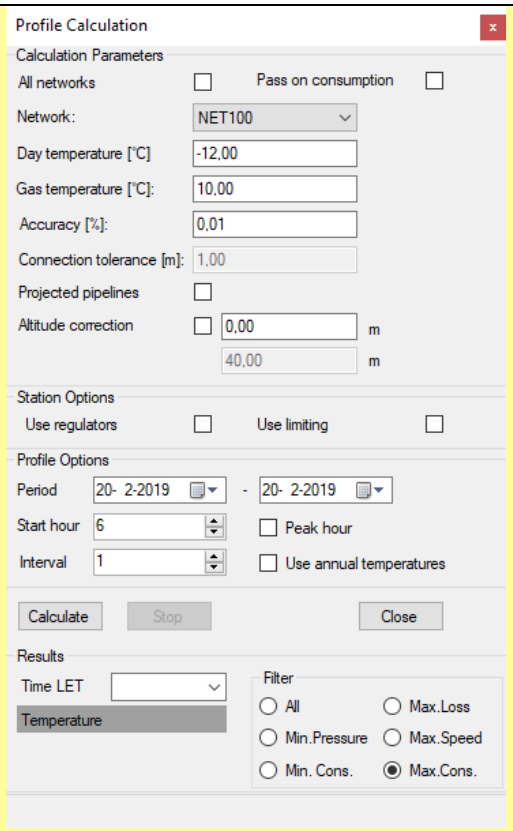
The Profile Calculation can be found via **Calculate** - **Profile**:



The Profile calculation is only available if the user has the appropriate license.

Procedure:

- Choose the menu **Calculate**.
- Click on **Profile**.
  The following window is opened:



- Complete the calculation settings (please, see below for an explanation)
- Click on **Calculate.**

As well as the already known parameters for the capacity calculation, it is now also possible to set the parameters for the profile calculation.

This concerns the following parameters:

Item	Type	Meaning
Period	date	Start and end date of the period for the hourly pressure distribution calculations.
Start Hour	integer (0 ... 23)	Daily starting hour for the calculation (only active if Peak Hour is not ticked).
Interval	1, 2, 3, 4, 6, 8 or 12	Time lapse between two calculation times. (only active if Peak Hour is not ticked).
Peak Hour	boolean	Only calculate the pressure distribution for the hour of maximum consumption of that day
Use Annual Temperatures	boolean	Use the list of day temperatures (only for profile calculation, overwrites the setting 'Temperature')

The calculation is started by clicking on the button 'Calculate'

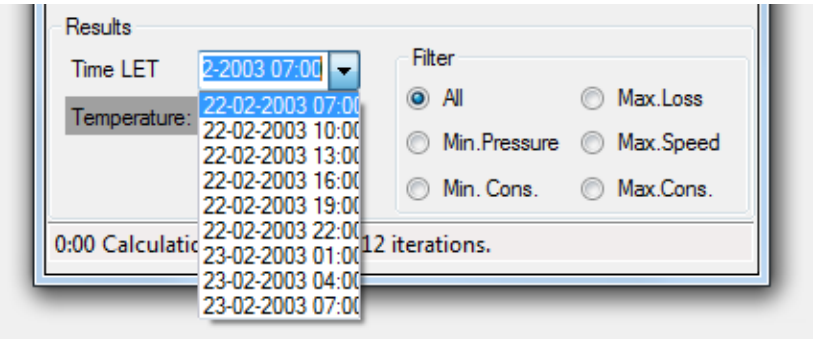
The calculation cannot be carried out if:

- Profile details are missing for the specified period.
- 'Use Annual Temperatures' is ticked and the annual temperature data is missing for the specified period.

If 'All Networks' is ticked, then these conditions must be fulfilled for all networks, otherwise this only needs to be fulfilled for the active network.

7.4.1 Show Profile Calculation Results

Once a Profile Calculation is completed, the combo-box 'Time LET' is completed with a list of times for which a calculation result is available.



The number of times in the list is a maximum of 24 x the number of days in the given period. Thus, this can be a substantial list. It is possible to filter the list by clicking on the radio buttons in the right hand panel. Once a time is selected, the drawing of the network will be adjusted.

7.4.2 Display and Alteration of Profiles

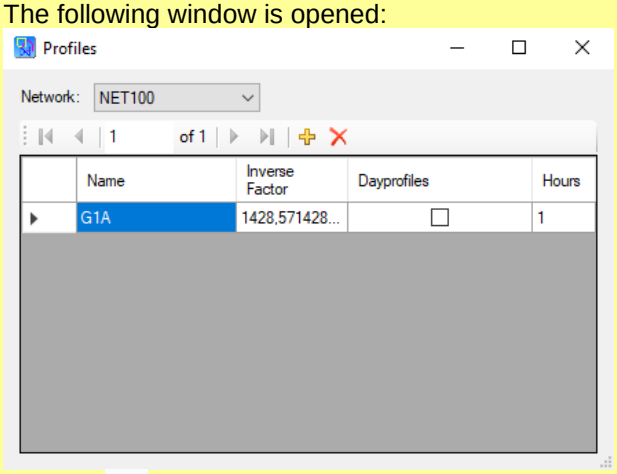
Profiles are defined for each network separately.

PLEASE NOTE: this paragraph handles just the method used for profile calculations. For Green+ a different technique is used, see §

For a more elaborate description, see §9.6.

Procedure:

- Choose the **Definitions** menu
- Click on **Profiles – Flow profiles**.
  The following window is opened:



- Click on  to add a new profile
- Click on  to delete an existing profile.
  This is only possible if no profile consumers exist in the network which have this particular profile.
- It is possible to change the name of the profile by changing the text in the fields.
- PLEASE NOTE: for profile calculations a profile based on date is used. The checkbox for 'Dayprofiles' should not be checked.

IRENE Pro has only limited functionality for the manipulation of profiles and profile data. To create correct profiles, much knowledge is needed of the profile consumers

to be defined and a more or less comprehensive statistical analysis. This is outside of the scope of the gas calculation itself.

The two remaining profile parameters shown ("Factor" and "Inverse Factor") cannot be user adjusted. These have the following meanings.

Item	Type	Meaning
Factor	double	factor used for the standard capacity calculation, in order to convert the standard annual consumption of a profile consumer into the peak consumption (the factor is (1.4 m^3/hr) / (2000 m^3/yr)
Inverse Factor	double	factor used to convert the peak consumption to the standard annual consumption for the profile calculation (if the standard annual consumption is zero (0)). This factor is automatically calculated and is such that the largest consumption at -12°C in the present profile values corresponds with the specified profile consumption. The unit is (m^3_n/yr)/(m^3_n/h)

7.4.3 Display and Alteration of Profile Details

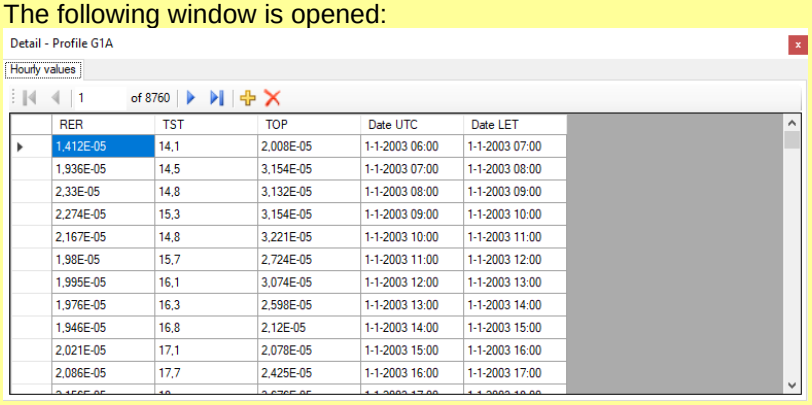
The following describes how the detail data of the profile can be viewed, and how these can be altered.

PLEASE NOTE: this paragraph handles just the method used for profile calculations. For Green+ a different technique is used, see §7.6

For a more elaborate description, see §9.6.

Procedure:

- Complete the procedure as given in the previous paragraph.
- Click on one of the lines in the '**Profiles'** window.
  The following window is opened:



RER	TST	TOP	Date UTC	Date LET
1,412E-05	14,1	2,008E-05	1-1-2003 06:00	1-1-2003 07:00
1,936E-05	14,5	3,154E-05	1-1-2003 07:00	1-1-2003 08:00
2,33E-05	14,8	3,132E-05	1-1-2003 08:00	1-1-2003 09:00
2,274E-05	15,3	3,154E-05	1-1-2003 09:00	1-1-2003 10:00
2,167E-05	14,8	3,221E-05	1-1-2003 10:00	1-1-2003 11:00
1,98E-05	15,7	2,724E-05	1-1-2003 11:00	1-1-2003 12:00
1,995E-05	16,1	3,074E-05	1-1-2003 12:00	1-1-2003 13:00
1,976E-05	16,3	2,598E-05	1-1-2003 13:00	1-1-2003 14:00
1,946E-05	16,8	2,12E-05	1-1-2003 14:00	1-1-2003 15:00
2,021E-05	17,1	2,078E-05	1-1-2003 15:00	1-1-2003 16:00
2,086E-05	17,7	2,425E-05	1-1-2003 16:00	1-1-2003 17:00

A (large) number of hourly values are shown in this window, which specify the consumption of a Profile Consumer from hour to hour.
(A description of the various possibilities follows.)

The consumption of a Profile Consumer is dependent upon its profile, the temperature and the standard annual consumption or peak consumption. This is calculated using the following formula:

If the standard annual consumption = 0:

$$Q = (top + \max(0, tst-t) \cdot rer)\ peak \cdot inverse\ factor$$

If the standard annual consumption ≠ 0:

$$Q = (top + \max(0, tst-t) \cdot rer)\ sac$$

where:

Q	consumption in m^3_n/h
t	the prevailing outside temperature in °C
sac	the standard annual consumption in m^3_n/yr
peak	the peak consumption in m^3_n/h
top	date and time dependent factor for the basic consumption
rer	date and time dependent gradient (slope) of the heating curve in $°C^{-1}$
tst	date and time dependent temperature of the heating curve in °C

The conversion of yr to h is also encompassed in the parameters top and rer (a factor of 1/8760).

It is possible to alter the date (UTC), top, rer and tst by changing the values in the fields. The local time (LET) is automatically adjusted.

It is possible to add information (Click on ) and delete information (Click on  to delete the selected row).

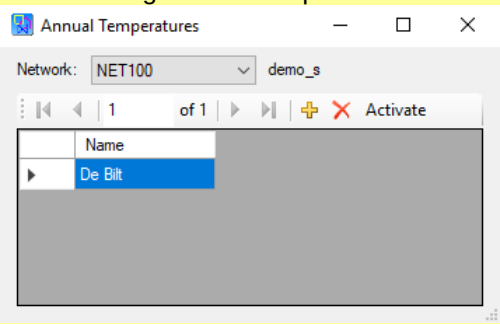
Records can also be copied and paste (use shortcuts Ctrl+c and Ctrl+v). In this way data can be exchange with other applications such as Excel and Word.

7.4.4 Display and Alteration of Annual Temperature Data

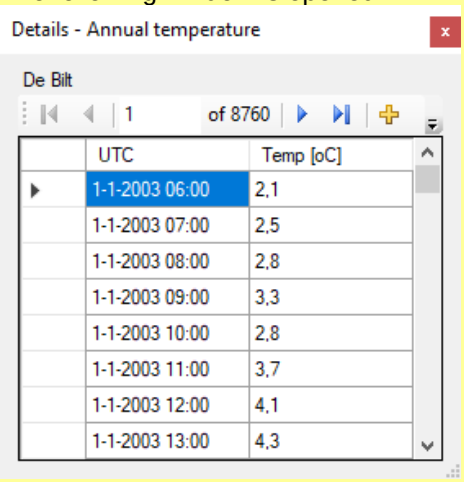
Annual temperatures form a part of the network.

Procedure:

- Select the **Definitions** menu.
- Click on **Annual temperatures**.
  The following window is opened:



- By double-clicking on one of the rows in the **Annual Temperatures** window, the detail data of the set are displayed.
  The following window is opened:



UTC	Temp [oC]
1-1-2003 06:00	2,1
1-1-2003 07:00	2,5
1-1-2003 08:00	2,8
1-1-2003 09:00	3,3
1-1-2003 10:00	2,8
1-1-2003 11:00	3,7
1-1-2003 12:00	4,1
1-1-2003 13:00	4,3

Although multiple sets of annual temperatures can be present in a network, only the uppermost (named “De Bilt’ in the example above) is used in the profile calculation. It is possible to move a different set of annual temperatures to the top of the list by selecting this row and clicking ‘**Activate’**.

It is possible to change the date (UTC) and the temperature by altering the values in the fields.

It is possible to add information (Click on) and delete information (Click on to delete the selected row). It is also possible to change the name of the set by clicking on the field.

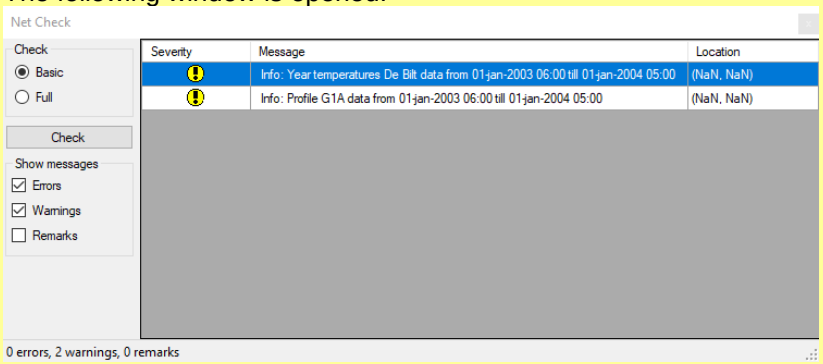
Records can also be copied to and from the clipboard of the computer. In this way data can be exchange with other applications such as Excel and Word.

7.4.4.1 Verification of the Profile and Annual Temperature Data

For a successful completion of the profile calculation all profile data and, if necessary, the annual temperature data for the period to be calculated must be available. The profile calculation will show an error message if this is not the case.
Use the Network Check to determine whether all data are complete and which may be missing.

Procedure:

- Select the **Analyse** menu.
- Click on **Verify Network**.
  The following window is opened:



Among others, errors and warnings concerning the profile definitions are displayed.

Network Check checks only for the presence or absence of data. The correctness of the values of temperatures, tst and top and rer is not assessed.

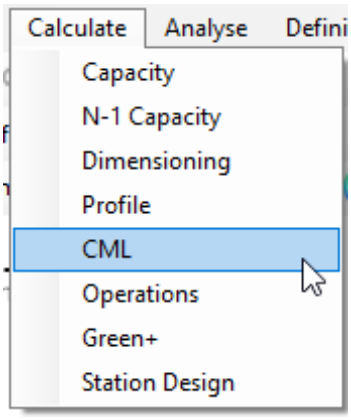
7.5 CML (Customer Minutes Lost)

With the CML module it is possible to make an estimate of the reliability of the gas network.

PLEASE NOTE: The CML calculation does not take customers into account that are present in underlying supplied networks. If the calculated network supplies other networks, the calculated CML will be inaccurate (too low).

PLEASE NOTE: The CML calculation is not able to calculate with the option “Use External Demand”. The demand that has to be supplied to other networks is not taken into account, unless as a consumer in the calculated network.

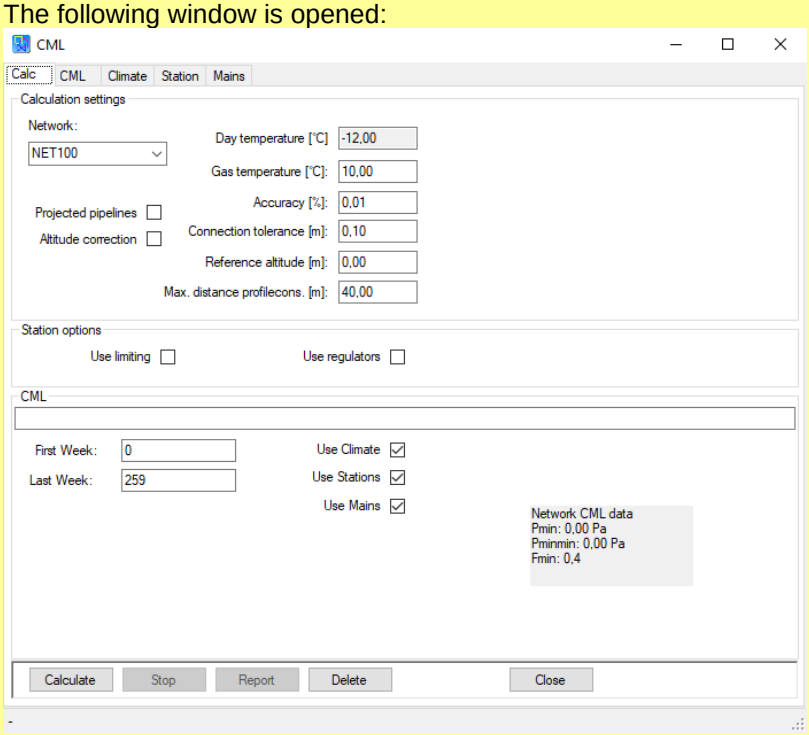
The CML calculation can be opened via **Calculate** => **CML**:



The CML calculation is only available when the user has the appropriate license.

Procedure:

- Select the **Calculate** menu.
- Click on **CML**.
  The following window is opened:



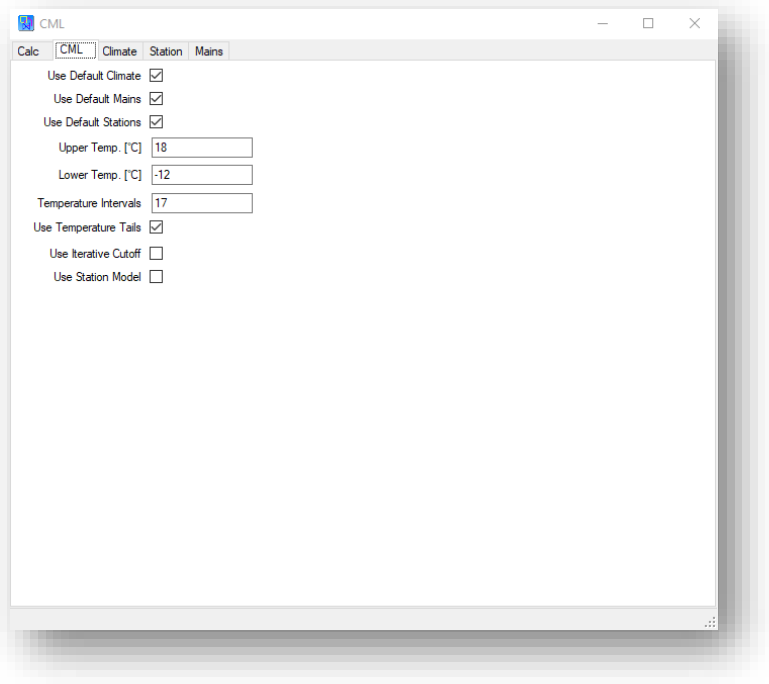
- Complete the desired calculation settings (please, see below for an explanation)
- Click on **Calculate**.
- Wait until the message '<time><network name>(<nominal pressure>) ready' is shown in the status bar. This can take some time, depending upon the size of the network. Progress messages will appear with intervals.

In addition to the parameters for the capacity calculation, it is also possible to set the parameters for the CML-calculation.
This concerns the following parameters:

Item	Type	Meaning
Commentary	string	Optional user supplied text string(i.e concerning the settings and calculation)

First week	integer (0 ... 259)	First week of the period over which the reliability calculation is performed.
Last week	integer (0 ... 259)	Last week of the period over which the reliability calculation is performed.
Use Climate	boolean	Calculate the CML's due to climate is taken.
Use Mains	boolean	Calculate the CML's due to pipeline failures.
Use Stations	boolean	Calculate the CML's due to station failures

Under the CML tab sheet, there are a number of detailed settlings.

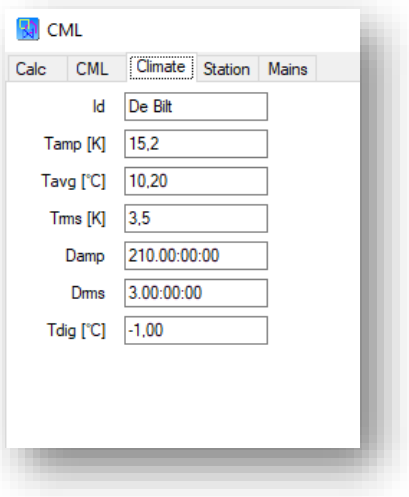


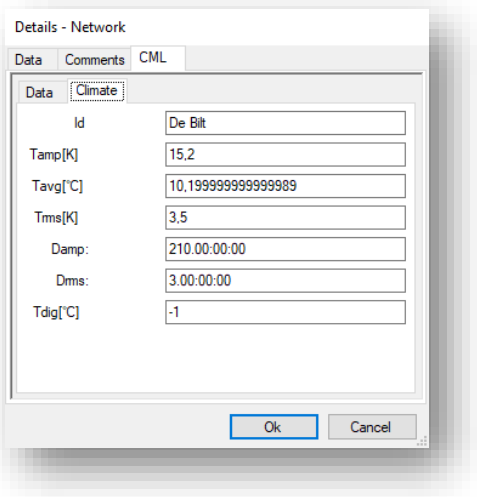
Item	Type	Meaning
Use Standard Climate	boolean	Always use the climate parameters according to the Climate tab (instead of the climate parameters of the network).
Use Standard Mains	boolean	Always use the pipeline parameters according to the Mains tab (instead of the pipeline parameters of the pipeline material or the individual pipeline).
Use Standard Stations	boolean	Always use the station parameters according to the Station tab (instead of the station parameters of each individual station).
Highest temperature	float	Upper limit of the temperature range over which the calculation is made.
Lowest temperature	float	Lower limit of the temperature range over which the calculation is made.
Temperature intervals	Integer	Number of intervals in which the temperature range is divided.
Use temperature extensions	boolean	If ticked, the first and last temperature interval are extended to respectively +/- infinity.

Use iterative cut-off	boolean	If ticked, users are disconnected when their supply pressure is less than Pminmin of the network. The pressure is then recalculated.
Use station model	boolean	If not ticked, a constant probability of failure of a station is assumed; If ticked, the probability of failure is based on the probabilities of failure of the station components and the inspection regime.

7.5.1 Input Climate Data into CML

The determination of the CML's as a result of climate is based on six parameters, that describe the fluctuation in day temperature over a year. The settings are available on the tab Climate for setting a default climate. A specific climate for a network can be defined in the network definition dialog, on the Climate tab of the CML tab, see figures below.



