How to use calibration

The calibration function in TERMIS Operation enables you to calibrate pressure losses due to friction and heat losses.

Calibration is based on the comparison of measurements and simulations within the same time period. In TERMIS Operation calibration is targeted at a path so that the comparison takes place between two node objects. In regards to the latter the prerequisite is therefore that the measurement is assigned to a node or source object.

A correction factor for the path is calculated as a factor that is multiplied for example on the pressure loss factor for pressure calibration.

The calibration ignores the presence of valves and pumps. These objects are not included in the calculation.

The correction factor for a path is calculated based on the following formula

$$f = \frac{\Delta X_{Measured}}{\Delta X_{Simulated}}$$

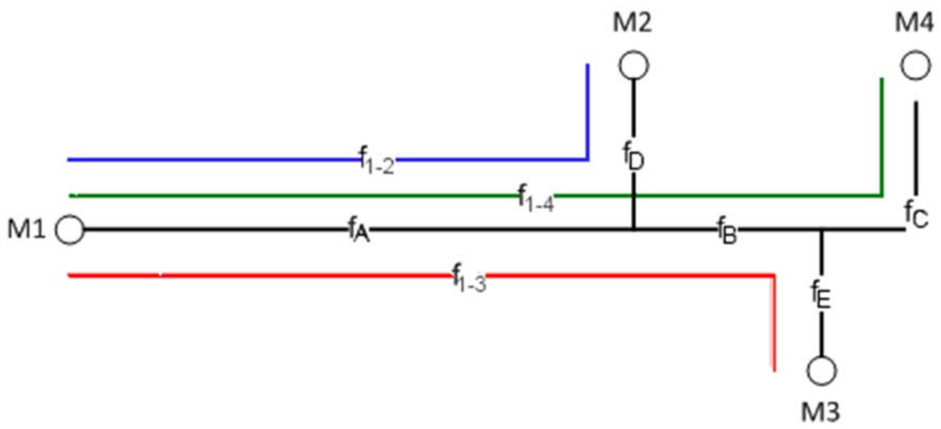
$\Delta X_{Measured}$ is the measured drop in pressure due to friction/temperature.

$\Delta X_{Simulated}$ is the simulated drop in pressure due to friction/temperature.

Multiple and overlapping paths

If you have created a calibration setup that encompasses several and/or overlapping paths, the correction factor for the path cannot be generally applied.

Instead, the calibration takes place as illustrated in the following.



where

$f_{i\text{-}j}$ are the factors related to the paths.

f_K are the resulting factors related to the calibration segments.

The calibration applies individual correction factor for pipes on a path between the two nodes that are used as calibrations points.

Pressure correction

The pressure correction can be applied as is or transferred as a correction to

- Diameter
- Roughness
- Single loss

Temperature correction

The temperature correction factor can be applied as is or transferred to the overall heat transfer coefficient.

Output of calibration

The calibration correction factor is always included in simulations. During simulation the correction factor is transferred as a pipe parameter and accordingly adjusted to the initial value of 1.0.

The output of a calibration is thus a correction factor that is stored as an attribute for all pipes.

You can apply this attribute to create a calibration factor theme.

How To: Perform Calibration

To perform a calibration you must go through the following main steps. Each of these steps is described in-depth in the ensuing sections. Calibration can only be done for node objects on the Scenario layer.

There must be an overlap in the time period between the measurements and the simulation results.

A. Create pressure or temperature measurement attributes for supply and return nodes respectively.

B. Point to and select the database that contains the relevant measurement entries; alternatively you can manually create new measurements.

C. Assign the measurements to nodes.

D. Calibration setup.

E. Calibrate.

F. View results.

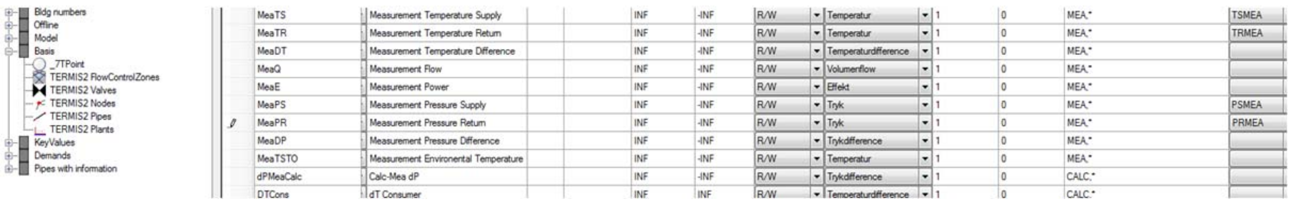
G. Convert factor to property.

