InBalance

Data Validation and Mass Balance
Module for Wonderware System Platform

User Guide
Ver 1.x Rev 1.4
PR 00160
PR 00161
PR 00162
PR 00163

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Contents

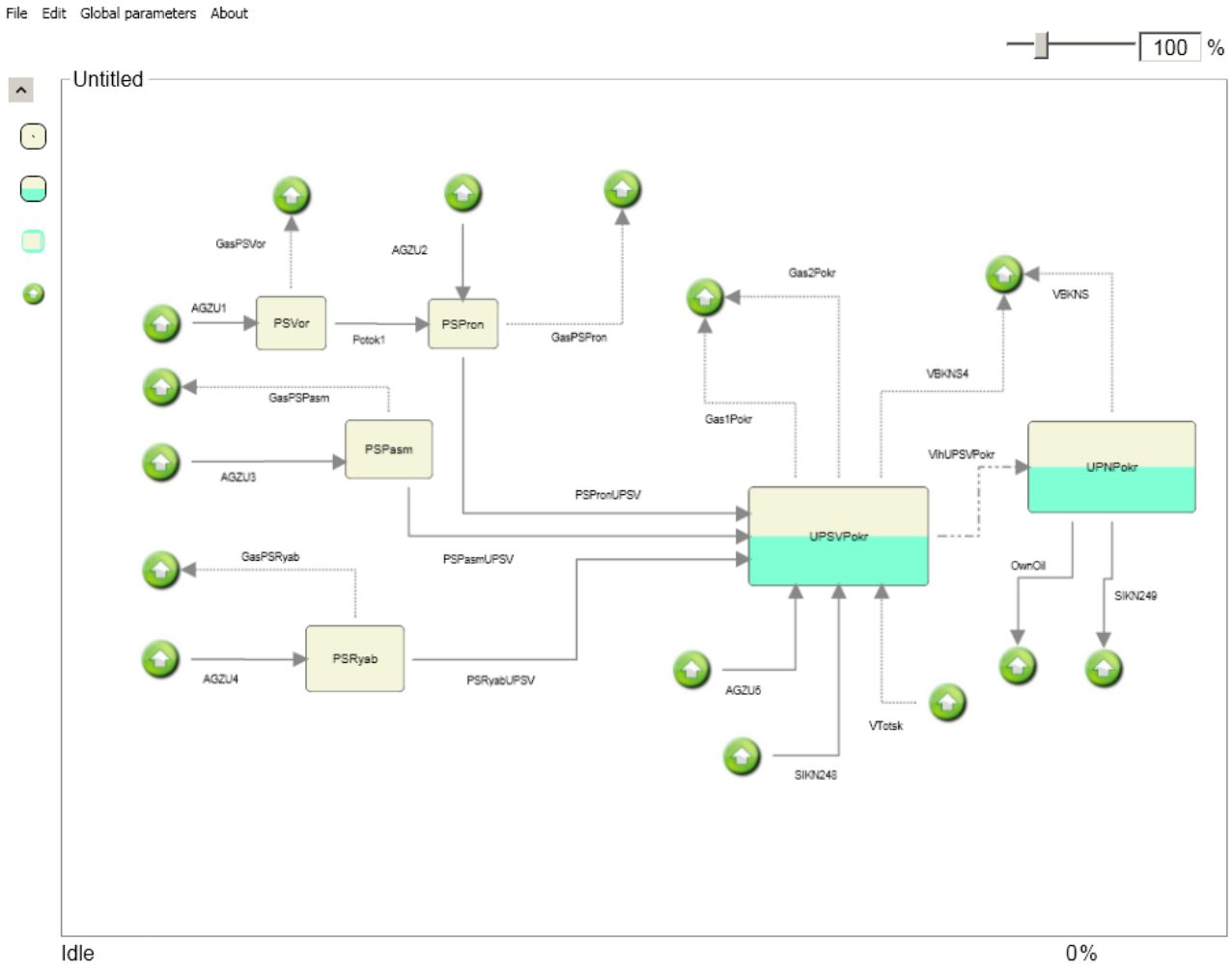
Overview

The **InBalance Module** (hereinafter InBalance) provides a solution for mass balance calculation, including data validation/reconciliation. The module is integrated in Wonderware System Platform, allowing an easy integration into existing and new projects.

The InBalance consists of two main submodules:

- **Model Editor**, implemented as an ArchestrA symbol (internally named IBEditor), inserted in InTouch application.
- **Calculator**, implemented as Wonderware Application Server object (internally named MBDataRecon).

The Model Editor is used to create a system model consisting of nodes, connected by streams. Typical nodes are technological facilities, tanks, apparatuses or their parts, connections or disjoins of pipes. Streams are process streams of material, characterized by flow rate.

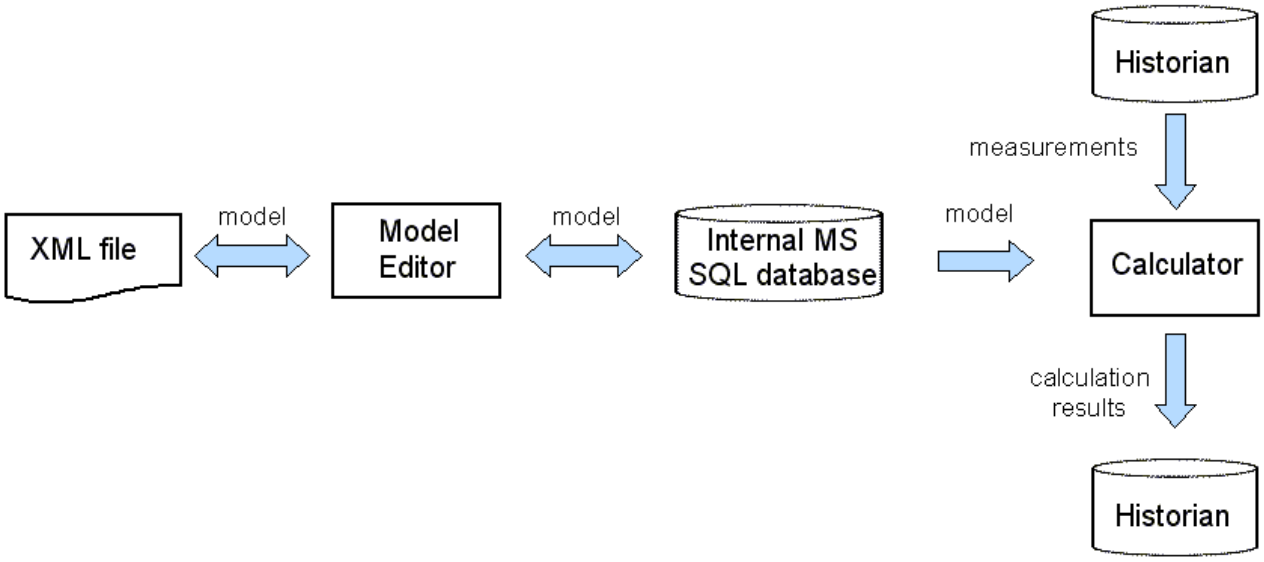


The data validation/reconciliation and mass balance calculation is performed by the Calculator. It includes:

- pre-processing and screening of input data, in order to remove evident errors and mistakes;
- automatic data classification and determination of solvability;
- data reconciliation, by using the least squares method to calculate reconciled values and their confidence intervals and to calculate the unmeasured values;
- checking of mass balance in order to find leakages, measurement errors or model errors (e.g. storages, not defined in the model).

The results of reconciliation, configuration data and runtime information are accessible as Calculator object attributes.

The data flow is following:



The system model, created with the Model Editor, is saved in the internal MS SQL database, used as internal interface between the Model Editor and the Calculator. The model can be also exported/imported to/from XML file.

The Wonderware Historian is used as a source of measured data – for each stream and storage (accumulation) node there is a “Historian tagname used to store measured data for this stream” attribute available.

The Wonderware Historian is used to store validated/reconciled and balanced results for further reporting and data export.

InBalance offers several advantages if compared with traditional dedicated systems:

- Reliable and well proven solution - the concept is based on the world leading Wonderware automation software.
- Easy to implement - you can use your Wonderware skills and application libraries to develop the main application.

- Wide application scope, easy integration – you can integrate pipeline/flow management and leakage detection to Wonderware visualization, reporting and MES concepts. The system is scalable from single workstation applications to wide distributed systems, and it interfaces with all major automation field buses and controllers.
- Low investment cost – you need just one add-on module to the standard Wonderware platform.
- Easy maintenance and upgrades – you can keep the main part of the system under Wonderware standard customer care contracts.

Installation

Hardware requirements

The InBalance has the same hardware requirements as Wonderware Application Server. It is strongly recommended to have computer with 2 gigahertz (GHz) or faster processor, 32/64-bit. A multi-core processor is also strongly recommended. The Intel Itanium 2 processor is not supported.

Software requirements

The following software should be installed prior to InBalance installation:

- Wonderware Application Server 3.1 SP1 or later
- Wonderware InTouch 10.1 or later
- Wonderware Historian (InSQL) 9.0 or later
- Wonderware ActiveFactory 9.2 or later
- MS Office 2003 or later

Licensing requirements

The InBalance requires either a **software key** or a **demo license**. As well it can be licensed under **License Server** in case InBalance is delivered as a part of Wonderware Finland **Automation Intelligence Suite** package.

The **demo license** is for free and provides an unlimited functionality, but is valid only for a limited time period. After demo license expiration the mass balance calculation request will be rejected (it still will be possible to use the Model Editor). The demo license can be obtained by sending inquiry to info@wonderware.fi.

The **software key** should be purchased and it is available for 4 product levels (xxx is the current version of InBalance release, e.g. 103):

- Product ID: PR00161 xxx (maximum 10 streams);
- Product ID: PR00162 xxx (maximum 50 streams);
- Product ID: PR00163 xxx (maximum 100 streams);
- Product ID: PR00164 xxx (unlimited number of streams).

Models with maximum 3 streams do not require licensing.

See *Configuring Calculator* section for details how to get and enable software key or demo license or how to enable the licensing under License Server.

Files

The InBalance is delivered as an archive file (.zip) and contains the following files:

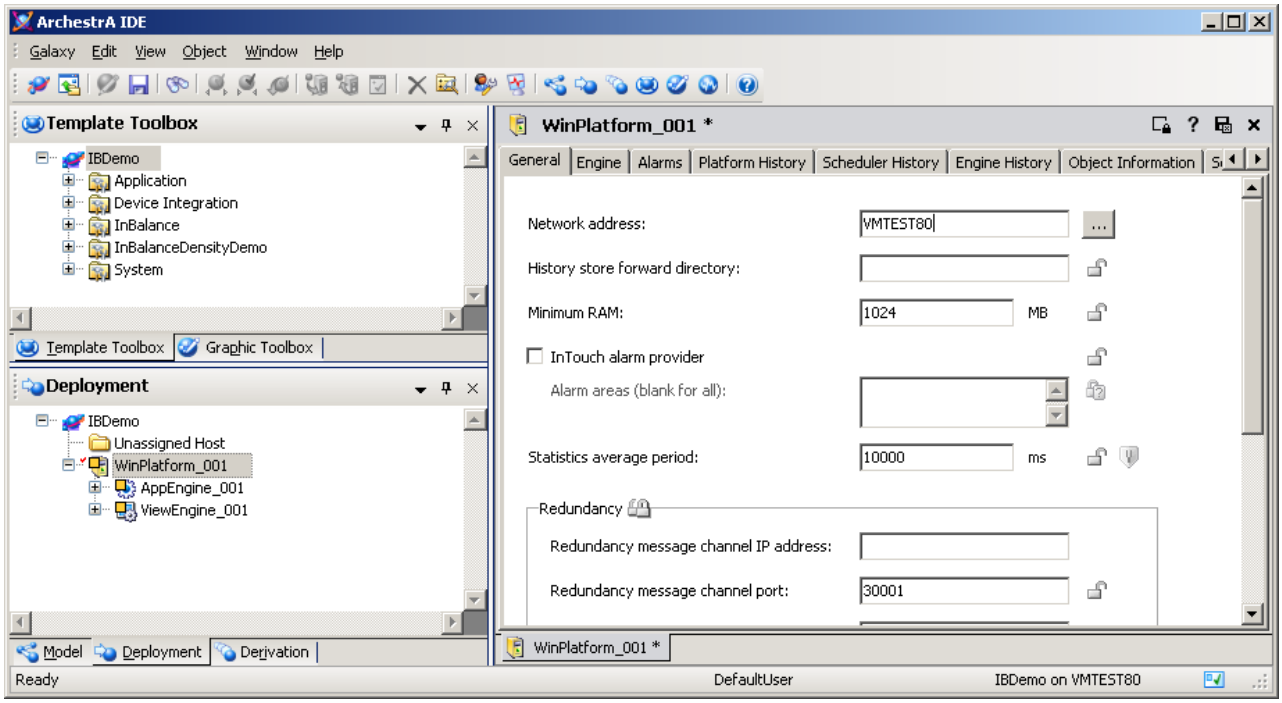
- PR0016xm14.pdf – User Guide (this document);
- PR0016xSG10.pdf – Security Guide;
- IBObjects.aaPKG – contains InBalance objects;
- IBManual.xml – demo model, using manually entered data;
- IBHist.xml – demo model, using simulated data from Historian database;
- IBDensity.xml – demo model for gas pipeline leak location detection;
- IBReport.xls – simple mass balance demo report;
- IBHistorianData.zip – contains simulated Historian data for IBHist.xml demo model.

Installation steps

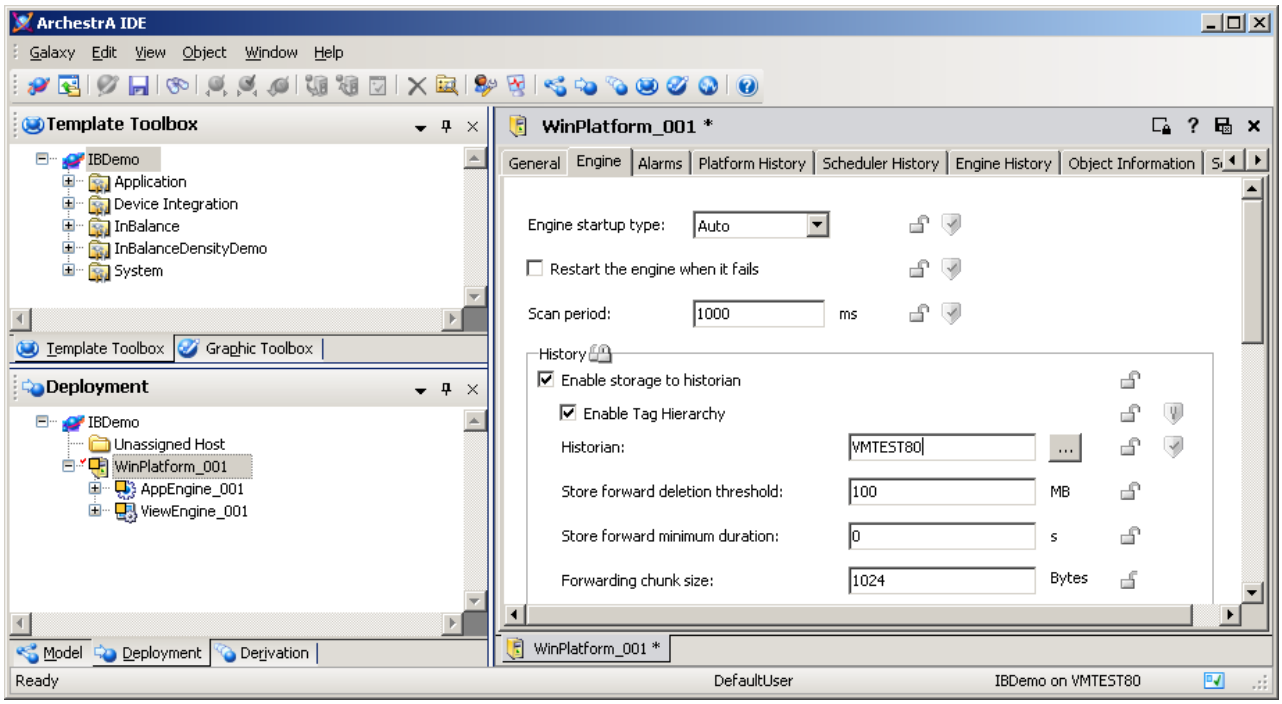
1. Unpack the archive file to e.g. C:/InBalance folder.

2. Start the ArchestrA IDE and import the IBObjects.aaPKG file to a new/existing galaxy. In the following explanation we will assume that a new galaxy IBDemo is used.

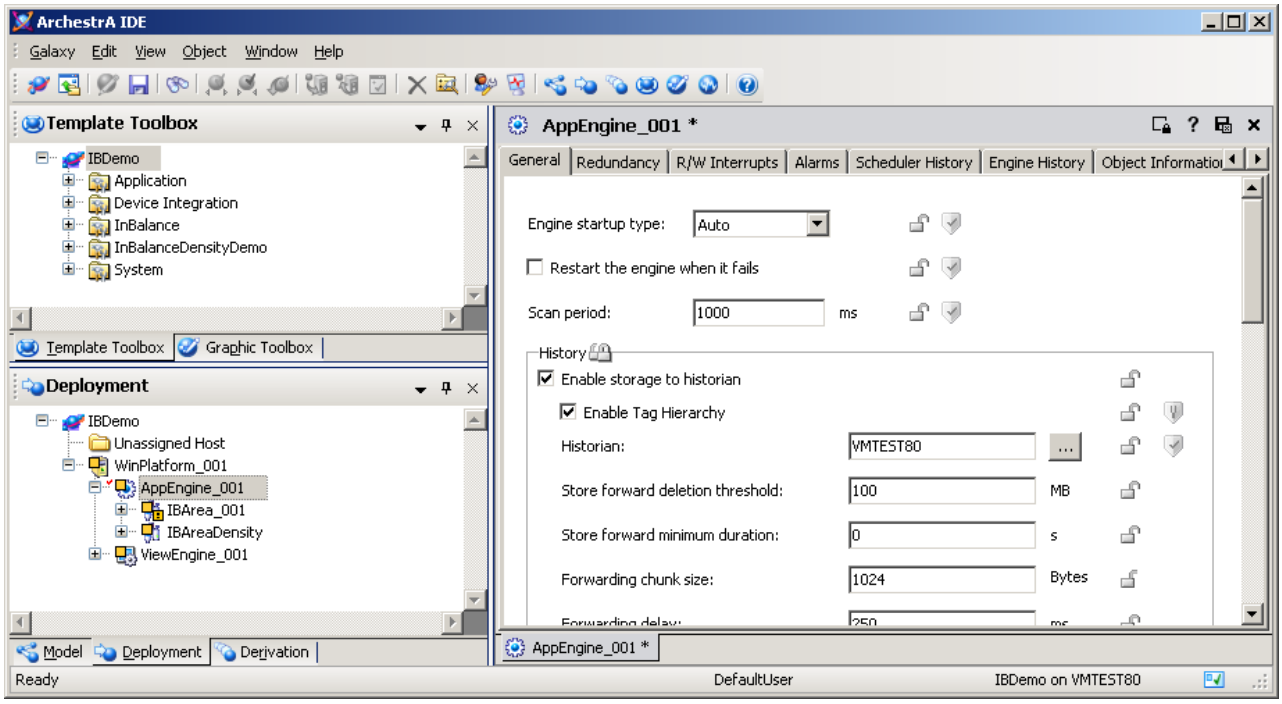
3. Configure WinPlatform_001 object – set Network address field to your PC hostname or IP Address:



4. Configure Historian field for WinPlatform_001 and AppEngine_001 if you will use second model (IBHist.xml) that uses Historian data:

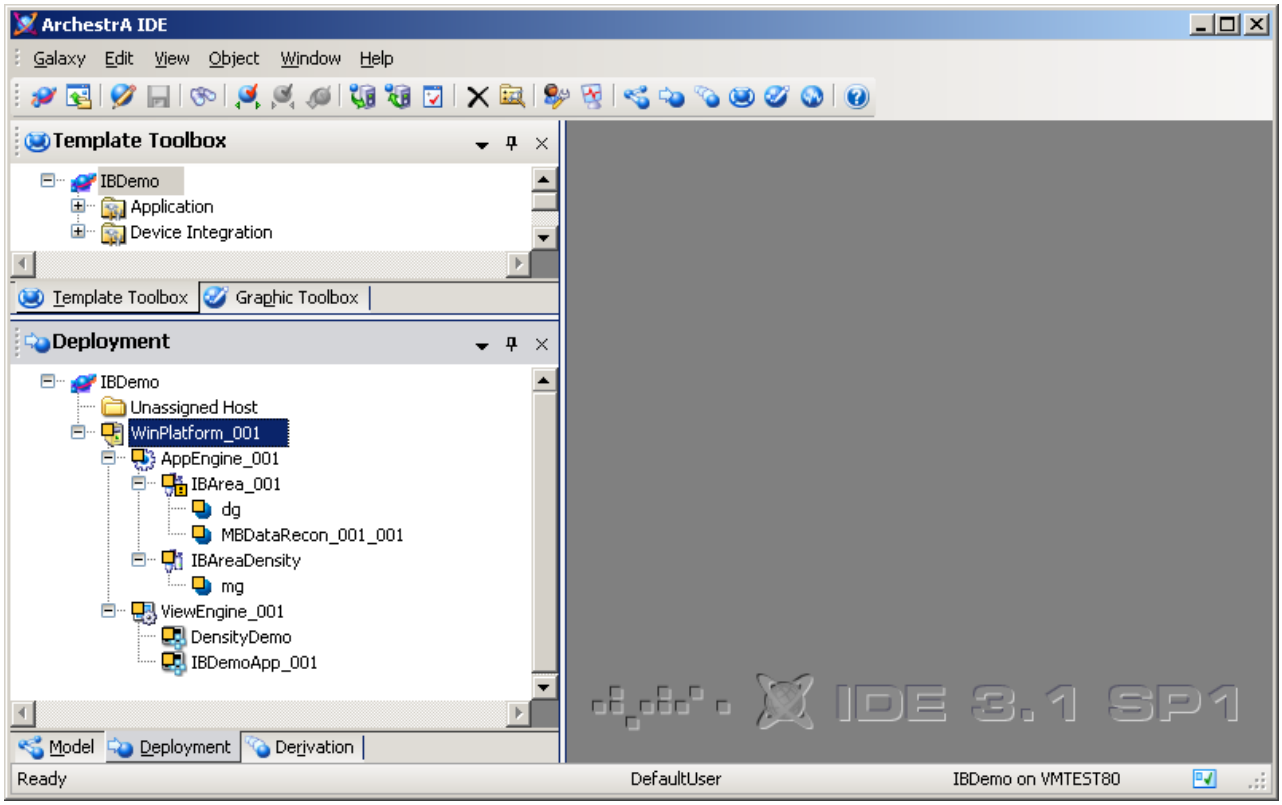


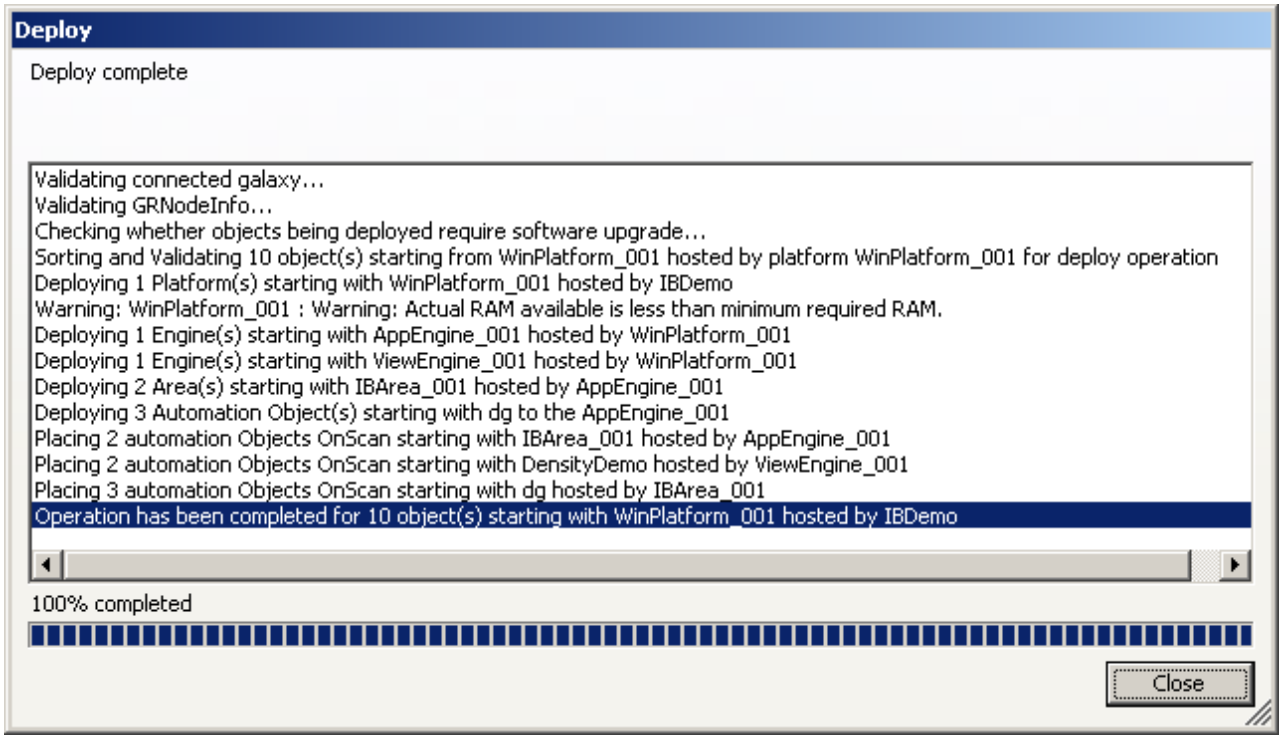
Save the configuration by clicking on the icon , located at the top right corner of the configuration editor.



Save the configuration by clicking on the icon , located at the top right corner of the configuration editor.

5. Deploy all InBalance objects – right-click and deploy WinPlatform_001:





The following steps are required only if you intend to work with the demo model IBHist.xml. Proceed with step 10, if this demo model will not be used.

6. Backup your InSQL data (default location is C:/InSQL/Data/Circular folder), if required.

7. Delete the contents of the C:/InSQL/Data/Circular folder.

8. Extract InBalance simulated InSQL data from IBHistorianData.zip archive (included in InBalance installation package) to your InSQL data folder (default location is C:/InSQL/Data/Circular).

9. Start the Historian server if it is not started already.

10. In order to work with the demo report by clicking the “Report” button in the InTouch application, copy the IBReport.xls file to the following folder:

    C:\Documents and Settings**[logged user name]**\Application Data\Microsoft\Excel\XLSTART\

    For example:
    C:\Documents and Settings**gr**\Application Data\Microsoft\Excel\XLSTART\

Adjusting demo project for your own model

After importing the IBObjects.aaPKG file, the galaxy contains objects adapted for work with the demo models. These model-specific features should be disabled or adapted for working with **your own model**. Below is a description of these features:

1) After importing the IBObjects.aaPKG file, the galaxy contains template $IBArea, derived from the base template $Area and supplemented with scripts for demo models. The instance IBArea_001 is derived from this $IBArea template and should be used when performing the calculation for demo models. Delete or modify the scripts in the $IBArea template (or, alternatively, derive a new template from base template $Area, which will not contain any scripts) before performing calculation for your own model.

2) After importing the IBObjects.aaPKG file, the galaxy contains template $DataGenerator, derived from the base template $UserDefined and supplemented with data generation scripts. The instance “dg” is derived from this $DataGenerator template and generates data for demo model IBHist.xml. Delete or modify the template $DataGenerator and instance “dg”, before performing calculation for your own model.

3) After importing the IBObjects.aaPKG file, the galaxy contains InTouch application template $InBalance, derived from the base template $InTouchViewApp. $InBalance uses ArchestrA symbols TotalMassAllTimePeriod1 and RecDataAllTimePeriod . These symbols are used to display the calculation results for demo models IBManual.xml and IBHist.xml, and should be edited before using them for your own model.

4) IBReport.xls file is used to display the report for demo models IBManual.xml and IBHist.xml, and should be edited before using it for your own model.

5) After importing the IBObjects.aaPKG file, the galaxy contains template $GasManualHistory, supplemented with UDAs. The instance “mg” is derived from this $GasManualHistory template and generates data for demo model IBDensity.xml.

6) After importing the IBObjects.aaPKG file, the galaxy contains InTouch application template $TDensityDemo, derived from the base template $InTouchViewApp. The instance DensityDemo is derived from this $TDensityDemo template and demonstrates gas pipeline leak location detection feature, using demo model IBDensity.xml.