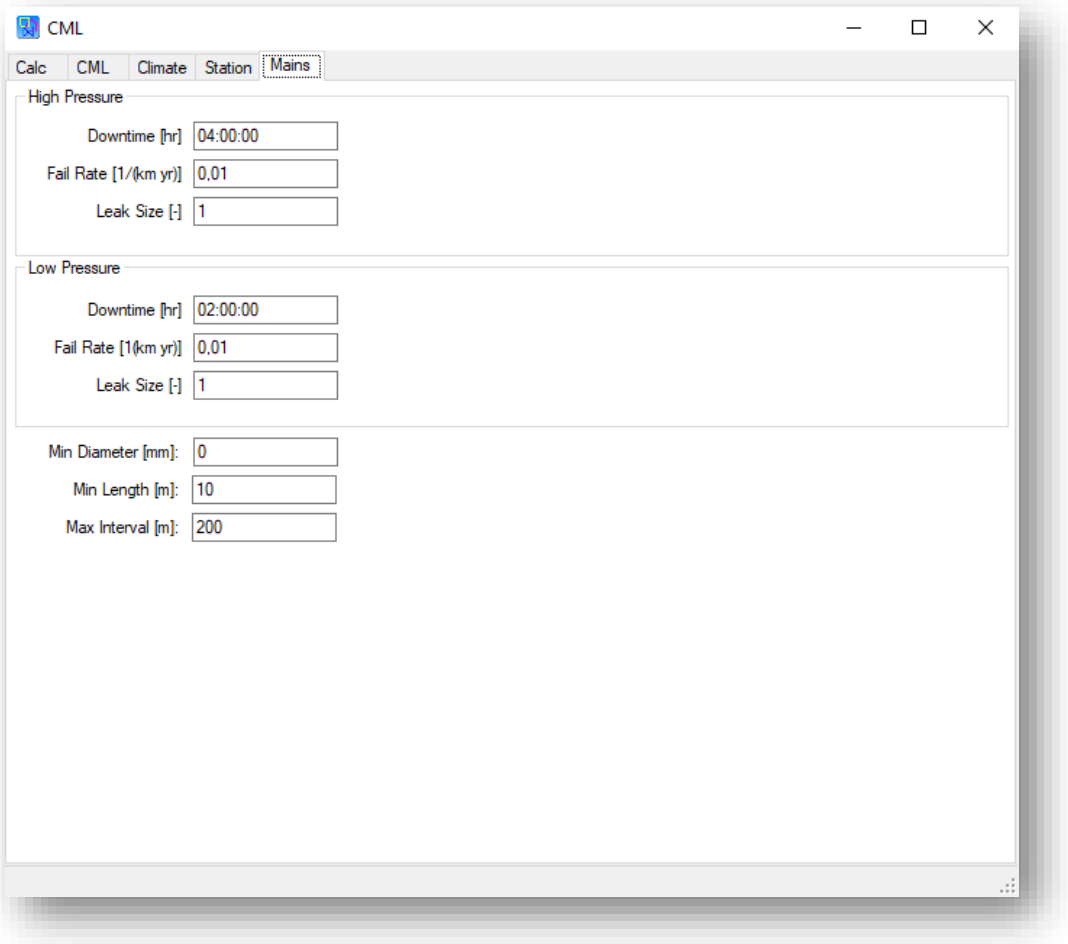


The different parameters are explained in the table below.

Item	Type	Meaning
Id	string	identification of the climate
Tampl	float	seasonal fluctuation in average day temperatures (top-top)
Tavg	float	Average annual temperature
Trms	float	Day to day variation in the average day temperatures
Damp	timespan	Date of maximum average day temperature (in northern hemisphere on about day 210 of the year).
Drms	timespan	Timescale of the day to day variations in average day temperatures.
Tdig	float	Average day temperature below which no pipeline failures will occur (because digging activities are stopped).

7.5.2 Input Data for CML Pipelines

The determination of the CML's due to pipeline failures is based on three parameters for each pipeline.



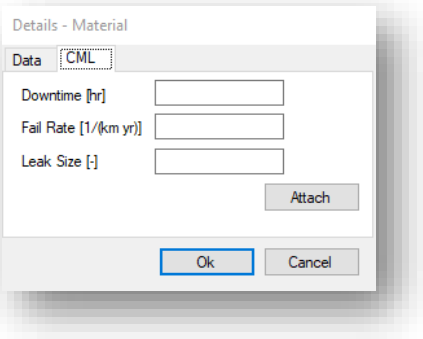
Which parameters are used, depends on the nominal pressure of the network. Pressures up to 500 mbar (7.25 psi) are considered as low pressures, while pressure above 500 mbar (7.25 psi) are considered as high pressures. The parameters are explained in the table below:

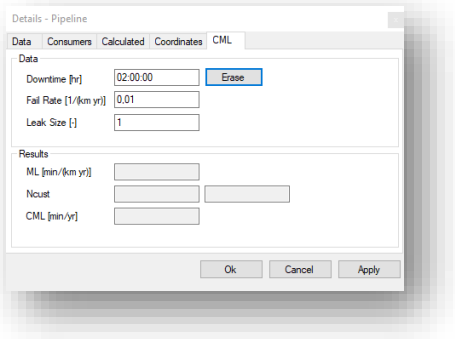
Item	Type	Meaning
High pressure / low pressure		High Pressure: MOP > 500 mbar (7.25 psi) Low Pressure: MOP ≤ 500 mbar (7.25 psi)
Downtime	timespan	Duration of the interruption, if the pipeline fails
Fail Rate	float	Probability of failure of the pipeline per unit of time, per unit of length.
Leak Size	float	Resistance factor of the leak (based on the inner diameter of the pipeline)
Min. Diameter	float	Only pipes with a diameter > Min. Diameter are calculated. Higher values decrease the calculation time (fewer pipe lines), but keep in mind that the summed CML of the whole network will be incorrect.
Min Length	float	Only pipes with a length > Min. Length are calculated. Higher values decrease the calculation time (fewer pipe lines), but keep in mind that the summed CML of the whole network will be incorrect.
Max. Interval	float	Max distance between simulated leaks. If a pipe has a length that is longer than this distance, more leaks are applied. Lower values increase calculation time and accuracy.

The parameters can be specified at three levels:

- For each individual pipeline. In the detail screen of the pipeline, tab CML.
- For each material/diameter. In the detail screen of the material, tab CML.
- Globally, as default parameters. In the Pipelines tab of the CML window.

These details are optional for a pipeline and for a material. If these data is not provided for a pipeline, then the data associated with the material is used. If there are no data associated with the material, the global default parameters are used.

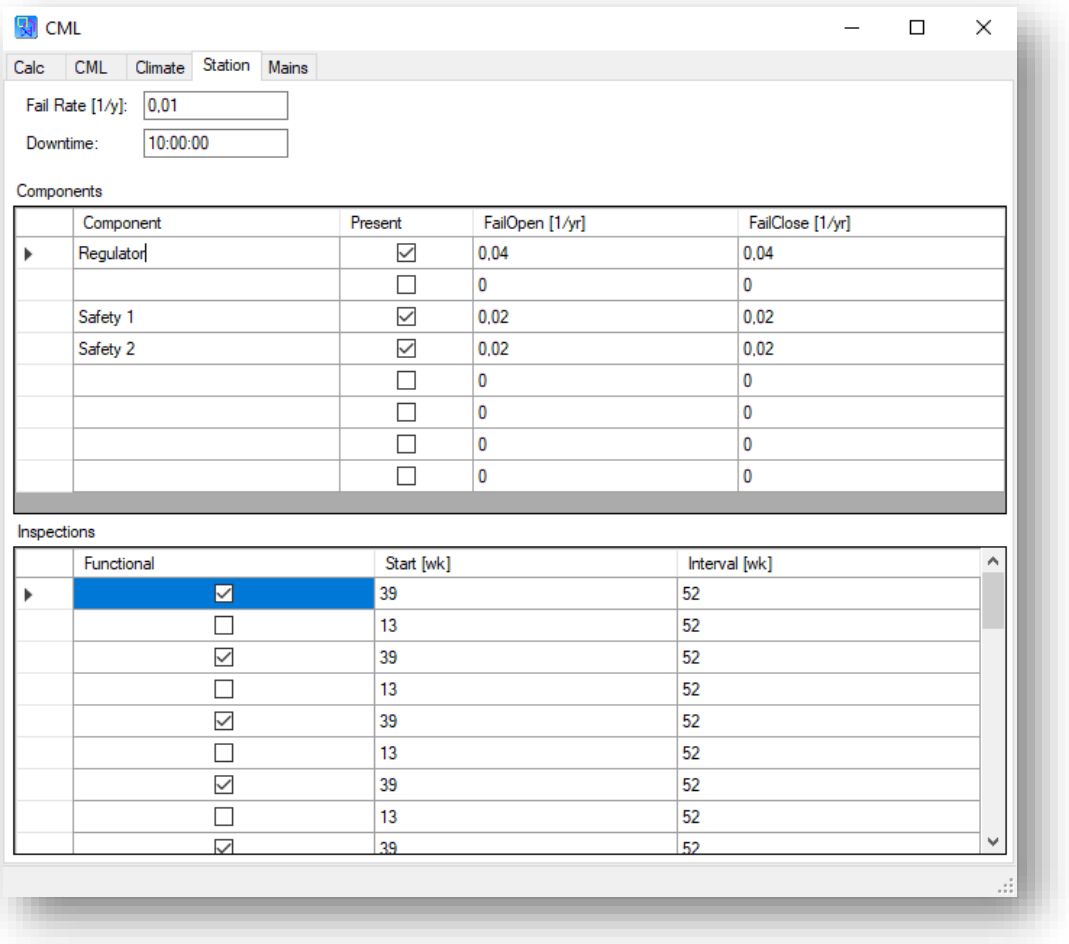




With the button Attach, the default parameters are loaded for the material or the pipeline, and can then be changed to make them specific for the material or pipeline. The button Attach changes into a button Erase. By pressing the Erase button, the specific CML parameters are removed and default parameters are used for the CML calculations.

7.5.3 Input Data CML Stations

The determination of the CML's due to failure of a station is based on a number of parameters for each station.

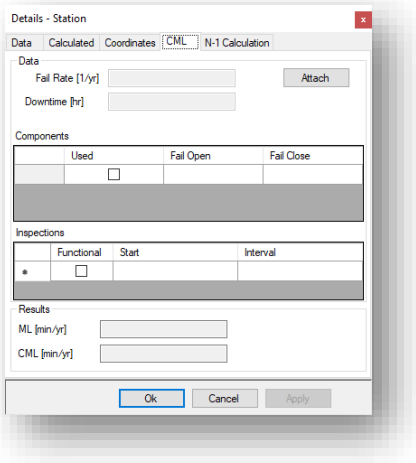


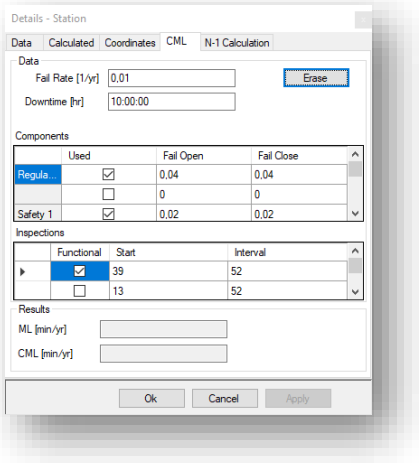
The meaning of the parameters is explained in the table below.
When the option ‘Use Station Model’ is not ticked, only the parameters ’Fail Rate’ and ‘Downtime’ are relevant.

Item	Type	Meaning
Downtime	timespan	Duration of interruption, if the station fails.
Fail Rate	float	Probability of failure of the station per unit of time (applies only when the option ‘Use Station Model’ is not ticked).
(Components) Present	boolean	If ticked, then the designated component is incorporated in the gas runs of the station.
(Components) FailOpen	float	Probability of unsafe failure of the component per unit of time.
(Components) FailClosed	float	Probability of safe failure of the component per unit of time.
(Inspections)) Functional	boolean	If not ticked, then it concerns a visual inspection. If ticked, then it concerns a functional inspection (unsafe failure of components is also detected if it has no effect on the gas transport through the gas run).
(Inspections) Start	integer	Week number of the first (recurring) inspection.
(Inspections) Interval	integer	Interval between the inspections of the same sequence (0 means a one-off inspection in week ‘Start’)

The parameters can be specified on two levels:

- For a individual station. In the detail screen of the station, tab CML.
- Globally, as default parameters in the Stations tab of the CML window.



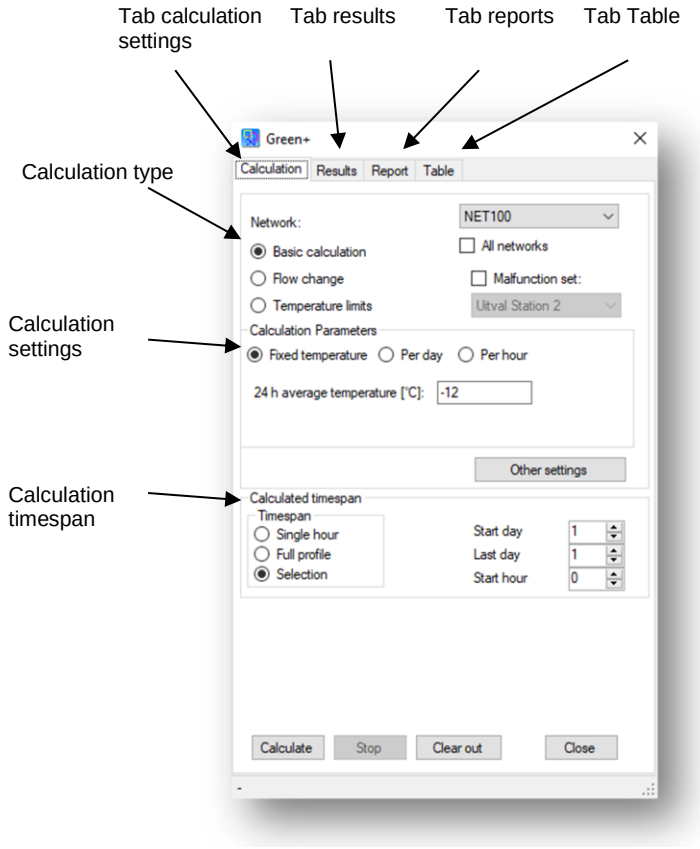


In case there are no specific CML data attached to the station, a button Attach is visible. By pressing the button Attach, the default configuration is applied and can be modified to make it specific for the selected station. The button changes to Erase. By pressing the Erase button, the specific CML data is detached and the default parameters are used for the CML calculations.

7.6 Green+

Green+ calculations are used to analyse the effects of so called green gas suppliers. Contrary to standard gas network calculations, the problems arise when the consumption is at the lowest levels. Green+ therefore uses consumption profiles in order to calculate the consumption at any time of the day. Also Green+ is able to take buffering effects into account. Buffering happens when the consumption is lower than the supply for a certain amount of time and the pressure in the pipe system rises to a certain level.

The Green+ dialog is as follows:



There are three types of Green+ calculations:

1. Basic
   For the selected period all hours are calculated. The size of the buffer is calculated for each hour. The size of the buffer during the former hour and the speed at which it is emptied or filled by the consumers, stations and compressors, is taken into account.
   The buffer size is defined as the extra amount of gas that is available on top of the minimal required amount of gas to keep the pressure above the set minimal pressure (buffer size in m_n^3). In other words, as long as the buffer size is larger than zero, the pressure is above the set minimum. In case the buffer is smaller than zero, somewhere the pressure is lower than the set minimum pressure.
2. Flow change
   The buffer time is being calculated, when a supplier suddenly changes it's supply. This is the time that it takes before the pressure is to low or high.
3. Temperature limits
   Green + calculates the minimal and maximal temperature at which the pressure stays within the bounds.

All three calculations can also be performed with a defined malfunction set.

7.6.1 Resultat presentation

Three tabs show the different results:

- Tab Results
  The table shows the results per hour (differentiates per calculation type). Below the results are shown in a chart if applicable. The table, the chart and the result presentation in the drawing are linked. By selecting a point in the chart, the accompanying result in the table is selected as well and the accompanying results are presented in the drawing.
  For the basic calculation the chart can show specific results for a specific

object . Drag, with Ctrl key pressed, the object from the drawing to the chart area. The chart can be copied with Ctrl+c to the clipboard.

- Tab report
  The results are presented as text. You can copy the text to your own report by selecting it and using Ctrl+c (copy) and Ctrl+v (paste).
- Tab table
  You can select which results the table shows. This can be done by using the buttons and or by dragging, with Ctrl key pressed. With Ctrl+c and Ctrl+v, you can copy the table to for instance Excel.

7.6.2 Display and Alteration of Profiles for Green+

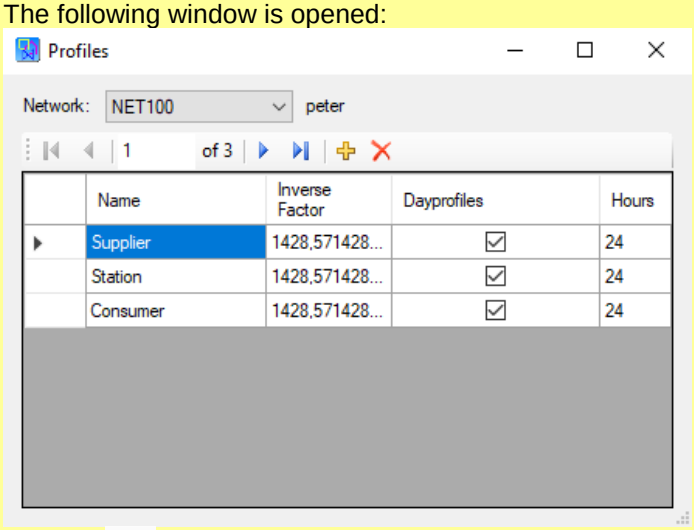
Profiles are defined per network.

PLEASE NOTE: this paragraph handles just the method used for Green+. For profile calculations a different technique is used, see §7.4.

For a more elaborate description, see §9.6.

Procedure:

- Select menu **Definitions**
- Select Profiles – **Flow profiles**
  The following window is opened:



- Click on for adding a new profile.
- Click on for removing an existing profile.
  This is only possible when it isn't in use for any of the profile consumers.
- The name can be changed by click on the text.
- PLEASE NOTE: for Green+ day profiles are used. These are not based on real dates. The checkbox for 'Dayprofiles' should be checked.

The two remaining profile parameters shown ("Factor" and "Inverse Factor") cannot be user adjusted. These have the following meanings.

Item	Type	Meaning
Factor	double	factor used for the standard capacity calculation, in order to convert the standard annual consumption of a profile consumer into the peak consumption (the factor is (1.4 m^3/hr) / (2000 m^3/yr)
Inverse Factor	double	factor used to convert the peak consumption to the standard annual consumption for the profile calculation (if the standard annual consumption is zero (0)). This factor is automatically calculated and is such

	that the largest consumption at -12°C in the present profile values corresponds with the specified profile consumption. The unit is (m^3_n/yr)/(m^3_n/h)

7.6.3 Display and Alteration of Profile Details

The following describes how the detail data of the profile can be viewed, and how these can be altered.

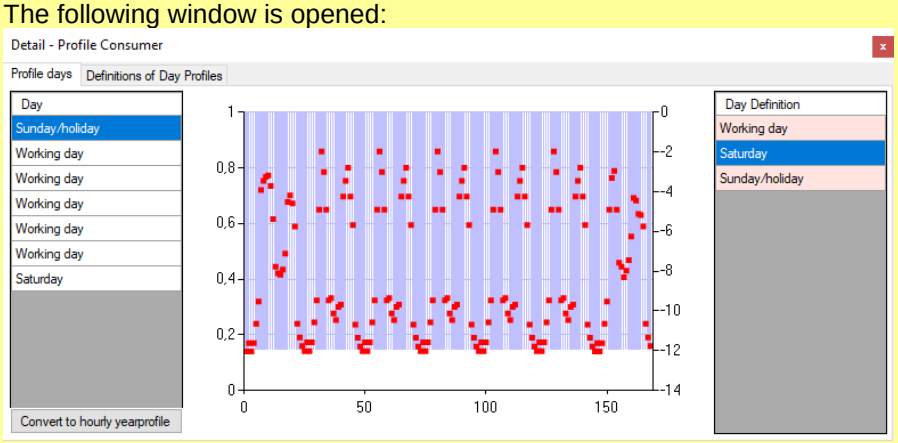
PLEASE NOTE: this paragraph handles just the method used for Green+. For profile calculations a different technique is used, see §7.4.

For a more elaborate description, see §9.6.

There are two types of profiles: flow profiles and pressure profiles. The system is exactly the same. The only difference is that the set factors are multiplied with respectively flows or pressures. De system is explained below, with a flow profile as example.

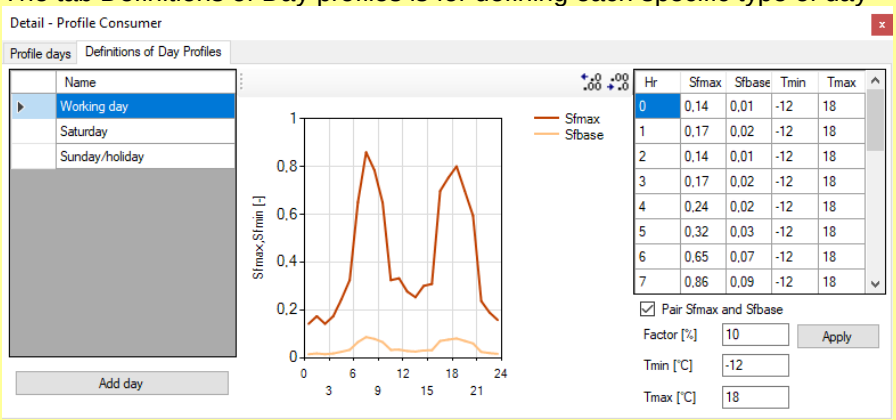
Procedure:

- Complete the procedure as given in the previous paragraph.
- Click on one of the lines in the '**Profiles'** window.
  The following window is opened:



- On the tab Profile days, the profile is assembled. At the left side the selected day profile definitions are listed in order. At the right side the available different day profiles are listed. The profile can be adjusted by dragging day profiles from right to left.
  Since there will be no day profiles available when a new profile is created, the second tab (Definitions of Day profiles) will be opened, see following bullet.

- The tab Definitions of Day profiles is for defining each specific type of day



At the left side the different day types are listed. These can be selected or a new day type can be added. The graph in the centre and the table at the right show the hourly factors. See below for a detailed explanation of the different factors.

The consumption of a Profile Consumer dependents upon its profile, the temperature and the standard annual consumption or peak consumption, see formula:

consumption = annual consumption / inverse factor	annual consumption ≠ 0
consumption = peak consumption	annual consumption = 0

Based on the set consumption and day definition, the demand Q at a certain time is calculated with the following formula:

Q = Sfmax * consumption	T ≤ tmin
Q = Sfbase * consumption	T ≥ tmax
Q = (Sfmax-Sfbase) / (tmax – tmin) * (T-tmin) * consumption	tmin < T < tmax

Where:

Q	het calculated demand
T	Actual day temperature (average over 24 hours)
Sfmax	Factor for the demand where day temperature T ≤ tmin.
Sfbase	Factor for the demand where day temperature T ≥ tmax.
tmin	Day temperature where below Sfbase is applicable.
tmax	Day temperature where above Sfmax is applicable.