A. Create pressure or temperature measurement attributes

Ensure that you have the following attributes else you must manually create the measurement attributes under node objects.

- Pressure measurement, supply (code PSMEA)
- Pressure measurement, return (code PRMEA)
- Temperature measurement, supply (code TSMEA)
- Temperature measurement, return (code TRMEA)

Follow the guidelines in the ensuing table to create the attributes.



Name	Group	Type	Object Type	Phys Type	Additional	Code
You can provide any name for the attribute, as long as you select the correct code.	Measurements	Local	Double	Pressure Temperature	**MEA,*** This allows you to add a measurement to the object.	PSMEA PRMEA TSMEA TRMEA

B. Select database with measurements

If you have a Data Manager database with relevant measurements, you can point to these entries. Or, you can manually create measurement entries. The example in this topic applies manual entries.

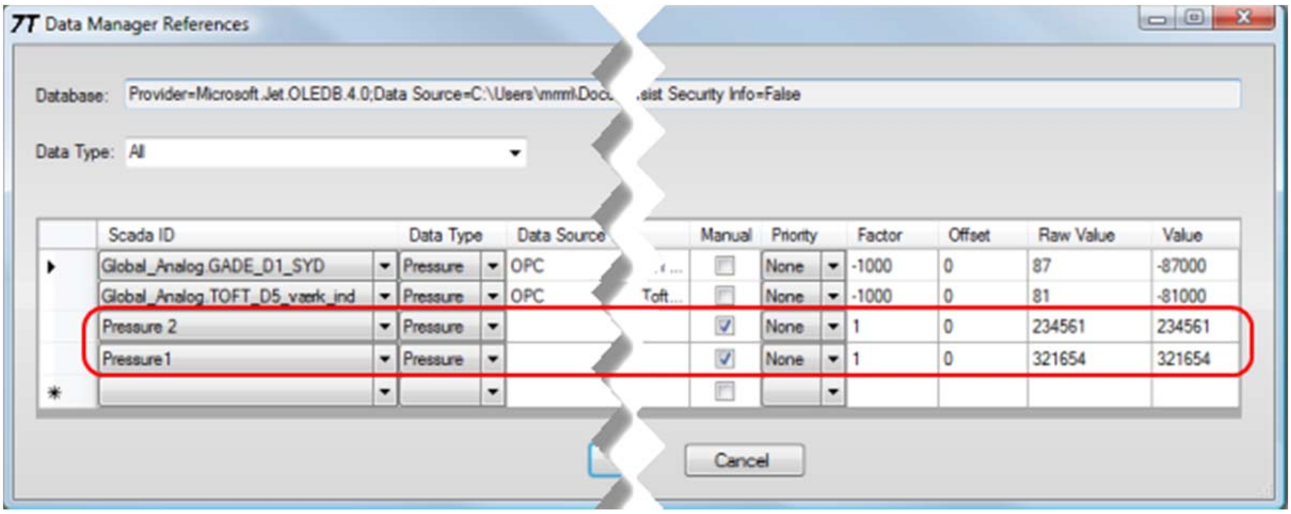
Optional: Create a time series

To present the calibration result, you can create a time series for the measurement under the Data Manager References dialog.

1. Under Data Manager References right-click the column Value (placed to the very right in the dialog).

2. Select Add Time Series and under the Time Series dialog create the appropriate time series. Save your changes.

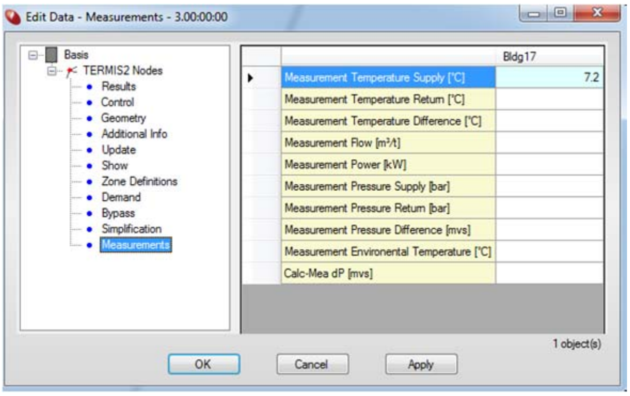
Sample setup for manual entries, showing the column Value as a time series.