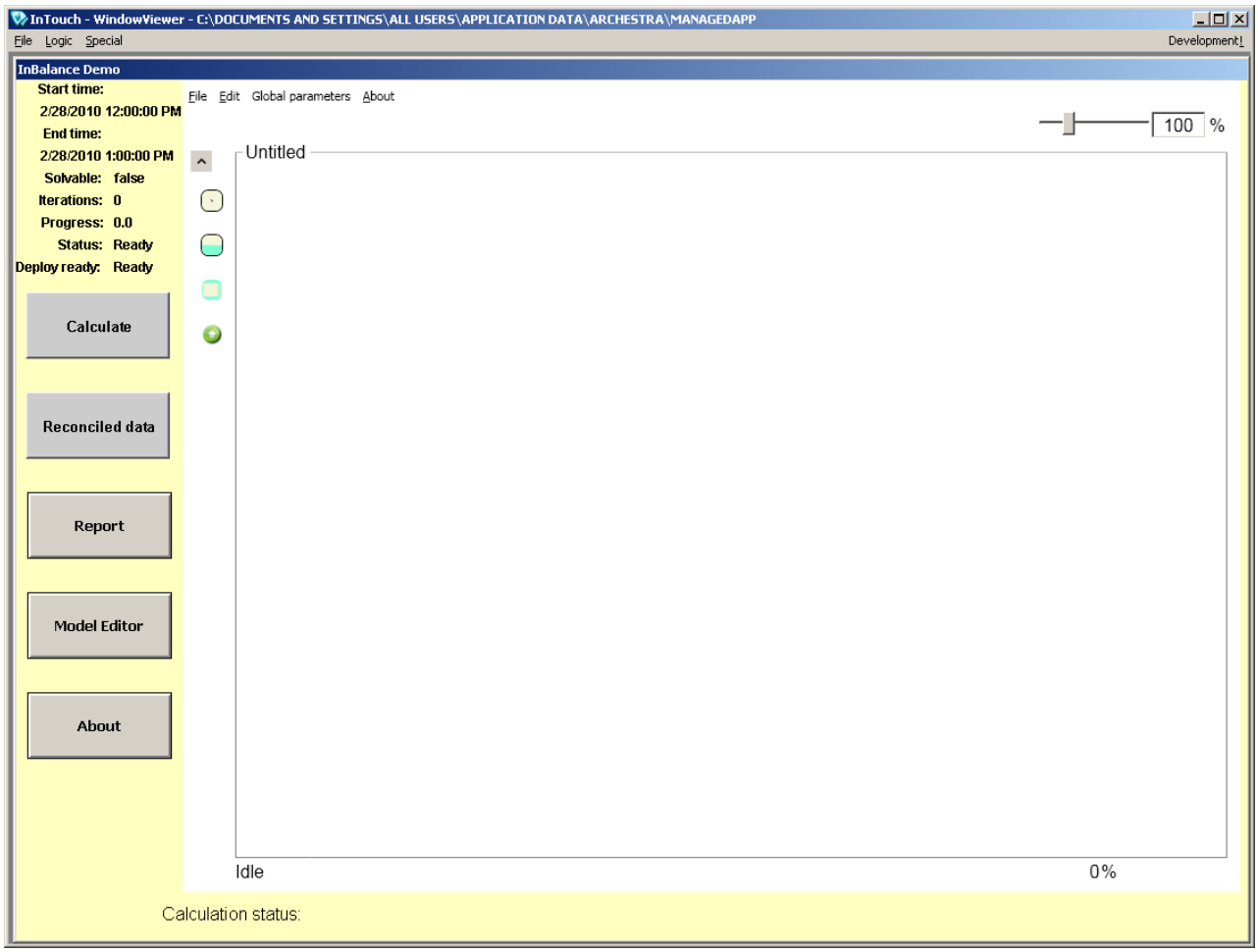
Getting started

After InBalance objects are installed and deployed, the InTouch application (instance IBDemoApp_001) and demo models IBManual.xml (using manually entered data) and IBHist.xml (using simulated data from Historian database) can be used to become familiar with the basic InBalance functionality. The InTouch application DensityDemo and model IBDensity.xml can be used to become familiar with the gas pipeline leak location detection feature of the InBalance.

Perform the following steps:

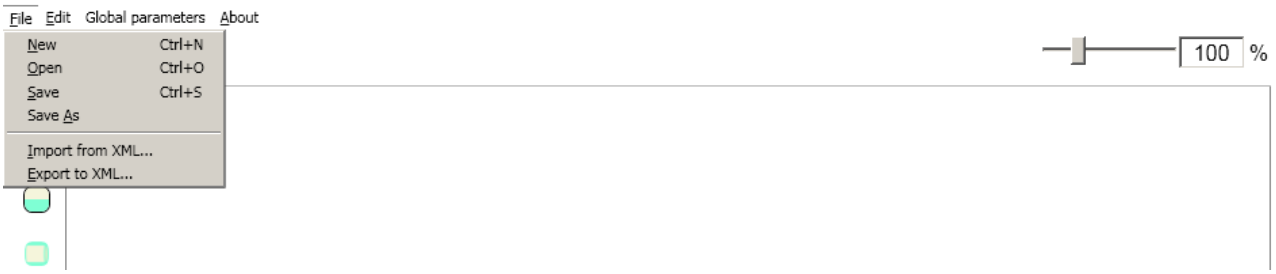
Importing model from XML file

1. Start the InTouch Application Manager, select $InBalance application and click on WindowViewer icon. The following window will be opened:

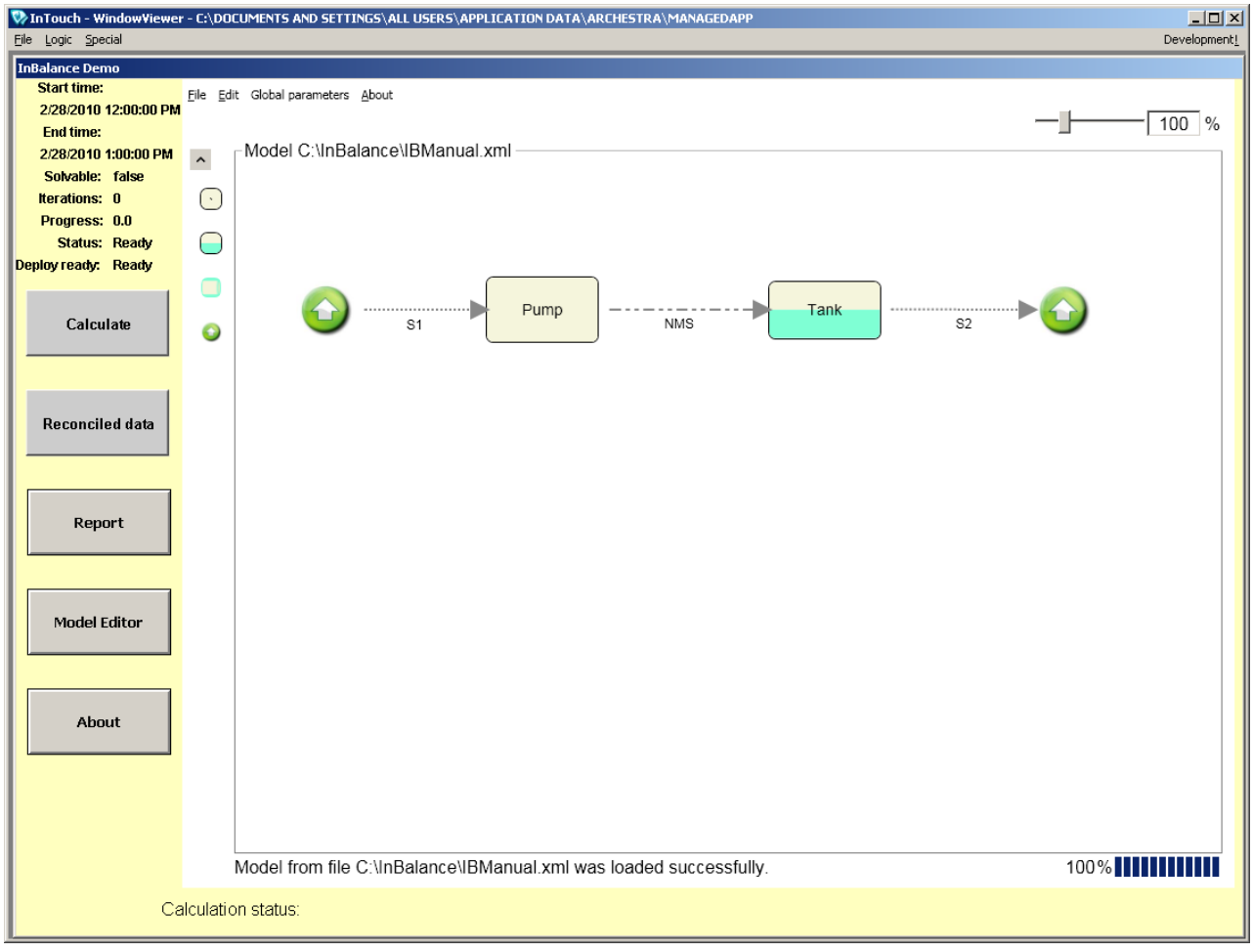


Note, that to be able to start the InTouch Managed application, computer needs to be connected to the network.

2. Select the menu command File ->Import from XML…

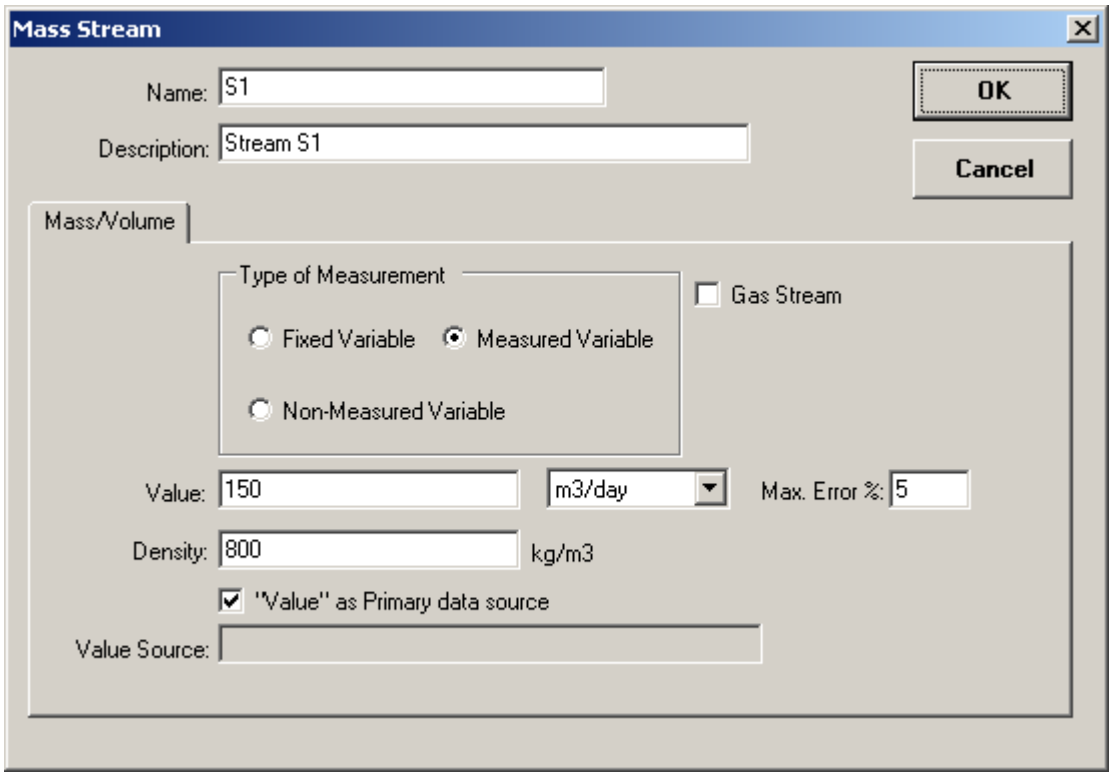


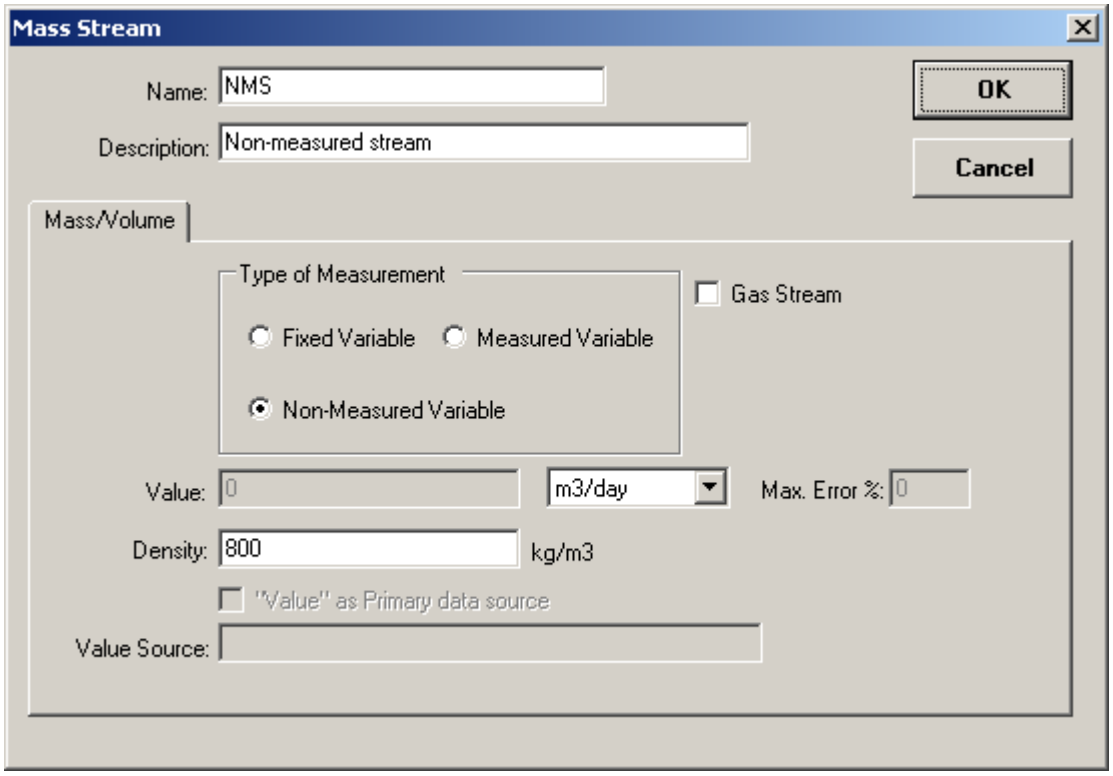
3. Browse for IBManual.xml file (demo model using manually entered data) and click the "Open" button. The IBManual.xml demo model will appear on Model Editor window:

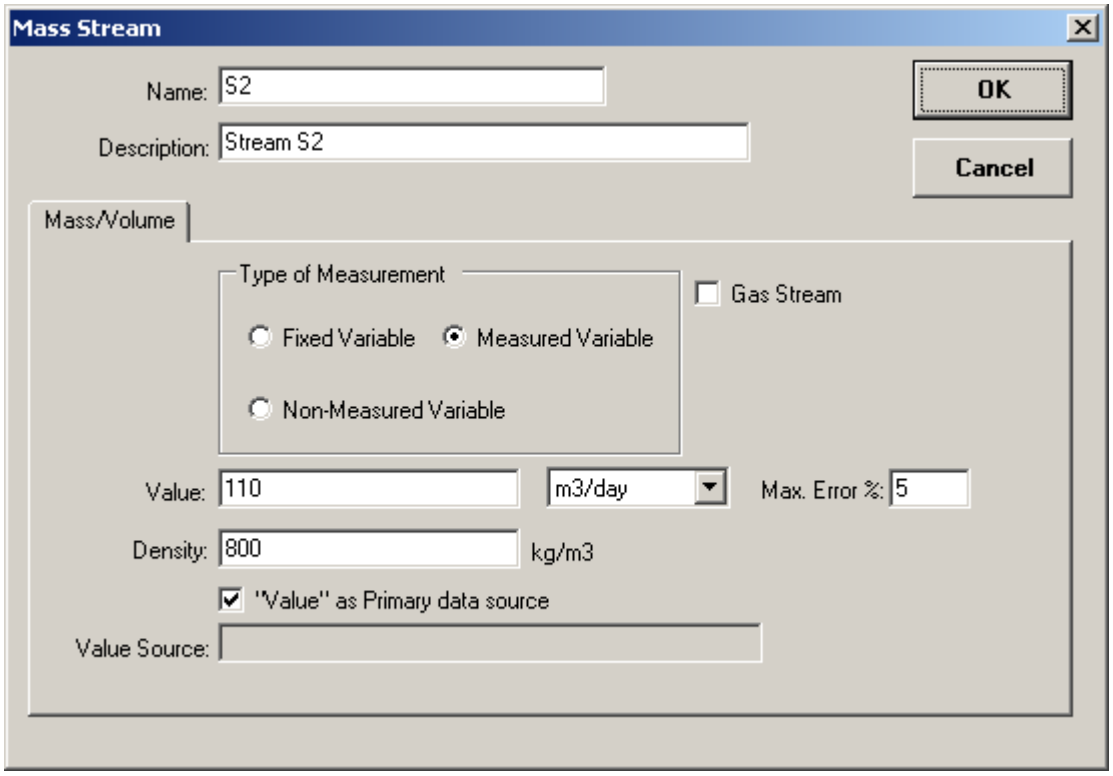


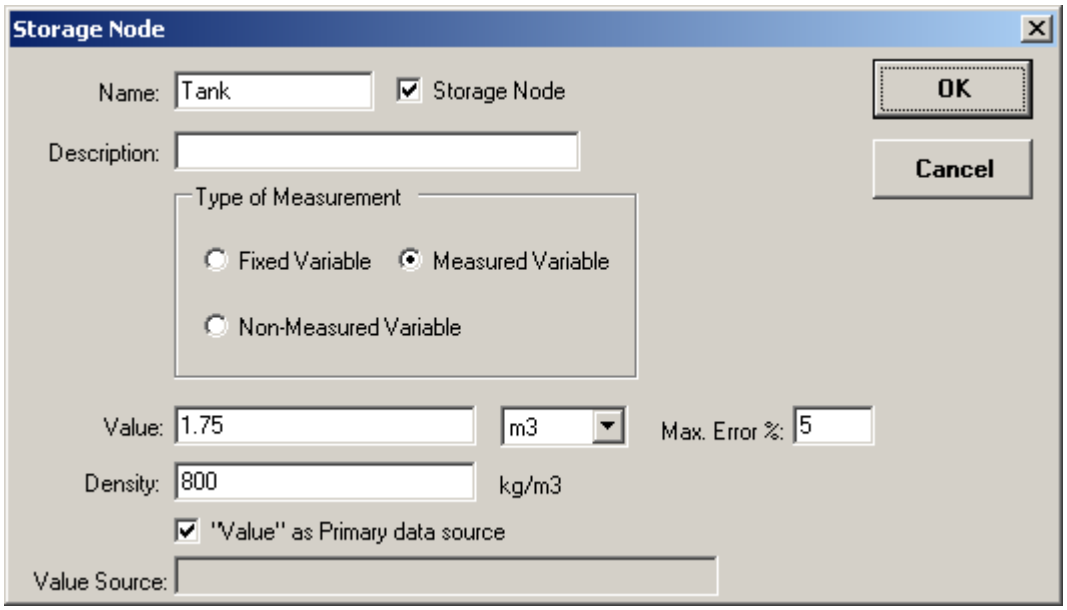
Configuring nodes and streams

4. Check the configuration of streams S1, NMS, S2 and storage node Tank by double-clicking on them:


Mass Stream
Name: S1
Description: Stream S1
OK
Cancel
Mass/Volume
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Gas Stream
Value: 150
m3/day
Max. Error %: 5
Density: 800
kg/m3
"Value" as Primary data source
Value Source:


Mass Stream
Name: NMS
Description: Non-measured stream
OK
Cancel
Mass/Volume
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Gas Stream
Value: 0
m3/day
Max. Error %: 0
Density: 800
kg/m3
"Value" as Primary data source
Value Source:



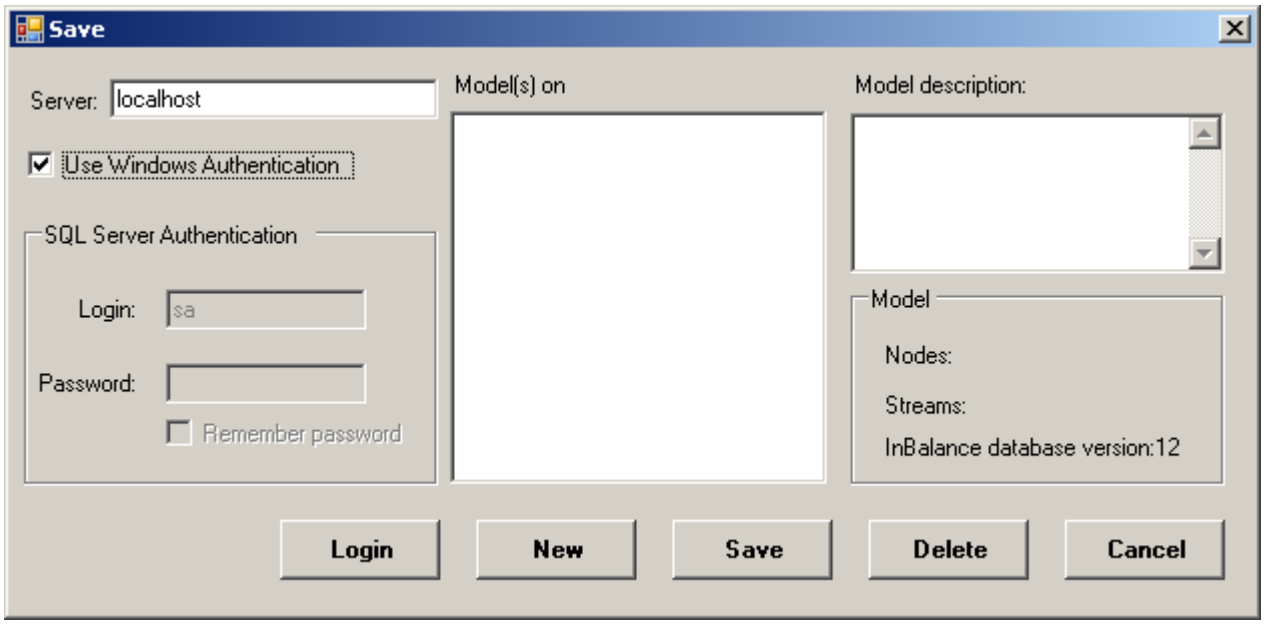


The streams **S1** and **S2** are measured streams, **NMS** is a non-measured stream and **Tank** is a storage node with measured accumulation. For S1, S2 and Tank the values are entered **manually** in "Value" field, what means: for streams it is constant flow rate during time interval used in calculation and for storage node it is accumulation difference during the time interval used in calculation (i.e.: end volume - start volume).

In this demo model all measured data (data in the "Value" field) are m^3/day (for streams) and m^3 (for storage node). Density is required for calculation; in this demo we set 800 kg/m^3 for oil streams and storage node.

Saving model to database

5. Create/save model configuration to internal MS SQL database – by invoking “Save Model” dialog (from Model Editor main menu -> File -> SaveAs...):



Here the following information related with model (stored in internal MS SQL database and used by InBalance) can be entered:

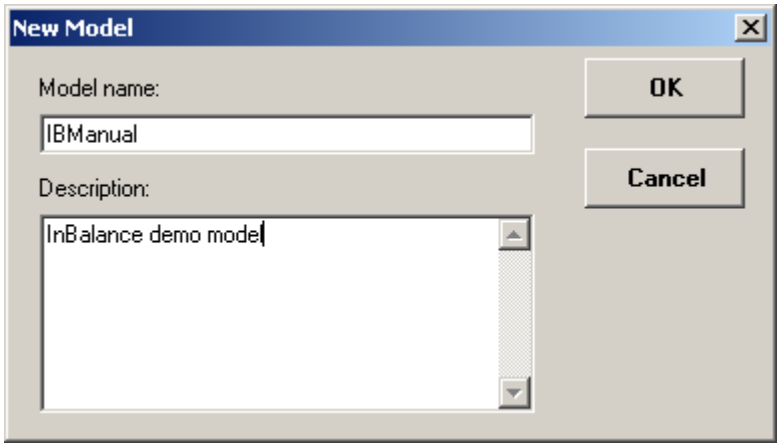
Server
Computer node name where internal MS SQL database is located.

Use Windows Authentication
If selected, then currently logged Windows User credentials will be used.

Login and Password
If SQL Server Authentication is used, then the Login and Password for accessing the internal MS SQL database should be entered.

Login
By pressing this button, currently available models will be displayed in “Model(s) on” listbox.

New
By pressing this button the “New Model” dialog will be invoked:



Here the **Model name** and **Description** can be entered.

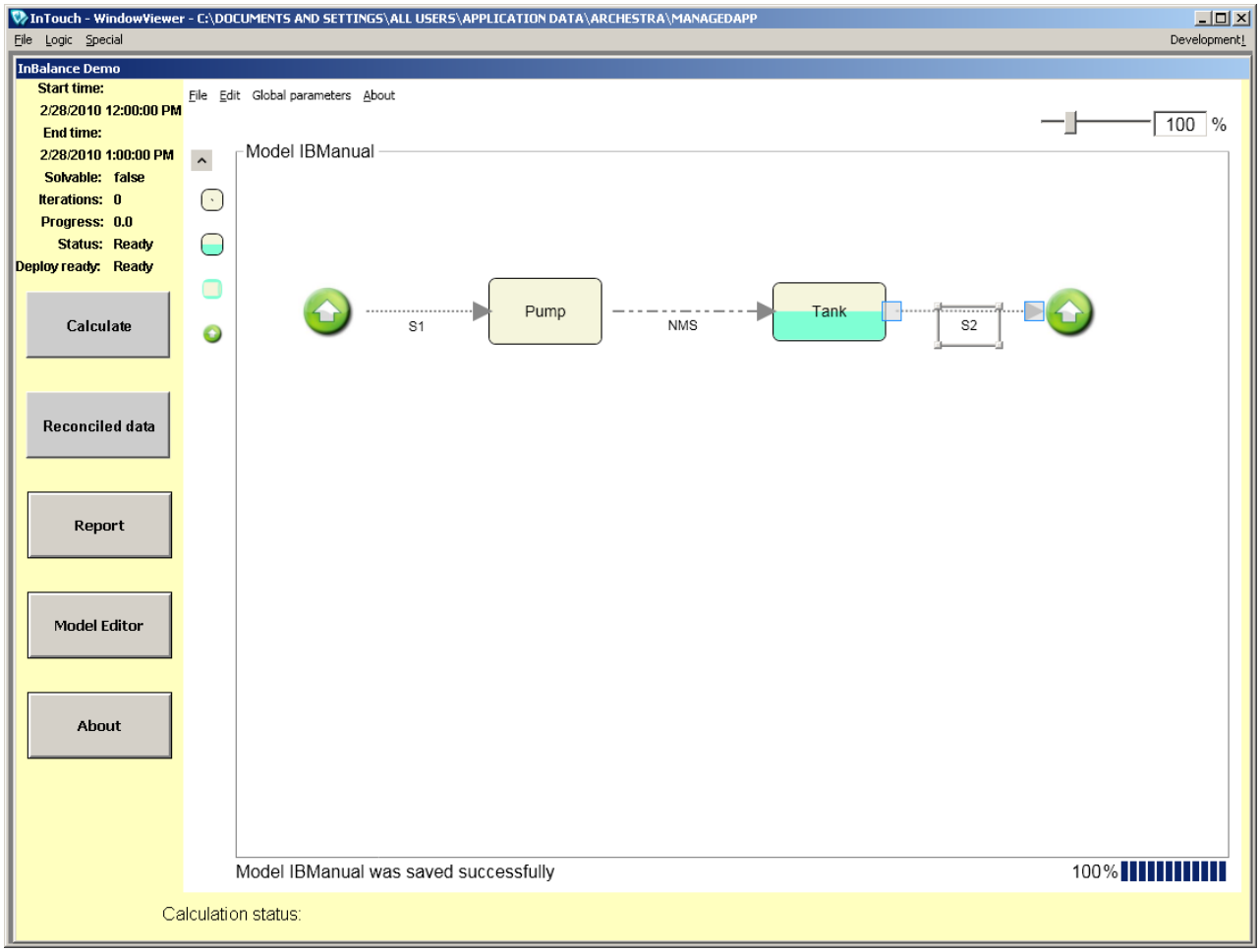
Save
Save the model selected from listbox.