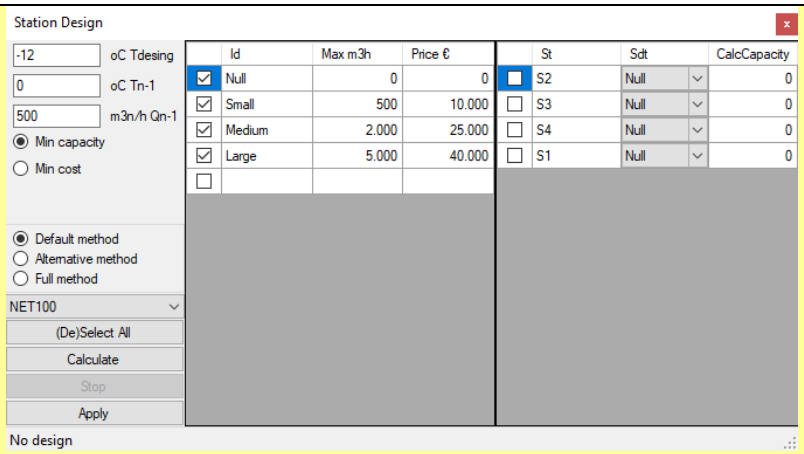
.

7.7 Station Design (beta version)

The module Station Design calculates the optimal sizes (capacities) of stations for a given network. The module can optimize on minimal size (capacity) or minimal cost. As input data, the different types of standard available stations and their cost needed. With this information the optimal station sizes for each location is calculated.

Procedure:

- Select menu **Calculation – Station design**
  The following dialog is opened:

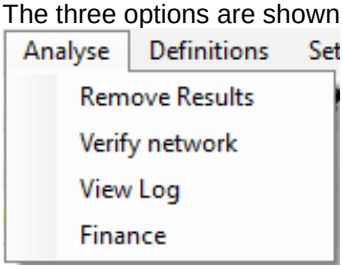


- Select the design temperature (default is this the design temperature as set for the network definition).
- Modify the left list with available station designs and their prices. The ‘Null’ design should be part of the list: IRENE Pro will select this type in case the station is not needed.
- Select in the list at the right the stations that are to be designed.
- Press **Calculate**.
- The list shows proposed design for each station after the calculation has finished.

Attention: All stations will be set the maximal size, in case IRENE Pro cannot find a possible solution due to too much pressure loss. The status bar at the bottom of the dialog will show a message that no solution is possible.

8 Analyse

A network verification can be executed and the associated **Log** can be viewed using the **Analyse** function**.** It is also possible to remove calculation results via **Analyse**. The three options are shown below.



8.1 Remove Results

Remove Results will remove all calculation results from the drawing (The results remain available; this applies strictly to the display).

Procedure:

- Select the **Analyse** menu.
- Click on **Remove Results**.
  The results are no longer shown.

8.2 Network Verification

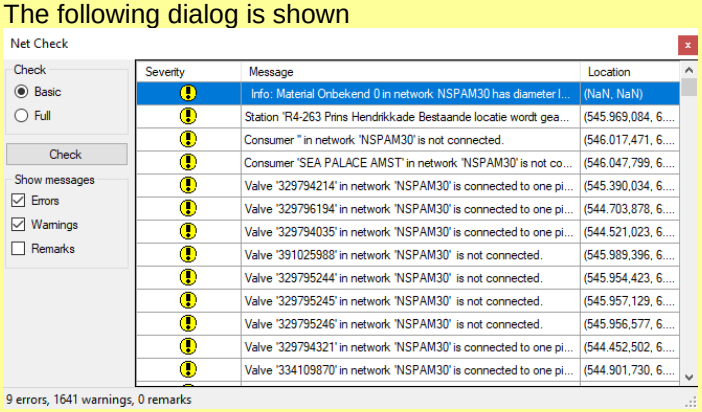
The **Network Verification** function checks the network for errors and situations which could indicate possibly incorrect details. There are two verification grades:

- Basic
  With the basic verification the following types of possible errors are checked:
  - Strange values in definitions
  - Near (no) connections of consumers, valves and stations to pipelines
  - Multiple objects at the same location.
- Full
  This is the basic verification together with checks on crossing and touching pipelines without connection.
  PLEASE NOTE: A full check can take a considerable amount of time.

After use of this function the user receives a message which states whether everything is correct, or whether there is an error somewhere:

Procedure:

- Select the **Analyse** - **Network Verification**
  The following dialog is shown



- The basic check has already been performed when the file was opened. If you want to perform a **Basic** check or a **Full** check, select the type of check you want and press Check.

- Select which messages you want to see:
  - Errors
    Errors cause that a part of the network will not be calculated correctly. For example, a pipeline with both endpoints at the same position (within the connection tolerance), creating a circular pipeline.
  - Warnings
    These are not necessarily errors, but they may result in a undefined or unwanted situation. For example, a consumer and a valve at the same position with the valve closed: it is not clear at what side of the valve the consumer resides.
  - Remarks .

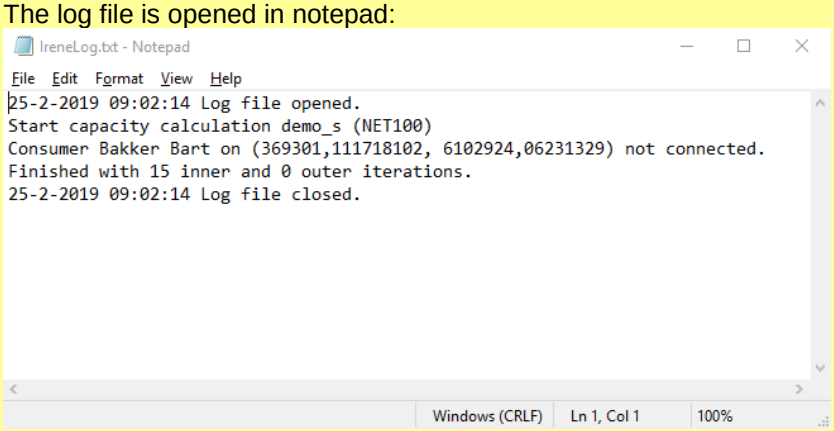
- Double click a message to locate it (this is only possible, in case of a warning or error related to an object: the column location contains an valid coordinate).

8.3 View log

All calculation messages are logged in a log file. View the messages of the latest calculation via menu **Analyse – View log**. The log file will be opened in Notepad.

Procedure:

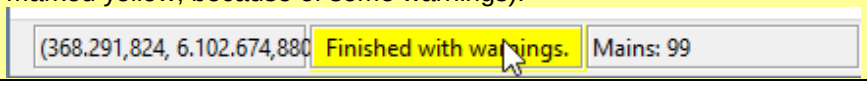
- Select **Analyse – View log**.
- The log file is opened in notepad:



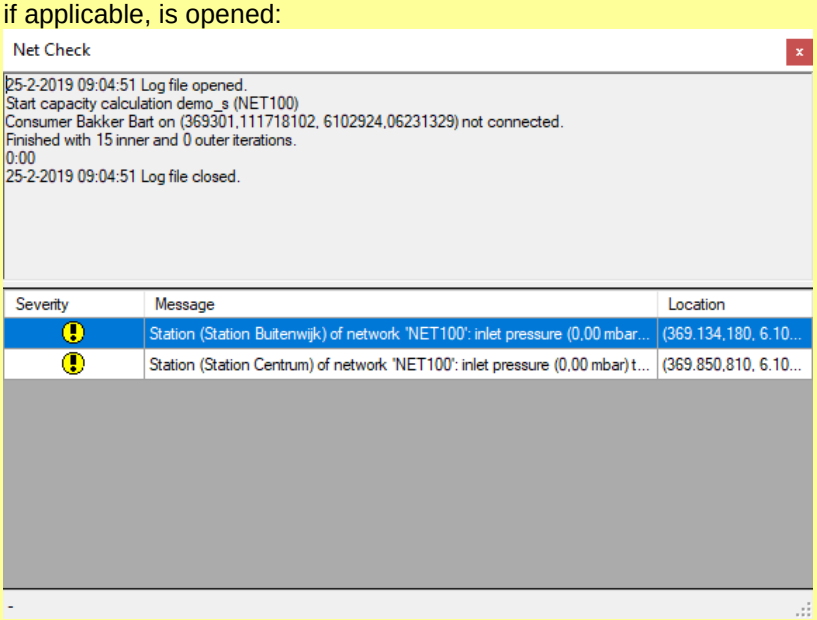
PLEASE NOTE: Notepad is not IRENE Pro, but a standard Windows application for editing text files.

Alternative approach:

- Click on the calculation messages in the status bar at the bottom (often marked yellow, because of some warnings):



- A dialog with both the calculation log and all warning and error messages, if applicable, is opened:



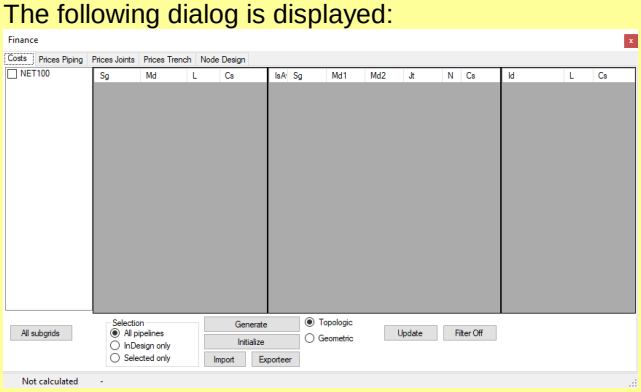
- Messages concerning objects, can be double clicked to locate them in the view (applicable if the Location column contains a valid coordinate).

8.4 Finance (beta version)

IRENE Pro Finance calculates the necessary materials and costs of a network. This is still a beta version and under development.

Procedure:

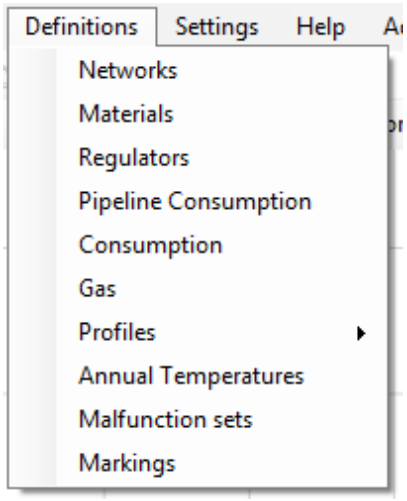
- Start first a capacity calculation (this is still necessary to calculate all nodes).
- Select menu **Analyse – Finance**.
  The following dialog is displayed:



- At the left select the network to be analysed
- At **Selection** (at the bottom): select which part has to be analysed:
  - All pipelines: the whole network is analysed
  - In Design only: only pipelines with state “In Design” are analysed.
  - Selected only: only pipelines within the fence are analysed. (See §6.2.2)
- Press **Initialize** to generate a standard list of materials, connections and digging work. (You can also press **Generate**. This will create a list of all materials and connections that are present in the network. Mind that this can take some time!)
- Press **Update** to calculate the costs of the selected network.
- See the tab Node Design in order to check if there are any connections that are possible with the standard connection options and therefore are not part of the calculation.

9 Definitions

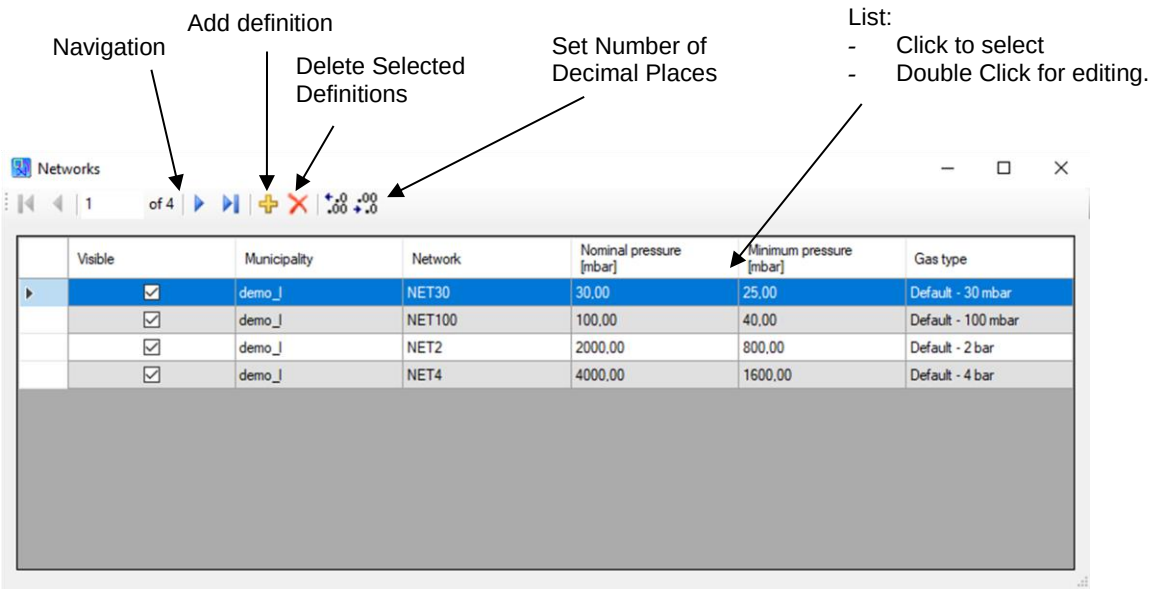
With the menu item **Definitions** you can inspect and change the definitions in the network.



The definitions are in listed and can be called up via the **Definitions** menu. This menu contains the following definitions:

Networks	Name of the network and its settings (for example the minimum and maximum pressure).
Materials	Material and diameter definitions to be used for the pipelines.
Regulators	Regulator definitions to be used in stations.
Pipeline consumption	Consumption definitions to be used when adding consumers to a pipeline.
Consumption	Definitions to be used for Node consumers (location bound consumers).
Gas	The definition of the gas in the network.
Profiles – Flow profiles	Profile definitions to be used for Profile Consumers and suppliers.
Profiles – Pressure profiles	Pressure profile definitions to be used for stations and profile suppliers
Annual Temperatures	Temperature lists to be used for the profile calculation.
Malfunction sets	Definitions for malfunction situations with a drop out or exceeding of the MOP by one or more stations, consumers, suppliers and/or compressors .
Markings	Here you can define selection queries with a colour to mark objects that comply with the selection criteria.

When one of these options is selected, a list opens. All the existing definitions are displayed. It is possible to edit these or to add new ones, if wished. By a double click on the definition, the details screen is opened and the definition can be modified.



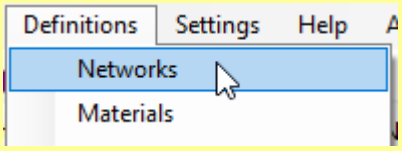
It is also possible to copy the definitions to Excel for example. Select the definitions and then use Ctrl+c to copy the selection. Paste them with Ctrl+v into Excel.

9.1 Network definition

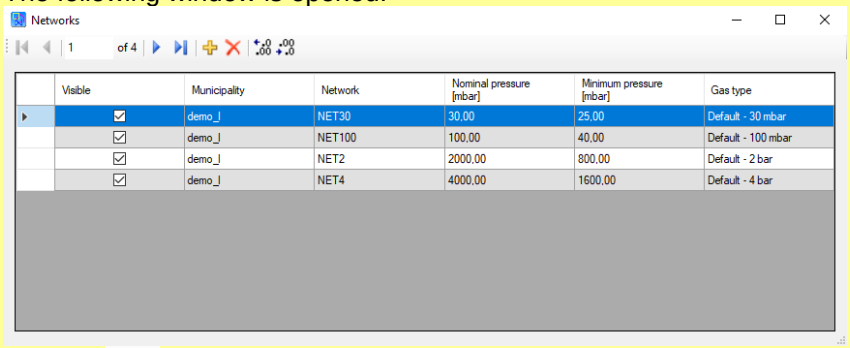
The definition of a network defines the characteristics of the network.

Procedure for adding a new network:

- Select the **Definitions** menu
- Click on **Networks**

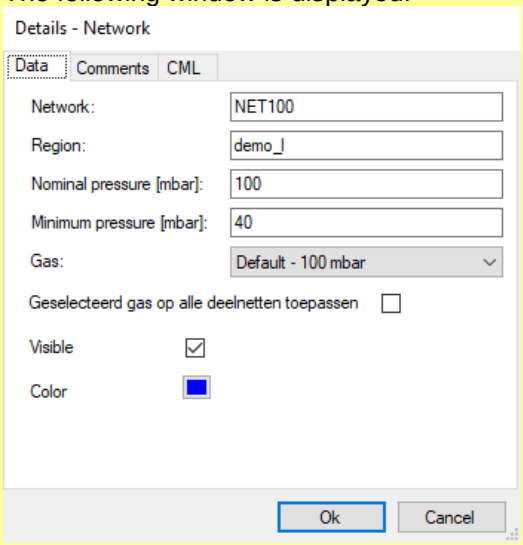


- The following window is opened:



- Click on  to add a new network, or double click an existing network for editing.

- The following window is displayed:



- Fill in all information
- Click on **Ok**
- The network will now be shown in the list.

The following properties can be set:

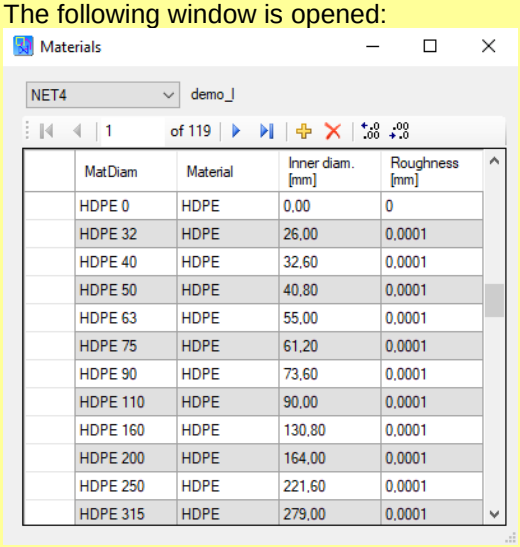
Property	Meaning
Network	Name, used by IRENE Pro, for instance for listing the networks and selecting the active network. It is recommended to include the nominal pressure.
Region	This information is not used anywhere else in IRENE Pro.
Nominal pressure	The nominal pressure (MOP). When new stations are added, this will be the outlet pressure by default. Furthermore, it is used for the maximum value for the colour range when showing the calculated pressure.
Minimal pressure	This is the default lowest pressure for the colour range when presenting the calculated pressures. It is also the (default) lower limit for design, CML and Green+ temperature range calculations.
Gas	Selected gas for this network (see §9.5)
Apply selected gas to all networks	If ticked, the selected gas will be applied to all available networks. PLEASE NOTE: The compressibility dependents on the pressure. When the same gas definition is applied to networks with different operating pressures, this can cause inaccuracy in the calculation results.
Visible	When ticked, the network is visible and selectable in the view.
Color	The colour of the pipelines in the network, when no specific pipeline result presentation is selected.
Comments	Add any comment for the specific network.
CML	Data for the CML calculation, see §7.5.

9.2 Material Definition

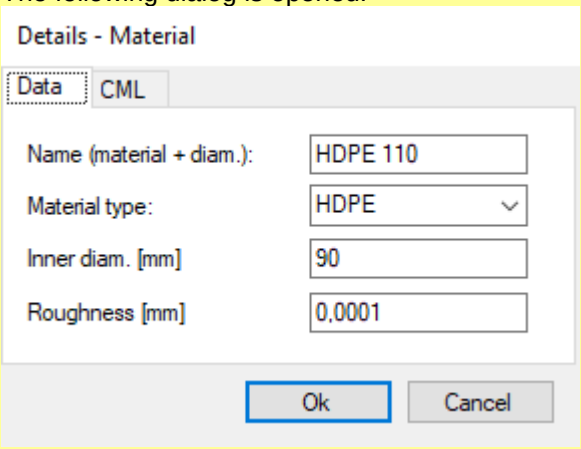
When a network is defined material definitions can be added to the network.

Procedure:

- Select the **Definitions** menu
- Click on **Materials**
- The following window is opened:



- Select the network whereof the definitions are to be modified.
- Click on  to add a new material, or double click an existing material for modification.
- The following dialog is opened:



- Complete all of the details and click **Ok.**

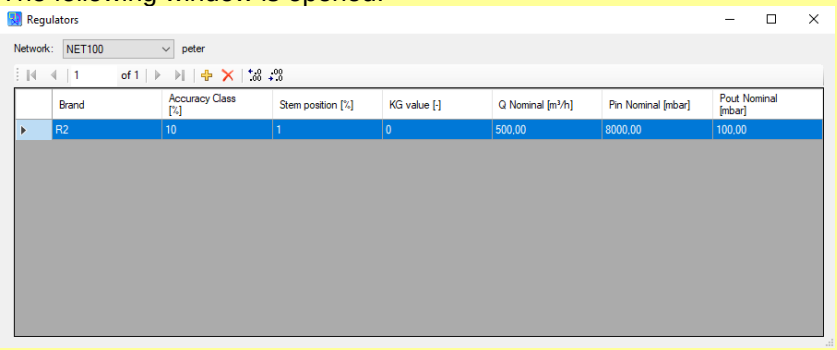
9.3 Regulators Definition

Regulators are defined per network.

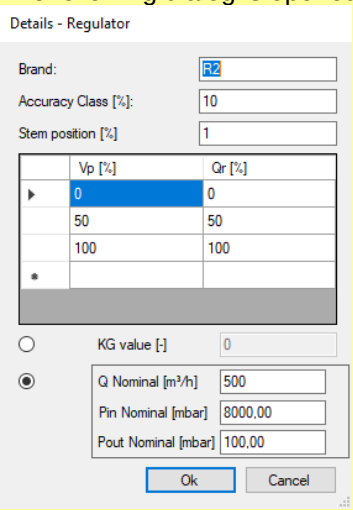
Procedure:

- Select the **Definitions** menu
- Click on **Regulators**

- The following window is opened:



- Select the network definition
- Click on  to add a new regulator or double click to edit an existing regulator.
- The following dialog is opened:



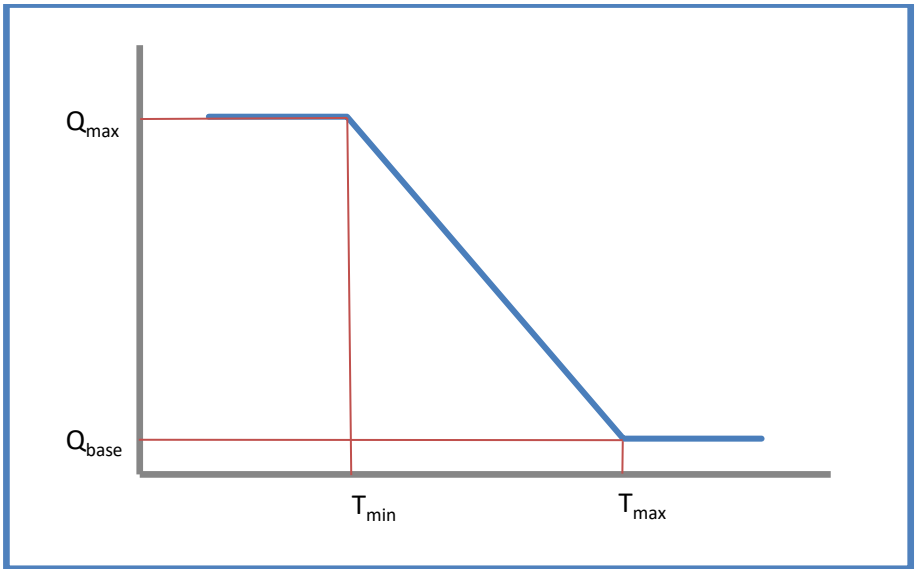
- Complete all of the details and click **Ok.**

9.4 Consumption Definition

The consumption definitions are defined per network. It is possible to add consumers to either a pipeline or to a specific position. In both cases a consumption definition must also be provided. The difference is that a pipeline consumption definition specifies a flow rate whereas a consumption definition specifies a simultaneity factor for consumers.