C. Assign measurements to nodes

1. Right-click the main model area to open the generic editor, select Edit All, and expand the Nodes objects. (Alternatively, you can locate each of the two nodes and assign the measurements.)

2. Locate the group for the attributes, Measurements, and identify the two nodes to which you want to assign measurements:



3. For the first node right-click the attribute for either pressure or temperature (in this example pressure measurement on supply side) and select Add Measurement.
4. Under the Select Data ManagerMeasurement highlight the entire row with the measurement and then OK.
5. For the second node, repeat steps 3 and 4 to complete the measurement assignment.

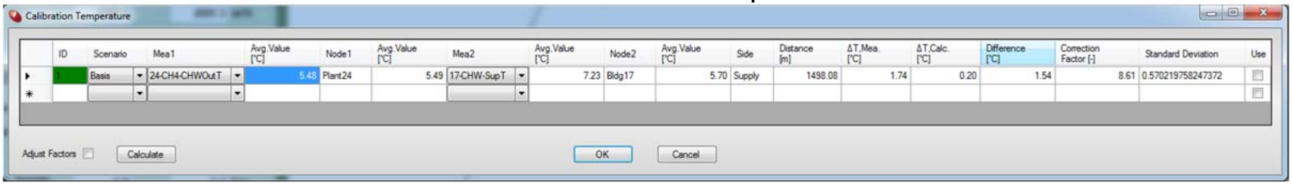
D. Calibration set up

See the Reading Guide for details. Click the link or scroll to the bottom of the topic to locate the guide.

1. From the menu bar select Tools, then Calibration, and point to Pressure. Alternatively, you can calibrate over Temperature. This example, however, focuses on pressure only.

2. Under the Calibration dialog do the following

- Enter a unique ID for the path.
- Select a Scenario layer.
- Under MEA1 select one of the appropriate measurement. In this example the manual database entry Temperature 1.
- Under MEA2 select the second measurement. Here Temperature 2.



3. When you have completed step 2, place the cursor in one of the other cells and watch the display of simulated and measured values in the row.

   The figure in the ensuing illustrates how the values are presented under the Calibration dialog. For an illustration of how the values are presented under the Calibration dialog see the Reading Guide.