Delete
Delete the model selected from listbox.

Cancel
Return without changes.

Note:
To create model database, you need to logon to MS SQL with user that have rights to create a database, since a new MS SQL database will be created that is used to store the model.

After clicking “OK” in “New Model” dialog, the “New Model” and “Save Model” dialogs will be closed and current model name entered (“IBManual” in our case) will be displayed on Model Editor window:



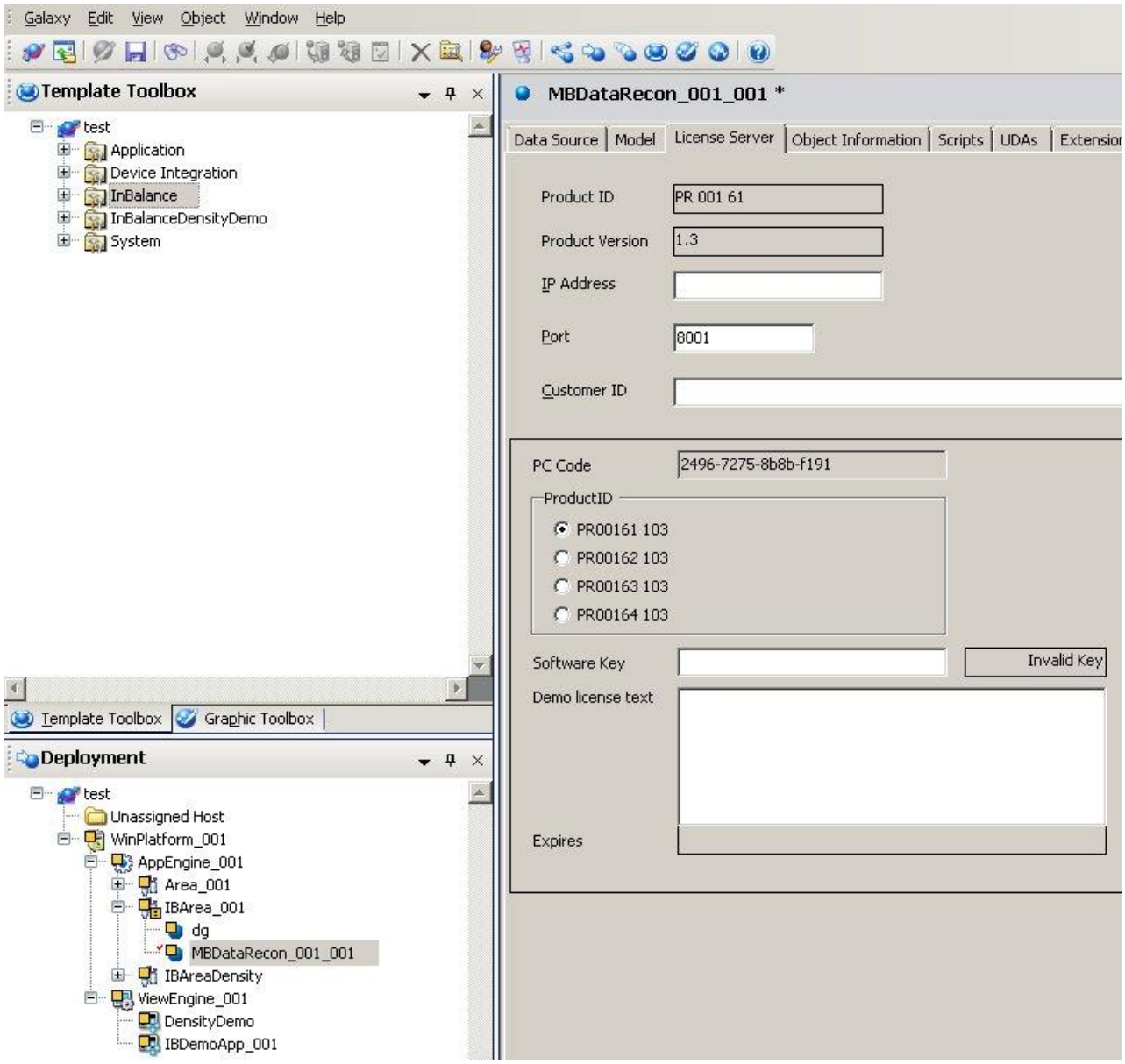
Configuring Calculator

6. Start ArchestrA IDE.

7. Open the Calculator configuration editor, by double-clicking the instance MBDataRecon_001_001, then click on the “License Server” tab. Here a **Software Key** or **Demo license** or licensing under **License Server** can be enabled.

The **Software Key** should be purchased and currently it is available for 4 product levels, based on total number of model streams used in deployed Calculator object on one computer. To get and enable the software key:

- select the appropriate “ProductID” (e.g. PR00161 103)
- copy/paste the automatically generated “PC Code” to e-mail (or text file or similar) and provide this “PC Code” string when ordering the InBalance product
- when InBalance product is purchased, copy the received “Software Key” to corresponding “License Server” tab “Software Key” field and check that it is evaluated as “Valid Key”:



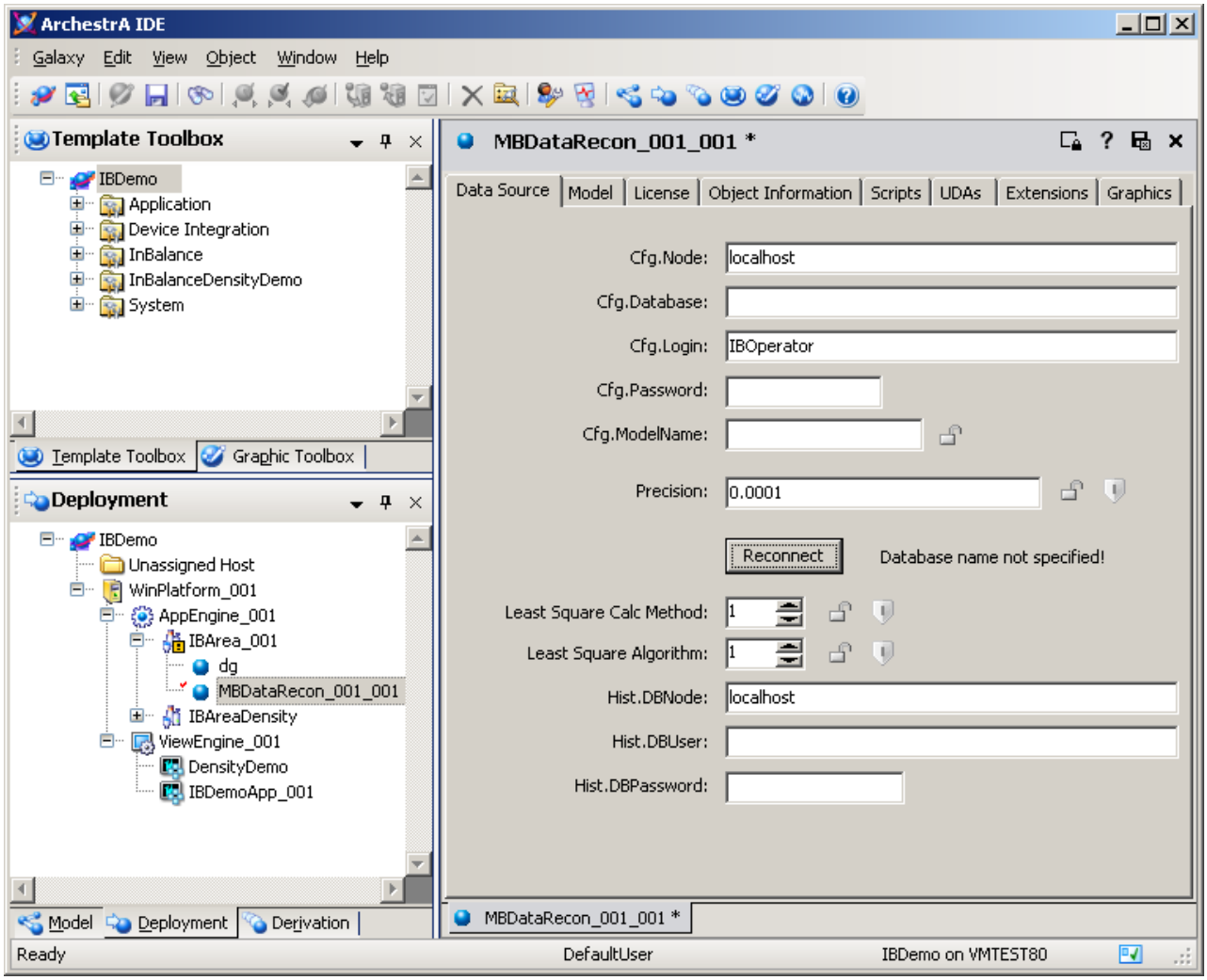
The **Demo license** is for free and provides an unlimited functionality, but is valid only for a limited time period. After demo license expiration the mass balance calculation request will be rejected (it still will be possible to use the Model Editor). The demo license can be obtained by sending request to info@wonderware.fi.

The Demo license is a text string containing 64 Hex symbols. When received, paste the demo license text string to the “Demo license text” field and check that it is evaluated as “Valid Key”.

To enable the licensing under **License Server** in case InBalance is delivered as a part of Wonderware Finland **Automation Intelligence Suite** package, the proper “Product ID” and “Product Version” should be selected, the “IP Address” of License Server node entered and proper “Customer ID” entered (“Customer ID” is generated automatically when License file (.kllic file) is obtained or it can be received via e-mail. About licensing under License Server, see more in separate “Automation Intelligence Suite License Server” guide.

Note: All included demo models (IBManual.xml, IBHist.xml and IBDensity.xml) do not require licensing, because the 3 stream limit is not exceeded.

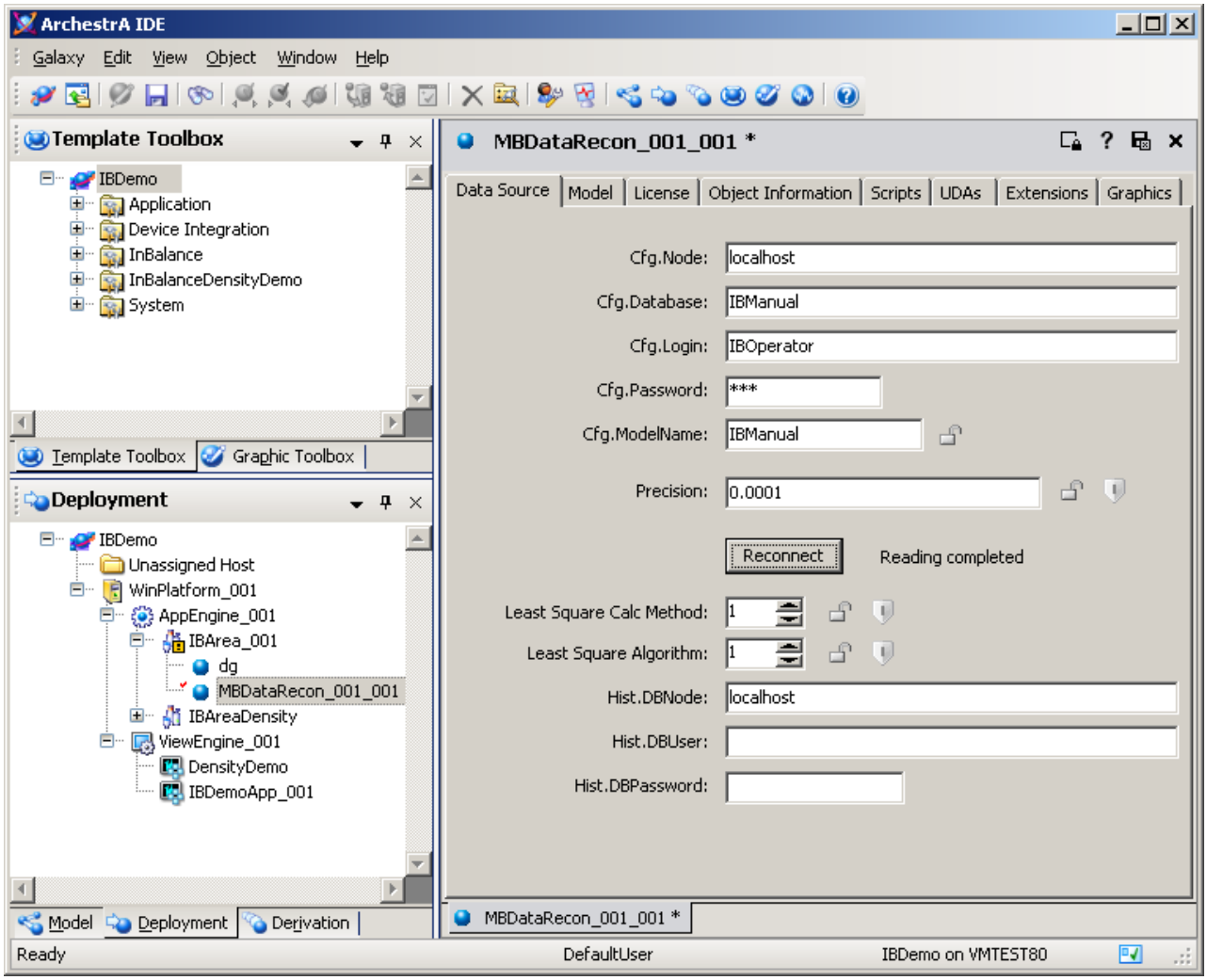
8. Click on the “Data Source” tab. The following window will be displayed:



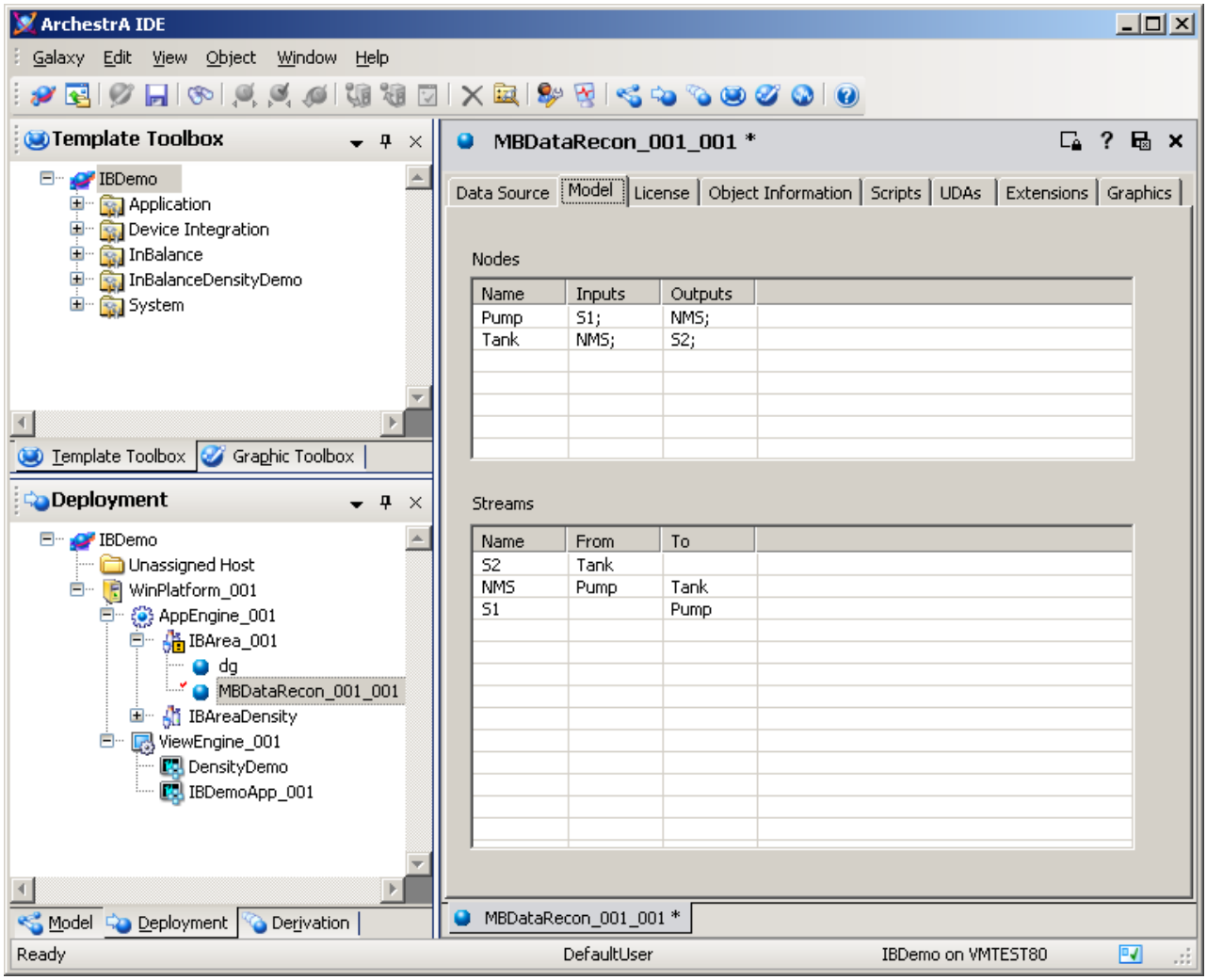
9. Enter following Calculator configuration for IBManual model

- Cfg.Node: enter the computer name where InBalance internal MS SQL database is located (“localhost”).
- Cfg.Database: enter the model database name (“IBManual”).
- Cfg.Login: enter the username for operator user, who has access rights to read the model (“IBOperator”).
- Cfg.Password: enter the password for operator, who has access rights to read the model (“123”).
- Cfg.ModelName: enter the model name (“IBManual”).

Press “Reconnect” button to read the model configuration from the internal MS SQL database.

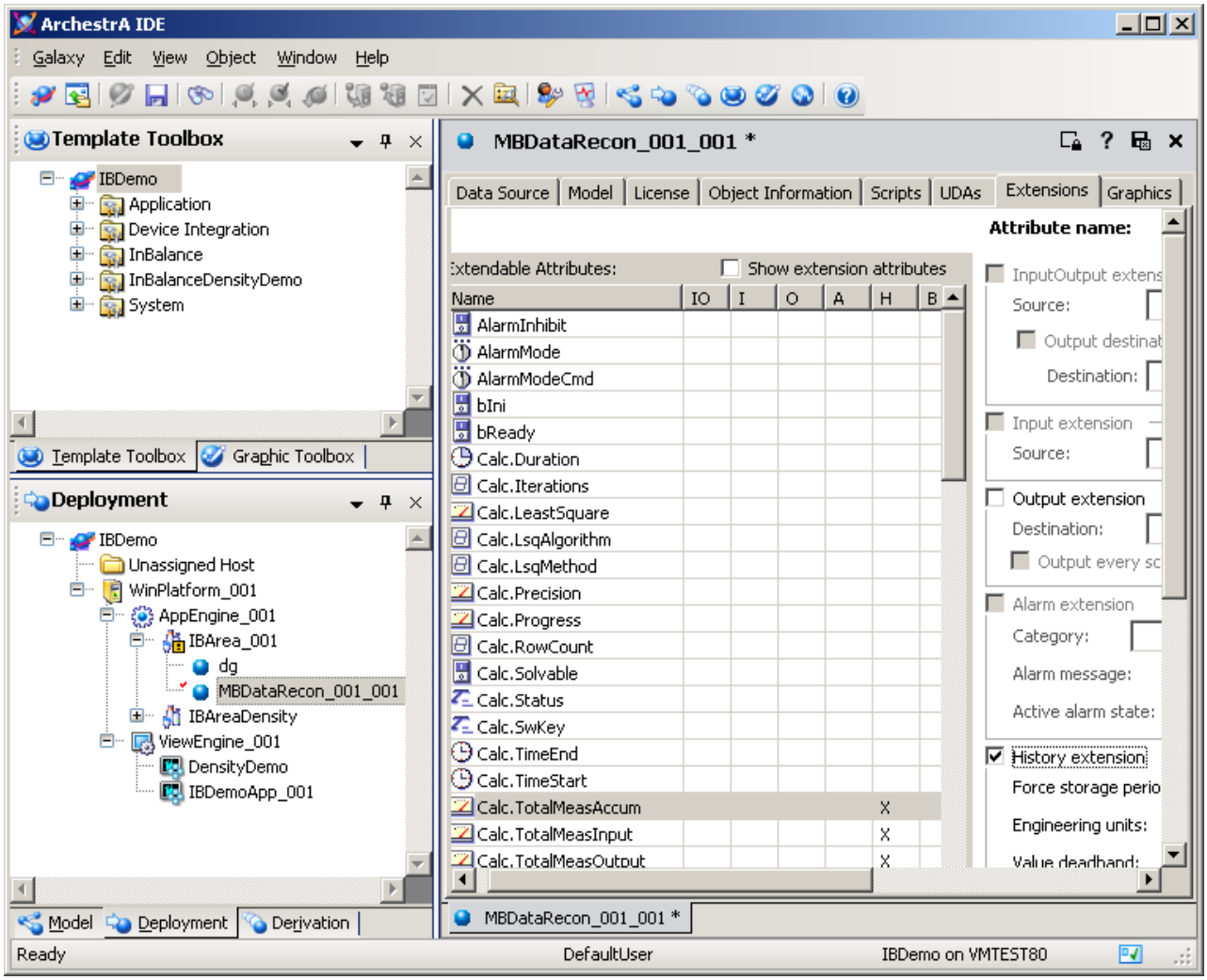


10. Check whether the model is loaded correctly – select the “Model” tab:



If there are no nodes and streams in the list, then check “Data source” tab configuration and Wonderware (SMC) logger for a possible reason.

11. In order to be able to invoke the MS Excel with mass balance demo report, it is necessary to set the “History extension” checkbox at “Extensions” tab for certain attributes:



Below is a list of these attributes:

Calc.TotalMeasInput
Calc.TotalMeasOutput
Calc.TotalMeasAccum
Calc.TotalRecInput
Calc.TotalRecOutput
Calc.TotalRecAccum

Pump.TotalMeasInput
Pump.TotalMeasOutput
Pump.TotalRecInput
Pump.TotalRecOutput

Tank.TotalMeasInput
Tank.TotalMeasOutput
Tank.TotalRecInput
Tank.TotalRecOutput
Tank.Meas.ReconMass
Tank.Meas.MeasuredMass

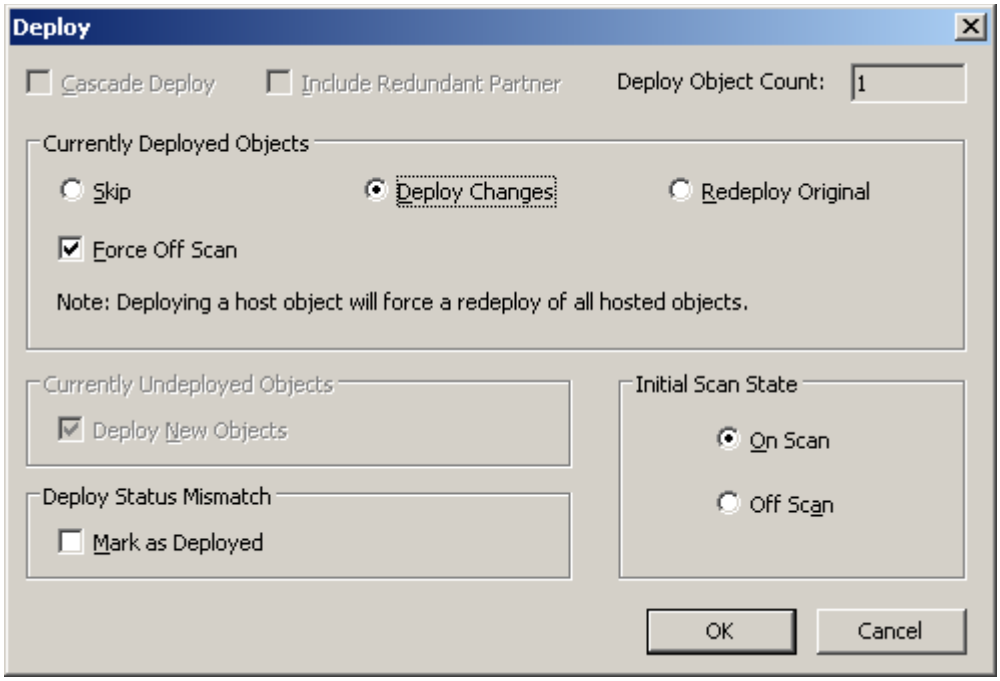
S1.Meas.MeasuredMass
S1.Meas.ReconMass

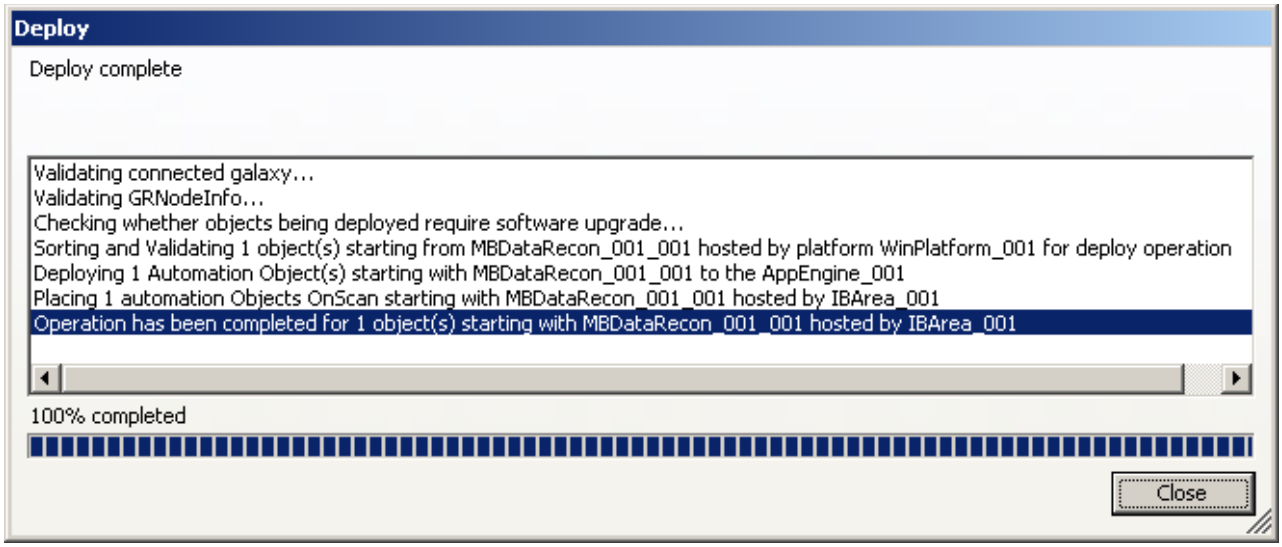
NMS.Meas.MeasuredMass
NMS.Meas.ReconMass

S2.Meas.MeasuredMass
S2.Meas.ReconMass

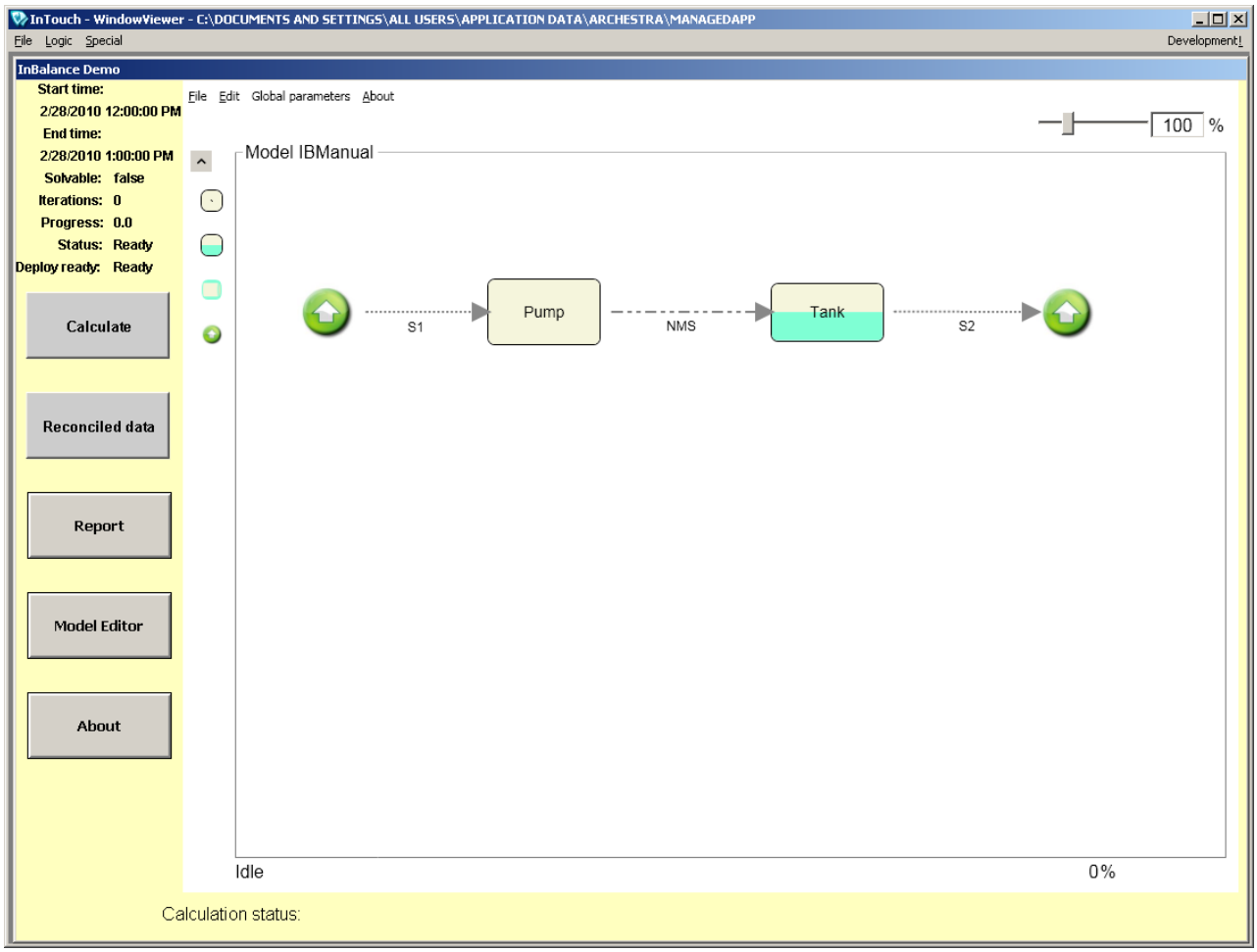
12. Save and close the MBDataRecon_001_001 configuration by clicking on the icon , located at the top right corner of the configuration editor.