9.4.1 Pipeline Consumption

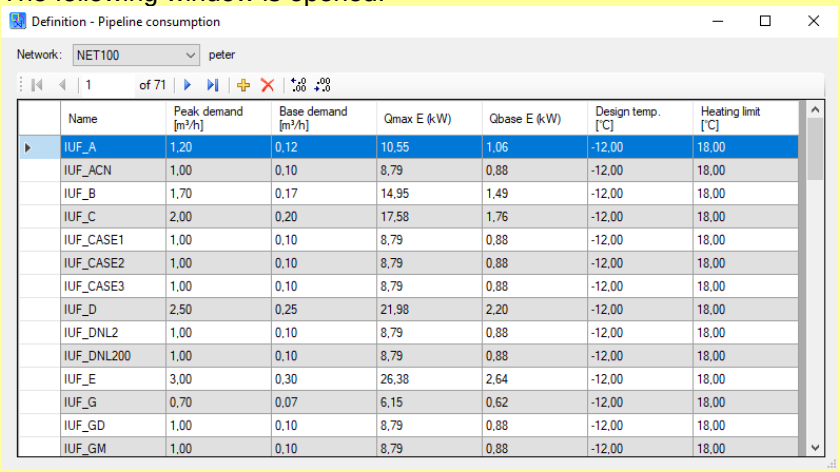
The pipeline consumption definitions are defined per network. The consumption Q per pipeline consumer is calculated according to the figure below in which the consumption Q is plotted against the outdoor temperature T.



The properties of the pipeline contain a list of the amount of consumers and the reference to their associated pipeline consumption definition.

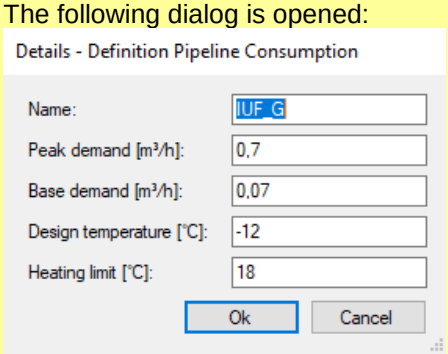
Procedure:

- Select the **Definitions** menu
- Click on **Pipeline consumption**
- The following window is opened:



Name	Peak demand [m³/h]	Base demand [m³/h]	Qmax E (kW)	Qbase E (kW)	Design temp. [°C]	Heating limit [°C]
IUF_A	1,20	0,12	10,55	1,06	-12,00	18,00
IUF_ACN	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_B	1,70	0,17	14,95	1,49	-12,00	18,00
IUF_C	2,00	0,20	17,58	1,76	-12,00	18,00
IUF_CASE1	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_CASE2	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_CASE3	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_D	2,50	0,25	21,98	2,20	-12,00	18,00
IUF_DNL2	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_DNL200	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_E	3,00	0,30	26,38	2,64	-12,00	18,00
IUF_G	0,70	0,07	6,15	0,62	-12,00	18,00
IUF_GD	1,00	0,10	8,79	0,88	-12,00	18,00
IUF_GM	1,00	0,10	8,79	0,88	-12,00	18,00

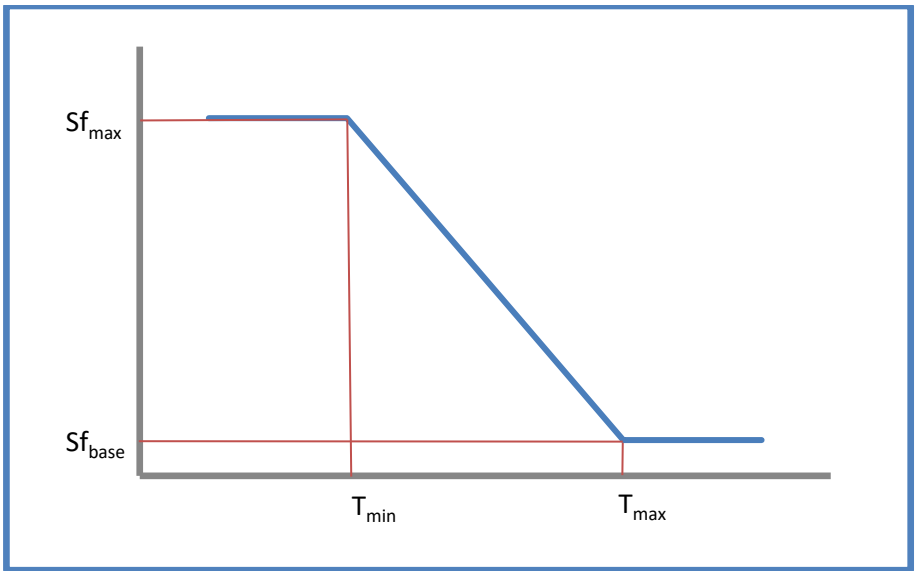
- Select the network definition
- Click on  to add a new definition or double click to edit an existing definition.
- The following dialog is opened:



- Complete all of the details and click **Ok.**

9.4.2 *Consumption at a Position (Node Consumer)*

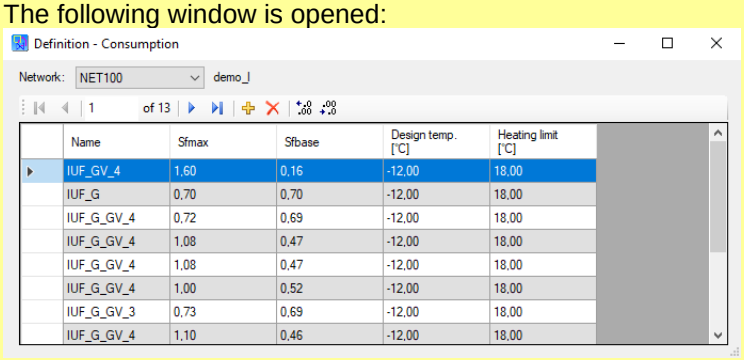
The consumption at a position bound consumer (a so called node consumer) is calculated in a similar manner as pipeline consumption, but the consumption definition is in terms of a simultaneity factor (Sf). Please refer to the diagram below.



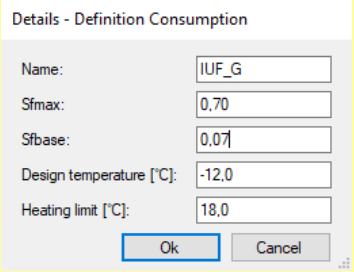
The peak consumption and the reference to the accompanying consumption definition can be set in the properties of the consumer.

Procedure:

- Select the **Definitions** - **Consumption**
- The following window is opened:



- Select the network definition
- Click on  to add a new definition or double click to edit an existing definition.
- The following dialog is opened:



- Complete all of the details and click **Ok.**

9.5 Gas definition

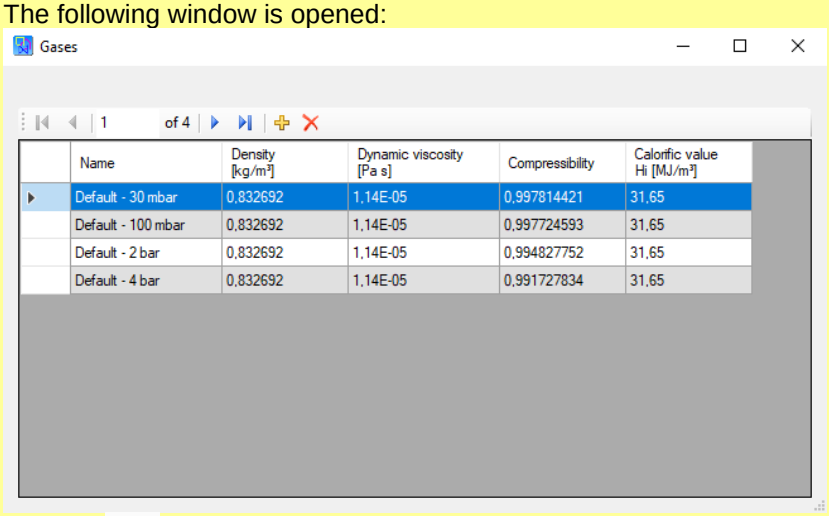
Gas definitions are defined globally. For each network a gas definition is can be selected from the available definitions. The reason for selecting a different gas definition per network is that the compressibility of the gas depends on the operating pressure. Therefore, for each network with a different operating pressure, a specific gas definition should be made to increase accuracy. Since the pressure varie, it is recommended to use the compressibility that is applicable at the average pressure of the network.

There is also a default gas setting, see settings menu. This is only applied in case there is no gas definition selected for the network or as default when creating a new gas definition.

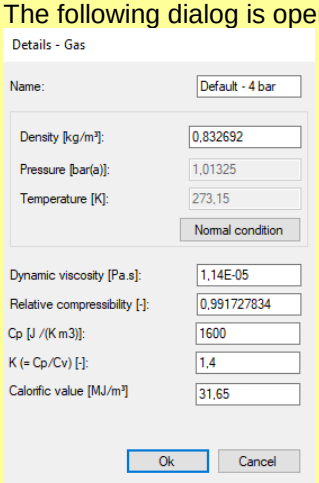
PLEASE NOTE: the reference pressure and refence temperature have to be set in the settings menu, tab Default Gas.

Procedure:

- Select the **Definitions** - **Gas**
- The following window is opened:



- Click on  to add a new definition or double click to edit an existing definition.
- The following dialog is opened:



- Complete all of the details and click **Ok.**

The following properties are available:

Property	Meaning
Name	Identification of the gas.
Density	Density of the gas at reference temperature and reference pressure.
Pressure	Reference pressure at which the density is defined, normally 1.01325 bar(a). It can't be modified here. Instead, go to the Settings menu and change the settings of thhe Default Gas. Apply the settings of the default gas by pressing the button **Normal Condition**.
Temperature	Reference temperature at which the density is defined, normally 273,15 K (= 0 °C). It can't be modified here. Instead, go to the Settings menu and change the settings for the Default Gas. Apply the default gas settings by, pressing button **Normal Condition**.
Normal condition	Applies the reference pressure and reference temperature, as set in the Settings menu for the default gas.
Dynamic viscosity	Dynamic viscosity.
Relative compressibility	Relative compressibility at the average network pressure. The compressibility of a gas is pressure dependent and the pressure dependency varies per type of gas. For low calorific gas, like used in the Netherlands, the pressure dependency can be approached with the following formula (up to 20 bar): compressibility = 1-0.0021*average pressure.
Cp	Heat capacity at constant pressure (just for Green Plus calculations).
K	Ratio between Heat capacity at constant pressure and constant volume (just for Green Plus calculations).
Calorific value	The calorific value (lower heating value) of the gas. It is used for recalculation of the demand, when for a network is switched to another gas.

9.6 Profile definition

9.6.1 Flow and pressure profiles

Profiles are used for Profile calculations and Green+ calculations. A profile gives factor for each hour of a day.

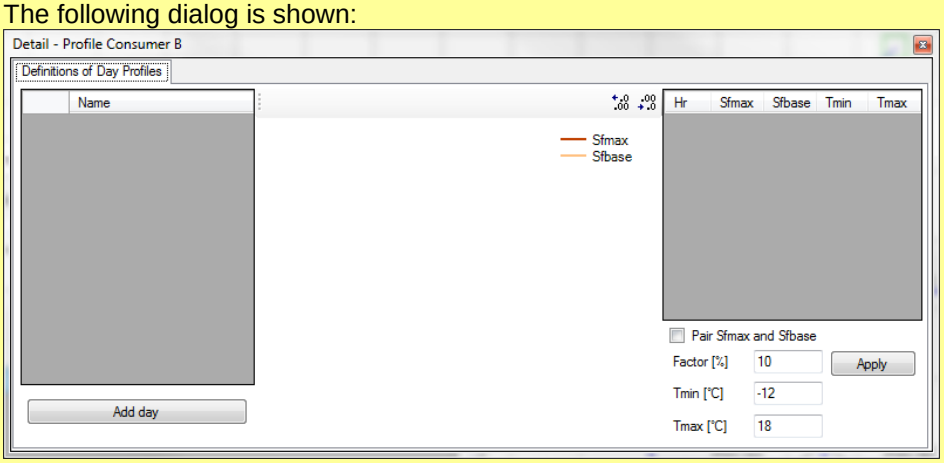
For profile calculations a different method of defining is used compared to Green+ calculations. The method for profile calculations is explained in §7.4.3. Here, the description will be limited to the method as used for Green+ calculations. These profiles can be changed into profiles suitable for profile calculations, see the last bullet of the procedure.

There are two types of profiles: flow profiles and pressure profiles. However, they are defined in a similar way. The difference is that flow profiles are used to calculate consumption or supply at a certain hour, while pressure profiles are used to calculate the pressure setting at a certain hour. But both use a factor to do so. Below the procedure is explained for a flow profile, but also applies to pressure profiles.

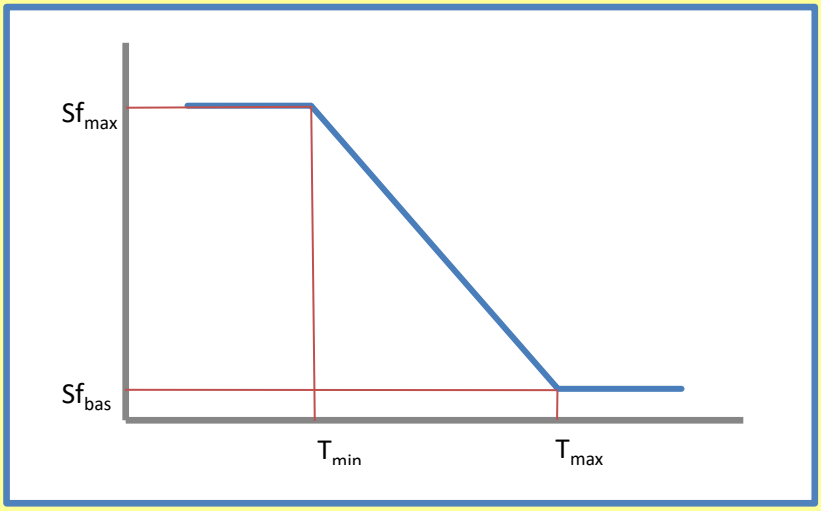
Procedure:

- Choose menu **Definitions** – **Profiles** –F**low profiles**
- Click button 
- Fill in a comprehensible name.
- Day profile is default selected (necessary for Green+).

- Double click the new added profile
  The following dialog is shown:

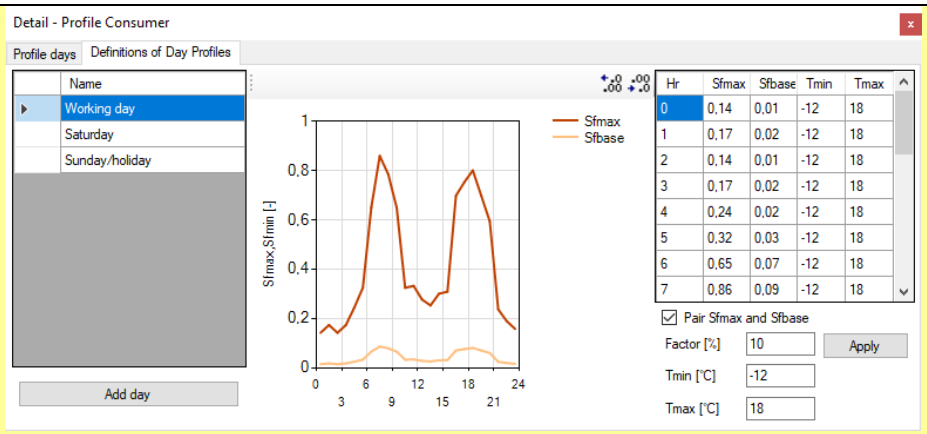


- First one or more day types have to be defined:
  - Click **Add day** and give it a comprehensible name. A day definition consists of 24 hours. Each day definition gives for each our the factor Sfmax at design temperature Tmin, and the Sfmin factor at the temperature Tmax, where no heating is applied. These parameter describe a linear relationship between temperature and demand, See chart below:



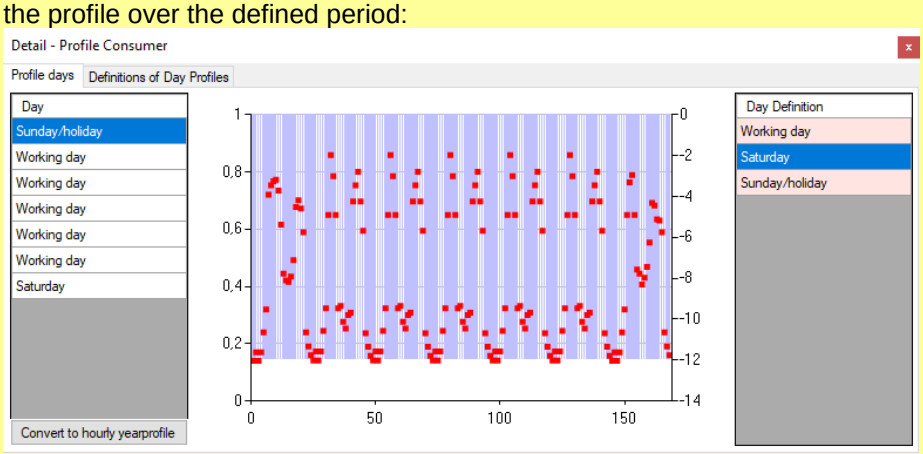
  - A fixed ration between Sfmax and Sfmin can be used. By pressing the apply button, the fixed ratio is applied for each hour by recalculating Sfbase according to: Sfbase = Sfmax * Factor.
  - If Pair Sfmax and Sfbase is checked, the Sfbase is recalculated when Sfmax changes according to the given ratio.
  - Values for Sfmax can not only be modified in the table, but also by clicking in the Chart area.
  - All values in the table can be copied and paste (for instance to another day profile or Excel), using Ctlr+c (copy) and Ctrl+v (paste).

  The result can be as follows:



When you have defined one or more days, you can define a period:

- Choose tab Day profiles
  At the right you see the different day types. By selecting a day and dragging it to the left column, you can define a period (for instance a week) The chart shows the profile over the defined period:



  - Drag day definitions from the right column to the left column to add more days.
  - Remove selected days from the left column by pressing delete on your keyboard.
- (The button Convert to hourly year profile tries to calculate a year profile from the period as defined by you. This is only needed for the profile calculation. Green+ calculates with day profiles.)

9.6.2 *Copy profiles*

Profiles can be copied within the same grid or to another grid.

Procedure:

- Open the profile dialog
  (depending on the type of profile: **Definitions** – **Profiles** –**Flow profiles** or **Definitions** – **Profiles –Pressure profiles**)
- Select the profile to be copied
- Press **Ctrl+c** to copy the profile.
- Select the network where you want to copy the profile (can be the same network as well).
- Paste by pressing **Ctrl+v**.

Ctrl+Drag to copy a profile to another existing profile

Within the same grid you can also copy one profile to another profile by dragging and dropping it on the other profile while pressing Ctrl.

Procedure:

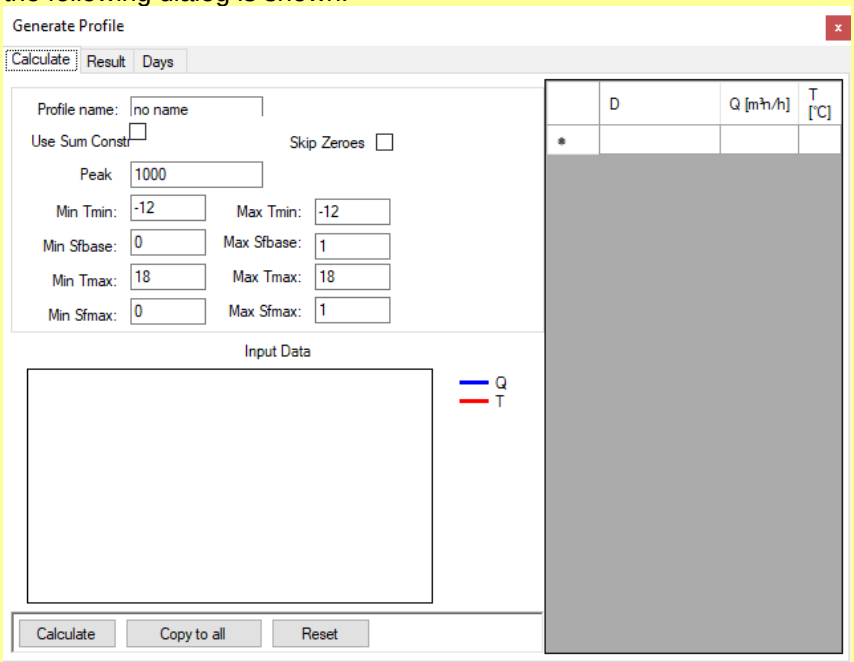
- Open the profile dialog
  (depending on the type of profile: **Definitions** – **Profiles** –**Flow profiles** or **Definitions** – **Profiles –Pressure profiles**)
- While pressing **Ctrl** select and drag and drop the profile to be copied to the other profile.
- Confirm that you want to copy the profile.

9.6.3 Generate flow profile

IRENE Pro can calculate a flow profile for a consumer or network based on actual measured hourly data.

Procedure:

- Create in Excel a table with hourly measured values for flow and average day temperature.
  The order of the columns has to be: date - time, flow, temperature.
- Select **Definitions – Profiles – Generate flow profile**
  the following dialog is shown:



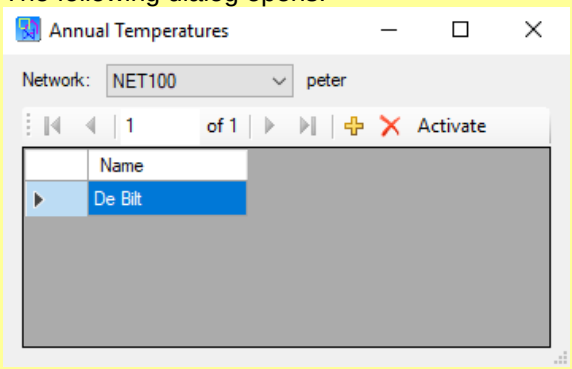
- Define the **Profile name** for the definition.
- Copy the columns from the Excel table and paste it in the table using Ctrl+v.
- Select the tab **Days**
- Define the names of the day profiles and link them to the weekdays.
- Define in the right column the dates for holidays in the period of the measurements, alongside with which day type they should be associated.
- Select the tab **Calculate**
- Press **Calculate**
- The results for the day profiles are visible on tab **Result** after the calculation has finished.
- Pressing button Copy all (tab Calculate) will add or update the profile in each network (existing profiles with the same name, will be updated). The profile will consist of seven days (Sunday to Saturday).