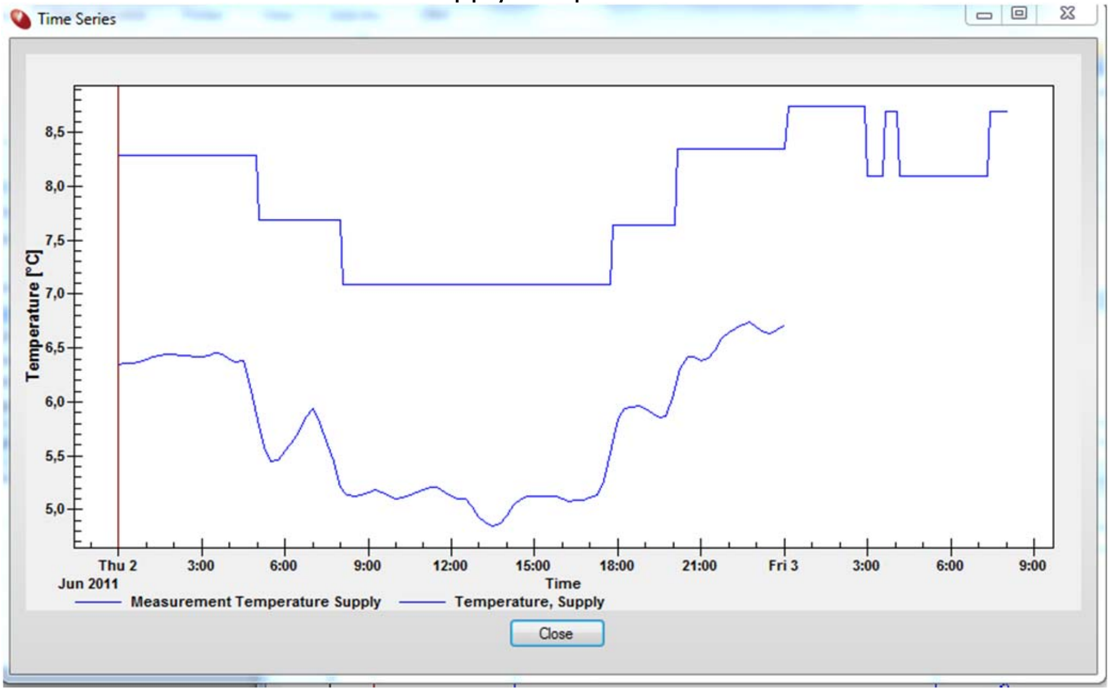
E. Calibrate

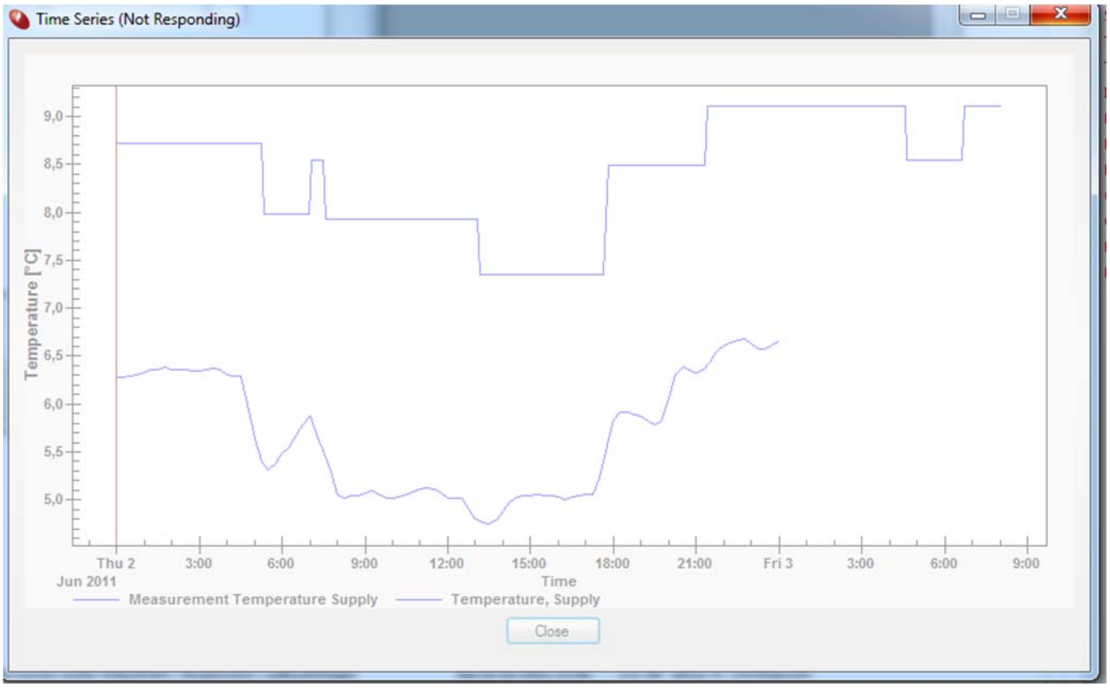
When you have defined all the required paths you can select one or several of these to be included in the calibration process. Select the check box for Use in the right-most column to add a path to the process.