13. Right-click MBDataRecon_001_001 and deploy it, using following settings:





14. Return to the InTouch application. The IBManual demo model now is ready for use. The data reconciliation, mass balance calculation, visualization and reporting of results now can be done from the InTouch “InBalance Demo” window:



Besides the Model Editor pane, there are following elements in the InTouch “InBalance Demo” window:

- **“Start time”** and **“End time”** are used to enter the calculation time interval; currently there are default settings “Start time” 2/28/2010 12:00 PM and “End time” 2/28/2010 13:00 PM – one hour calculation interval;

- **“Solvable”** shows whether model is solvable;

- **“Iterations”** – shows the count of mathematical iterations used to perform the calculation;

- “**Progress**” – displays the calculation progress in % from 0 to 100;

- **“Status”** indicates the possibility of calculation: “Ready” or “Not ready”; the “Ready” status indicates next/new calculation can be done by pressing the “Calculate” button;

- **"Deploy ready"** indicates the system state of Calculator object (MBDataRecon) deployment: "Ready" or "Not ready"; the "Ready" state indicates next/new calculation can be done by pressing the "Calculate" button;

- **"Calculate"** button is used to perform the calculation for time interval specified in "Start time" and "End time" field; by pressing this button the "Mass balance" window will open, where total volumes in m^3 and mass balances in kg are displayed:

Mass balance

Total Volume in m3:

	Measured				Reconciled		
	Input	Output	Disbalance	Accumulated	Input	Output	Accumulated
All System	6.25	4.58	-0.08	1.75	6.302	4.556	1.746
Pump	6.25	6.25	0.00		6.302	6.302	
Tank	6.25	4.58	-0.08	1.75	6.302	4.556	1.746

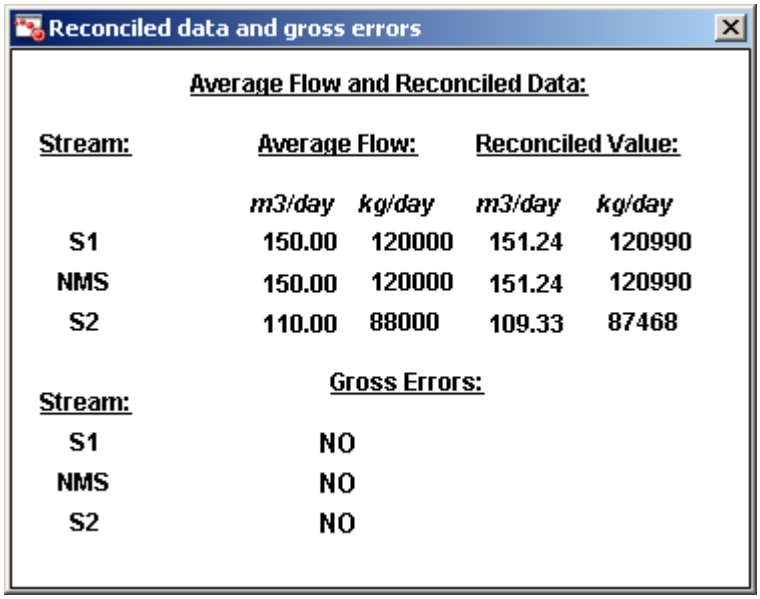
S1	6.25	6.302
NMS	6.25	6.302
S2	4.58	4.556

Total Mass in kg:

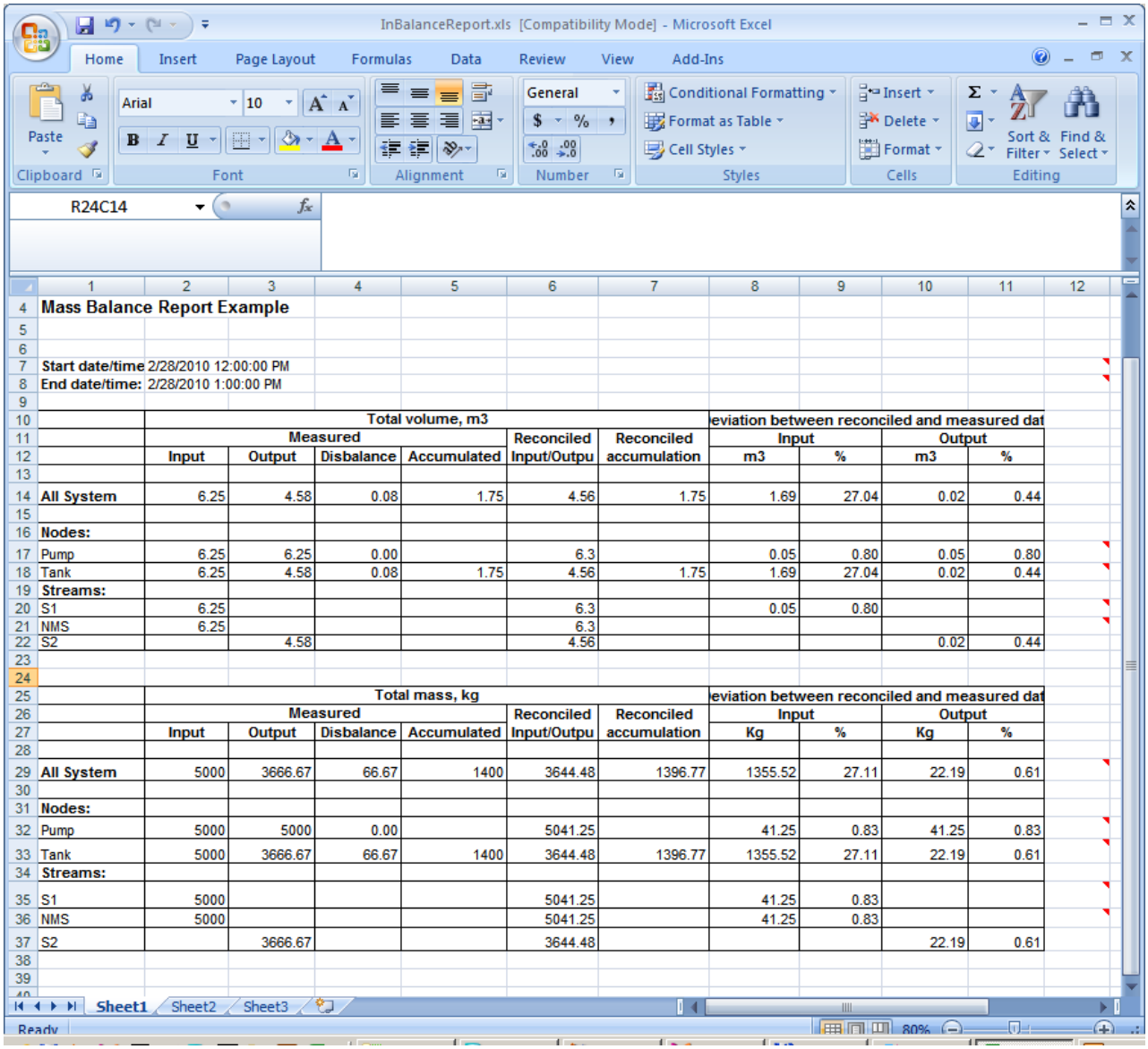
	Measured				Reconciled		
	Input	Output	Disbalance	Accumulated	Input	Output	Accumulated
All System	5000	3667	-67	1400	5041	3644	1397
Pump	5000	5000	0		5041	5041	
Tank	5000	3667	-67	1400	5041	3644	1397

S1	5000	5041
NMS	5000	5041
S2	3667	3644

- **"Reconciled data"** button is used to open window with last calculation reconciled data for all streams (in m^3/day and kg/day) and gross errors (if any) displayed:



- **"Report"** button can be used to invoke the MS Excel with simple mass balance report generated based on last calculation:



InBalanceReport.xls [Compatibility Mode] - Microsoft Excel

Mass Balance Report Example

Start date/time: 2/28/2010 12:00:00 PM
End date/time: 2/28/2010 1:00:00 PM

	Total volume, m3						eviation between reconciled and measured dat			
	Measured				Reconciled	Reconciled	Input		Output	
	Input	Output	Disbalance	Accumulated	Input/Outpu	accumulation	m3	%	m3	%
All System	6.25	4.58	0.08	1.75	4.56	1.75	1.69	27.04	0.02	0.44
Nodes:										
Pump	6.25	6.25	0.00		6.3		0.05	0.80	0.05	0.80
Tank	6.25	4.58	0.08	1.75	4.56	1.75	1.69	27.04	0.02	0.44
Streams:										
S1	6.25				6.3		0.05	0.80		
NMS	6.25				6.3					
S2		4.58			4.56				0.02	0.44

	Total mass, kg						eviation between reconciled and measured dat			
	Measured				Reconciled	Reconciled	Input		Output	
	Input	Output	Disbalance	Accumulated	Input/Outpu	accumulation	Kg	%	Kg	%
All System	5000	3666.67	66.67	1400	3644.48	1396.77	1355.52	27.11	22.19	0.61
Nodes:										
Pump	5000	5000	0.00		5041.25		41.25	0.83	41.25	0.83
Tank	5000	3666.67	66.67	1400	3644.48	1396.77	1355.52	27.11	22.19	0.61
Streams:										
S1	5000				5041.25		41.25	0.83		
NMS	5000				5041.25		41.25	0.83		
S2		3666.67			3644.48				22.19	0.61

- **"Model Editor"** button can be used to invoke the separate "Model Editor" window;

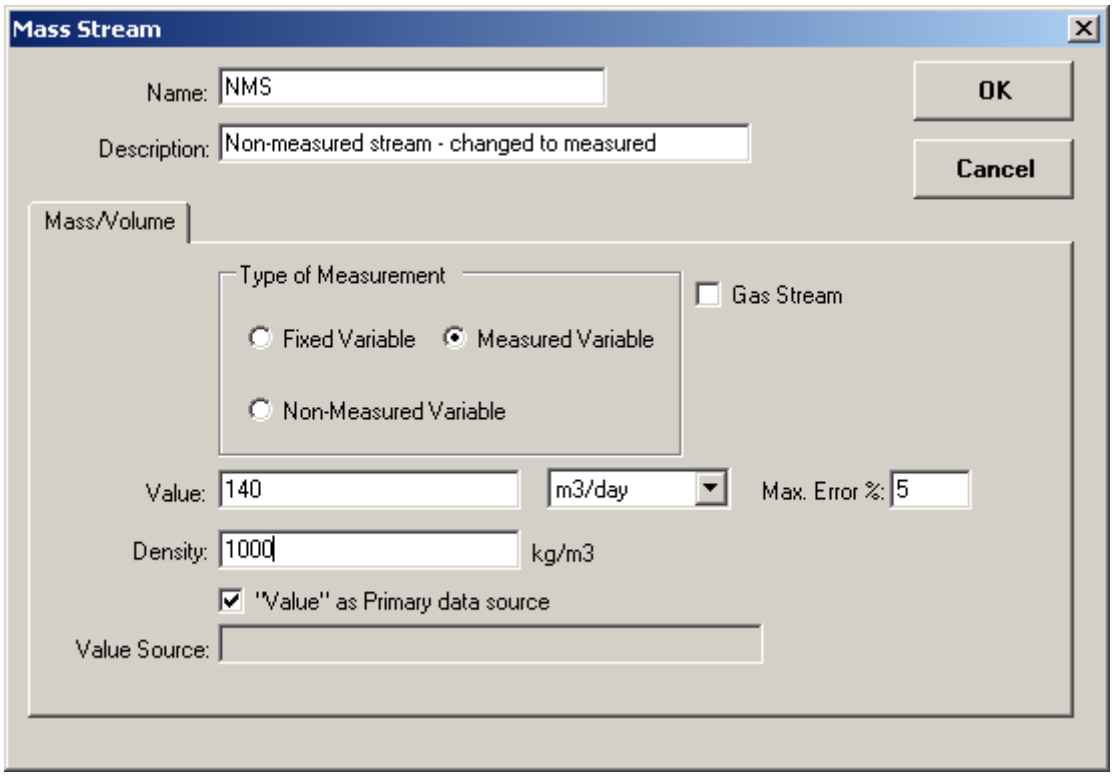
- **"About"** button can be used to invoke the InBalance general description window.

- **"Calculation status",** at the bottom of the "InBalance Demo" window, shows the current calculation status. In case of error an error message will be displayed here.

15. Now, by changing the "Start time" and "End time", the calculation can be performed for different time intervals (using same default manually entered values).

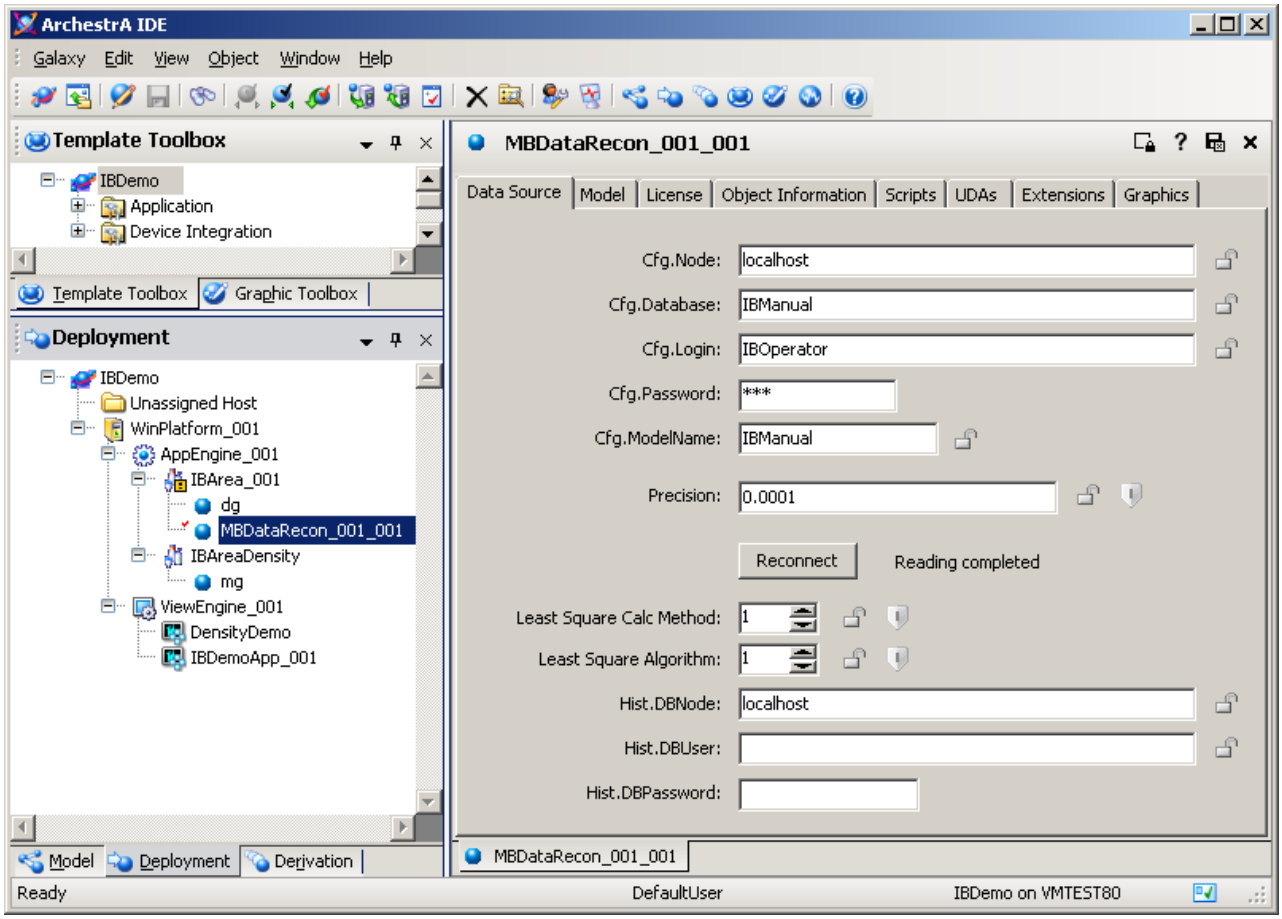
16. You can experiment and change the parameters of streams or nodes within existing model and perform the calculation by using changed parameters (model remains unchanged – number of nodes and streams, their names and links between them remain the same). For example, to change stream NMS from "non-measured" to "measured/manually entered value", go to the Model Editor, double click on stream NMS to change its configuration – check "Measured variable" and ""Value" as Primary

data source", enter "Value": 140 (in m^3/day), leave "Transformation to mass (kg/s) coefficient" equal to 1 and "Max. Error %": 5 and click "OK":



17. Save model configuration to internal MS SQL database (select command File -> Save in the Model Editor main menu).

18. Open ArchestrA IDE and double click the MBDataRecon_001_001 object to open its configuration editor:



19. Save and close the MBDataRecon_001_001 configuration by clicking on the icon , located at the top right corner of the configuration editor.

20. Right-click the MBDataRecon_001_001 and deploy it.

21. When the deploy is completed, return to the InTouch application and wait until “Deploy ready” parameter, indicating the system state of the Calculator object (internally named MBDataRecon_001_001) deployment, changes from “Not Ready” to “Ready.

22. Click on the ”Calculate” button to perform the calculation. Now, by changing the “Start time” and “End time”, the calculation can be performed for different time intervals (using the same model configuration).

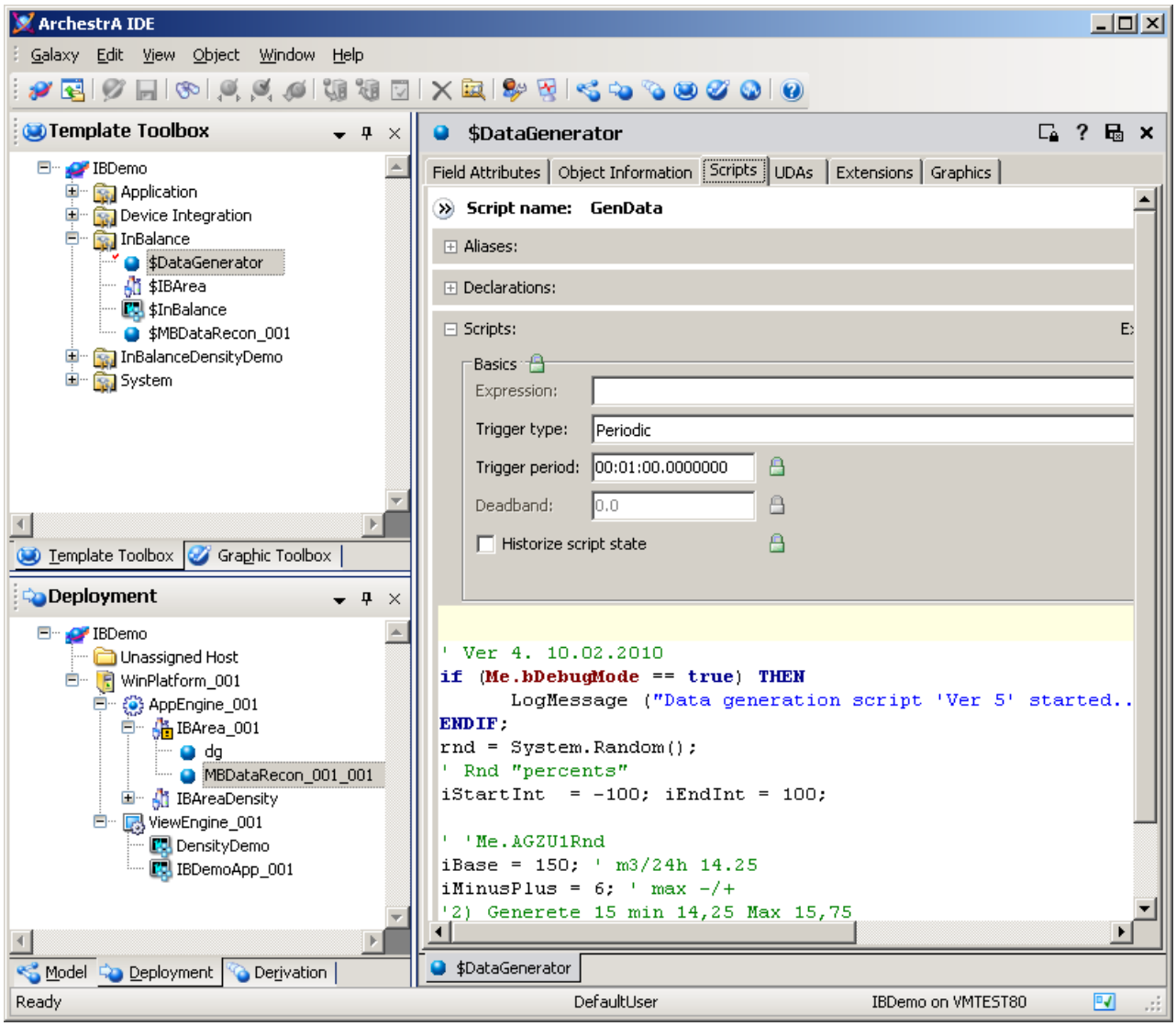
Using model with data from Historian database

23. Now, let’s use another demo model IBHist.xml (using simulated data from Historian database). The simulated data for InBalance calculations are available in two ways:

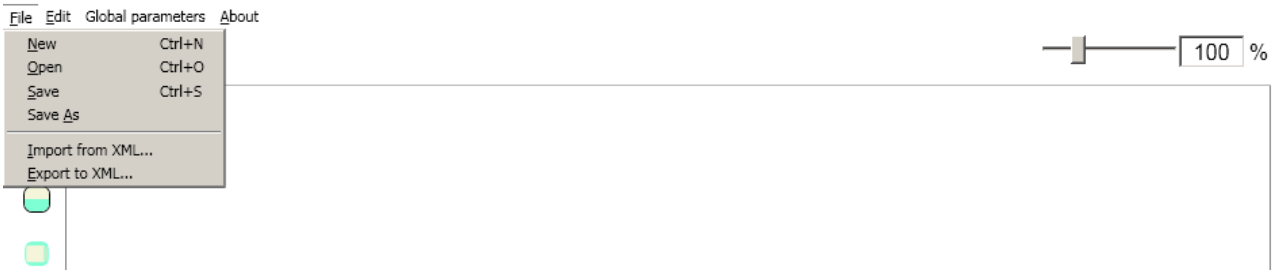
    a) there are generated & stored data for time period from 2010/02/27 00:00:00 till 2010/03/01 00:00:00 (supplied as IBHistorianData.zip file);

    b) new data generation is started automatically after Historian is started and InBalance objects deployed. New data are generated by the $DataGenerator object scripts

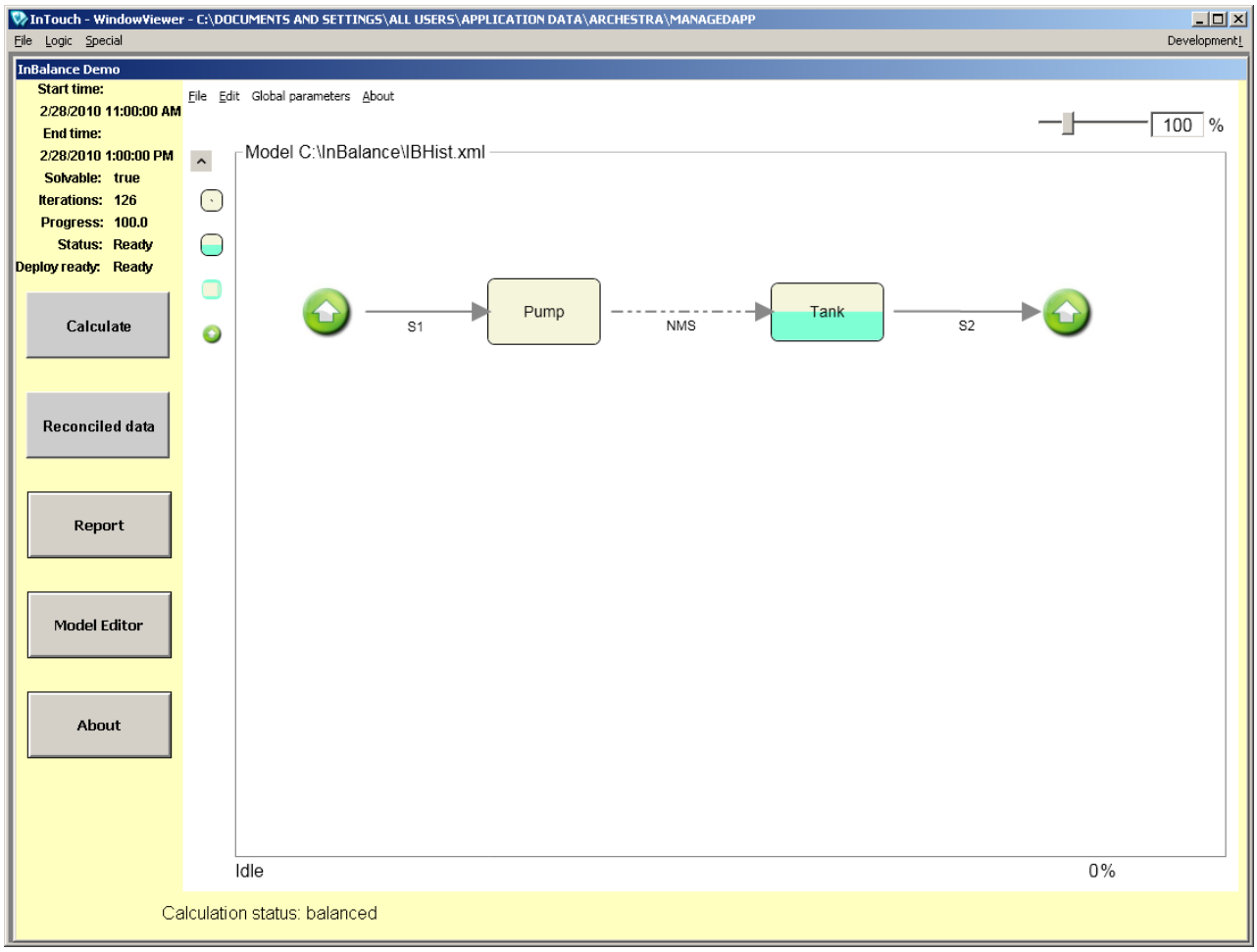
GenData and GenDataS3. GenData script generates data for streams S1 (150 m^3/day ± 6 m^3/day) and S2 (110 m^3/day ± 4.4 m^3/day) once per minute. GenDataS3 script generates data for storage node Tank. Initial value is 25 and every hour it is incremented by 0.073, until after 24 hours is reaches 26.75 and then is reset back to 25. The data are stored in the Historian database.