9.7 Annual temperatures

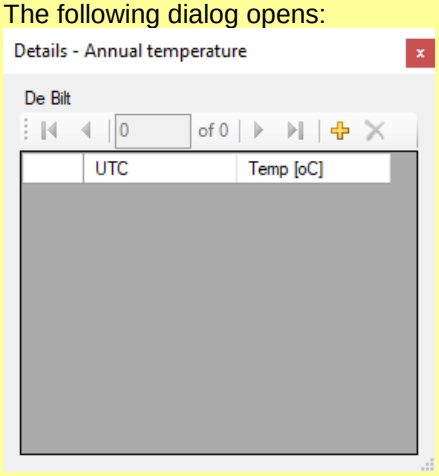
An annual temperature definition can be used for Profile calculations and Green+ calculations. Each our contains an expected average 24h. temperature.

Procedure:

- Select menu **Definitions**
- Click **Annual temperatures**
- The following dialog opens:



- Select the network for which a set of annual year temperatures should be defined.
- Click  to add a new definition, or double click an existing definition for modification .
- The following dialog opens:



- Add hourly temperatures or copy/paste them from Excel.
- Close the dialog

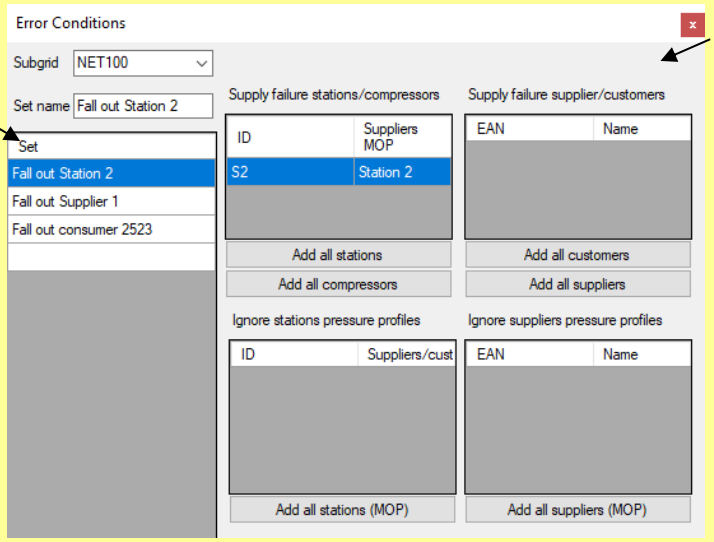
9.8 Malfunction sets

Malfunction sets can be used with special Green+ analysis. A malfunction set is defined by a combination of one or more malfunctions. There are four types of malfunctioning:

1. Supply failures stations/compressors
   Selected stations and/or compressors that fail to supply.
2. Supply failure suppliers/consumers
   Suppliers that fail to supply and or consumers that stop consuming.
3. Ignore pressure profiles stations
   It is possible to define pressure profiles for stations that simulate a different pressure setting for certain periods of time. This pressure profile for the selected station is ignored.
4. Ignore pressure profiles suppliers
   Just like a station, it is possible to assign a pressure profile to a supplier, simulating different pressure settings for different periods of time. The pressure profile of the selected supplier is ignored..

Procedure:

- Choose menu **Definitions** – **Malfunction sets**
- The following dialog opens:



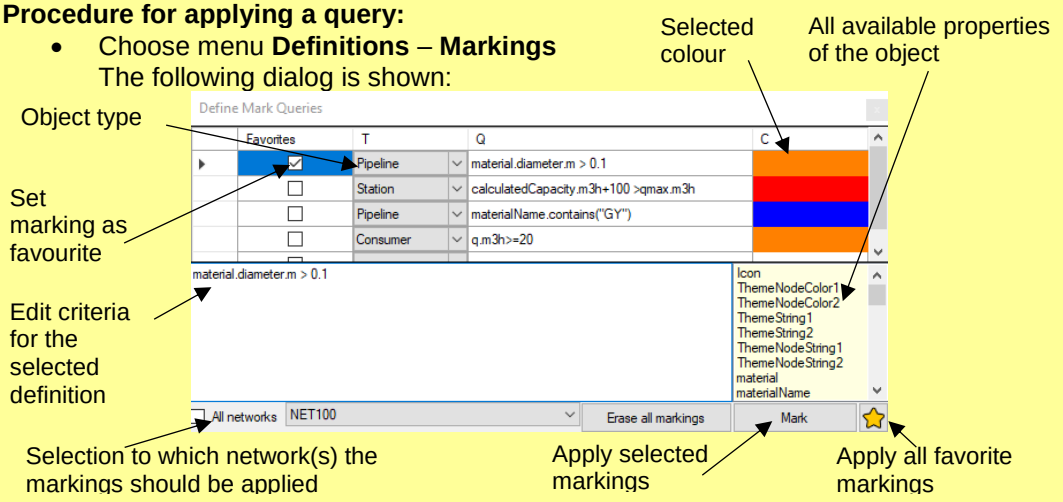
- Select the empty field in the left column in order to add a new set of malfunctions. (or select an existing definitions in order to modify it)
- Double click the field to modify the name.
- Modify the lists, for instance by:
  - Using buttons below the lists.
  - Pressing the Ctrl key and dragging with the mouse an object from the drawing to the list.
  - Objects can be removed from a list, by selecting the object in the list and pressing delete.

9.9 Markings

You can define queries for selecting and marking objects. These definitions are saved to your personal profile, and can therefore be used for any file that you open. When a marking definition is applied, all objects that comply with the query, are marked with the selected colour.

Procedure for applying a query:

- Choose menu **Definitions** – **Markings**
  The following dialog is shown:



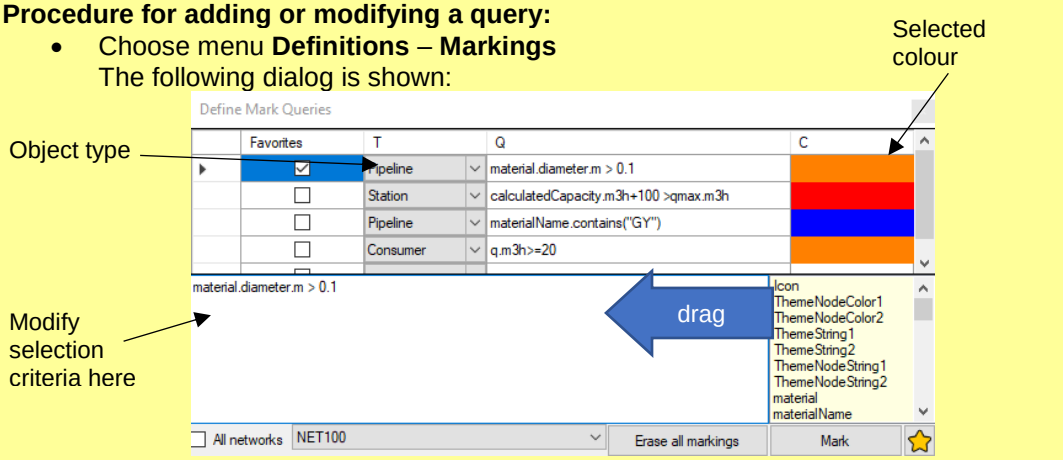
- Select the row with the query that you want to apply
- You can change the colour by clicking on the coloured cell in the C column.
- Select the network (see picklist at the bottom)
- Press Mark
- (Pressing the button with a star will apply all favourite markings).

All objects that comply with the selection criteria, are marked with the selected colour.

You can define your own selection criteria or modify existing selection criteria. These will be saved in your personal profile and can be applied on any file and network that you open.

Procedure for adding or modifying a query:

- Choose menu **Definitions** – **Markings**
  The following dialog is shown:

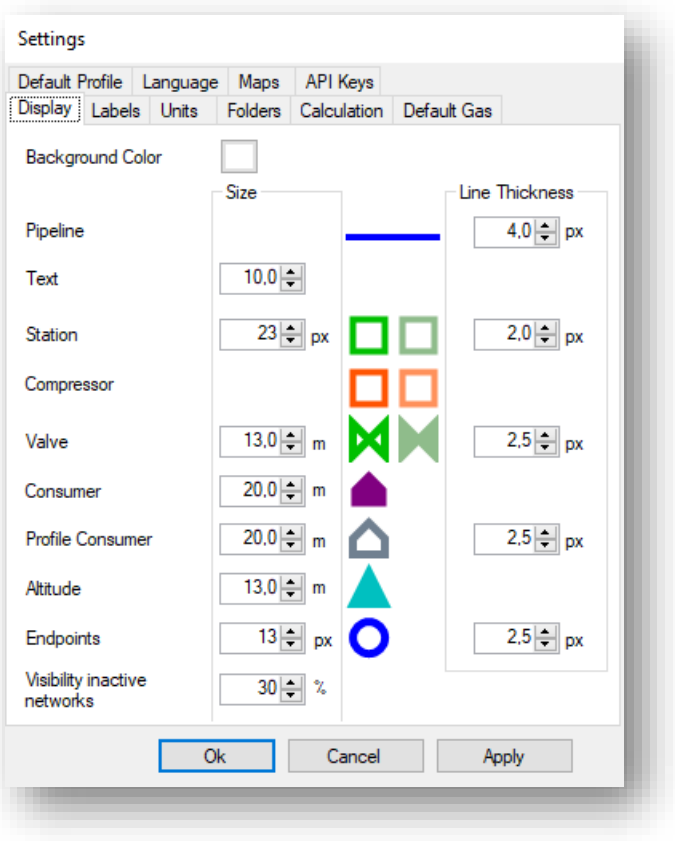


- Select the row with the query that you want to modify or select the last row to add a new query
- Select the type of object.
- Type the selection criteria in the text box below the table. At the right all available propertie of the object are visible. You can drag them to the edit box. For more information, please , see appendix II.
- You can change the colour by clicking on the cell in the C column.

10 Settings

The settings menu is used fort he different user settigns. This settings are saved when IRENE Pro is exited.

When clicking on menu Settings, the following dialogue appears:



The following tabs are available:

Tab	Contents/Function
Display	Settings for the graphical presentation of the network
Labels	Settings for text placement by certain network objects
Units	Settings of the units for the input data and the calculation results
Folders	Settings for locations of data.
Calculation	Standard settings for the capacity calculation
Default Gas	Settings for standard gas. When calculating a network without gas data these settings are added to the network. Here the normal conditions (reference pressure and temperature) are set.
Default Profile	Consumer definition which is used for a profile consumer during the capacity calculation
Language	Selected language
Maps	Settings for background maps (such as fixed maps or maps from internet providers like Open Street Map).

API Keys	Here you can add the API keys for OpenWeather and Google. The API key for OpenWeather can be requested at https://home.openweathermap.org.

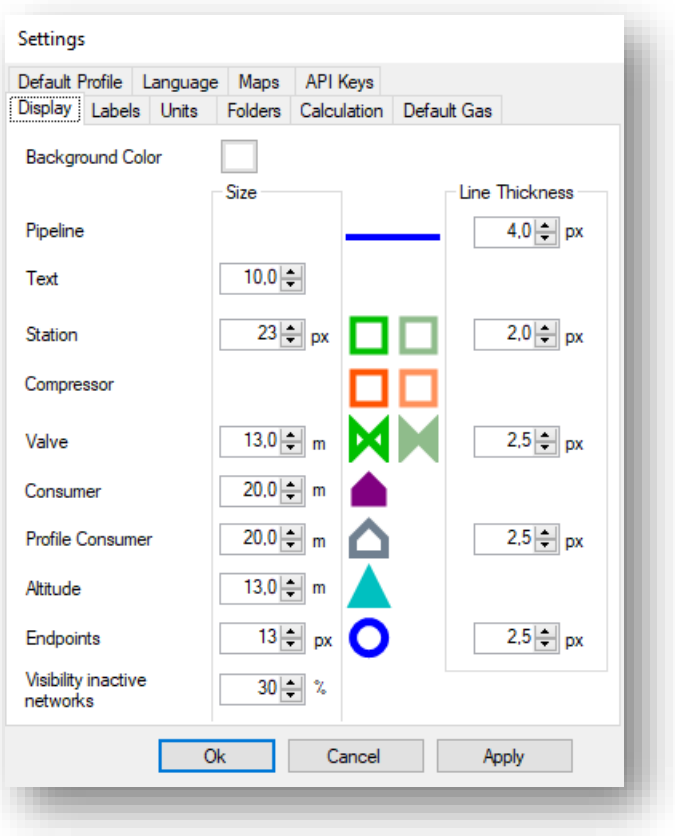
PLEASE NOTE: These are user settings. Other user can have their own settings without any interference.

PLEASE NOTE: If so called company settings are applied, the settings cannot be modified, or they can only be altered temporarily by the user. These temporary settings are reverted acording to the company settings after closing and restarting IRENE Pro.

The different tabs are explained in the following paragraphs.

10.1 Display

The tab display contains the following settings:

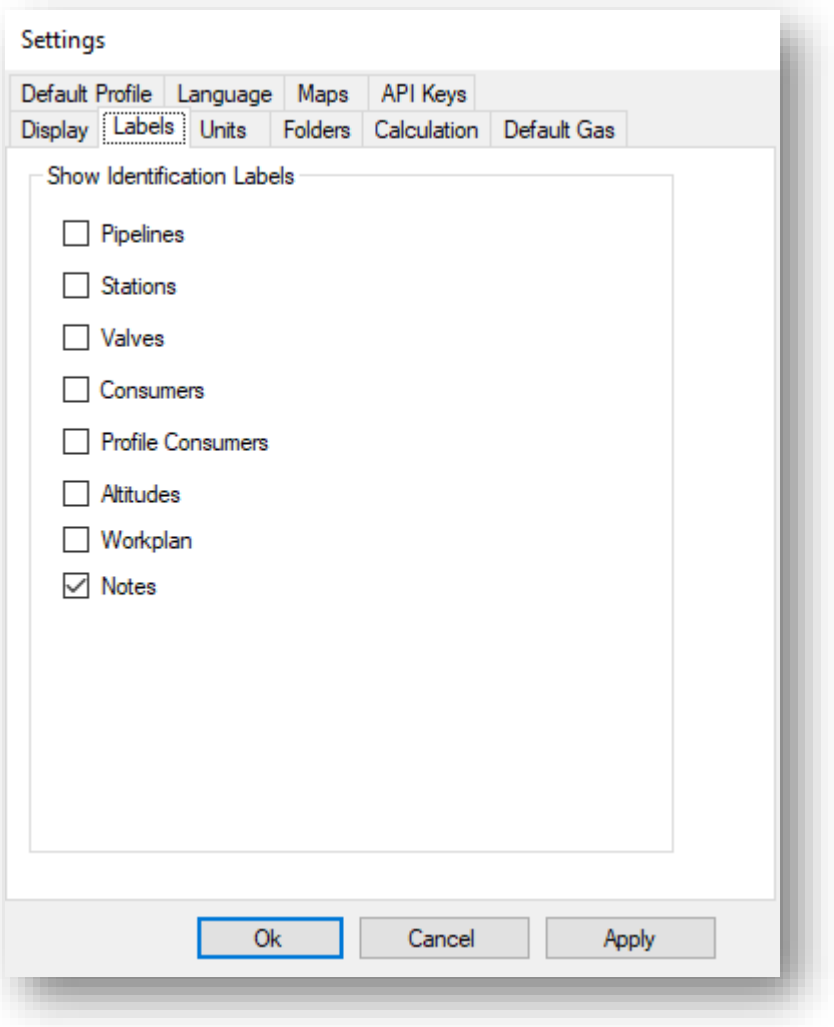


Property	Meaning
Background color	Sets the colour of the background.
Size	In this column all the sizes of the objects as they are drawn in the view. PLEASE NOTE: Some sizes are in meters, others are in pixels. Objects with sizes in pixels are always the same size at any zoom level.
Colour (centre column)	The centre column shows the colours (and shapes) of the different types of objects. When the shape is clicked, a colour picker opens and a different colour can be selected (except for the pipelines: their colour depends on the network settings).

	Some objects have two different appearances. For instance, a valve: the first appearance is for open valves, the second for closed valves.
Line Thickness	The line thickness used for drawing the object.
Visibility inactive networks	Networks that are not active, can be made less visible: 0% for completely hidden and 100% for the same visibility as the active network.

10.2 Labels

These are the same items as found in the Identification toolbar. The difference is that these changes are saved. The following user settings are available:

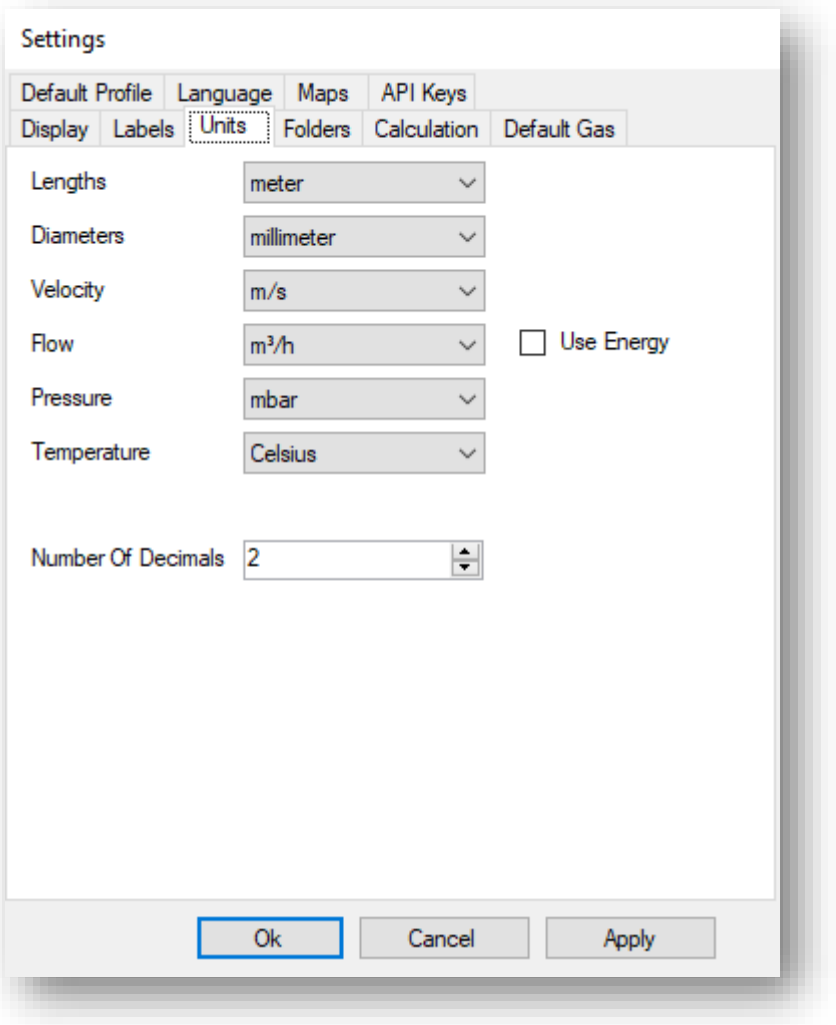


Property	Meaning
Pipelines	If ticked, the ID of the pipeline is displayed alongside the pipeline.
Stations	If ticked, the ID of the station is displayed alongside the station.
Valves	If ticked, the ID of the valve is displayed alongside the valve.
Consumers	If ticked, the ID of the consumer is displayed alongside the consumer.
Profile consumers	If ticked, the ID of the profile consumers is displayed alongside the profile consumers.

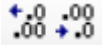
Altitudes	If ticked, the ID of the altitudes is displayed alongside the altitudes.
Workplan	If ticked, the ID of the workplan is displayed alongside the workplan.
Notes	If ticked, the short text of the note is displayed in a yellow box alongside the pin.

10.3 Units

Here you can select which units are to be used for displaying the different properties. The following user settings are available:

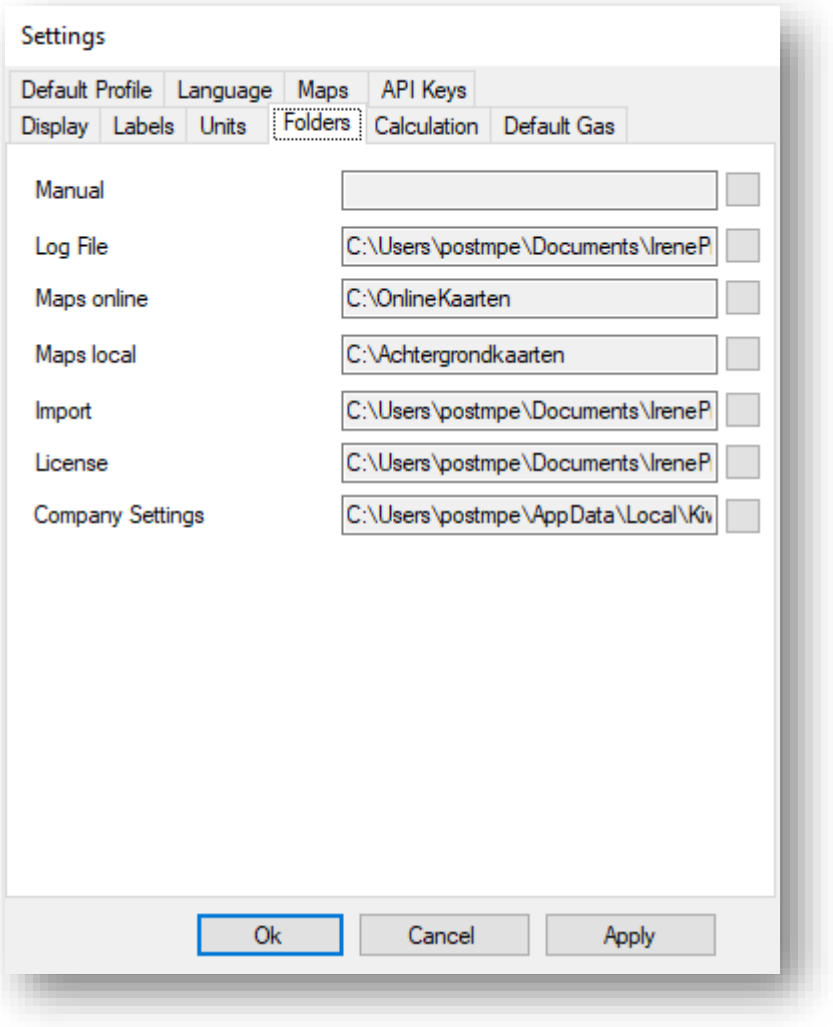


Property	Meaning
Length	Unit for distances and lengths.
Diameters	Unit for diameters.
Speed	Unit for the speed at which the gas flows (always at operational conditions).
Flow	Unit for flow (always at normal conditions as set in the gas definition)
Use energy	If ticked, instead of a flow, the energy per time unit is displayed
Pressure	Unit for displaying pressures (this can be temporarily set directly by using the toolbar mbar)

Temperature	Unit for displaying temperatures.
Number Of Decimals	The number of decimals with which the values are displayed (this can also be adjusted temporarily, using the buttons )

10.4 Folders

Op het tabblad kunnen de locaties van bepaalde bestanden en mappen worden ingesteld:

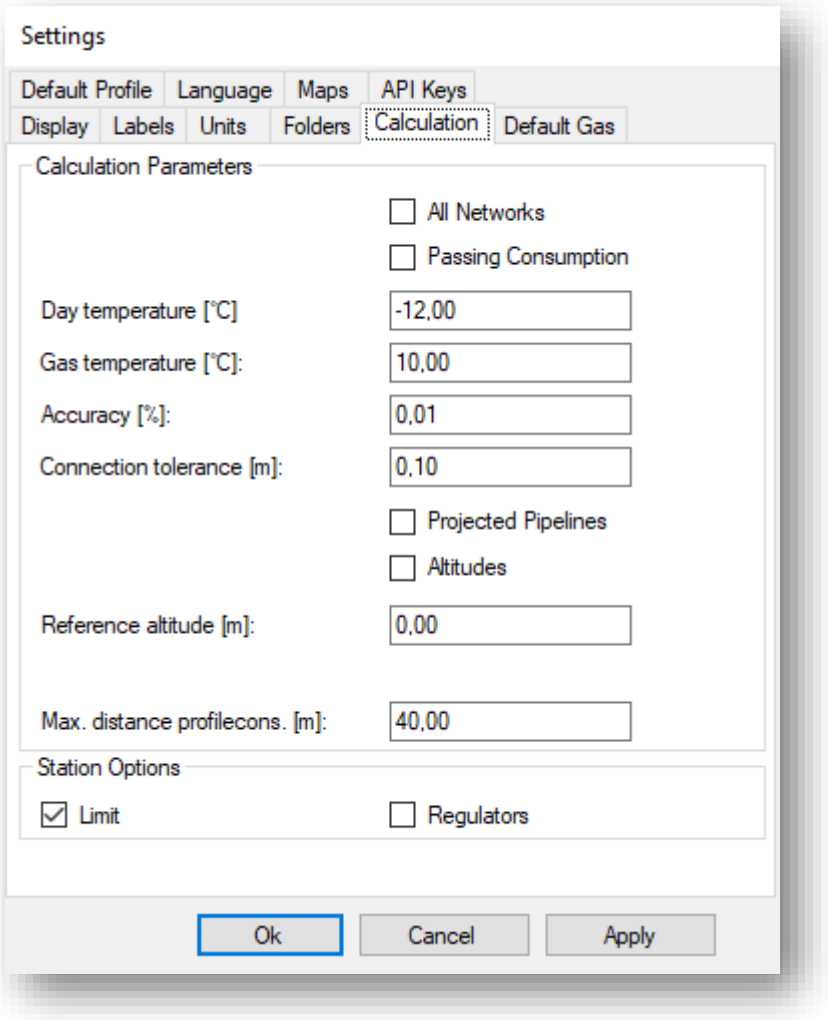


Property	Meaning
Manual	Location for the manual (if empty, the manual is used that was installed in the program folder)>
Log File	Location where the log file is stored.
Maps online	Location where maps are cached, when using background maps from an internet provider.
Maps local	Location where fixed background maps are stored together with their ESRI worldfiles.
Import	Default location for irene-files (only used for opening files).
License	Location of the license file. If no license file is available, IRENE Pro will be started in demo-mode.