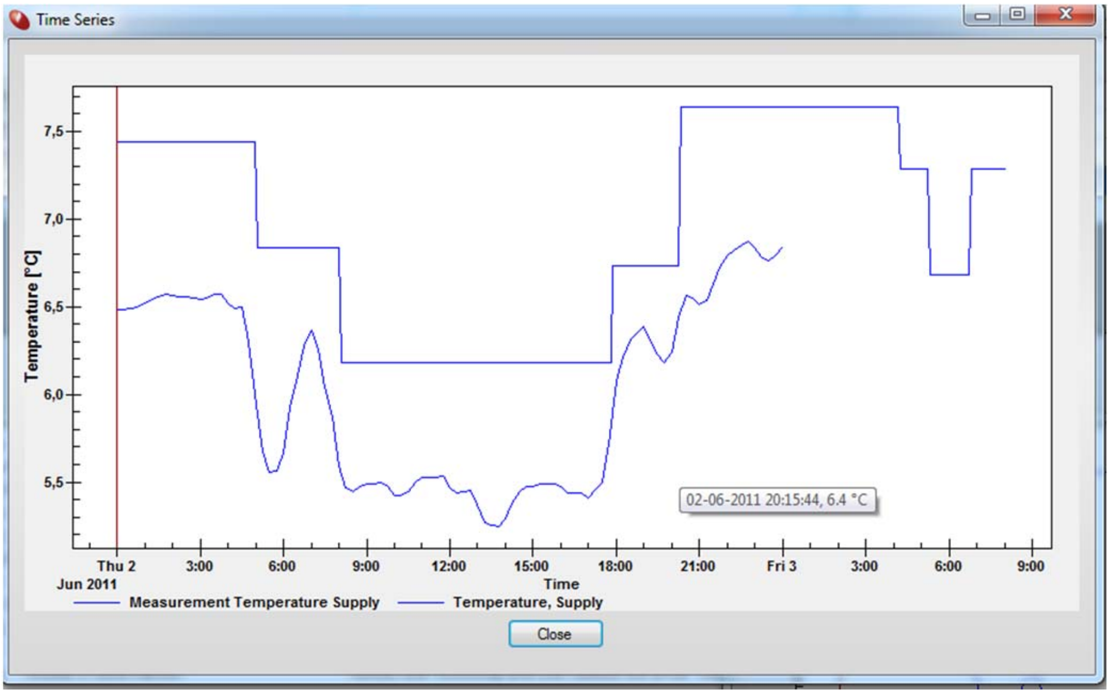
- Optional: If the result of a calibration - and subsequent simulation - is still not satisfactory, select the check box for Adjust Factors and then press Calculate. For details see the Reading Guide.

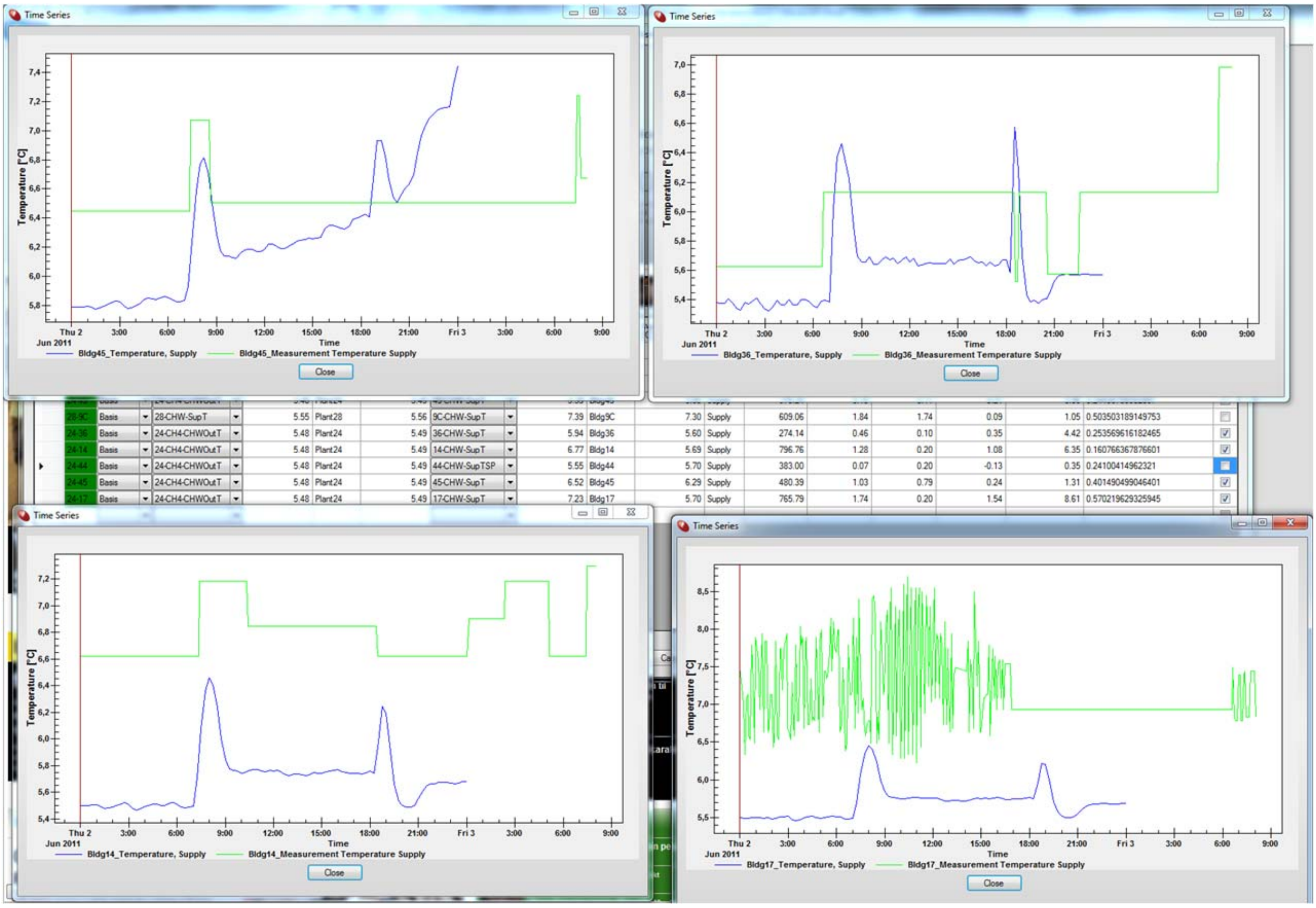
F. View results of calibration

Before the calibration the time supply temperature timeseries looks like this:






Time Series
7,5
7,0
6,5
6,0
5,5
Temperature [°C]
02-06-2011 20:15:44, 6.4 °C
Thu 2
Jun 2011
3:00
6:00
9:00
12:00
15:00
18:00
21:00
Fri 3
3:00
6:00
9:00
Time
Measurement Temperature Supply
Temperature, Supply
Close