Company Settings	Location for the company settings file (used by some companies instead of user settings)

10.5 Calculation

The tab calculation contains default calculation settings (only applicable if the irene-file doesn't contain calculation settings):

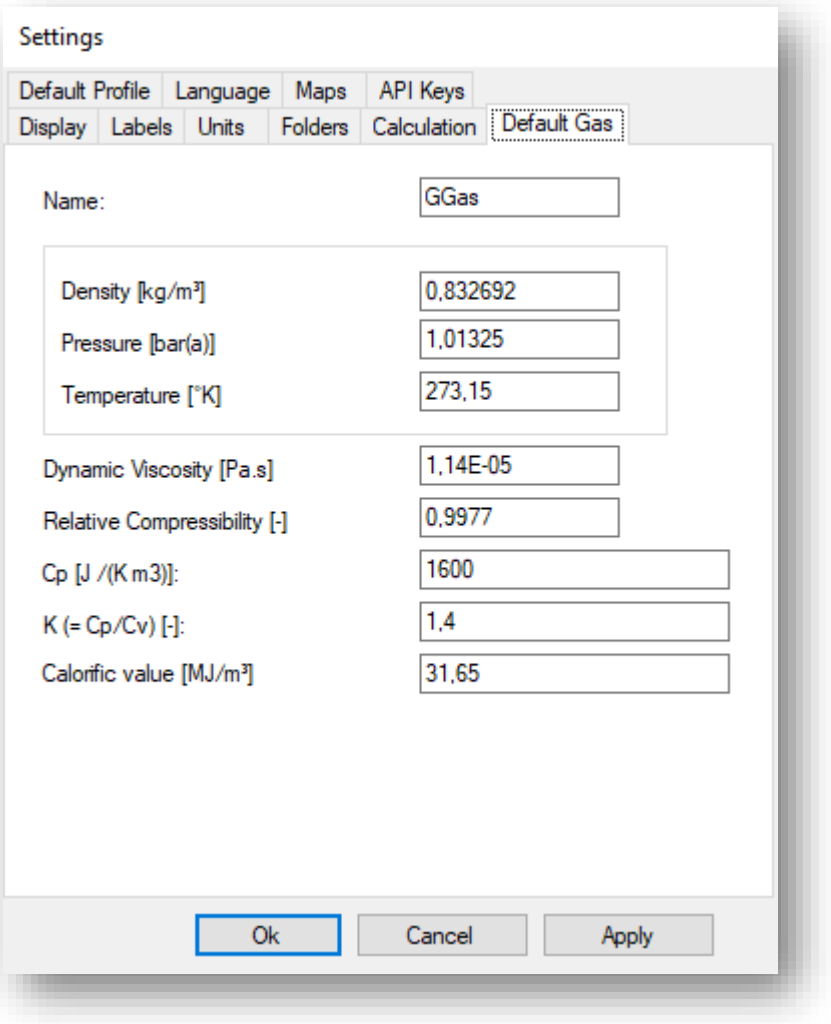


Property	Meaning
Network	The selected network (effective only if All Networks is not ticked)
All Networks	If ticked, then all the networks will be calculated, starting with the networks with the lowest pressures.
Pass On Consumption	The calculated consumption of a network is passed on to the network which feeds the Station (if All Networks is not ticked, any existing old calculation results are used to define the consumption of the lower pressure networks!).
Day Temperature	Mean day temperature on which the gas consumption is based.
Gas Temperature	The temperature of the gas in the pipeline.
Accuracy	The accuracy with which the pressures are calculated. The accuracy is given as a percentage of the maximum allowable pressure loss.

Connection Tolerance	The maximum distance between pipelines ends to the objects to be joined to them (e.g. other pipelines, stations, valves, consumers and altitude markers), which are considered as hydraulically connected.
Projected Pipelines	If ticked, projected pipelines are included in the calculation as well.
Altitude correction	If ticked, the calculation is carried out using the correction for altitude.
Reference Altitude	Reference level for the altitude from which the ascent pressure gain is determined
Max. Distance Profile Consumer	Maximum distance for a profile consumer to a pipeline, onto which they can be automatically connected (maximum length of the connection pipeline).
Use limiting (Station Options)	If ticked, the calculation is performed taking into account the parameters Maximum capacity and Minimum capacity of the stations.
Use regulators (Station Options)	If ticked, the calculation is performed with the control characteristic of the regulator present in the stations, if one is present (please refer to Appendix IV for details).

10.6 Default Gas

This tab defines the default gas. The default gas is used for the default settings when defining a new gas. The set pressure and temperature are the reference pressure and temperature for the so called normal conditions. For backwards compatibility, the calorific value is used when an older file is opened, where the gas definition doesn't contain a calorific value. The following settings are available :

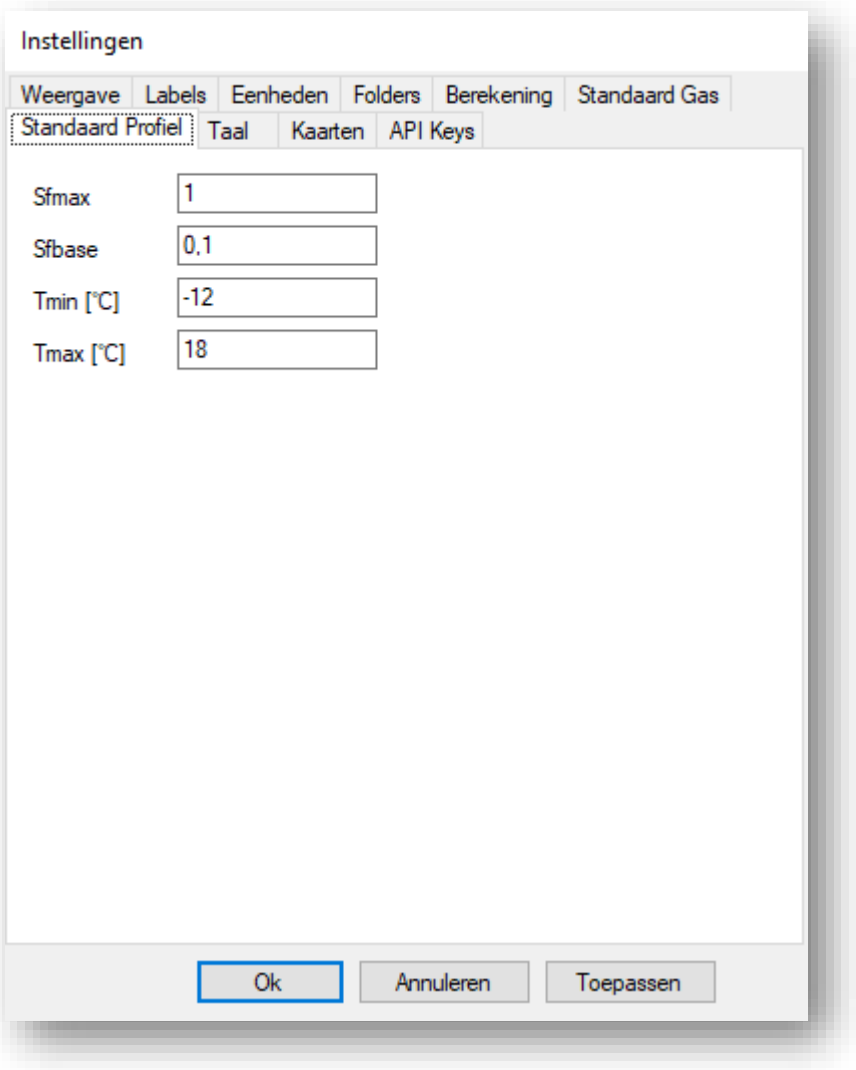


Property	Meaning
Name	Identification of the gas.
Density	Density of the gas at reference temperature and reference pressure.
Pressure	Reference pressure, normally 1.01325 bar(a).
Temperature	Reference temperature, normally 273,15 K (= 0 °C).
Dynamic viscosity	Dynamic viscosity.
Relative compressibility	Relative compressibility at the average network pressure. The compressibility of a gas is pressure dependent and the pressure dependency varies per type of gas. For low calorific gas, like used in the Netherlands, the pressure dependency can be approached with the following formula (up to 20 bar): compressibility = 1-0.0021*average pressure.
Cp	Heat capacity at constant pressure (just for Green Plus calculations).
K	Ratio between Heat capacity at constant pressure and constant volume (just for Green Plus calculations).

Calorific value	The calorific value (lower heating value) of the gas. It is used for recalculation of the demand, when for a network is switched to another gas. PLEASE NOTE: This value is also used in case an old file is opened where the gas definitions do not contain a calorific value.

10.7 Default profile

The default profile is used for profile consumers that do not have a consumer definition themselves, in case of calculations that do not use a profile definition (capacity, n-1, design, CML). The following settings are available (see also §9.4.2) :



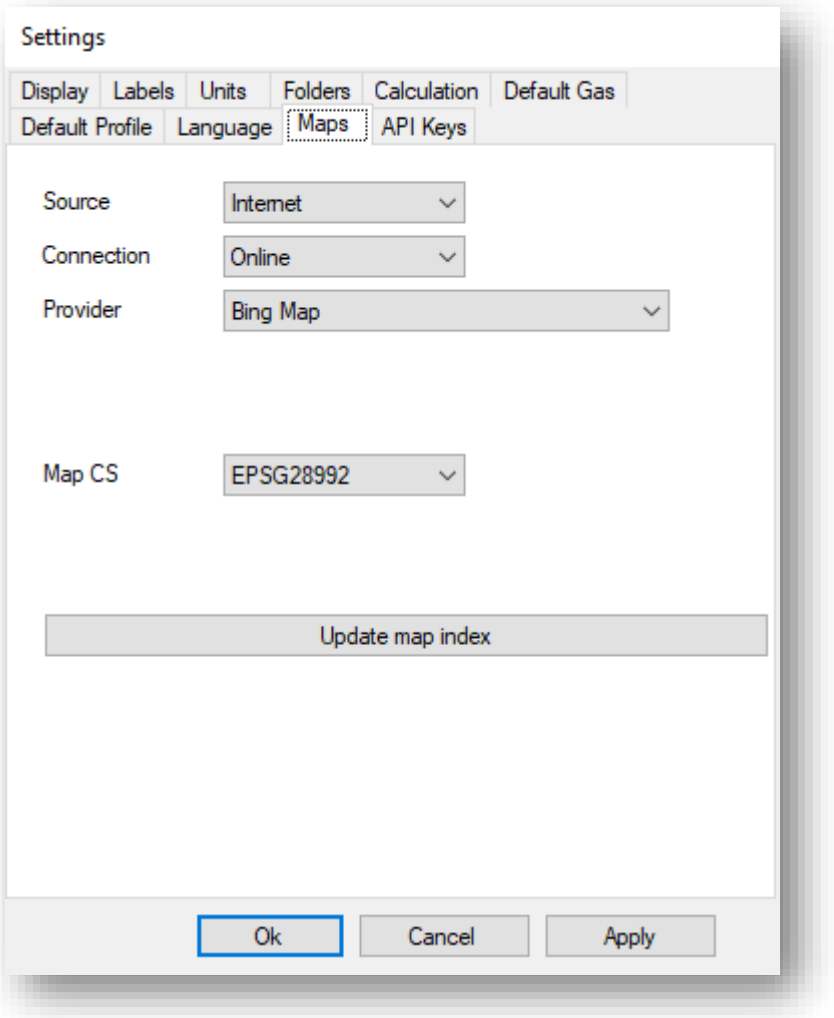
Property	Meaning
Sfmax	Factor for the demand at a day temperature T ≤ tmin
Sfbase	Factor for the demand at a day temperature T ≥ tmax
tmin	Day temperature at and below which Sfbase applies.
tmax	Day temperature at and above which Sfmax applies.

10.8 Language

Choose the preferred language. There is a choice between Dutch and English.

10.9 Maps

Settings for the use of background maps:

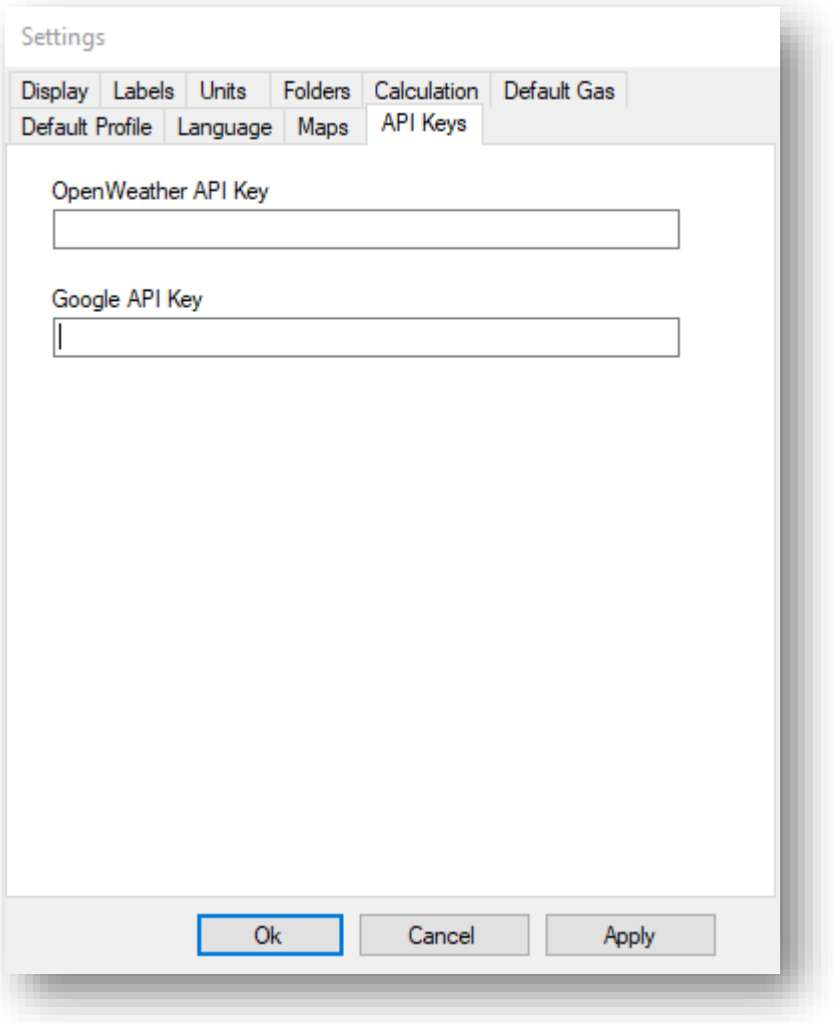


Property	Meaning
Source	Set the source for the background maps. There are two options: • Local folder: fixed maps are located in a folder. These is applicable when using maps based on the so-called ESRI world file system. The location has to be set on the tab Folders, at the option ‘Maps local’. • Internet: maps are downloaded from an online service. PLEASE NOTE: the downloaded maps are locally cached. You have to set a location for the cached files, see tab Folder, option ‘Maps online’.
Connection	Applicable if the source is set to Internet: • Offline: only cached files from a previous session are used. No new maps are downloaded or updated. This can be useful if you have a slow internet connection. This

	can cause that sometimes no background is visible, since the needed map is missing. • Online: maps are downloaded or updated if applicable.
Provider	Applicable if the source is set to Internet. Select which provider you want to use for your background maps.
Map CS	Coordinate system that is to be used in the view. PLEASE NOTE: when using ESRI worldfile maps, the coordinate system has to be the same. Otherwise the maps are not (correctly) displayed.
Update map index	Applicable if the source is set to local folder. When new maps have been added or maps have been updated, the index has to be updated as well, by pressing the button. If not, the new maps will not show up in the view.

10.10 API Keys

For some internet services you will need an API Key. The API Key can be requested at the provider (an account is required):



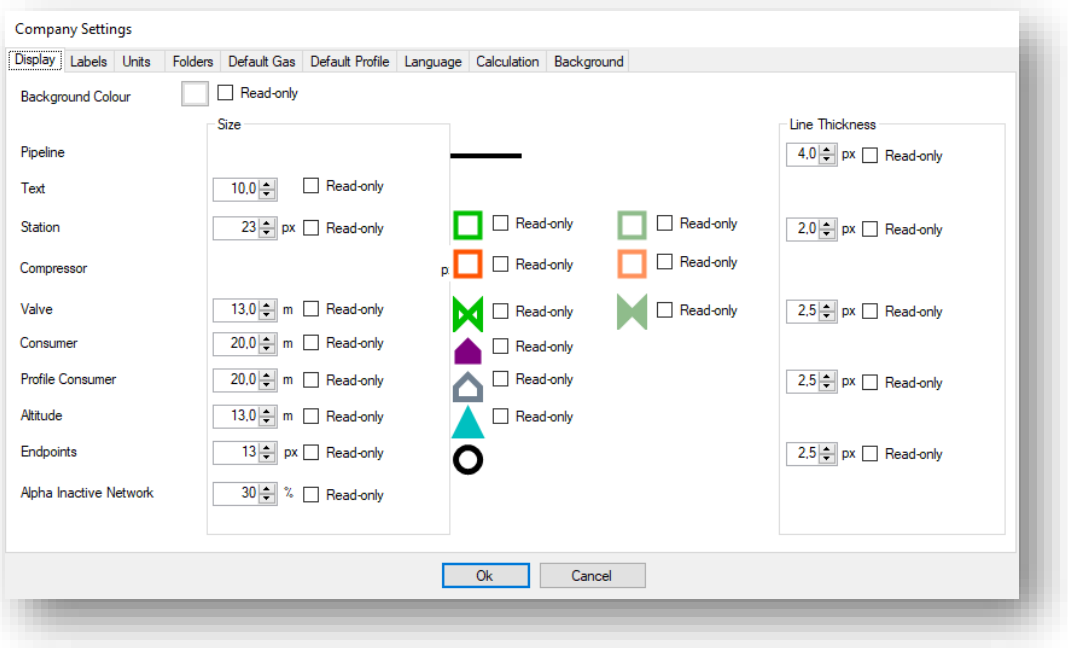
Property	Meaning
OpenWeather API Key	Needed for automatically receiving the current day temperature for the location of the current network

	(IRENE Pro Operations). The API key can be requested at https://home.openweathermap.org
Google API Key	Needed for enabling searching on address. The API Key can be requested at the Google Maps Platform (https://cloud.google.com/maps-platform/?hl=en).

10.11 Company settings

All users setting can also be set as company setting. This means that the user is not able to modify or only temporarily modify the settings. A file with the company settings has to be created. The file has to be located on a server that is accessible for all users that are involved. The location of the company settings file has to be set on the tab Folders, option Location company settigngs.

Creating a company settings file is only possible for users that own a so-called Admin license. It will make an extra menu option available: Administrator – Company settings. It will open the following window.



All settings, described in this chapter, are available. See, for detailed descriptions, the previous different paragraphs.

There is one extra option: Read-only. If ticked, the setting cannot be modified anymore by the user. If not ticked, the user can modify the setting, but it is temporarily. As soon as IRENE Pro is closed and restarted, the company settings are applied again.