Time Series
Temperature [°C]
Time
Bldg45_Temperature, Supply
Bldg45_Measurement Temperature Supply
Bldg36_Temperature, Supply
Bldg36_Measurement Temperature Supply
Bldg14_Temperature, Supply
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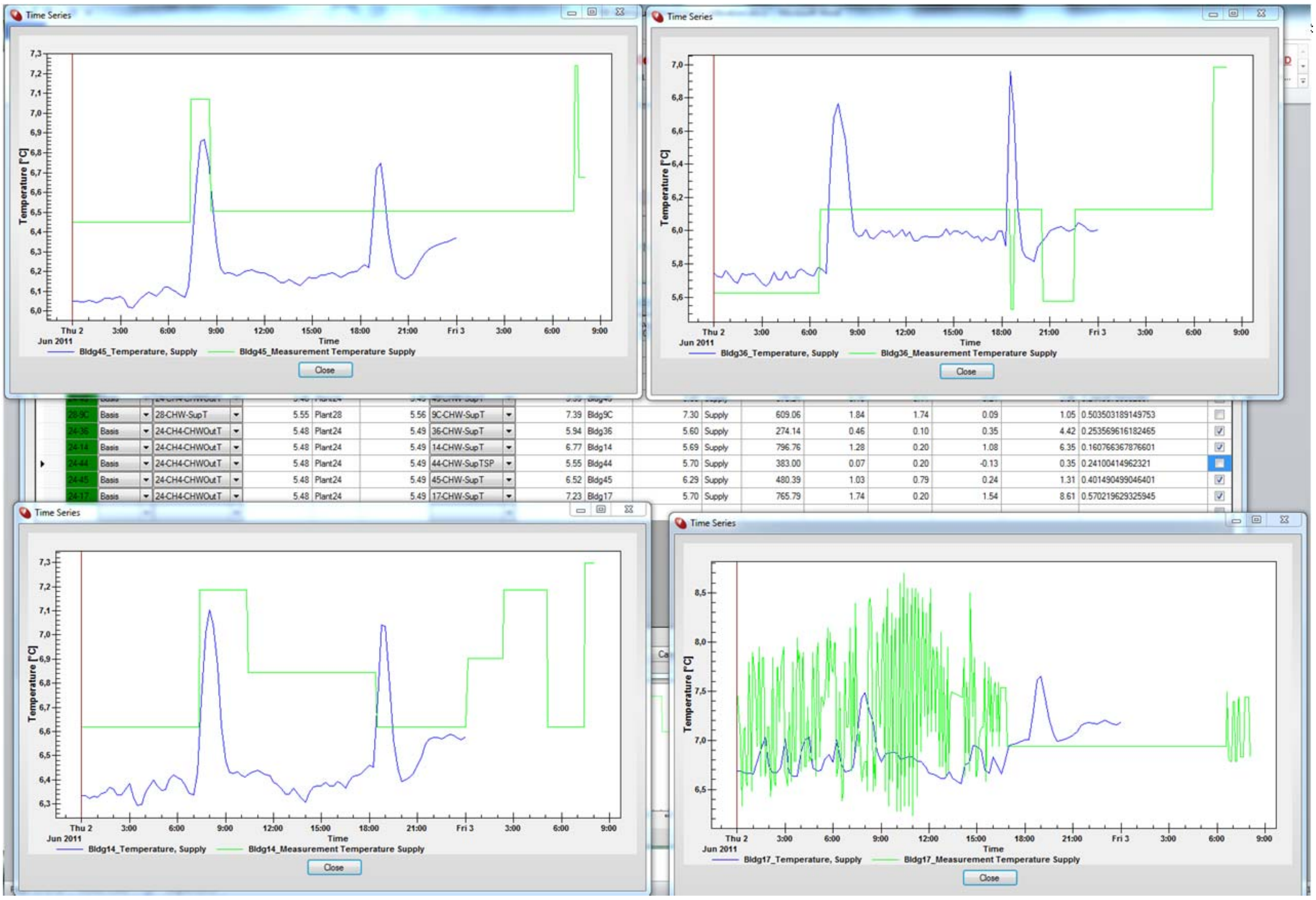
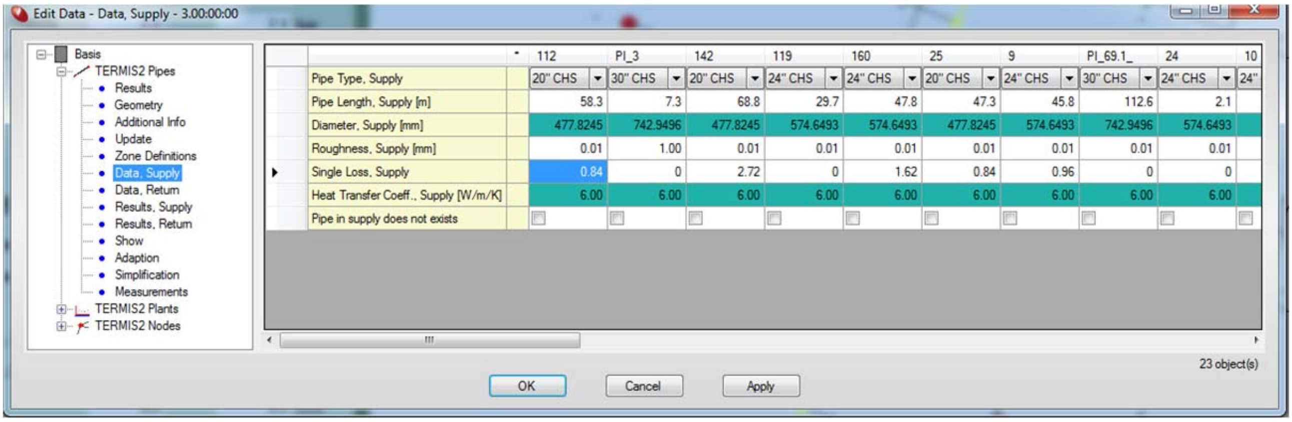
Bldg17_Measurement Temperature Supply
Close



G. Convert factor to properties

For the pipes involved you can change the factors to the attribute values. Depending on the calibration type the properties listed in the ensuing.

- Diameter
- Roughness
- Single loss
- Heat Transfer Coefficient



To display the values you must first create the attributes under the Layer Data Configuration dialog. You can for example create a specific Calibration group to display the values.

Subsequently, you can convert the factors to property values.

1. Highlight one of the calibration definitions (path), right-click and select Convert Factor to Property.

2. From the list of properties select the one that applies to your scenario.

Additional actions under calibration dialog

Show path

- Right-click the row under the Calibration dialog and select Show Path.

- Subsequently, you can read the results under the pipe objects. Right-click the main model area, select Edit Selection and point to the group Calibration.

Add path to list

- Right-click the row one more time and select Save Path to List.

The path displays with all the paths you have defined for your model. To access the list, right-click the main model area and select Path, then Display.

View in profile

Right-click the row under the Calibration dialog and select View in Profile. Notice that the window is minimized to display all the available paths. You need to maximize the window for correct display.

Edit node

You can edit the nodes directly from the Calibration dialog.

- Right-click the node and select Edit Node.

This opens the generic editor from where you can also edit the measurements

It is important to ensure that there is a consistent overlap in the period for the measurement and the simulation period as the average values are calculated based on these periods.

If the overlapping period exceeds one time entry, the average fields constitute a time series.

Results under Calibration dialog

#	Column	Description
1	ID	Input required. This is the unique name for the path that you have defined. When you right-click the main model area to view the list of paths in the entire model, you will also see this particular path name. *Color coding*

#	Column	Description
		Green cell — Calibration definition correct. Red cell — Incorrect calibration definition. Input required.
2	Scenario	You can only perform calibration on the Scenario layer. Select the scenario that contains the simulation result that you want to use for the calibration of the defined path. Input required.
3	Mea1	Select the measurement for the upstream end node in the new path. The measurement for Mea 1 must be associated with the node name under the column Node 1.
4	Avg. Value	Average value for Mea1 for the overlap period.
5	Node 1	The node that contains the value for Mea1
6	Avg. Value	Average value for Node 1 of the simulated pressure or temperature that corresponds to Mea 1 for the overlap period. Input required.
7	Mea2	Select the measurement for the downstream end node in the new path. The measurement for Mea 2 must be associated with the node name under the column Node 2.
8	Avg. Value	Average value for Mea2 for the overlap period.
9	Node 2	The node that contains the value for Mea2.
10	Avg. Value	Average value for Node 2 of the simulated pressure or temperature that corresponds to Mea 2 for the overlap period.

#	Column	Description	
11	Distance	This value indicates the physical distance between the two nodes in the calibration process. The value indicates the calculated distance of the path. The path distance is the shortest stretch between Node 1 to Node 2.	
12	ΔHead, Mea	The difference between Mea 1, Avg.Value and Mea 2, Avg.Value; corrected for changes in elevation (pressure only). The difference between Node 1, Avg.Value and Node 2, Avg.Value; corrected for changes in elevation (pressure only).	
		Color coding	
13	ΔHead, Calc	White cell	Calibration is recommended. Values: >5000 Pa
		Yellow cell	Calibration is not optimal. Consider your model configuration and validity of measurements. Values: >1000 Pa <5000 Pa
		Red cell	Pressure loss is insignificant and cannot form basis for a calibration.
14	Difference	The difference between ΔHead, Mea and ΔHead, Calc. ΔHead, Mea divided by ΔHead, Calc.	
15	Correction Factor	When calculated the correction factors show the minimum standard deviation discrepancy between measured and simulated values over a certain time interval.	

#	Column	Description	
		Color coding	
		White cell	Calibration is recommended. Values: [0.1;10].
		Yellow cell	Calibration is not optimal. Consider your model configuration and validity of measurements. Values: <0.1 or >10
		Red cell	Pressure loss is minimal and calculation is not a viable solution. Values: <0 or >100
16	Standard Deviation	The standard deviation of the difference.	
17	Use	Select the check box for the path you want to include in the calibration process. If selected, the path is part of the overall calculation of individual pipe corrections.	
18	Adjust Factors	Due to the non-linear nature of the calibration process, it may be necessary to enhance the first calibration attempt. Consequently, when you have run a first calibration followed by a simulation and the result is still not acceptable, you can opt to select the Adjust Factors check box. When you run a calibration process allowing for an adjustment of	

#	Column	Description
		factors, the calculation will then adjust the pipe factors rather than running a calculation that generates new factors. However, consider the drawbacks such an action may have on subsequent processes.
19	Side	Select either the supply side or the return side.

Result(s) under generic object editor for pipe objects

Pressure drop correction	When you have performed a calibration to detect the pressure drop in your network, you can view the result for under the generic object editor. Right-click the main model area, point to the pipes object and locate the attribute Pressure drop correction. Typically, the attribute is placed under the Adaption folder.
Temperature drop correction	When you have performed a calibration to detect the heat loss in your network, you can view the result for under the generic object editor. Right-click the main model area, point to the pipes object and locate the attribute Temperature drop correction. Typically, the attribute is placed under the Adaption folder.