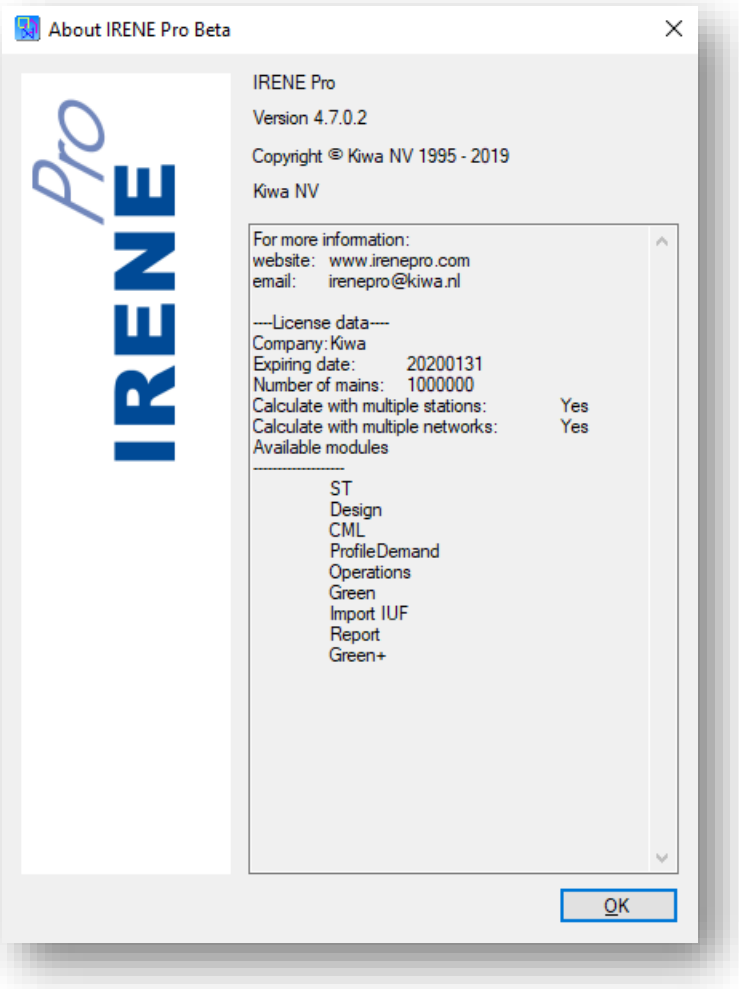
11 Help

11.1 User's Manual

If User's Manual is clicked via the Help menu, the user's manual of this application will be opened. The manual is supplied in PDF format together with the installation. It is assumed that the user has a software installed on his workstation (for example, Acrobat Reader) with which the user's manual can be viewed.

11.1.1 About

Clicking '**About'** reveals the following window which shows the version information for the software as well as the license information.



I Functionalities of IRENE Pro dialogs

The following functionalities are typically available to the user when a dialog is open:

- Set Units
  The values are given in the units which have been set as preferences by the user (via the Settings menu).
- Copy to Clipboard
  The contents of the list can be copied (for example, to Excel). Use Ctrl en Shift in combination with the mouse pointer to make a selection, and use Ctrl+C to copy the selection.
- Paste from clipboard
  The values can be pasted in the list from another application. Use Ctrl+v to paste the values.
- Sorting
  The list can be sorted by clicking on the column header.
- Filtering
  The list can be filtered by clicking with the right mouse button on the column and then setting a filter.

The following table shows which functionality is available in the specific dialogs:

Dialog Overviews (Lists)

Name (title)	Set Units	**Copy to clipboard**	**Paste from clipboard**	Sorting	Filtering
Definitions					
Networks	yes	yes	no	yes	no
Gases	n/a	yes	no	no	no
Materials	yes	yes	no	yes	no
Consumption Definitions	yes	yes	no	yes	no
Definitions Pipeline Consumption	yes	yes	no	yes	no
Profiles	n/a	yes	yes	no	no
Annual Temperatures	n/a	yes	yes	no	no
Malfunction sets	n/a	no	no	no	no
Assets					
Consumers	yes	yes	yes	yes	yes
Profile Consumer/supplier	yes	yes	yes	yes	yes
Regulators	yes	yes	no	yes	yes
Station / compressor	yes	yes	no	yes	yes
Valves	n/a	yes	no	yes	yes
Altitude	yes	yes	no	yes	yes
Pipelines	yes	yes	Yes(just ID in order to mark pipelines)	yes	yes

Detail Dialogs

Name (title)	Set Units
Details – Network	yes
Details – Gas	no

Details – Material	yes
Details – Consumption definition	yes
Details - Definition pipeline consumption	yes
Details – Flow/Pressure Profile	no
Details – Annual Temperature	no
Details – Consumer	yes
Details – Profile Consumer	yes
Details - Regulator	yes
Details - Station	yes
Details - Valve	n/a
Details - Altitude	yes
Details – Pipeline	yes
Details – Text	n/a

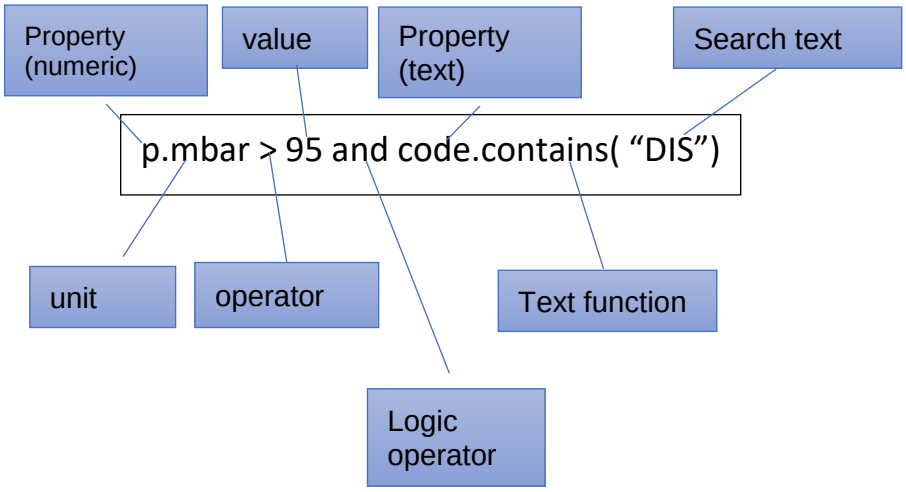
Other

Name (title)	Set Units
IRENE Pro	yes (legends)
Capacity	yes
Dimensioning	yes
Profile Calculation	yes
Reports	yes
Save image	n/a
Settings	n/a
XML Log	n/a
About IRENE Pro	n/a

II Define queries

Via the menu Definitions – Markings you can define queries. The objects that comply to the query are marked with a colour. This appendix explains how the query has to be defined.

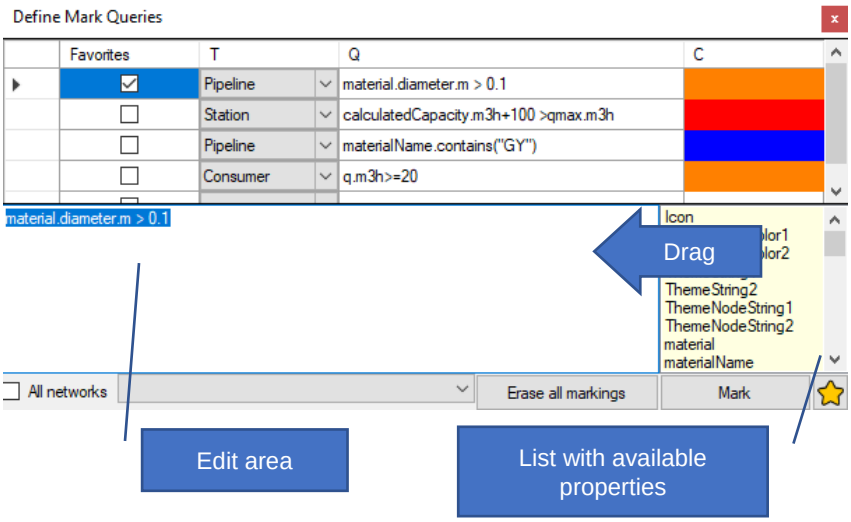
A query text has a fixes structure, as is shown in the following example. The example query selects all stations with an outlet pressure of more than 95 mbar and a name containing “DIS”:



II.1 Property

Each object has a number of properties, see II.6. They can be of different types, like text, numeric, date, etc. The type of a property determines also the possible functions and operators. For numeric properties you will often need to select a unit in which it has to be evaluated, see II.2 Units. For text you will need to define a search text. Search text should always be enclosed between quotes.

All the available properties of an object are shown in the dialogue, in a list at the bottom-right. These properties can be dragged to the edit field.



II.2 Units

For numeric properties you can select the unit by typing behind the property name a point followed by the unit name. The following units can be selected depending on the type of property:

Type	Units	Meaning
Flow	m3h	normal cubic meter per hour
	m3s	normal cubic meter per per second
	m3y	normal cubic meter per per year
Length	mm	millimetre
	m	meter
	cm	centimetre
	hm	hectometre
	km	kilometre
	inch	inch
Pressure	Pa	pascal (over pressure)
	hPa	hector pascal (over pressure)
	kPa	kilo pascal (over pressure)
	MPa	mega pascal (over pressure)
	mbar	milibar (over pressure)
	bar	bar (over pressure)
	bara	bar (absolute)
	psi	pounds per square inch (over pressure)
Speed	ms	meter per second
	kmh	kilometre per hour
Temperature	kelvin	Kelvin
	celsius	degrees Celsius
	fahrenheit	degrees Fahrenheit

II.3 Operators

With the operators you define the property should be or not be. The following operators can be used:

operator	Meaning
= of ==	equal (can also be used for text)
!= of <>	not equal (can also be used for text)
>	More than
<	Less than
>=	More than or equal
<=	Less than or equal

II.4 Logic operators

Logic operators can be used to combine several conditions. The following logic operators are available:

Logic operator	Meaning
AND	Both conditions have to be true.
OR	One of each conditions have to be true

By using brackets you can force the order in which multiple conditions are evaluated. For example:

(condition 1 AND condition 2) OR (condition 3 AND condition 4)

The conditions between brackets are evaluated first. Thus in this case the object is select if it complies to both condition 1 and 2 or if the object complies to both condition 3 and 4.

II.5 Text functions

For tekst properties there are special functions available. These can be used by typing a point after the property name followed by the function name and brackets. Sometimes you will need to give the search text between the brackets. The following functions are available:

ATTENTION: the functions are case sensitive.

Text function	Meaning
contains("search text")	The text contains the search text
startswith("search text")	The text starts with the search text
endswith("search text")	The text ends with the search text
tolower()	Gives the whole text in lower case
toupper()	Gives the whole text in upper case

To avoid case sensitive search, use the tolower or toupper functions. For example, if you want to search within the property Code, but not case sensitive, than create the following condition:

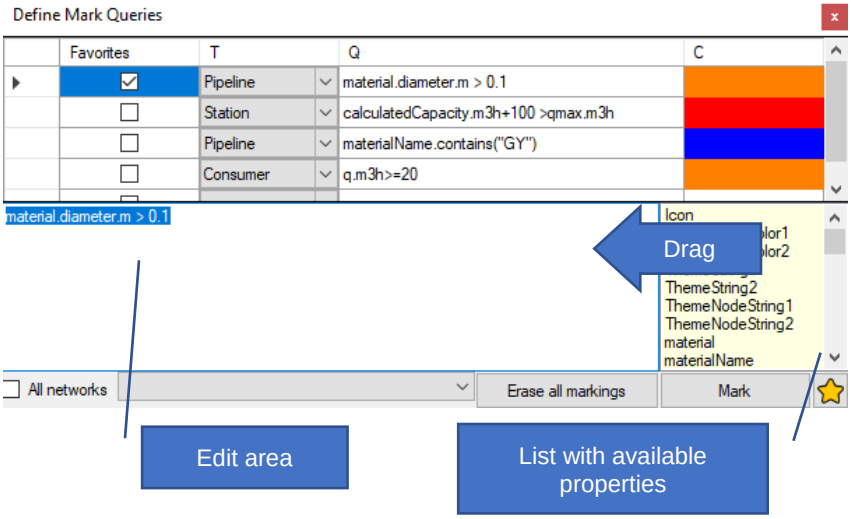
Example:

Code.tolower().contains("dis")

In this example, stations whereof the code (ID) contains "dis" (not case sensitive) are found. The same can be achieved using only Caps and using function toupper().

II.6 Available properties for each object

For each object type a number of different properties is available, that can be used to define selection criteria. All available properties of an object are shown in the dialogue, in a list at the bottom-right. These properties can be dragged to the edit field.



It is important to know whether a numeric value is involved and if it has a certain unit. The most important properties are described below. If you use functions, you will need to add brackets at the end of the function name.

II.6.1 Pipeline

Properties

Property	Type	Unit	Use this in query
ID	Text		code
Name	Text		Name
Material – Name	Text		materialName
Material – inner diameter	Numeric	Length	Diameter
Length	Numeric	Length	length
State	Text	Options: • In Service • Projected • Design • Out Of Service	StateToStr
Year	Numeric		year

Calculated values

Value	Type	Unit	Use this in query
Flow	Numeric	Flow	flowAbs
Speed	Numeric	Speed	speedAbs
Pressure 1	Numeric	Pressure	remainingPressure1
Pressure 2	Numeric	Pressure	remainingPressure2

Functions

Value	Type	Unit	Use this in query
Number of pipeline consumers	Numeric	-	Smallcustomercount()

II.6.2 Station

Properties

Property	Type	Unit	Use this in query
ID	Text		code
Name	Text		name
Inlet pressure	Numeric	Pressure	p
Outlet pressure	Numeric	Pressure	pin
Maximum capacity	Numeric	Flow	qmax
Minimum capacity	Numeric	Flow	qmin
State	Text	Options: • In Service • Out Of Service	StateToStr

Calculated values

Value	Type	Unit	Use this in query
Flow	Numeric	Flow	calculatedCapacity
State	Text	Options: • open • limited at maximum • limited at minimum • closed	LimitedString
Inlet pressure	Numeric	Pressure	calculatedPin
Outlet pressure	Numeric	Pressure	Pcalc

II.6.3 Valve

Properties

Property	Type	Unit	Use this in query
ID	Text		Code
Name	Text		Name
State	Text	Options: • Open • Closed	StateToStr

II.6.4 Consumer

Properties

Property	Type	Unit	Use this in query
ID	Text		Code
Name	Text		Name
Demand	Numeric	Flow	q
Definition	Text		definitionName

Calculated values

Value	Type	Unit	Use this in query
Pressure	Numeric	Pressure	P
Calculated demand	Numeric	Flow	Qcalc
Name nearest station	Text	-	NearestFeed

II.6.5 Profileconsumer

ATTENTION: this is also valid for profile suppliers

Properties

Property	Type	Unit	Use this in query
EAN	Text		Code
Name	Text		Name
Year consumption	Numeric	Flow	syc
Peak demand	Numeric	Flow	PeakConsumption
Consumption definition	Text		CdefName
Profile	Text		ProfileName
Linked	Text	Options: • Automatic • By Pipeline • Not Connected	
Connected	boolean	Options: • true • false	connected
Automatically linked	boolean	Options: • true • false	autoconnected
Linked Pipeline ID	Text		pipelineid
Max. inlet pressure	Numeric	Pressure	Pmax

Calculated values

Value	Type	Unit	Use this in query
Pressure	Numeric	Pressure	P
Demand	Numeric	Flow	Qcalc
Name nearest station	Text		Nearest Feed

III Capacity Calculation

IRENE Pro uses the Hardy-Cross iterative calculation method, based on the two laws of Kirchhoff:

- The sum of the pressure loss in a closed loop of pipelines is equal to 0 (no pumps present).
- The sum of the amount of gas arriving at a pipeline junction (node) is equal to the sum of the gas leaving.

The calculation of the pressure drop is completed using the following formula:

$$p_1^{\,2} - p_2^{\,2} = z \cdot \lambda \cdot \frac{L}{D} \cdot \rho_{(n)} \cdot v^2 \cdot \frac{T}{T_{(n)}} \cdot p_{(n)}$$

with:

p_1	Absolute pressure at the beginning (inlet side) of the pipeline.
p_2	Absolute pressure at the end (outlet side) of the pipeline.
z	Compressibility factor of the gas
λ	Friction factor according to the formula of Colebrook & White formula (see further down).
L	Length of the pipeline
D	Diameter of the pipeline
$\rho_{(n)}$	Density of the gas under reference conditions
T	Gas temperature (K)
$T_{(n)}$	Temperature at reference conditions (273.15 K)
$p_{(n)}$	Pressure at reference conditions (101325 Pa)

For the determination of the friction factor, IRENE Pro uses the formula of Colebrook & White. The friction factor is recalculated for each iteration in the meshed gas network.

Colebrook & White formula:

$$\lambda = \frac{0.25}{[\log(\frac{2.51}{\mathrm{Re}\cdot\sqrt{\lambda}} + \frac{k}{3.71\cdot D})]^2}$$

met:

λ	Friction factor
Re	Reynolds-number = Q □(n)/ (¼ □□D □)
k	Wall roughness length for the inner wall (m)
D	Inside diameter of the pipeline (m)
□	Dynamic viscosity (Pa s)
Q	Gas flow rate (m^3_n/s)

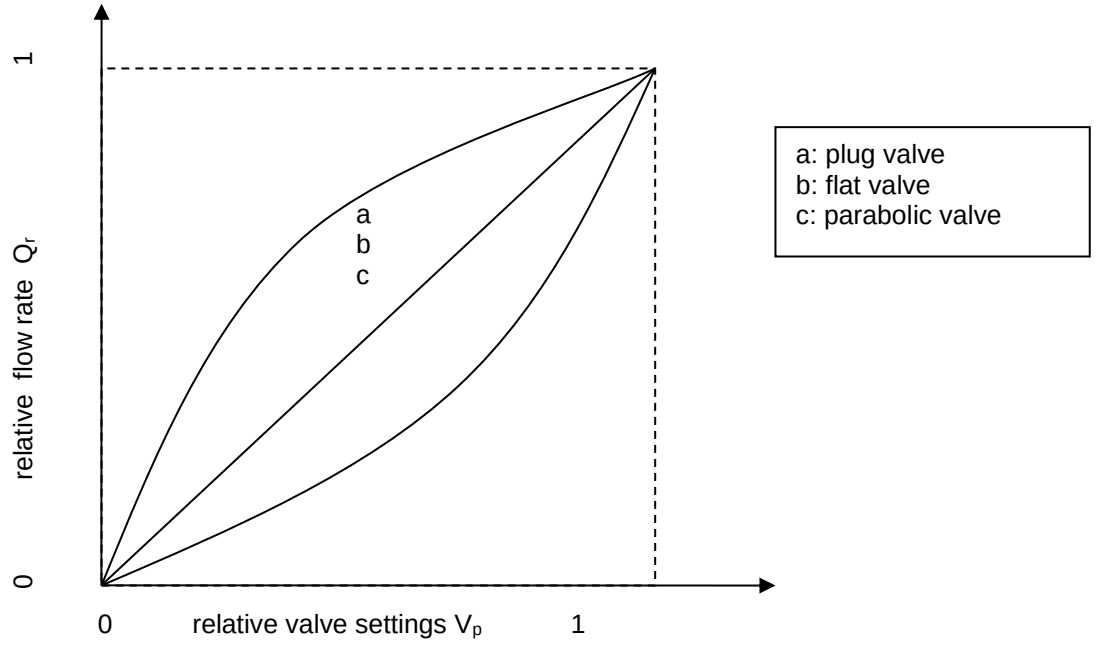
IV Regulators

Basic Formulas

The relationship between the flow rate through a regulator and its outlet pressure is described by three relations.
The first relation is that between the valve settings V_p and the relative flow rate Q_r. Here, Q_r is a function of V_p , or vice versa. Both units are numbers which can vary between 0 and 1, where applies, by definition, that:

$Q_r(V_p=0) = 0$
$Q_r(V_p=1) = 1$

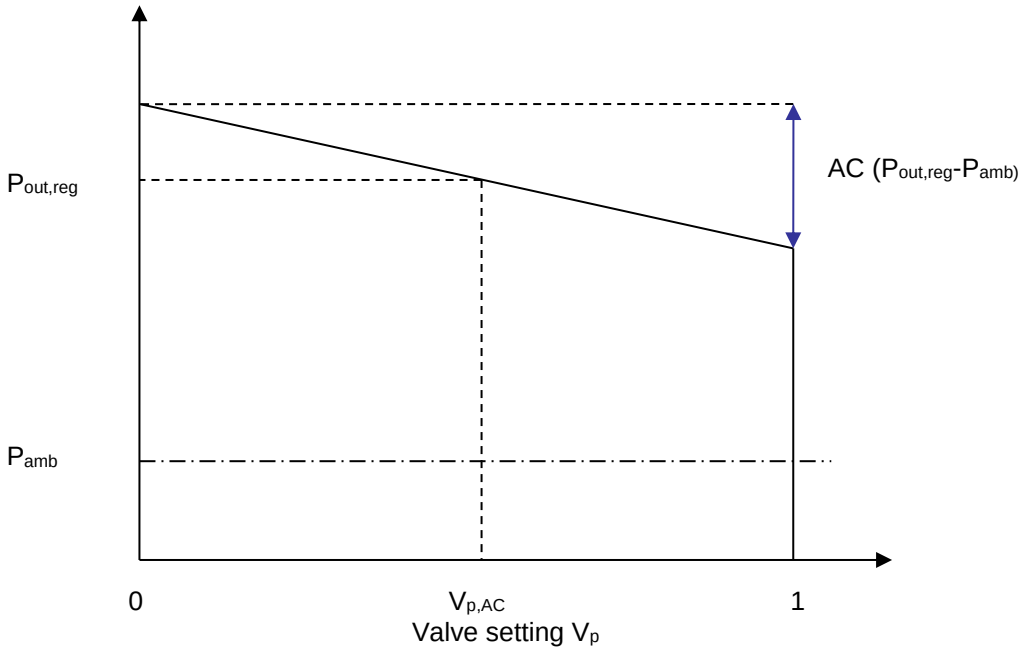
The function is monotonically increasing: if $V_{p1} > V_{p2}$ then $Q_{r,1} > Q_{r,2}$.



The relation between Q_r and V_r is given in table format, where a number of V_pQ_r-combinations have been tabulated.

The second relation is that between the relative valve setting V_p and the outlet pressure P_{out} . These are described using three parameters: the Accuracy Class AC, the nominal valve setting at determination of the regulation class $V_{p,AC}$ and the nominal outlet pressure $P_{out,nom}$.
For the outlet pressure of the regulator, the following is applicable:

$$P_{out}(V_p) = \begin{cases} P_{out,reg}\left(1 - AC\left(V_p - V_{p,AC}\right)\right) & if\ 0 \le V_p \le 1 \\ undefined & if\ V_p > 1\ or\ V_p < 0 \end{cases}$$



Finally, there is the relation between the flow rate Q and the relative flow rate Q_r:

$$Qr = Q/Q_{max}$$

In principle the above relations with corresponding numerical values for the parameters are sufficient to determine the outlet pressure of a station as a function of its supply flow rate.
In practice, there are two extra complications. These are described in more detail below.

1. Definition of Q_{max}
The Q_{max} is dependent upon the operating conditions of the regulator, namely its inlet pressure, outlet pressure and the gas type. The inlet pressure especially is an important variable in practice.
As natural gas is normally used, variation in gas type as a condition is left outside consideration here, but the remaining two, especially the inlet pressure, are relevant indeed.

Therefore:

$$Q_{max} = K_G P_{in} / 2 \quad \text{if } P_{out} < 0.54 \text{ Pin}$$
$$Q_{max} = K_G \sqrt{P_{out}(P_{in}-P_{out})} \quad \text{if } P_{out} > 0.54 \text{ Pin}$$

Here, K_G is a constant which does depend upon the regulator, but no longer upon the pressures.
There are therefore two ways to specify the size (maximum capacity) of a regulator:

- specify KG
- specify a Q_{max} with the corresponding P_{in} and P_{out}

2. Definition of P_{out}
The nominal outlet pressure of the regulator $P_{out,reg}$ is specified with a valve setting of $V_{p,AC}$. Mostly, $V_{p,AC} = 0.5$.
The nominal outlet pressure of a station $P_{out,stat}$ is mostly specified by a much lower valve setting at adjustment, $V_{p,ref} = 0.2$ or 0.1.
Therefore:

$$P_{out,stat} = P_{out,reg} (1 - AC (V_{p,ref} - V_{p,AC}))$$

The $P_{out,reg}$ is calculated using this formula, where the $P_{out,stat}$ is given at the station as a constant outlet pressure. The outlet pressure of the station as function of the flow rate is set by the function defined earlier, $P_{out}(V_p)$.

Details for the implementation
A station can be used in three different ways in the capacity calculation in IRENE Pro :

1. Without regulator and without limitation
2. Without regulator and with limitation
3. With regulator and without limitation

This choice not only has influence on the behaviour of the calculated outlet pressure of the station, but also has influence on the meaning of the station parameters Station.P and Station.Qmax.

1. Without Regulator and Without Limitation
The outlet pressure is always Station Pressure and the parameter Maximum Capacity has no influence on the calculation.

2. Without regulator and With Limitation
If Maximum Capacity = 0, the calculation is performed as in situation 1.
If Maximum Capacity > Minimum Capacity > 0, a station can be in one of three states:

- Maximize: The flow rate is Maximum Capacity, the outlet pressure is determined by the capacity calculation (Generally lower than Station Pressure)
- Minimize: the flow rate is Minimum Capacity, the outlet pressure is determined by the capacity calculation (generally higher than station pressure).
- Open: the outlet pressure is Station Pressure and the flow rate Q (Minimum Capacity < Q < Maximum Capacity) is determined by the capacity calculation.

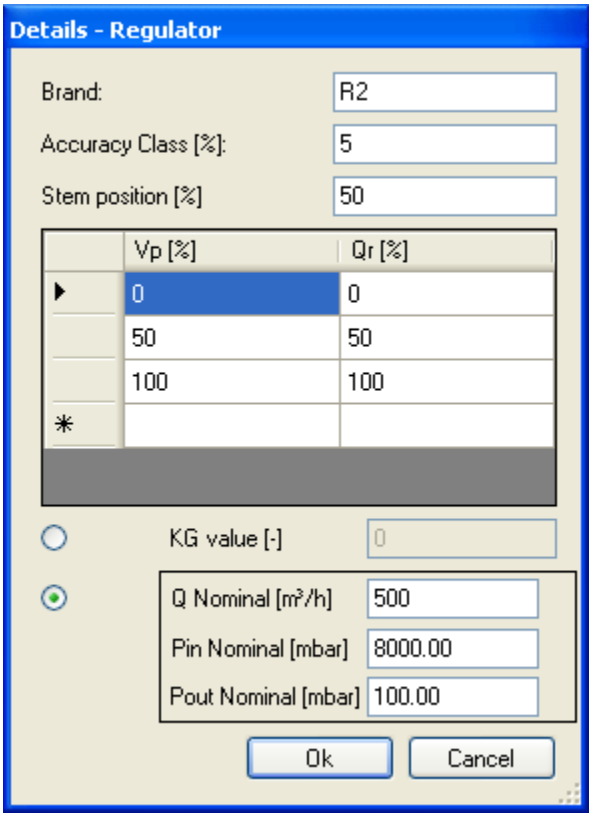
3. With Regulator and Without Limitation
In this situation Maximum Capacity en Minimum Capacity have no meaning.
If Station Regulator has not been defined, then the calculation is performed as in situation 1.
If Station Regulator has been defined, then the calculation proceeds as follows:

- Using Station Regulator Inlet pressure and the KG defined at the Regulator or the combination (P_{in}, P_{out}, Q_{max}), a Q_{max} for the station is calculated.
- The Q_{min} for the station is always 0.
- Using the Station Valve Position, Station Pressure and the Regulator AC and Valve Position, AC defined at the Regulator, a outlet pressure is calculated, as well as a maximal and minimal outlet pressure resulting from this.
- As initial valve setting = 50% is chosen and as station status Open is chosen (provided that the station was not in the Closed status).
- Subsequently, the iterations of the capacity calculation are carried out, where the valve setting and the status of the station are altered until convergence is reached.

After completion the station can be in one of three states:

- Maximize: the flow rate is Q_{max} as calculated for the station, the outlet pressure is determined by the capacity calculation and is lower than the minimal outlet pressure.
- Minimize: the flow rate is 0, the outlet pressure is determined by the capacity calculation and is higher than the maximal outlet pressure.
- Open: the outlet pressure is the flow rate dependent P_{out} ($P_{out,min} < P_{out} < P_{out,max}$) and the flow rate Q (0 < Q < calculated Q_{max}) is determined by the capacity calculation.

The properties of a regulator are adjusted via the following window.



The list of VpQr values can be shortened by selecting a row (click on the left, grey cell of the row) and by using the delete key on the keyboard. The list can be extended by completing the bottom row.
It is also possible to alter the numbers in the list by editing the fields. Only numbers between 0 and 1 are accepted.
The list is automatically sorted according to Vp-value when the window is closed.
The Qr-values must then form a monotonically increasing sequence. If this is not the case, the window cannot be closed.
The outlet pressure of the regulator is calculated by linear interpolation between the table values. If necessary, VpQr = (0,0) is added implicitly as the first element and VpQr = (1,1) as the last element.

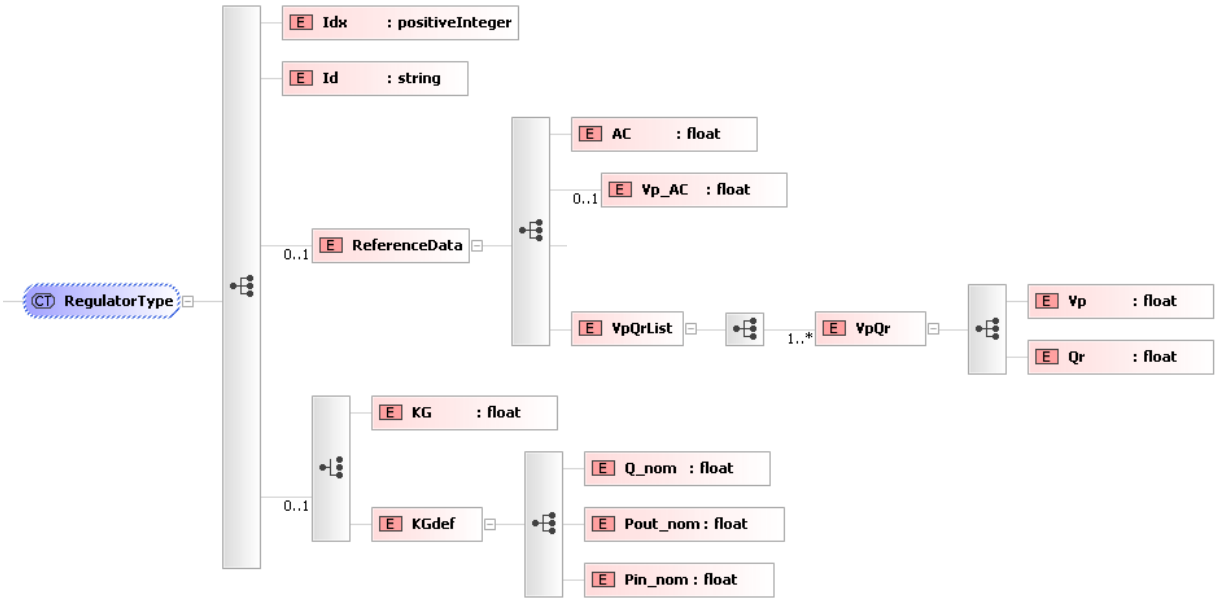
The XSD does not force the V_pQ_r-table to show a monotonically increasing relationship. This is verified prior to a calculation involving regulators. If relevant, an error message is shown and the calculation is not carried out.

The adjustment valve setting (Vp_ref) is a property of the station. The value for this is shown in the station window and can be altered there.

Alterations of the XSD (for Import from IRENE Pro V 3.0)
The original XSD was incomplete if regulator data needed to be exchanged. This is why the alteration took place. The alterations are in such a way that the old XML's are still valid, as long as they contain no regulator data (i.e. the element Network.SubNetwork.Regulators is absent or empty).
With regard to the original XSD, changes have been made in two places.
The definition of Regulator type has been changed:

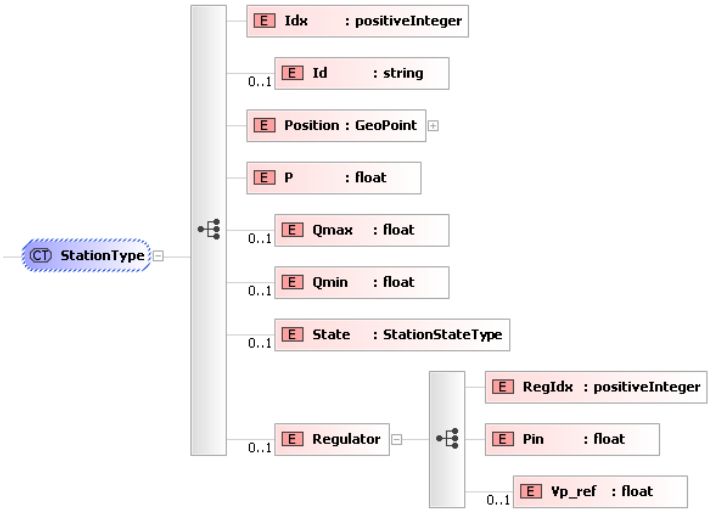
- The block ReferenceData has been added

- The definition of VpQrList has been moved from the choice-block with KG and KGdef to ReferenceData.



The definition of StationType has been changed:

- The optional element Vp_ref has been added to Regulator.



V Dimensioning

Introduction
The dimensioning of gas networks is just as much an art as a craft. In the beginning it is a technical optimization, i.e. the selection of the smallest pipeline diameters so that gas is still delivered to all consumers at a sufficient pressure.

However, additional pre-conditions also exist implicitly:

- The security of supply must be at a sufficiently high level. This means that the failure of one or more pipelines may not have too severe an effect.
- The network must be cost-efficient and built up practically. This means that there may not be diameter reductions or enlargements made at random places in order to be able to use the smallest pipeline diameters.

(Sometimes there are other considerations, such as that the network must be prepared for any future expansions. This aspect will be left completely out of consideration here).

In the practice of dimensioning, these extra pre-conditions are “translated” to the demand that the pressure loss must be distributed as evenly as possible over the entire network (pressure loss per length unit as constant as possible). Moreover, only a limited number of pipeline segments are allowed for which a limited amount of diameters may be selected. In this manner a combination-optimization problem arises, which in principle can be solved by the calculation of a very large but finite number of network designs. The number of possible configurations is far too large to be calculated within a practical time period. Furthermore, it appears that this optimization problem is “NP-hard”, which means that no algorithm exists which can efficiently find the optimum configuration with certainty.

This means that we must work with heuristics (rules of thumb) which will select a configuration out of the vast number of possible network configurations which is acceptable.
The heuristic which is applied in IRENE is as follows:

1. Select the largest diameter for all the pipelines and calculate the pressure distribution at the maximum gas demand. If there is sufficient pressure under these circumstances, then it is shown that a network dimensioning is possible with the diameters available.
2. Select the smallest diameter for all the pipelines and calculate the pressure distribution at maximum gas demand. Mostly, the pressure is now too low at a number of nodes or end points.
    a. Determine for each of these nodes the series of pipeline segments upstream to the closest supply point;
    b. Determine the minimum pressure gradient which is necessary to supply the node concerned with sufficient pressure;
    c. Select from the series of pipeline segments the pipelines with an excessive pressure gradient;
    d. Enlarge all of the diameters of the selected pipeline segments with the same factor, until, at constant flow rate distribution in the network, the point is reached where the node is supplied with sufficient pressure. As there are only a limited number of diameters available, the factor of diameter enlargement will not be exactly the desired factor. Select the largest available diameter which leads to a factor which is not larger than the desired factor;
    e. It is conceivable and also probable that the same pipeline segment occurs in multiple upstream paths. In this instance, choose the largest diameter which follows from the evaluation of the separate

paths;

f. Optional: Limit the diameter enlargement to a maximum number of (small) increments.

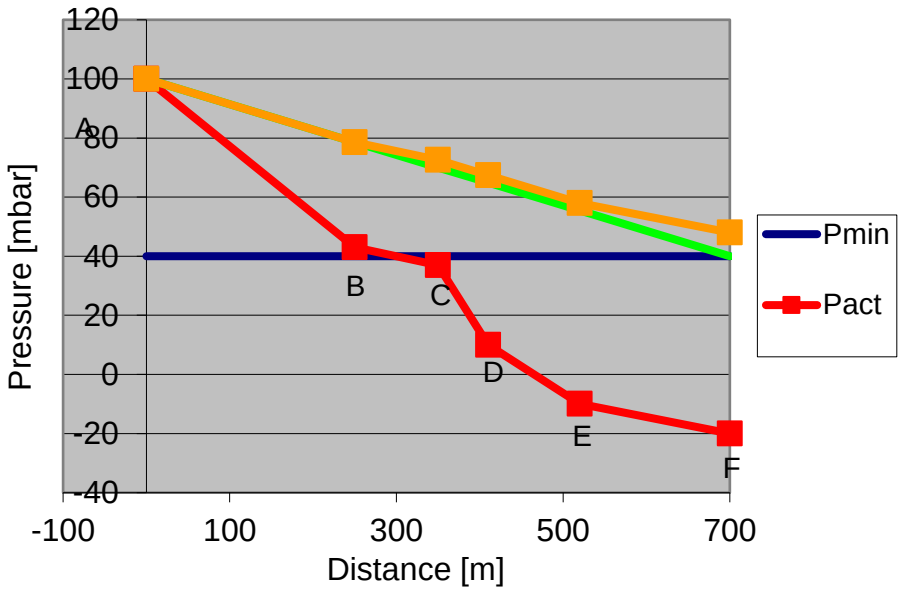


Figure 1: Example of the pressure distribution between node F (end point) and node A (supply point). Pipeline sections AB, CD and DE have a pressure gradient which is larger than ideal. The diameter in these segments will be enlarged. Orange Line: after diameter enlargement using factor.

3. Re-calculate the pressure and flow rate distribution in the network with the altered diameters. In the case that after the execution of diameter enlargements the network does not yet reach the state of sufficient pressure at all nodes and end points, the diameters of pipelines can be enlarged selectively in the following manner:

   Perform the same actions as described under step 2, but in this case enlarge all the pipeline segments which have an excessive pressure gradient with a maximum of one diameter size (also if this means that the factor with which the diameter would be enlarged will then be exceeded).

4. Repeat step 3 until all of the node and end points have sufficient pressure. (the test at point 1 guarantees that this should be possible within a finite number of iterations.)

Limitations

The above heuristic algorithm works in general, but is not optimal. There are two disadvantages:

- There are situations in which the diameters of pipelines are enlarged too much (please see figure 2). This effect is less pronounced when more design diameters are available.

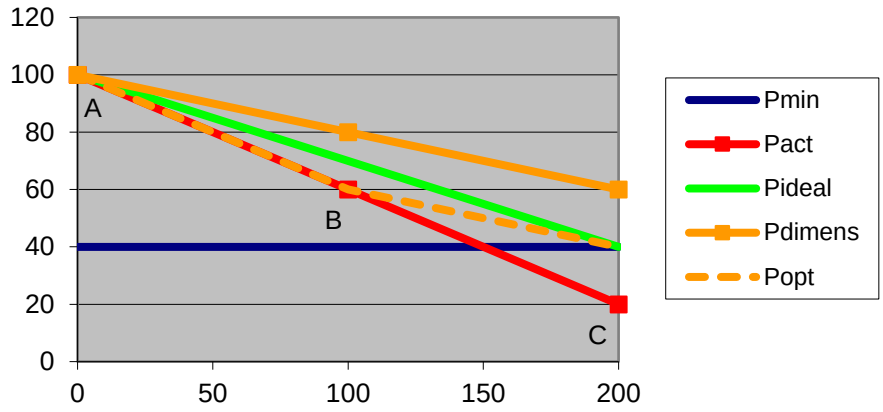
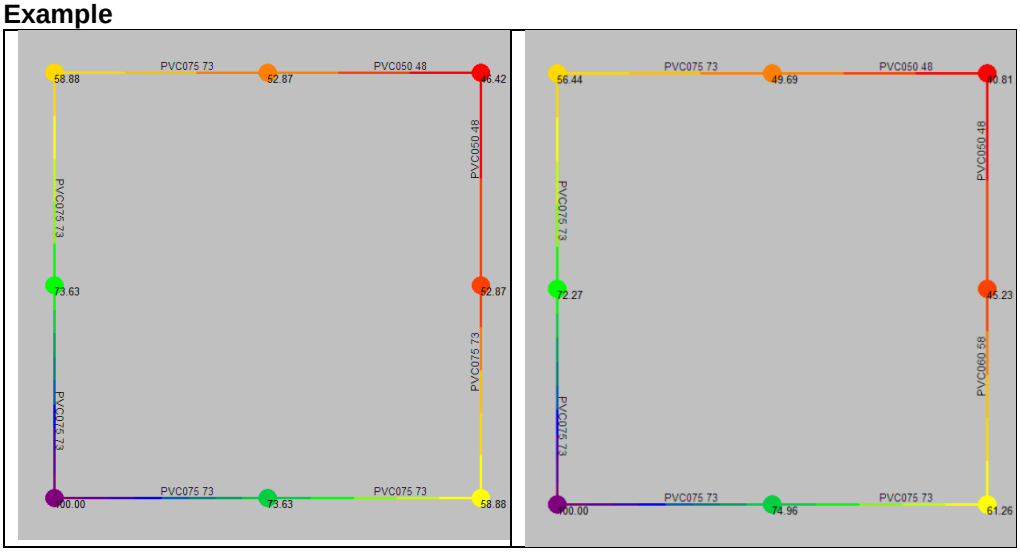


Figure 2: Example of a situation in which the diameters of pipelines have been enlarged too much. The algorithm has enlarged the diameter of both pipeline AB and BC (solid orange line) whilst it would have been sufficient to enlarge the diameter of BC (or AB) (dotted orange line).

- With parallel pipelines which have the same 'function', only the diameter of the pipeline which happens to have the largest pressure gradient is enlarged. This pipeline will then transport the maximum amount of the gas, resulting in a further enlargement of the diameter of this pipeline during a possible next iteration. Firstly enlarging the diameter the other parallel pipeline would be more logical. The same effect is seen in a ring of pipelines. The diameter of the pipeline with initially the lowest pressure gradient is not enlarged, and the ring is in fact split into two branches.
  This effect is inherent to step 3 of the algorithm. The effect can be somewhat minimised by the definition of many design diameters and to allow many diameter enlargements in step 2.

Finally, the comment must be made that it is not 100% certain that the heuristic will always find a solution. Only the diameters of the pipelines in the upstream path of the critical nodes and end points are enlarged. It is conceivable that it is necessary to enlarge the diameter of one of the other pipelines. Until now, no networks have been found in which this problem appears.

Example



Initial (phase 2) max 2 diameter steps Initially no diameter enlargement (only phase 3)

Figure 3: The dimensioning of a ring comprising of eight pipelines. Selection made from three pipeline diameters: 48 mm, 58 mm and 73 mm. By not allowing any diameter enlargement in phase 2, a sharper dimensioning is acquired. The difference is the pipeline below right: 58 mm instead of 73 mm.

Possible Improvements

One of the reasons why the dimensioning is occasionally less sharp than is possible, is the fact that the diameters of multiple pipelines are enlarged simultaneously. The possible interaction between these enlargements is not completely taken into account in the heuristic.

One way of making sure that the dimensioning is sharper, is to enlarge the pipelines one at a time. Treat the pipelines which according to phase 3 should be enlarged as a proposal, and choose, on the basis of the other heuristic arguments, the most important of these. For example, sort the pipelines to be enlarged on the basis of flow rate and length (or pressure, or supply point), and choose the pipeline with the highest flow rate and/or length (or a weighted combination). Next, apply only this single diameter enlargement (or allow only one enlargement per supply point).

Such an adaptation of the algorithm is relatively easy to implement. The disadvantage of this algorithm is that the calculation time is increased considerably. For smaller networks this is not such a problem, but for larger networks it is. It is therefore obvious that this possibility is only added as an option to the currently existing algorithm, which the user can turn on and off himself.

VI Installation IRENE Pro

Step 1: Login on www.irenepro.com

Step 2: Click on Downloads

Step 3: Click on IRENEPRO.ZIP

Step 4: Unzip IRENEPRO.ZIP in the installation folder of choice.

Step 5: Read the release notes and follow the instructions

The Export folder is empty. The Import folder contains the demo file standard_demo.xml. The manual folder contains the user's manual in PDF format. The XSD folder contains the XSD of the IUF-XML exchange format.

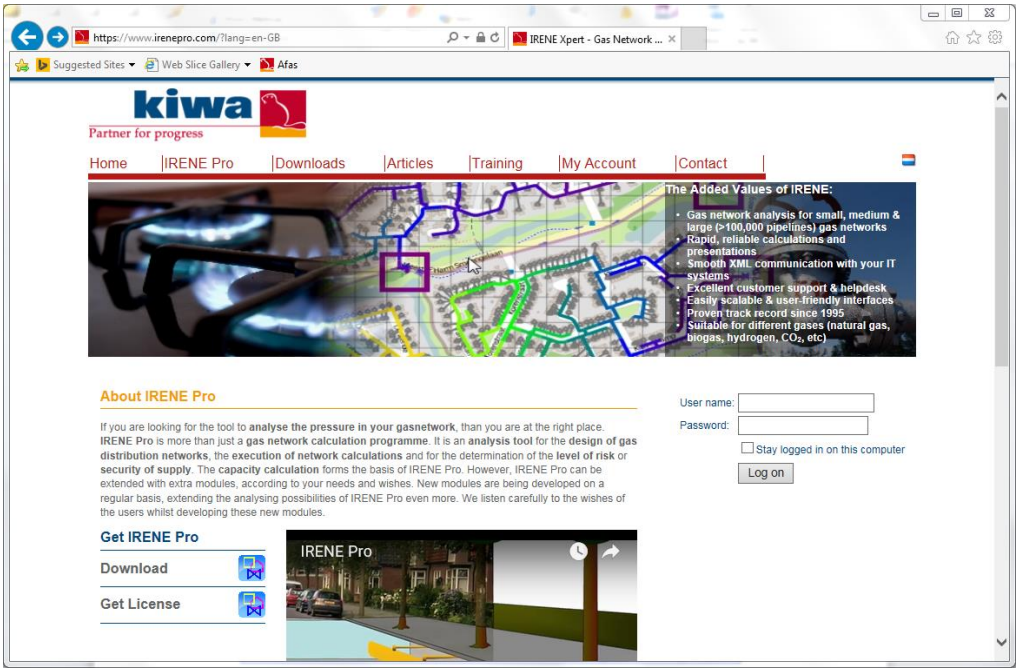
Step 6: Start IRENE Pro.

Step 7: Import standard_demo.xml. You can then begin.

Contact Details

Please visit the website of IRENE Pro for more information, tips, tricks and more:

www.irenepro.com



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