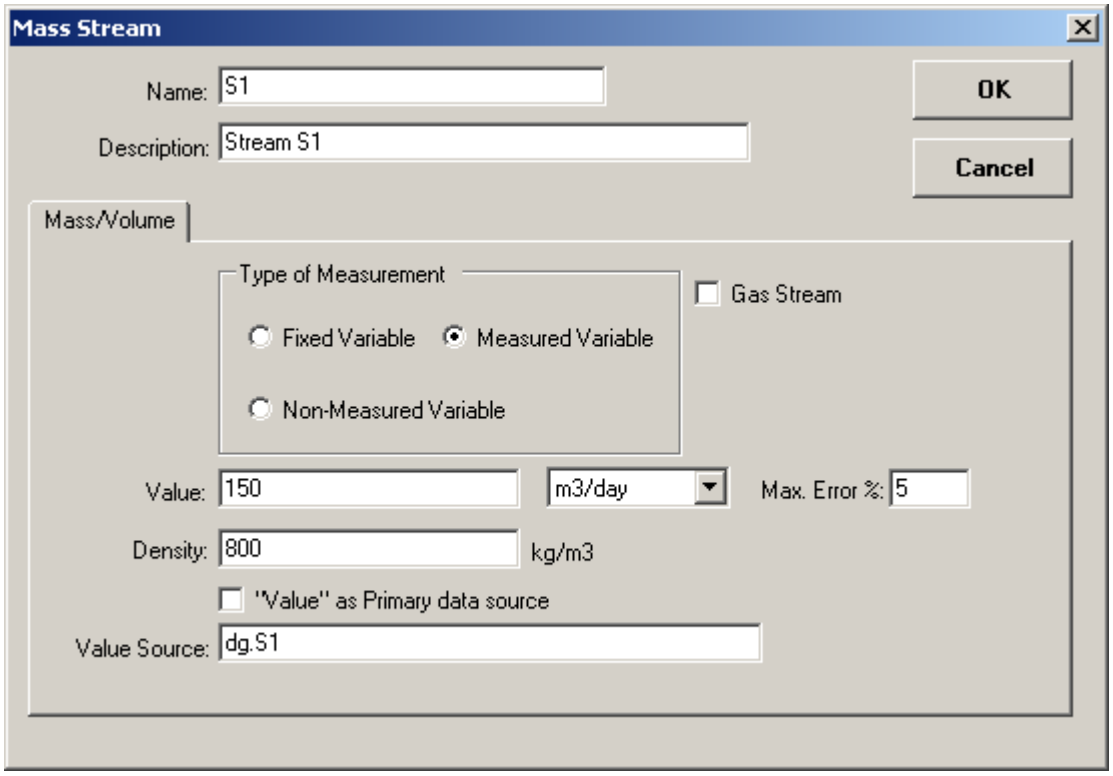
In order to switch to this model, in InTouch application Model Editor window select the menu command File ->Import from XML…

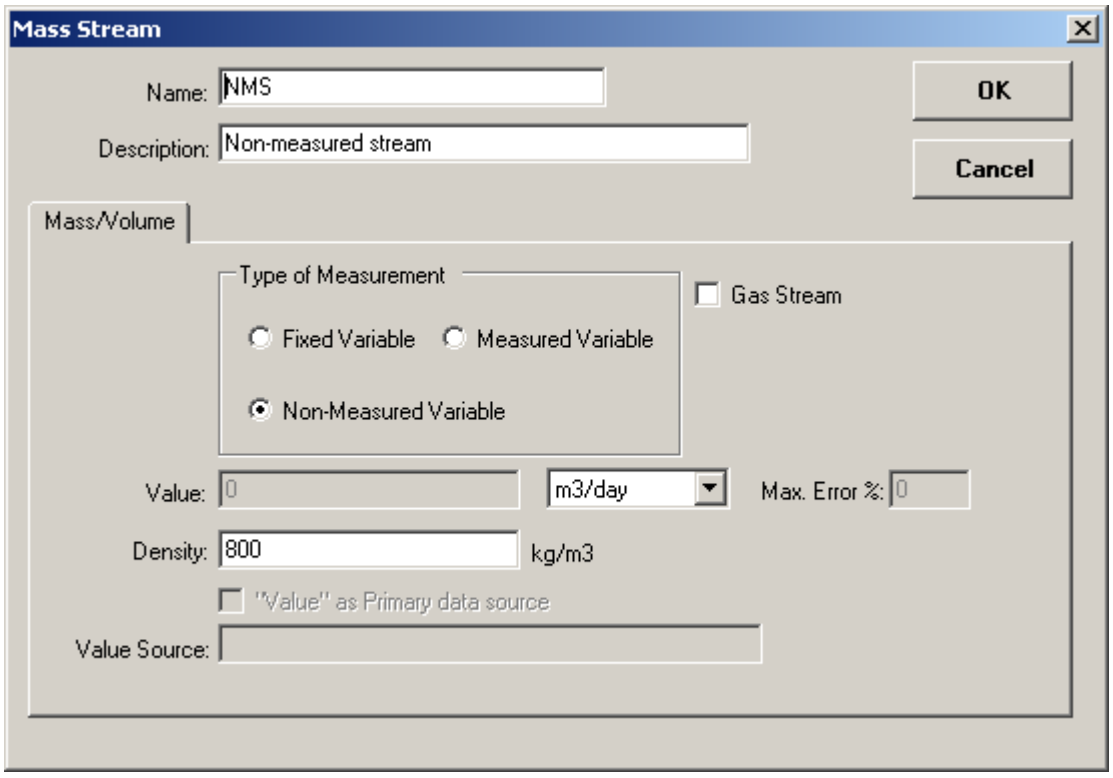


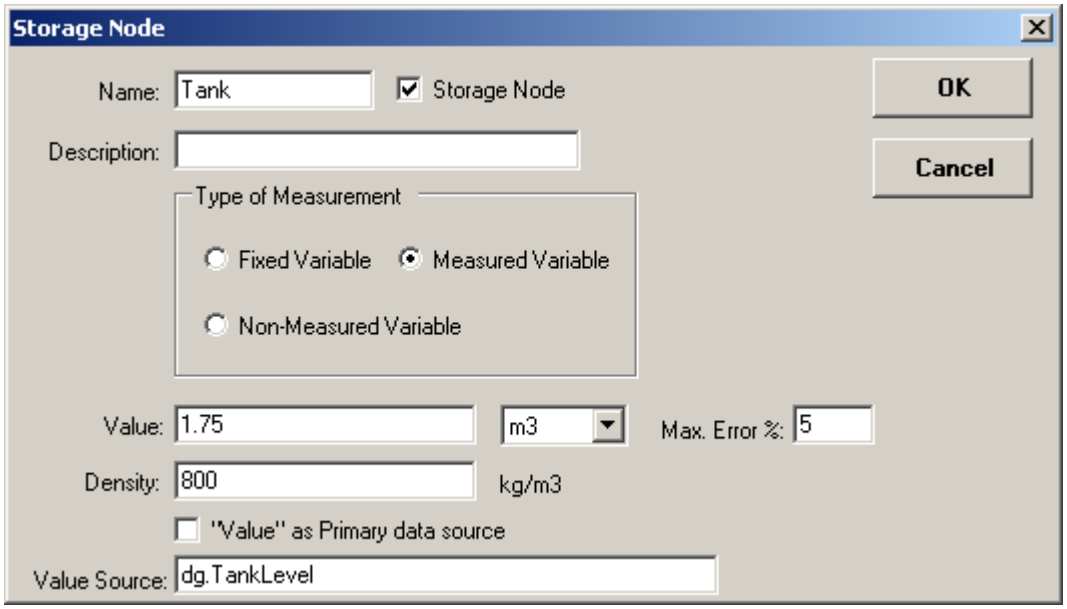
24. Browse for IBHist.xml file and click the “Open” button. The IBHist.xml demo model will appear in the Model Editor window:

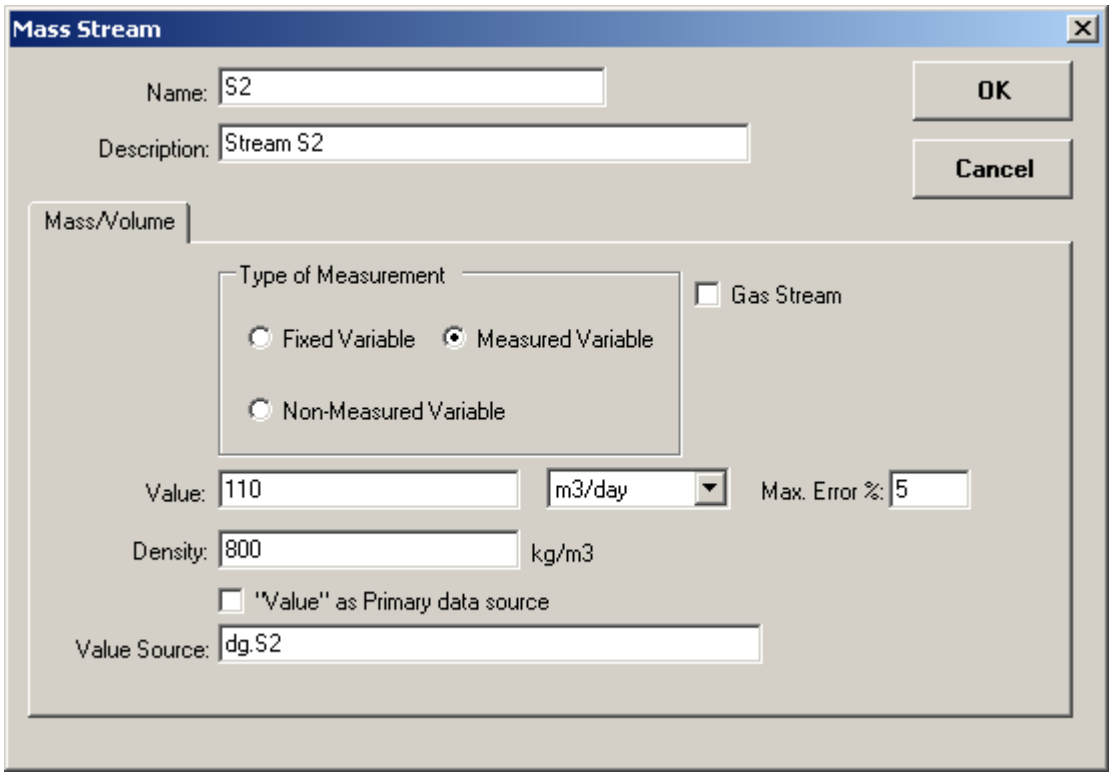


25. Check the configuration of streams S1, NMS, S2 and storage node Tank by double-clicking on them:


Mass Stream
Name: S1
Description: Stream S1
OK
Cancel
Mass/Volume
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Gas Stream
Value: 150
m3/day
Max. Error %: 5
Density: 800
kg/m3
"Value" as Primary data source
Value Source: dg.S1

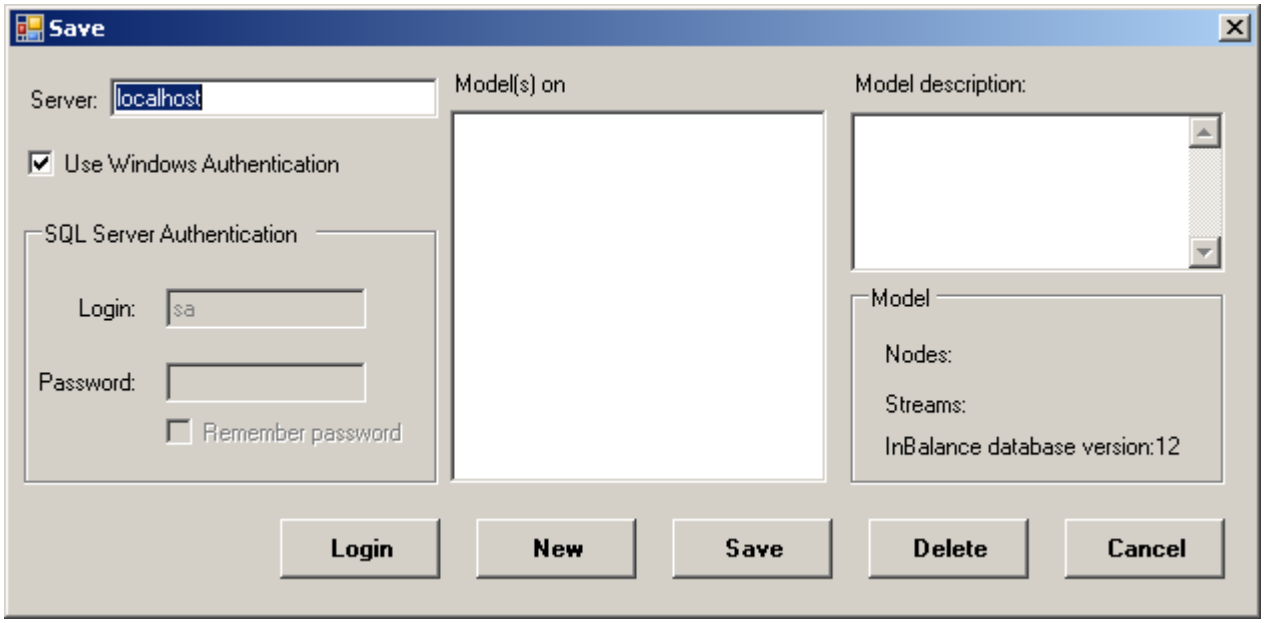

Mass Stream
Name: NMS
Description: Non-measured stream
OK
Cancel
Mass/Volume
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Gas Stream
Value: 0
m3/day
Max. Error %: 0
Density: 800
kg/m3
"Value" as Primary data source
Value Source:



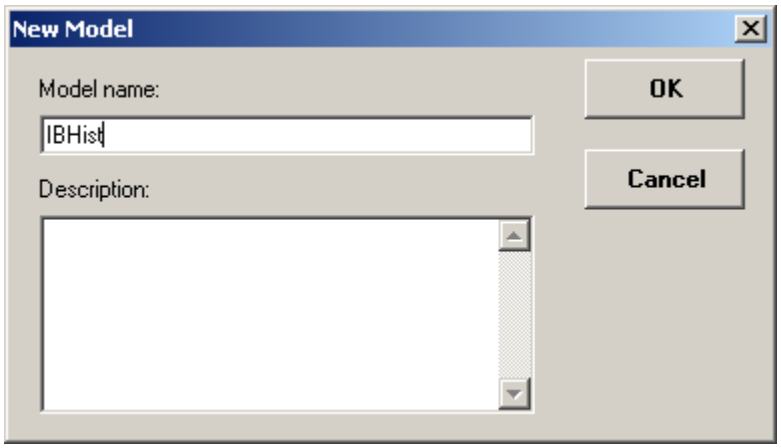


The streams **S1** and **S2** are measured streams, **NMS** is a non-measured stream and **Tank** is a storage node with measured accumulation. For S1, S2 and Tank the values are taken from Historian database – correspondingly Historian tagnames dg.S1, dg.S2 and dg.TankLevel are used.
In this demo model all measured data are m^3/day (for streams) and m^3 (for storage node), Density is required for calculation in this demo we set 800 kg/m3 for oil streams and storage node.

26. Save model to internal MS SQL database IBHist (from Model Editor main menu -> File -> Save...):



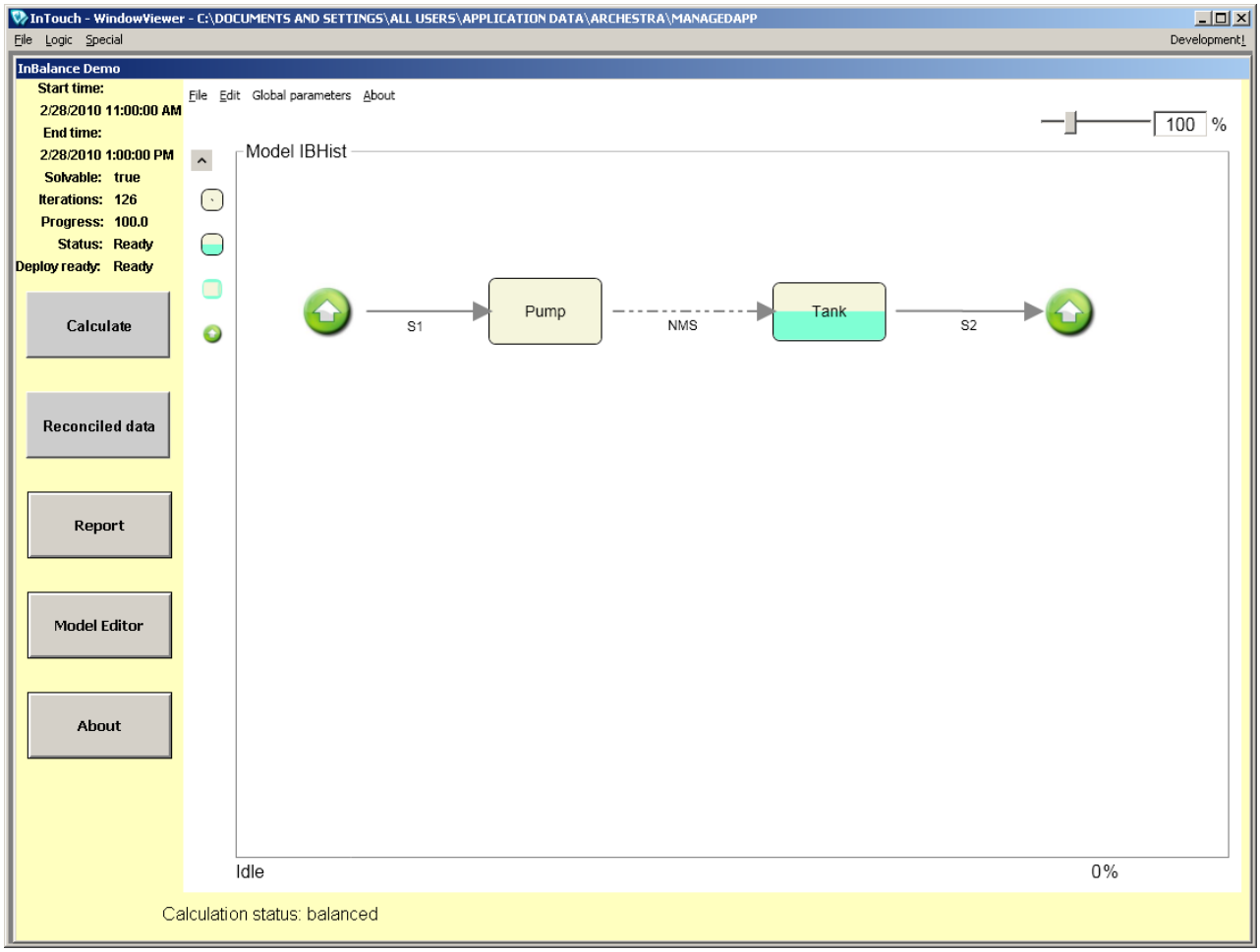
Click on the “New” button. The following dialog box will be displayed:



Enter the Model name and click on the OK button.

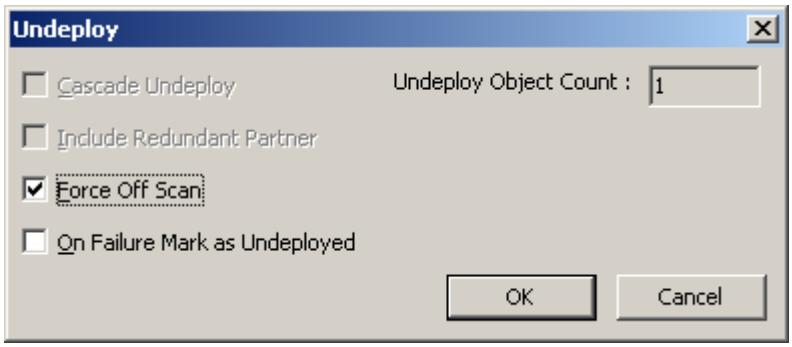
Note:
To create model database, you need to logon to MS SQL with user that have rights to create a database, since a new MS SQL database will be created that is used to store the model.

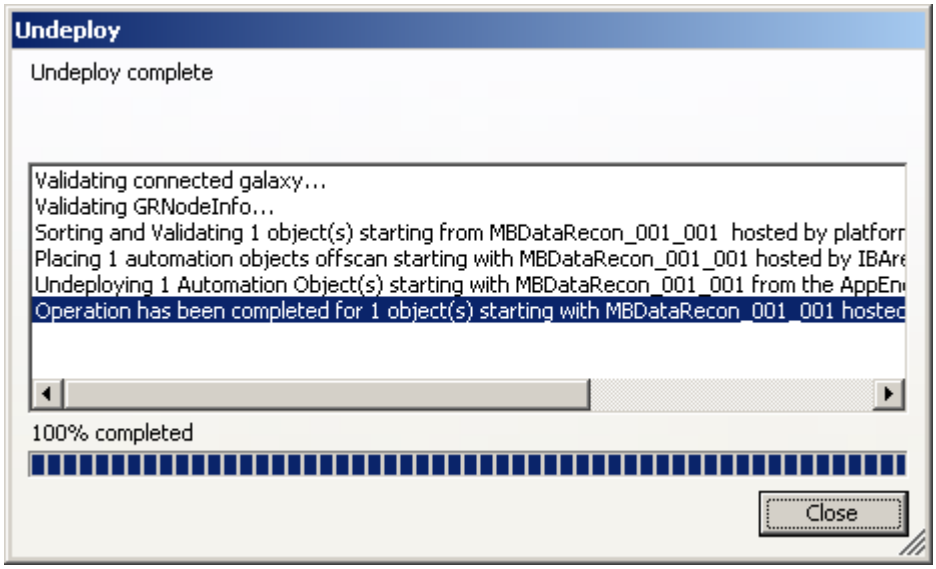
The current database name “IBHist” will be displayed in Model Editor window:



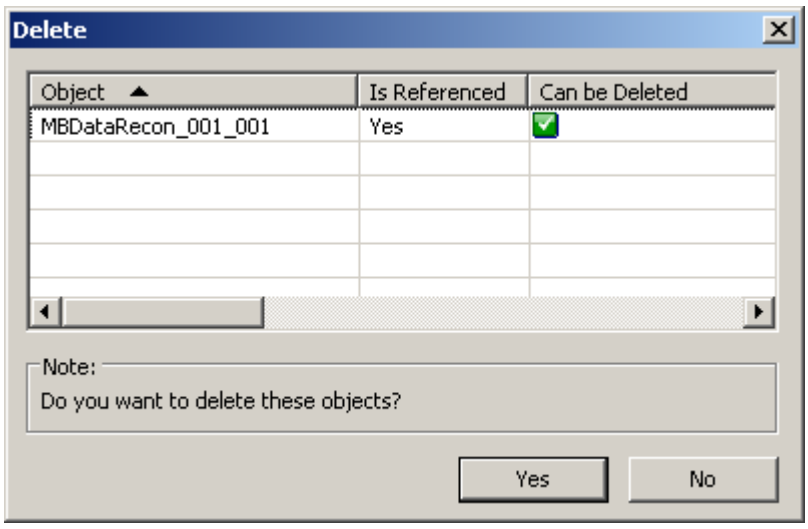
27. Start ArchestrA IDE:

28. Right-click and undeploy MBDataRecon_001_001:

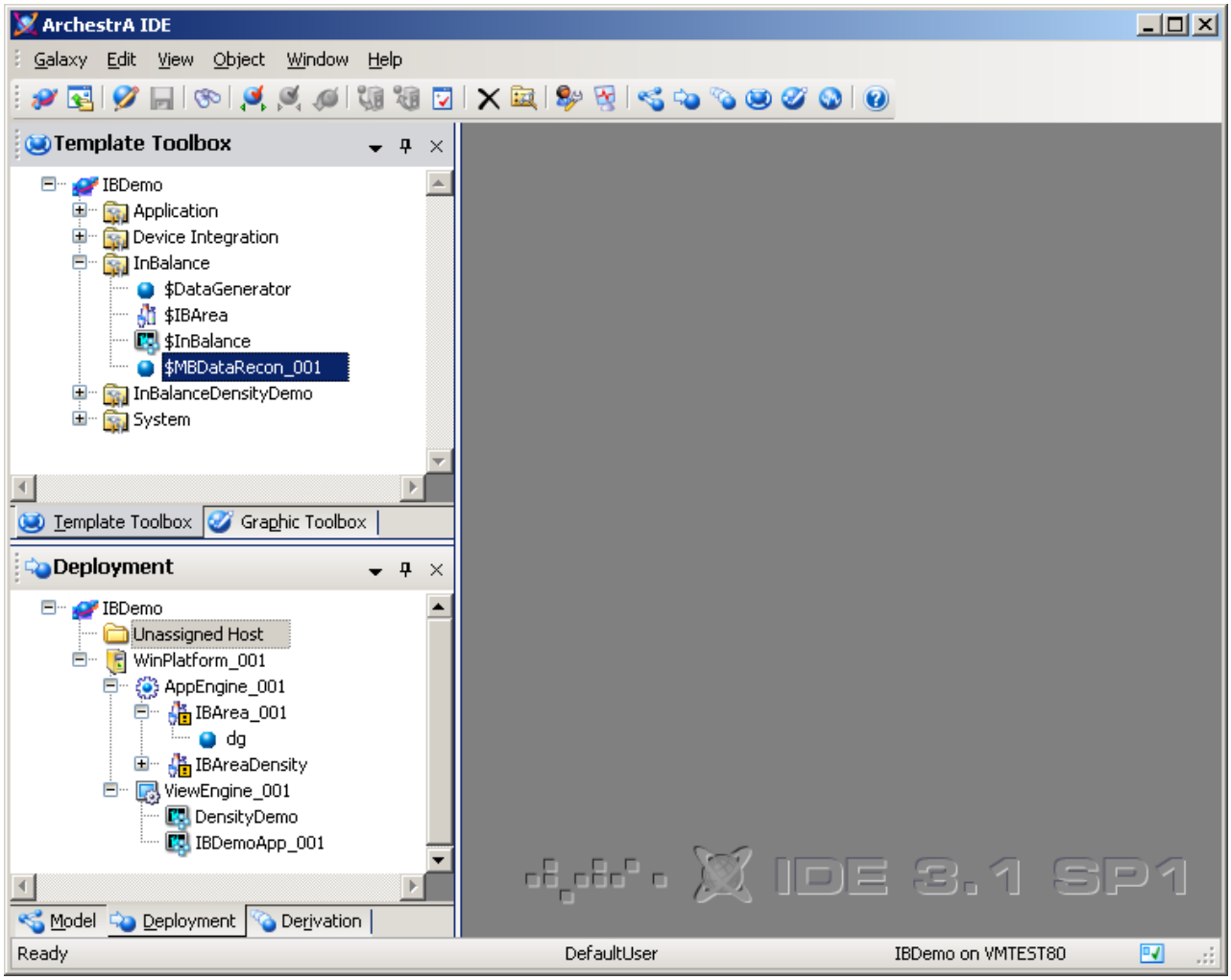




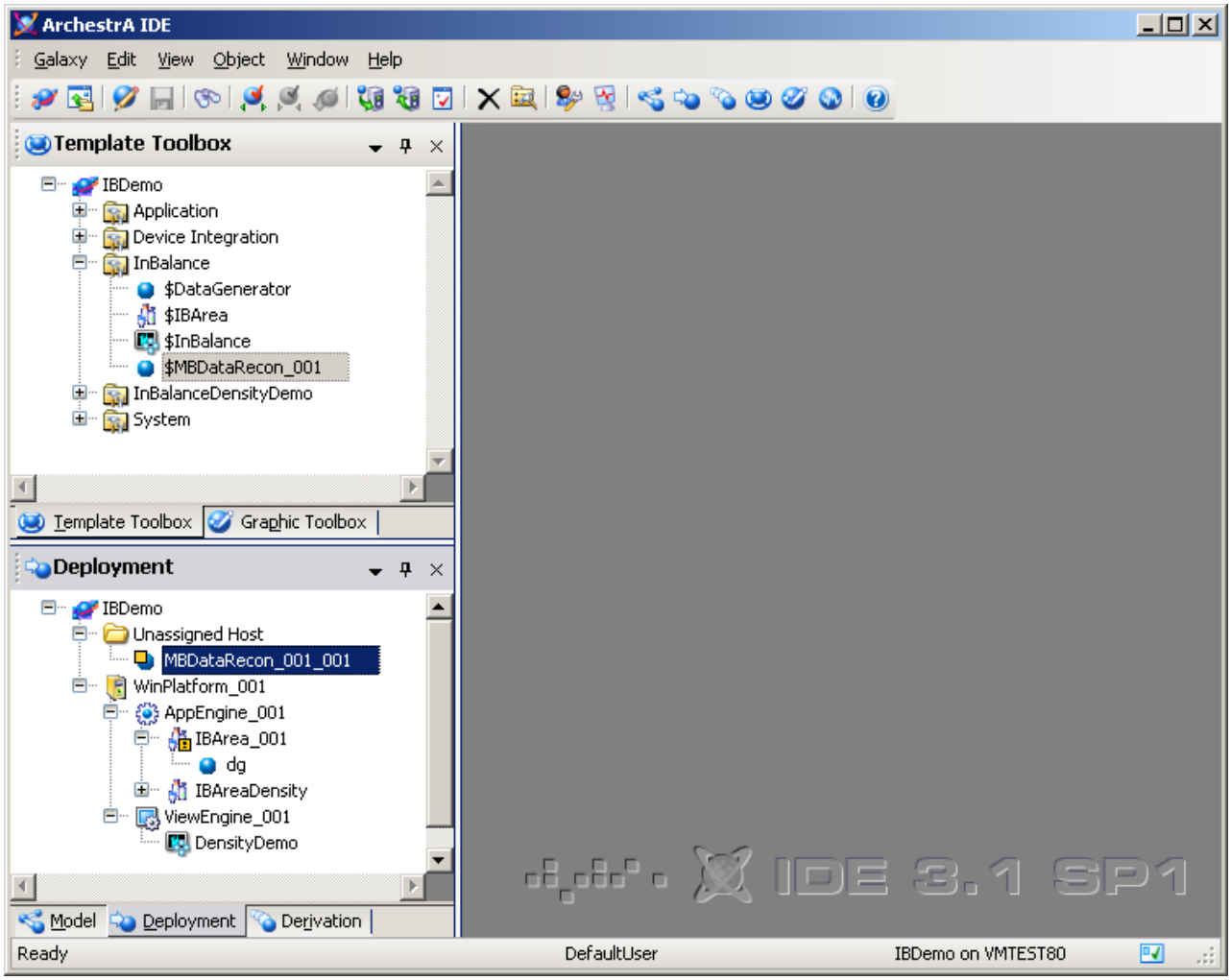
29. Right-click and delete MBDataRecon_001_001:



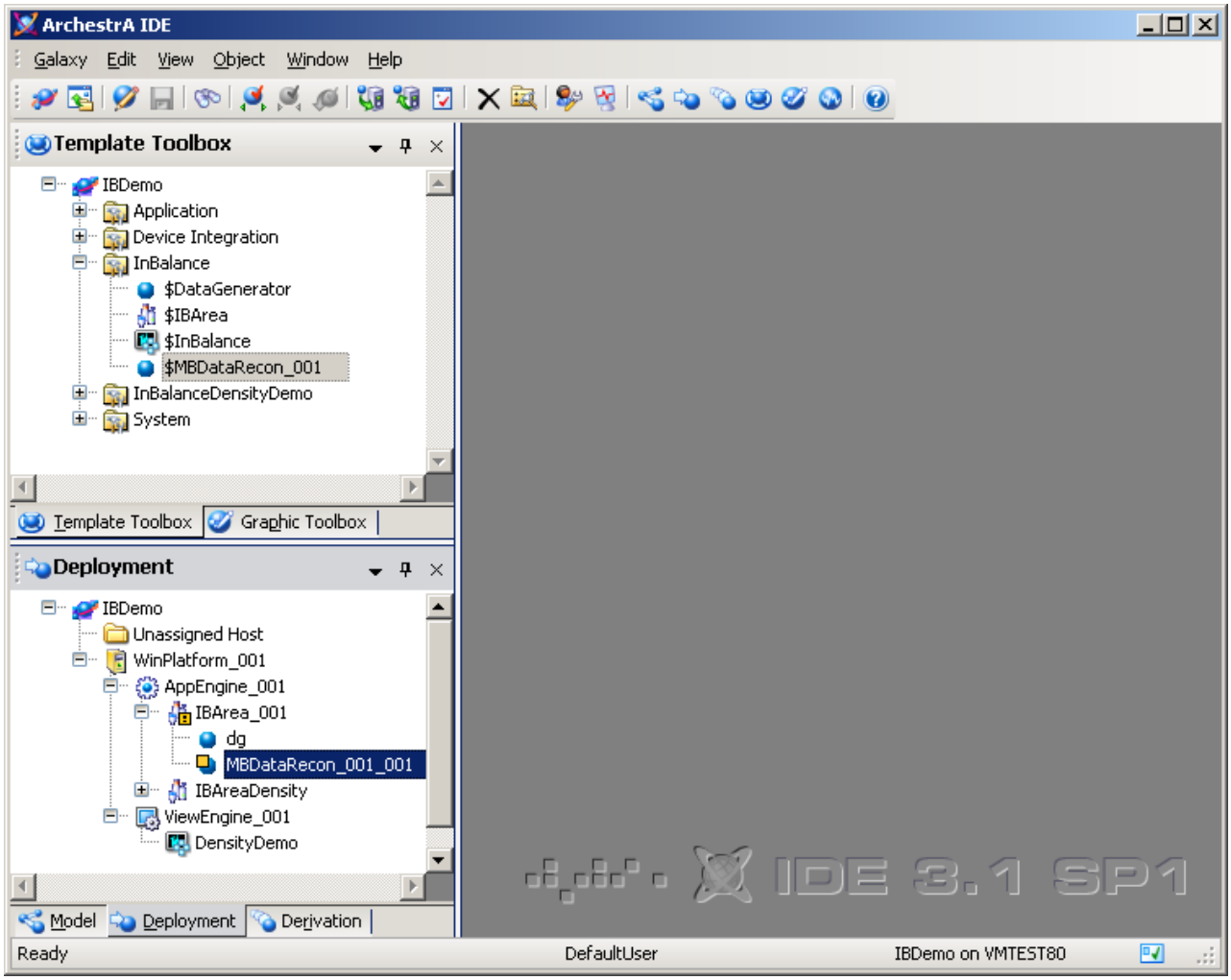
30. Create new instance by right-clicking the **$MBDataRecon_001** in IDE Template Toolbox “InBalance” Toolset and then by selecting “New”/“Instance” from drop-down menu:



The new MBDataRecon_001_001 instance will be added to the Unassigned Host.



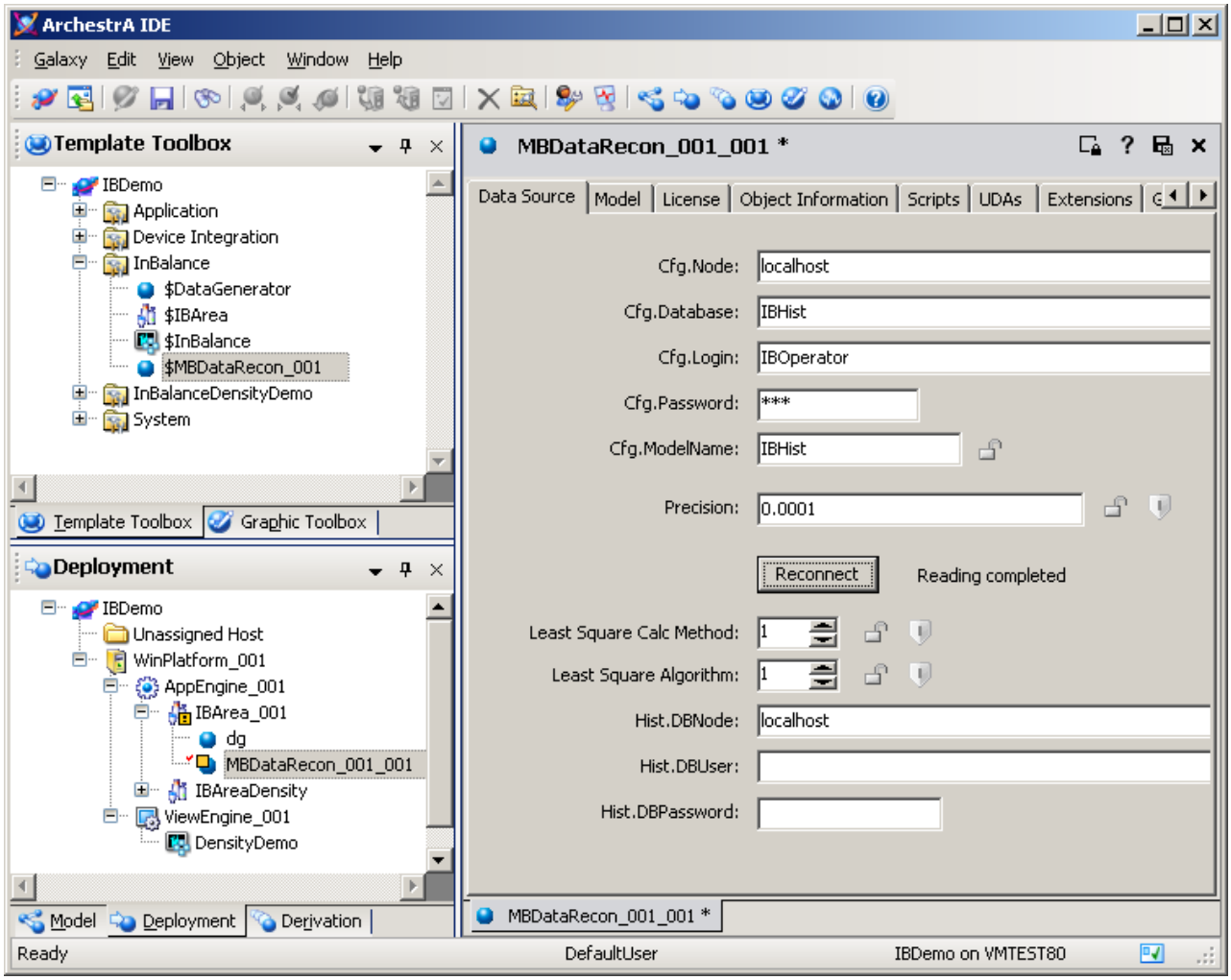
32. Drag and drop MBDataRecon_001_001 instance to IBArea_001:



33. Double click on MBDataRecon_001_001 to open its configuration editor.

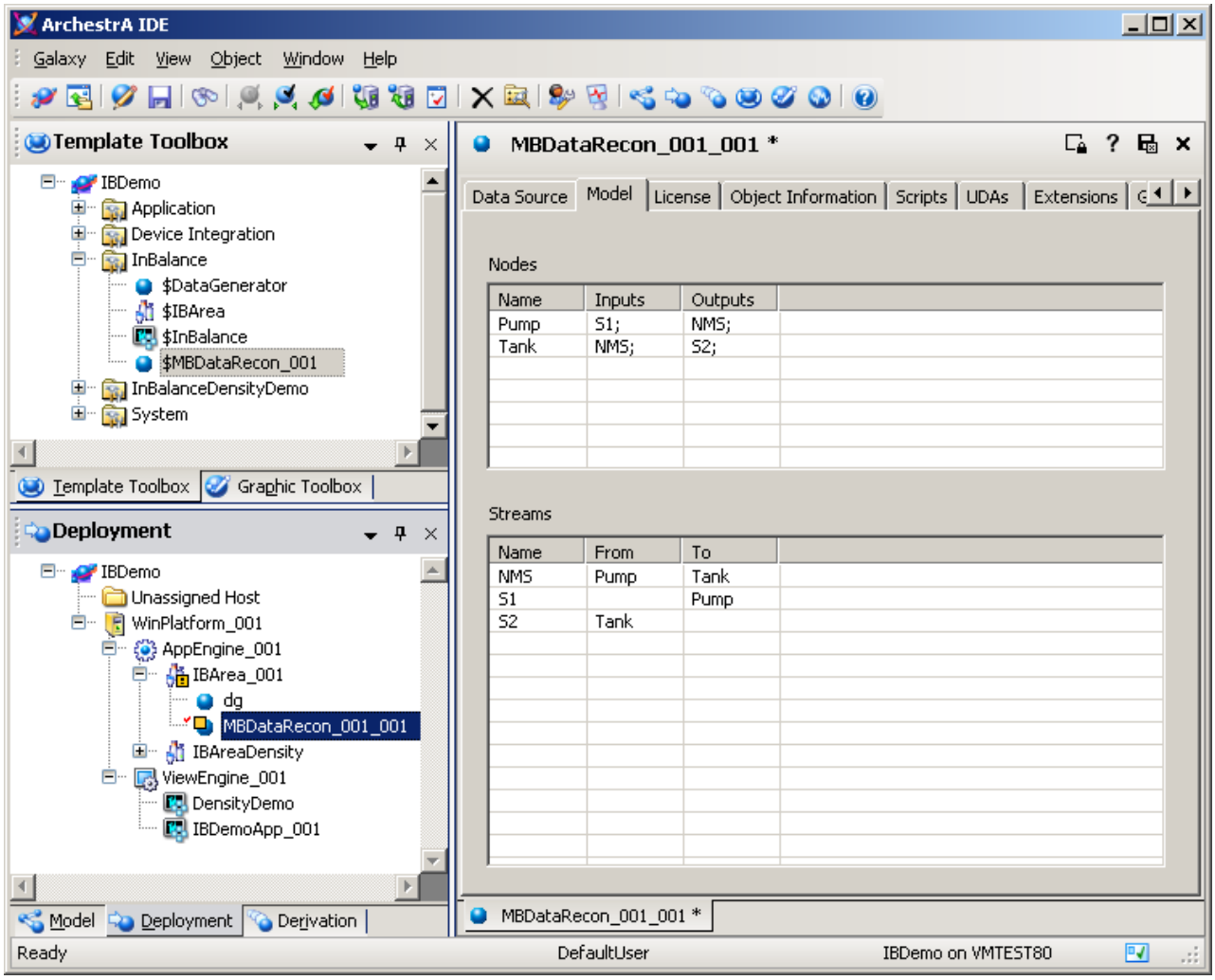
34. Enter the following configuration for IBHist model:

- Cfg.Node: enter the computer name where InBalance internal MS SQL database is located in our case (“localhost”).
- Cfg.Database: enter the model database name (“IBHist”).
- Cfg.Login: enter the username for operator user, who has access rights to read the model (“IBOperator”).
- Cfg.Password: enter the password for operator, who has access rights to read the model (“123”).
- Cfg.ModelName: enter the model name (“IBHist”).



35. Press the “Reconnect” button to read the model configuration from internal MS SQL database.

36. Check if model is loaded correctly – select the “Model” tab:

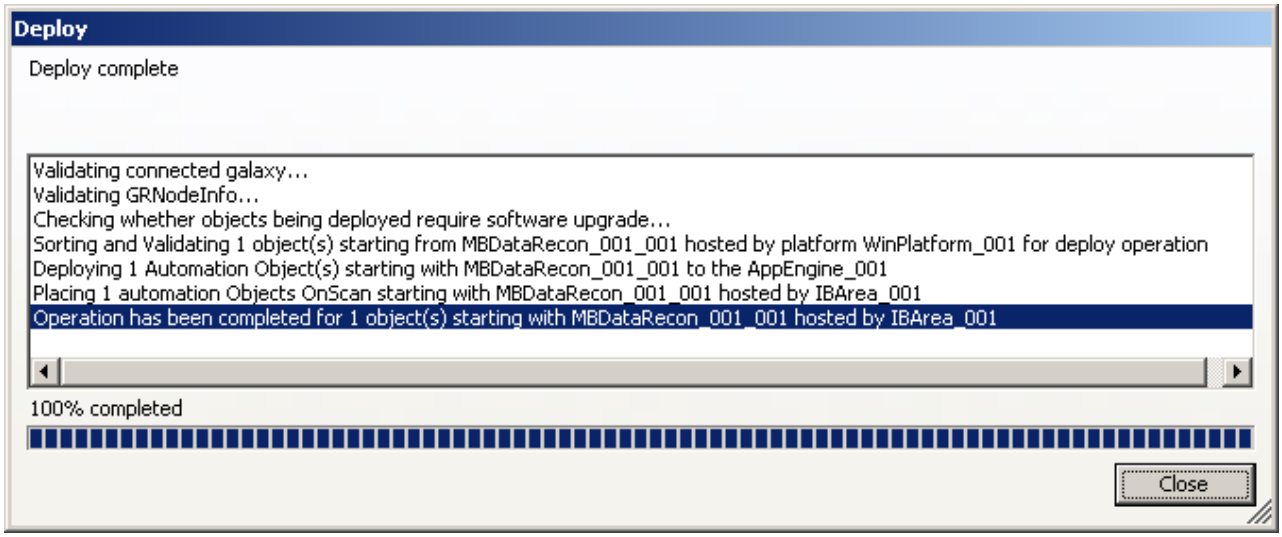


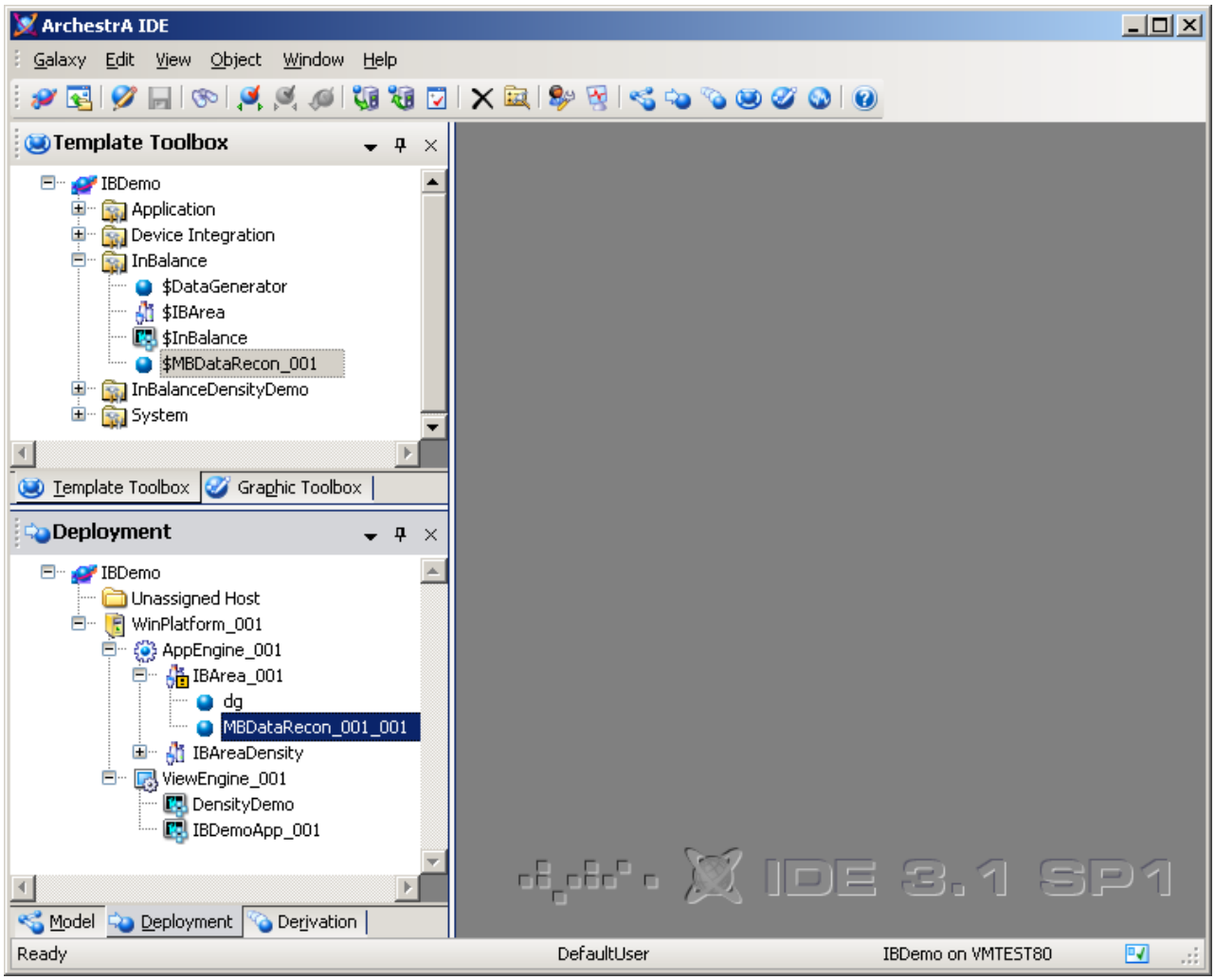
If there are no any nodes and streams loaded then check “Data Source” tab configuration and Wonderware (SMC) logger for possible reason.

37. In purpose to be able to invoke the MS Excel with simple mass balance report (this report supports also the IBHist.xml model), it is necessary to enable appropriate “History extensions” at “Extensions” tab (see step 11 in this chapter).

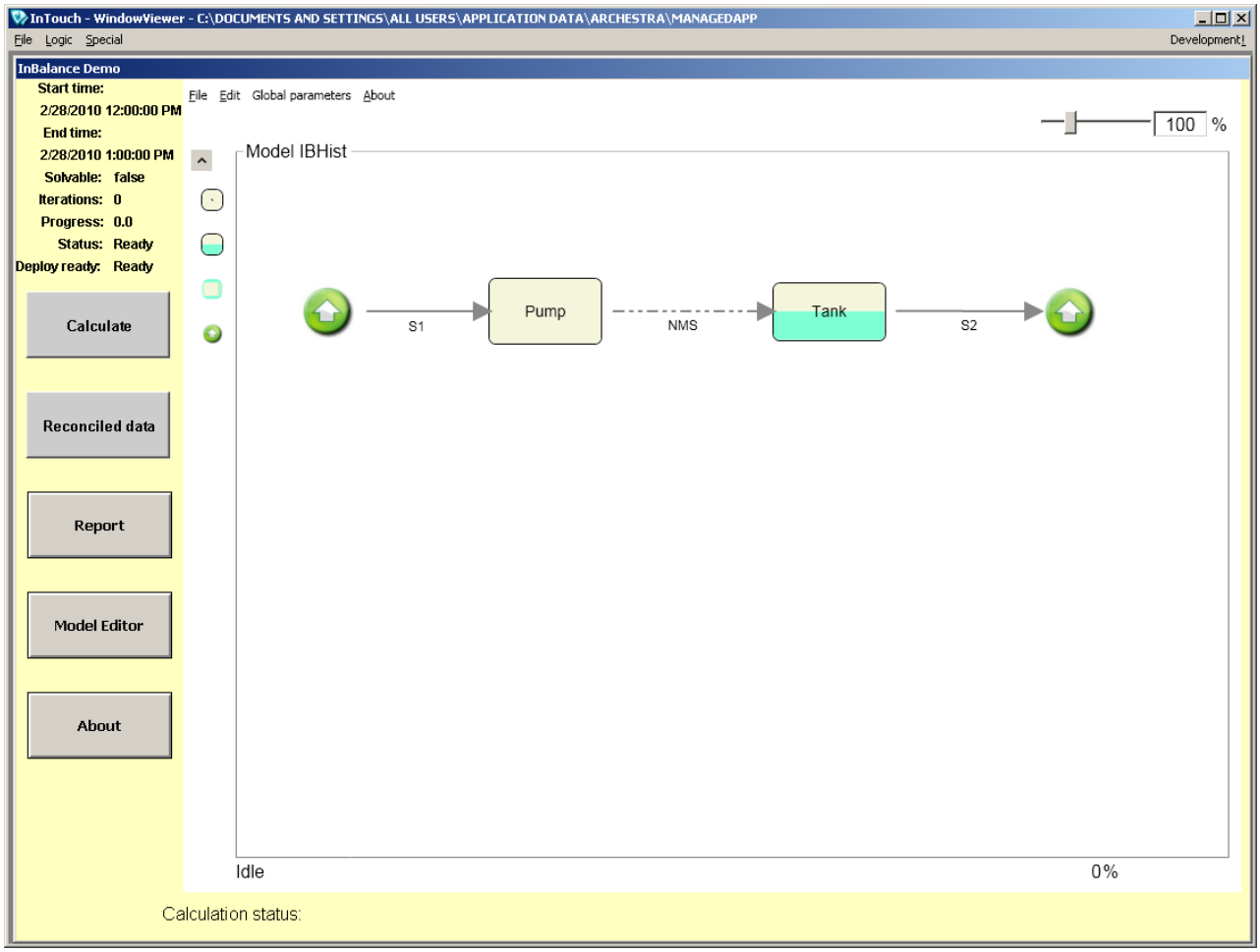
38. Save and close the MBDataRecon_001_001 configuration by clicking on the icon , located at the top right corner of the configuration editor.

39. Right-click and deploy the MBDataRecon_001_001.

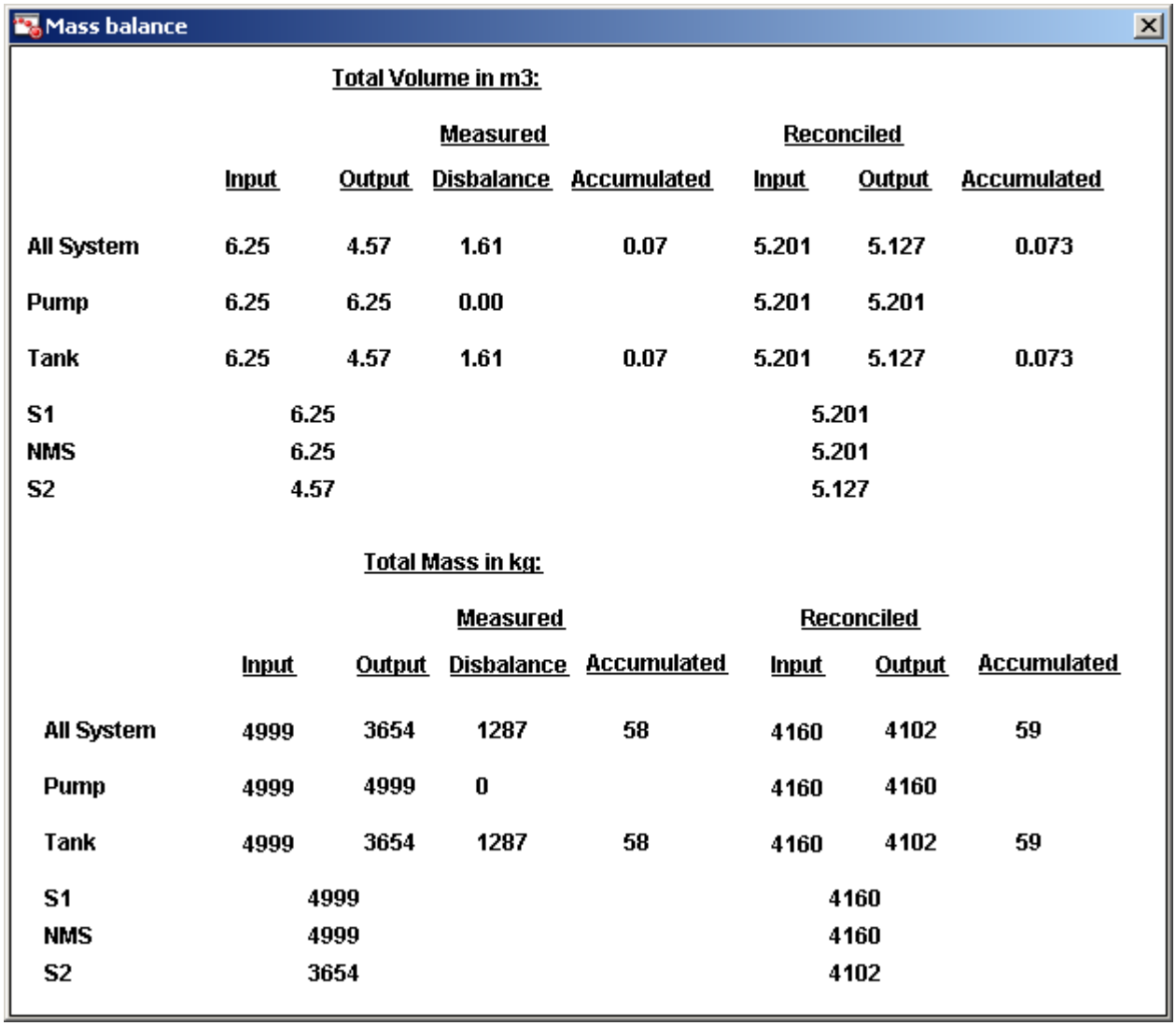




40. Return to the InTouch application:



41. The IBHist demo model now is ready for use. The mass balance calculation and reporting of results can be done by clicking “Calculate”, “Reconciled data” and “Report” buttons:



Mass balance

Total Volume in m3:

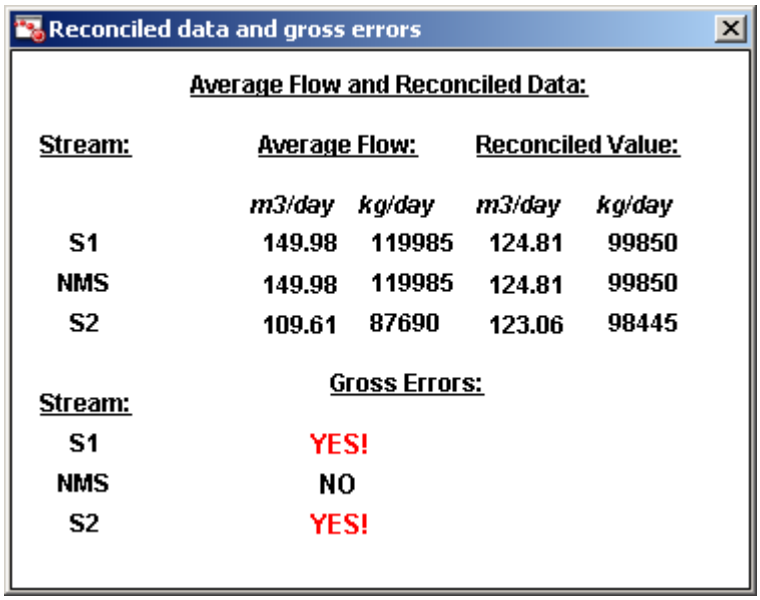
	Measured				Reconciled		
	Input	Output	Disbalance	Accumulated	Input	Output	Accumulated
All System	6.25	4.57	1.61	0.07	5.201	5.127	0.073
Pump	6.25	6.25	0.00		5.201	5.201	
Tank	6.25	4.57	1.61	0.07	5.201	5.127	0.073

S1	6.25	5.201
NMS	6.25	5.201
S2	4.57	5.127

Total Mass in kg:

	Measured				Reconciled		
	Input	Output	Disbalance	Accumulated	Input	Output	Accumulated
All System	4999	3654	1287	58	4160	4102	59
Pump	4999	4999	0		4160	4160	
Tank	4999	3654	1287	58	4160	4102	59

S1	4999	4160
NMS	4999	4160
S2	3654	4102



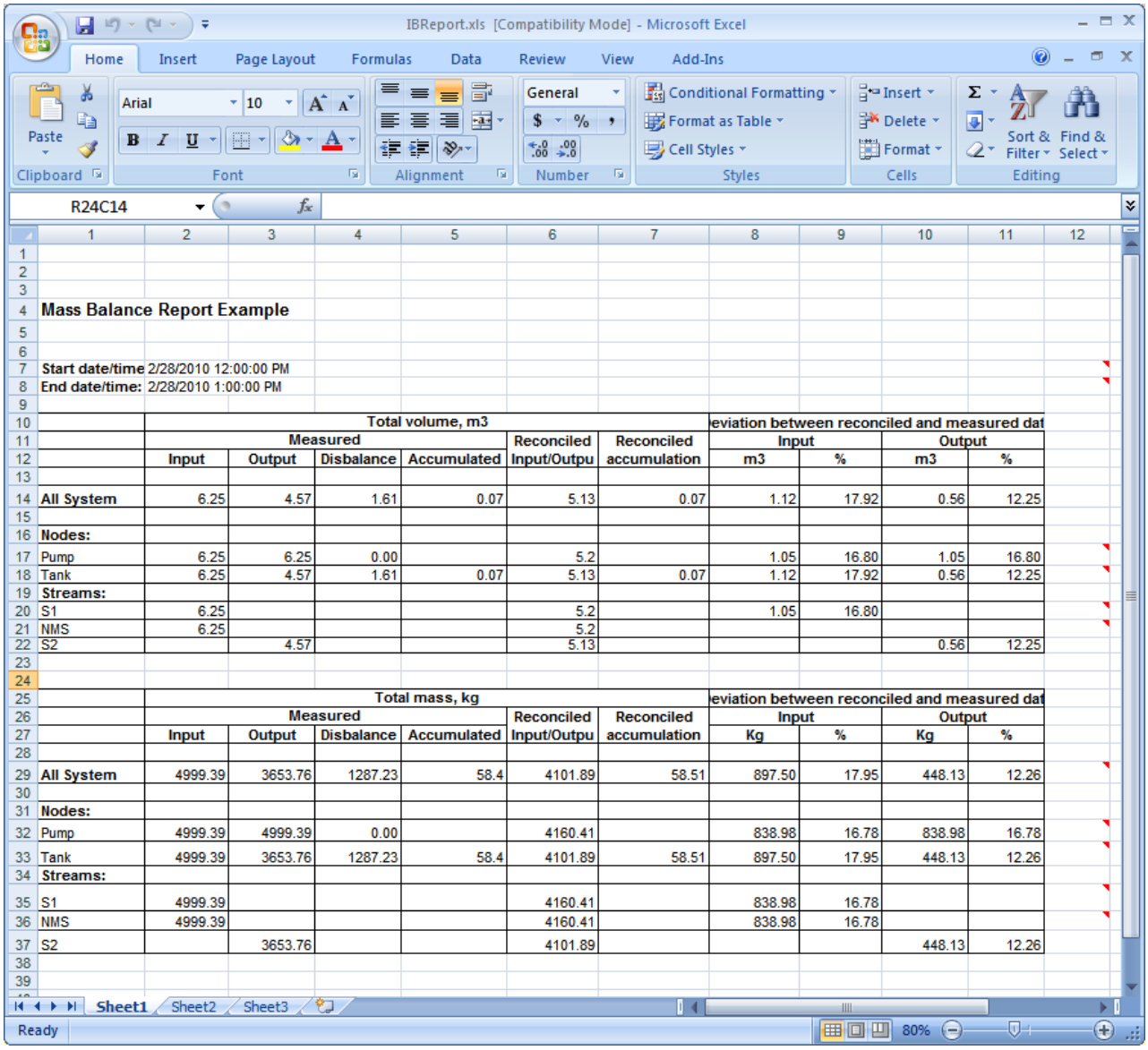
Reconciled data and gross errors

Average Flow and Reconciled Data:

Stream:	Average Flow:		Reconciled Value:	
	m3/day	*kg/day*	*m3/day*	*kg/day*
S1	149.98	119985	124.81	99850
NMS	149.98	119985	124.81	99850
S2	109.61	87690	123.06	98445

Gross Errors:

Stream:	
S1	YES!
NMS	NO
S2	YES!



IBReport.xls [Compatibility Mode] - Microsoft Excel

Mass Balance Report Example

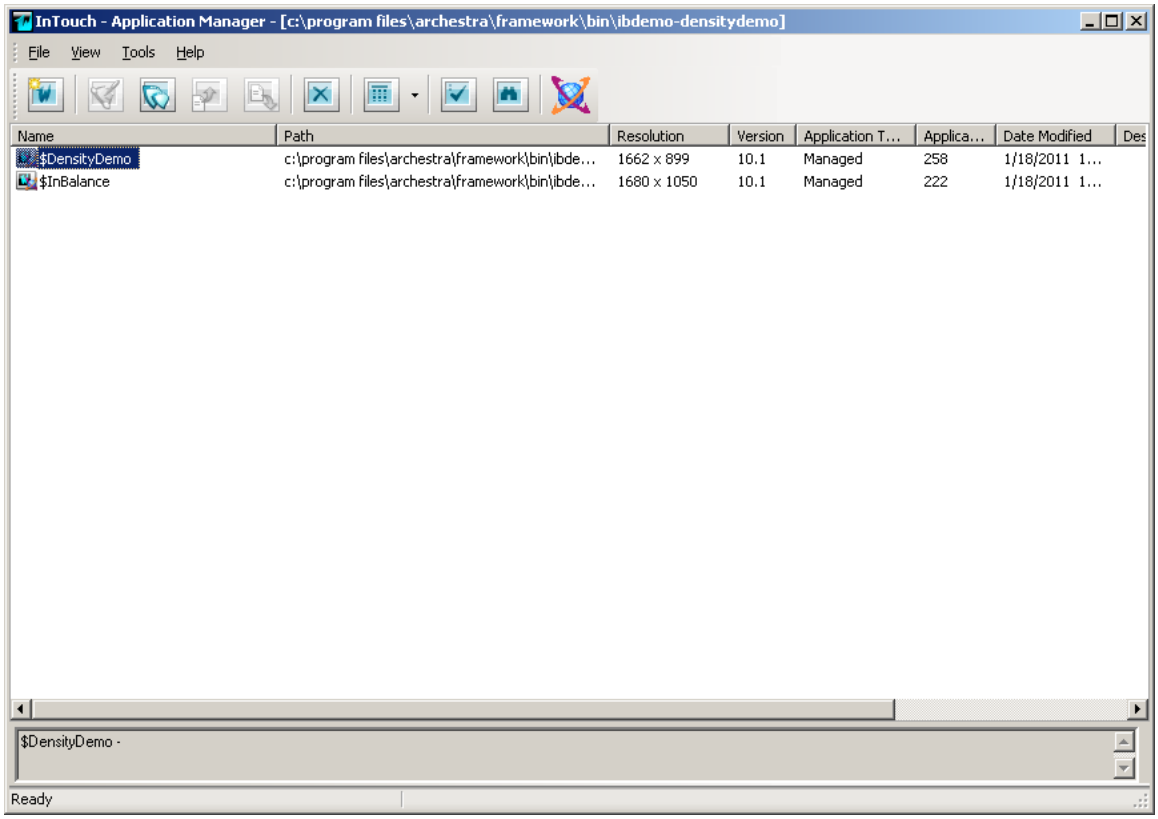
Start date/time 2/28/2010 12:00:00 PM
End date/time: 2/28/2010 1:00:00 PM

	Total volume, m3						eviation between reconciled and measured dat			
	Measured				Reconciled	Reconciled	Input		Output	
	Input	Output	Disbalance	Accumulated	Input/Outpu	accumulation	m3	%	m3	%
All System	6.25	4.57	1.61	0.07	5.13	0.07	1.12	17.92	0.56	12.25
Nodes:										
Pump	6.25	6.25	0.00		5.2		1.05	16.80	1.05	16.80
Tank	6.25	4.57	1.61	0.07	5.13	0.07	1.12	17.92	0.56	12.25
Streams:										
S1	6.25				5.2		1.05	16.80		
NMS	6.25				5.2					
S2		4.57			5.13				0.56	12.25

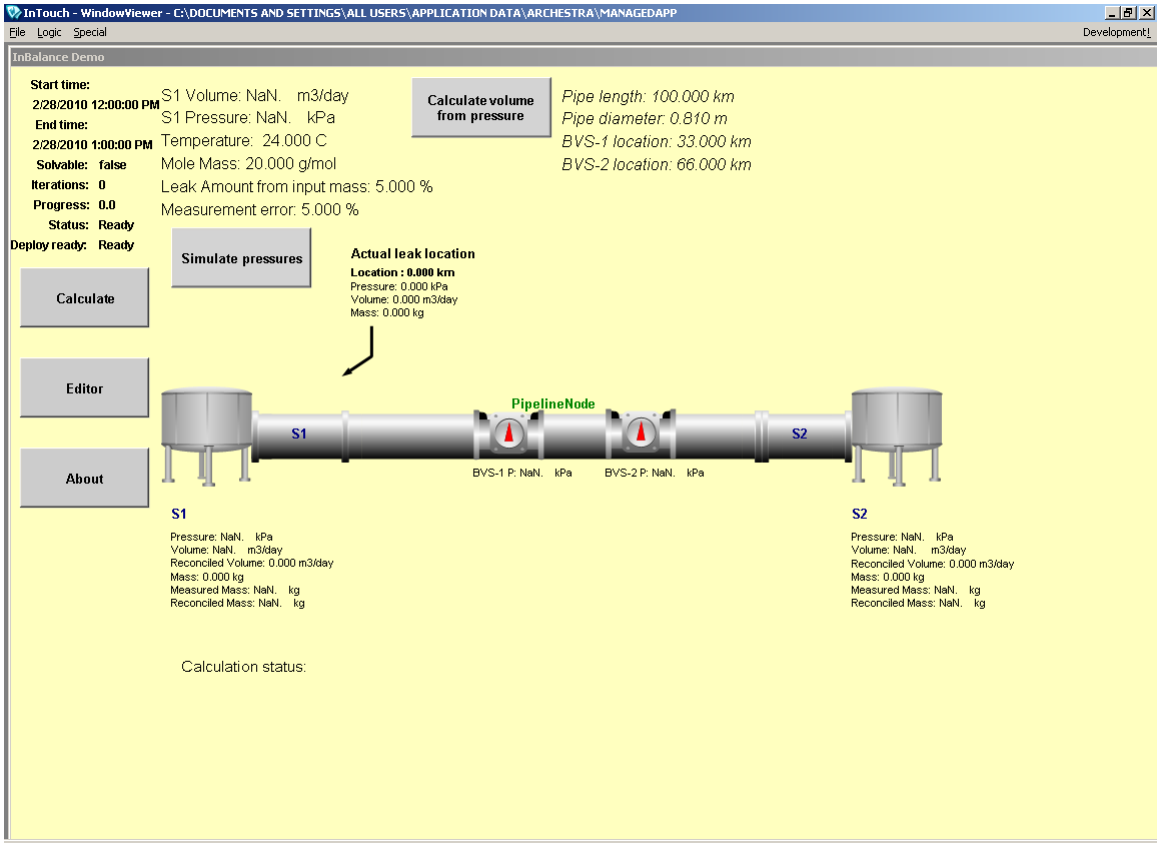
	Total mass, kg						eviation between reconciled and measured dat			
	Measured				Reconciled	Reconciled	Input		Output	
	Input	Output	Disbalance	Accumulated	Input/Outpu	accumulation	Kg	%	Kg	%
All System	4999.39	3653.76	1287.23	58.4	4101.89	58.51	897.50	17.95	448.13	12.26
Nodes:										
Pump	4999.39	4999.39	0.00		4160.41		838.98	16.78	838.98	16.78
Tank	4999.39	3653.76	1287.23	58.4	4101.89	58.51	897.50	17.95	448.13	12.26
Streams:										
S1	4999.39				4160.41		838.98	16.78		
NMS	4999.39				4160.41		838.98	16.78		
S2		3653.76			4101.89				448.13	12.26

Using model for gas leak detection

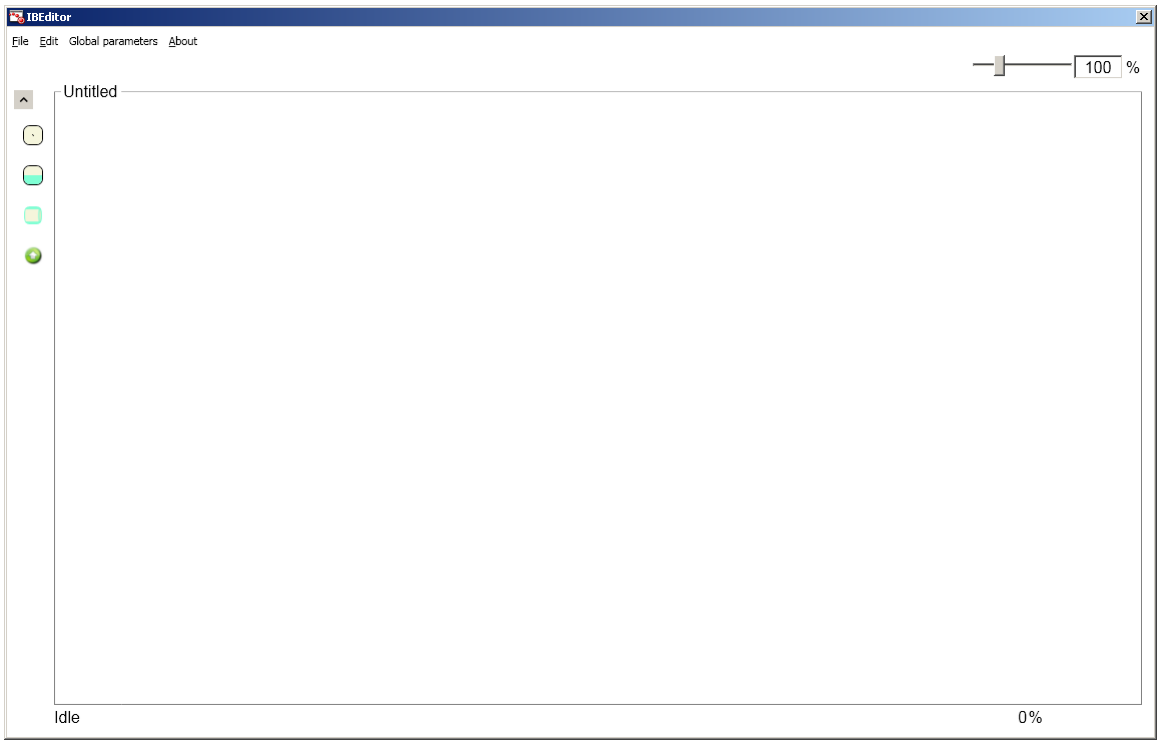
42. Now, let's use another demo model IBDensity.xml, demonstrating the InBalance gas pipeline leak detection feature. Start InTouch Application Manager, select the application $DensityDemo and start WindowViewer:



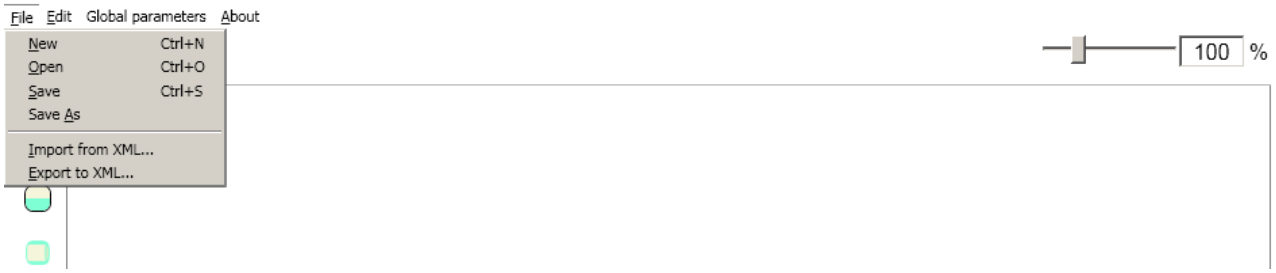
43. In the WindowViewer open the window “InBalance Demo”:



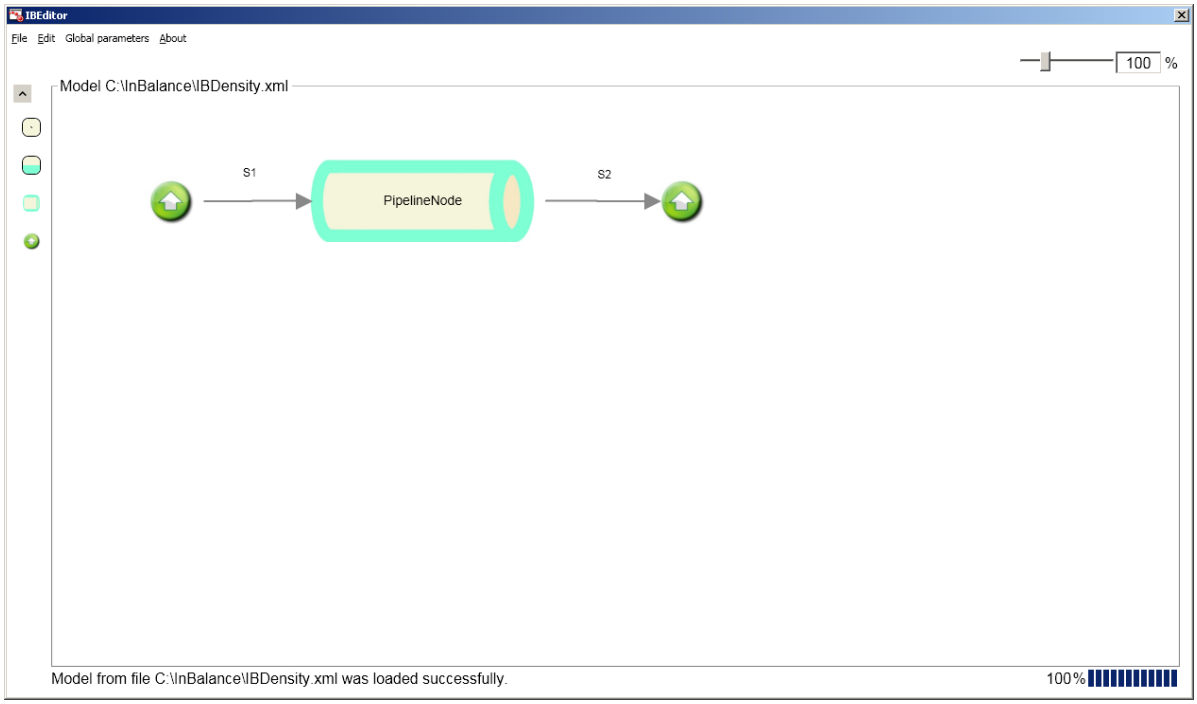
44. Click on the button “Editor” to start Model Editor:



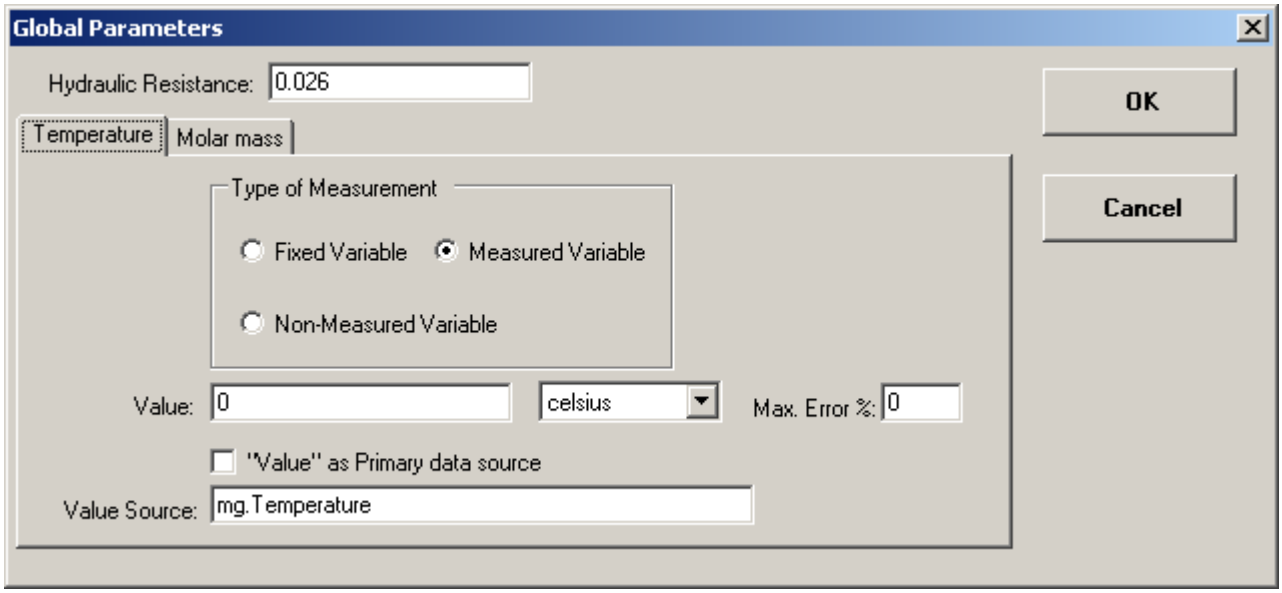
45. Select the menu command File ->Import from XML…

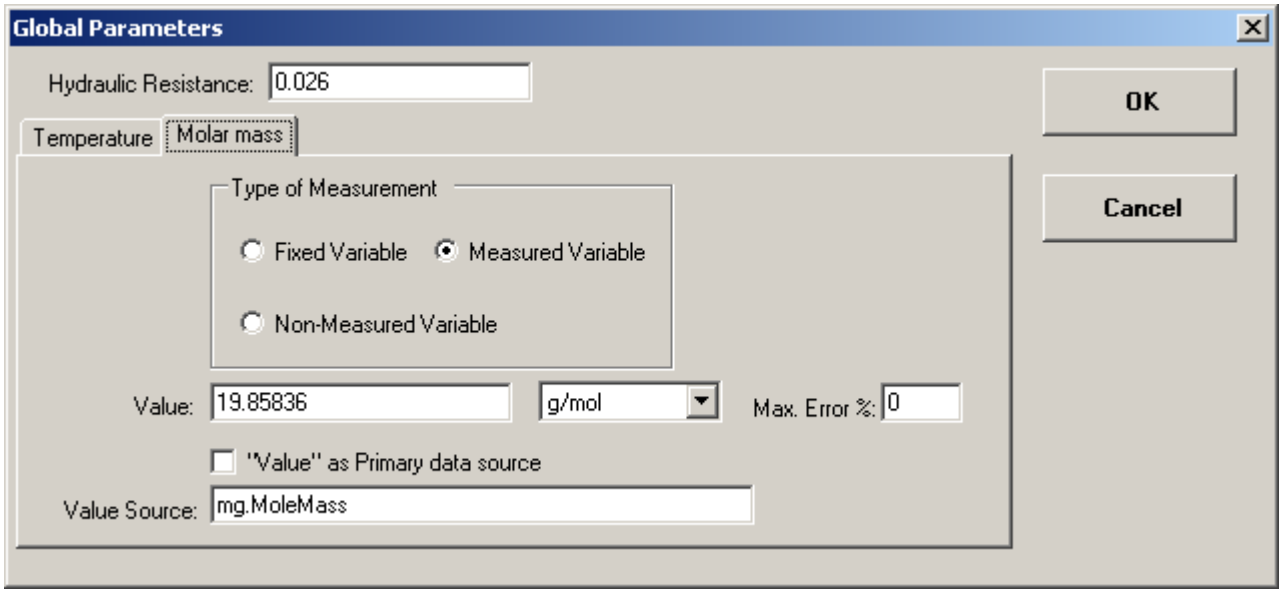


46. Browse for IBDensity.xml file and click the “Open” button. The IBDensity.xml demo model will appear on the model Editor window:

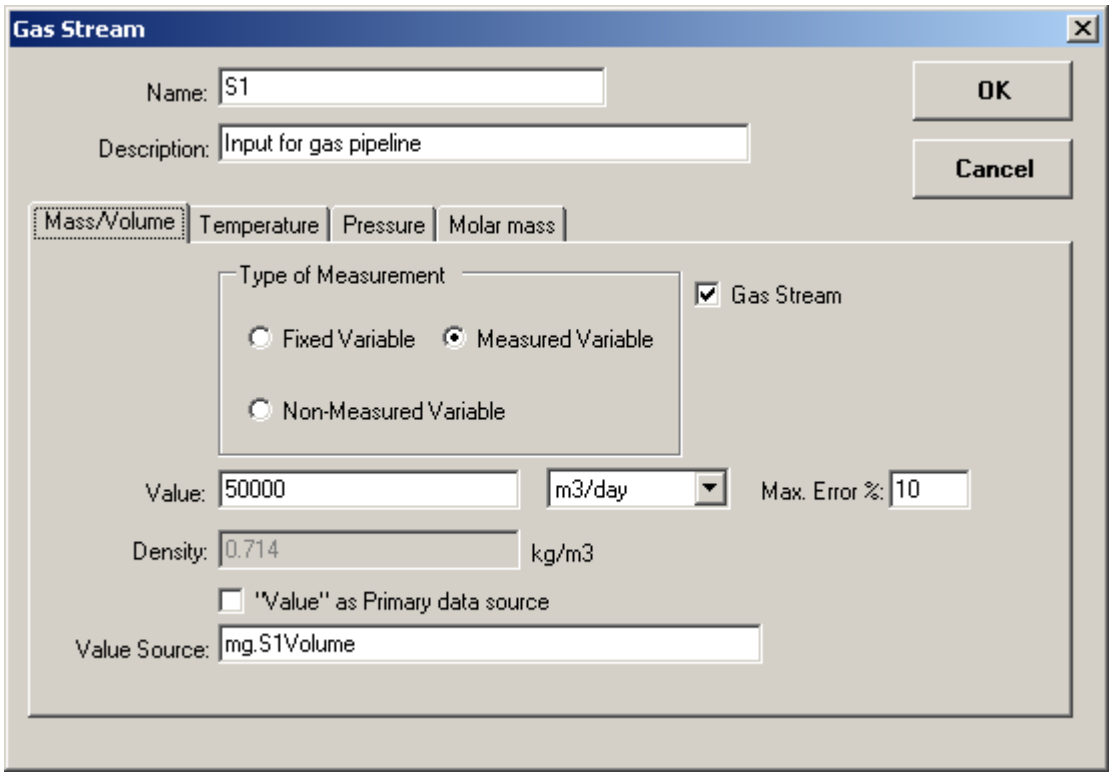


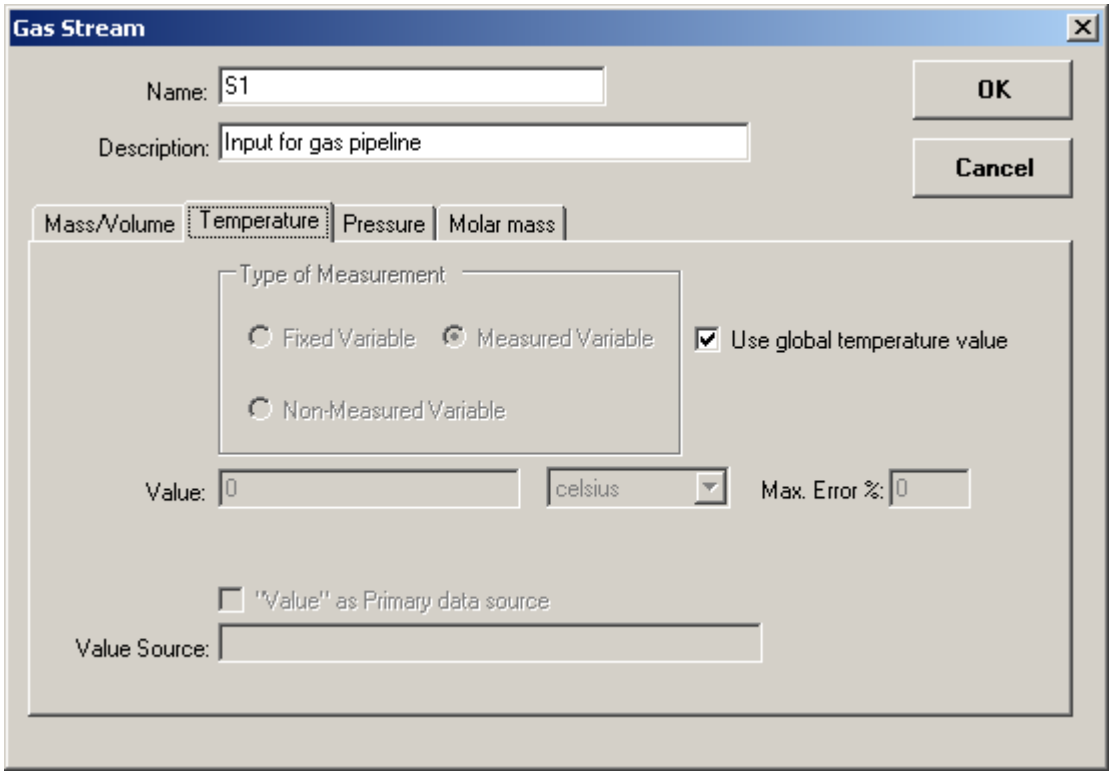
47. Select the menu command “Global parameters” and check the global parameter values:



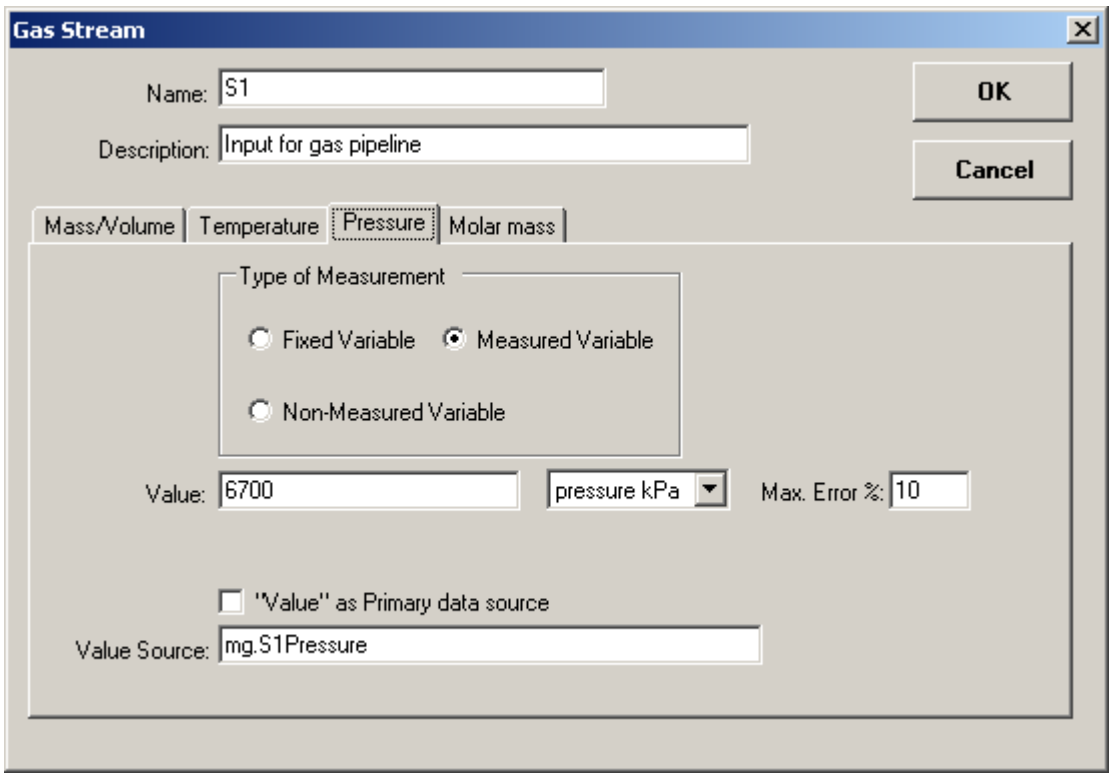


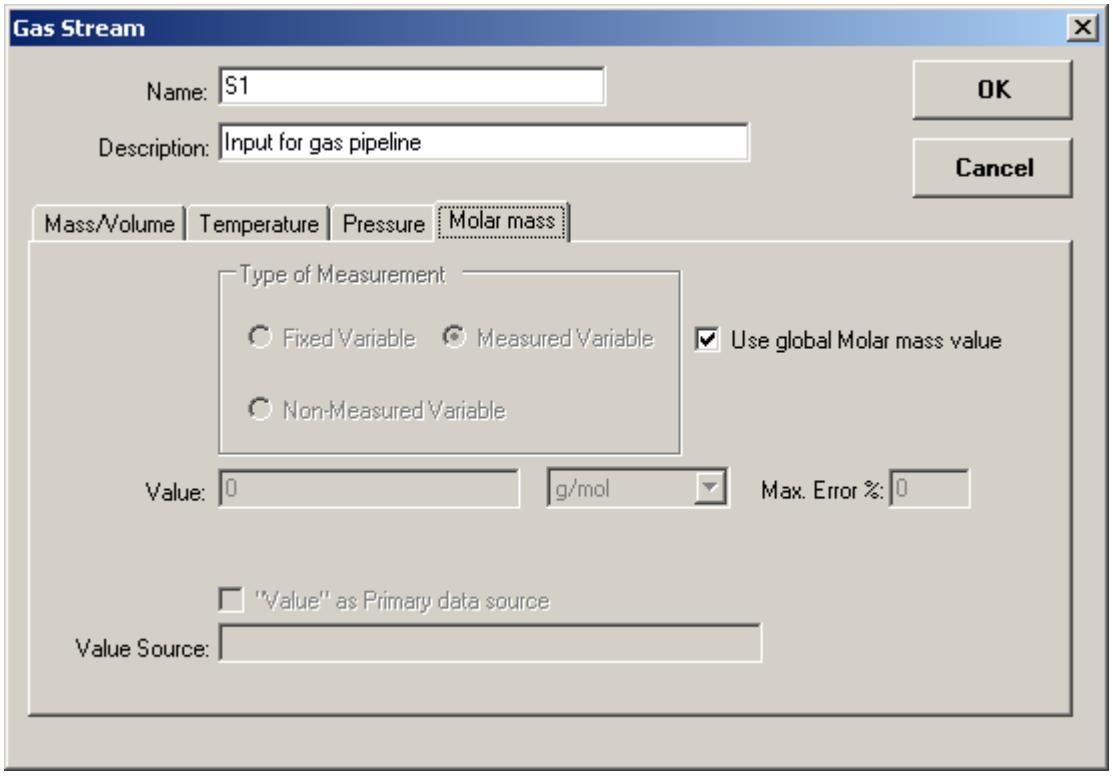
48. Double-click on the S1 stream and check the configuration:





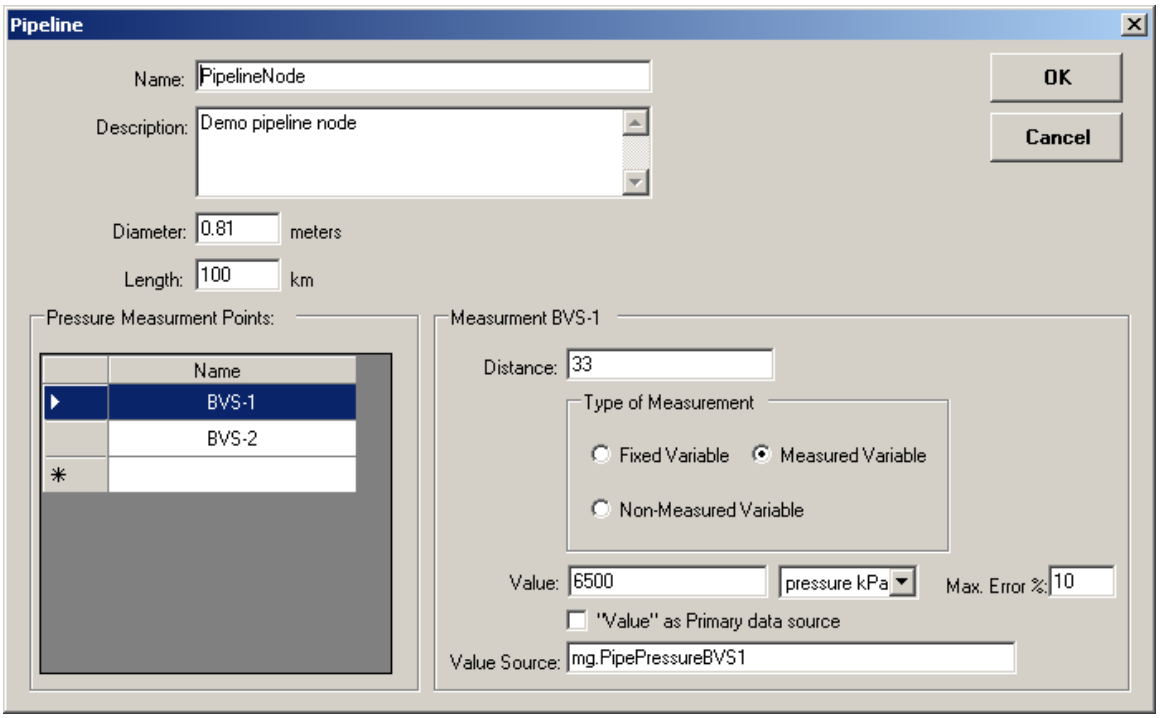
Set “Use global temperature value” checkbox means that for S1 stream calculation the temperature value will be taken from the Global parameters.

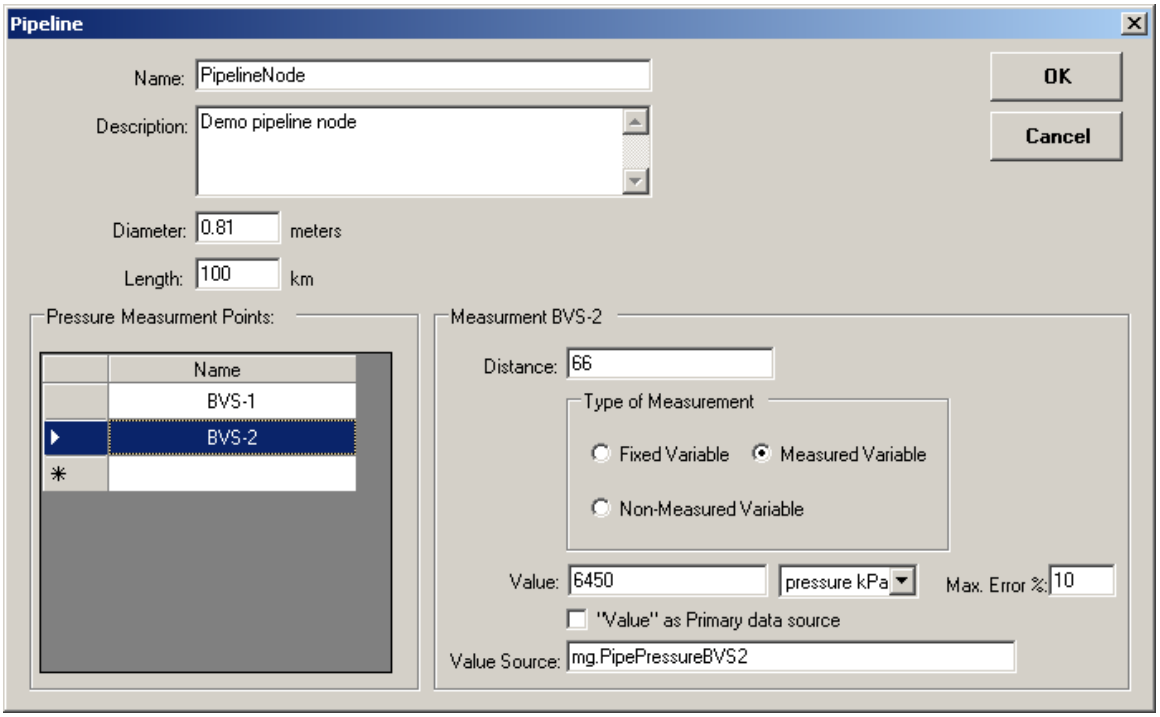




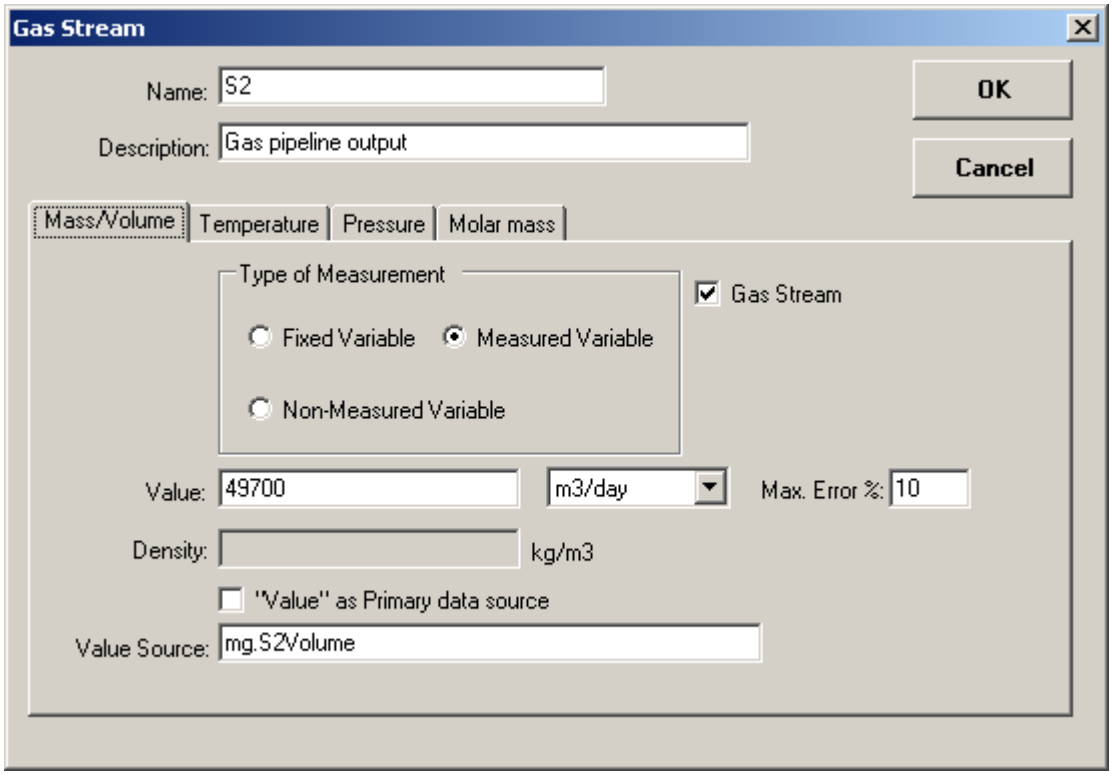
Set “Use global Molar mass value” checkbox means that for S1 stream calculation the molar mass value will be taken from the Global parameters.

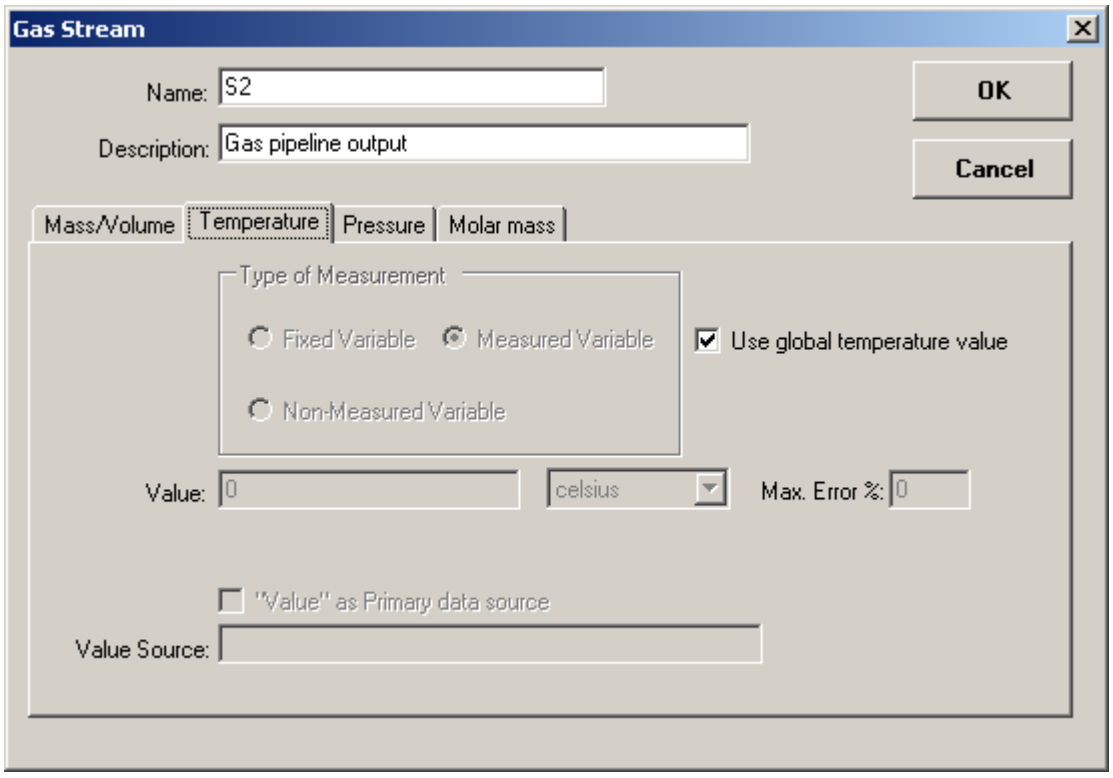
49. Double-click on the “PipelineNode” and check the configuration. The node has two configured pressure measurement points (block valve stations BVS-1 and BVS-2):

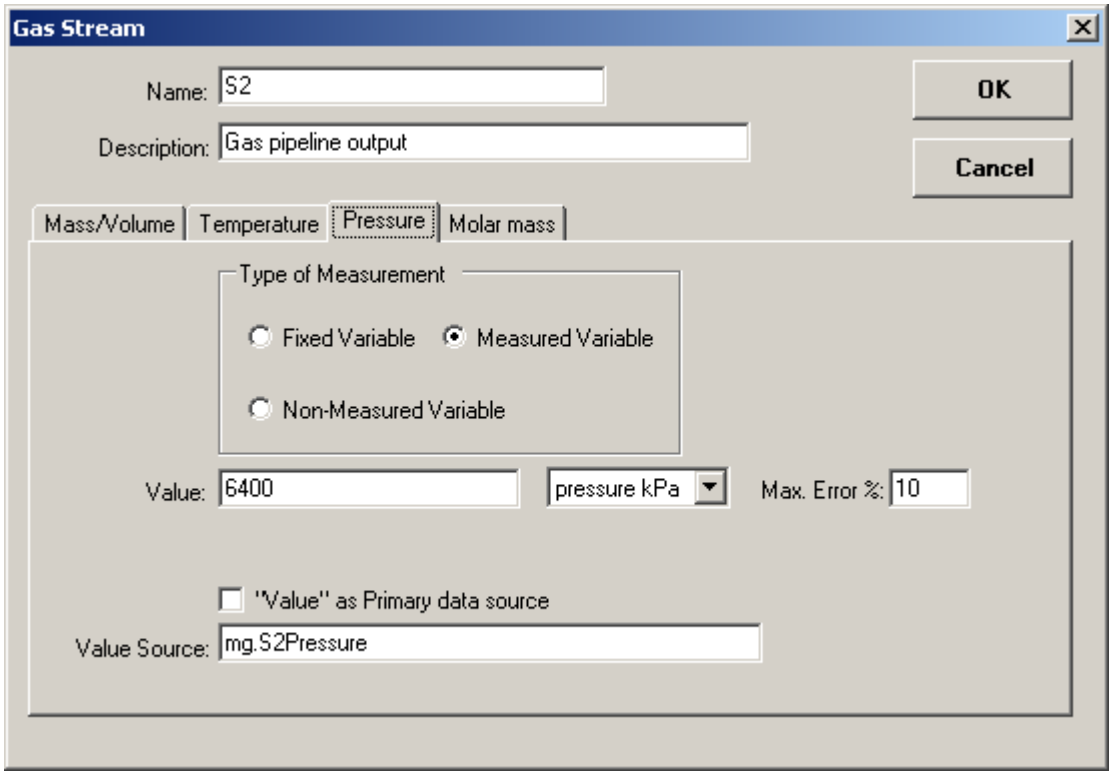


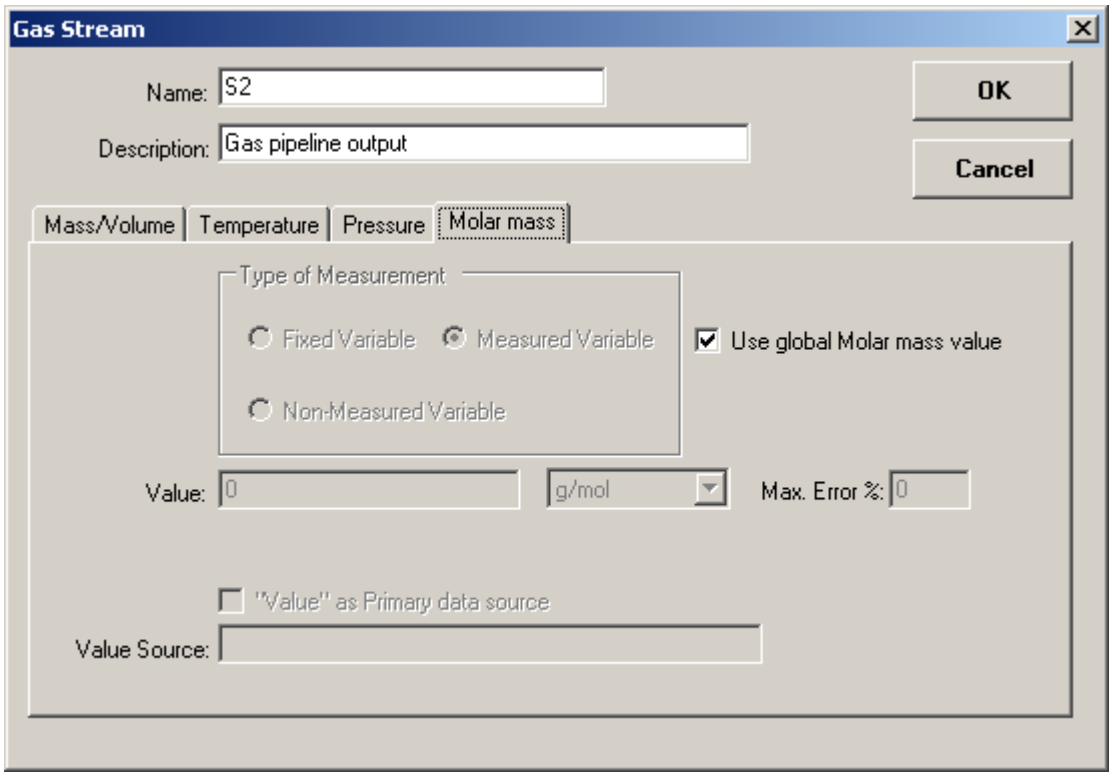


50. Double-click on the S2 stream and check the configuration:

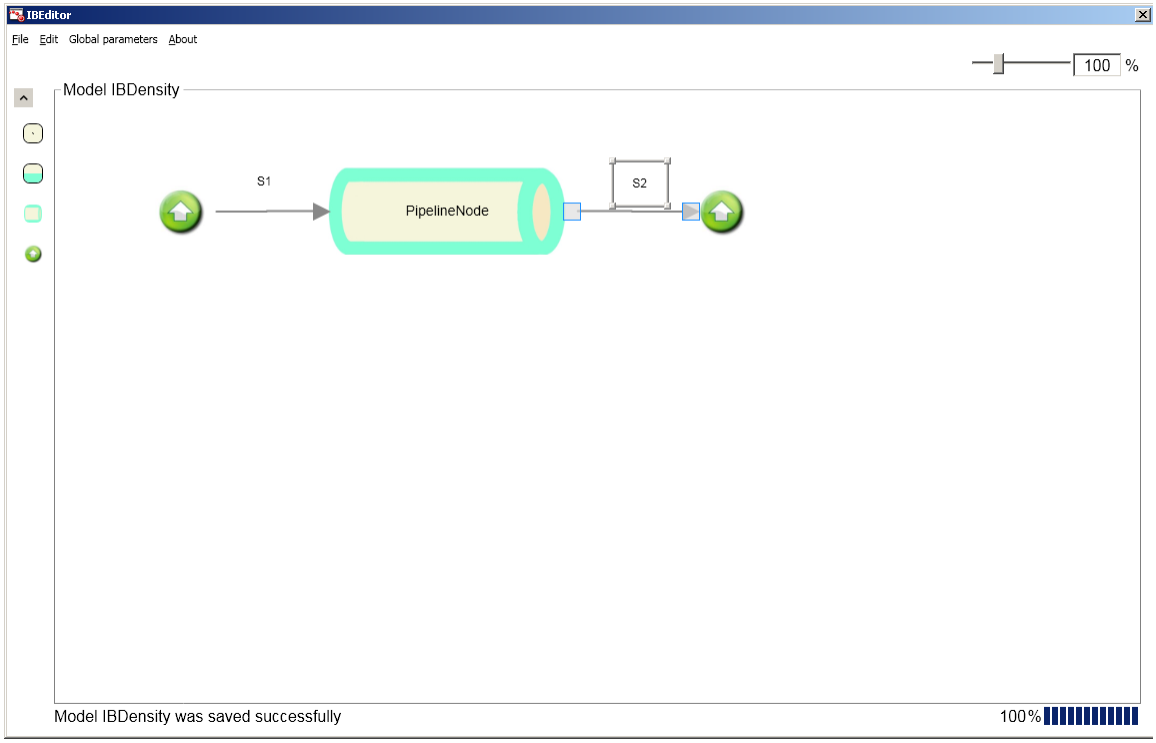

Gas Stream
Name: S2
Description: Gas pipeline output
OK
Cancel
Mass/Volume
Temperature
Pressure
Molar mass
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Gas Stream
Value: 49700
m3/day
Max. Error %: 10
Density:
kg/m3
"Value" as Primary data source
Value Source: mg.S2Volume


Gas Stream
Name: S2
Description: Gas pipeline output
OK
Cancel
Mass/Volume
Temperature
Pressure
Molar mass
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Use global temperature value
Value: 0
celsius
Max. Error %: 0
"Value" as Primary data source
Value Source:


Gas Stream
Name: S2
Description: Gas pipeline output
OK
Cancel
Mass/Volume
Temperature
Pressure
Molar mass
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Value: 6400
pressure kPa
Max. Error %: 10
"Value" as Primary data source
Value Source: mg.S2Pressure


Gas Stream
Name: S2
Description: Gas pipeline output
OK
Cancel
Mass/Volume
Temperature
Pressure
Molar mass
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Use global Molar mass value
Value: 0
g/mol
Max. Error %: 0
"Value" as Primary data source
Value Source:

51. Select the menu command File -> Save As and save the model as a new model with name “IBDensity” to the internal MS SQL database. After saving the Model Editor window will have a following look:



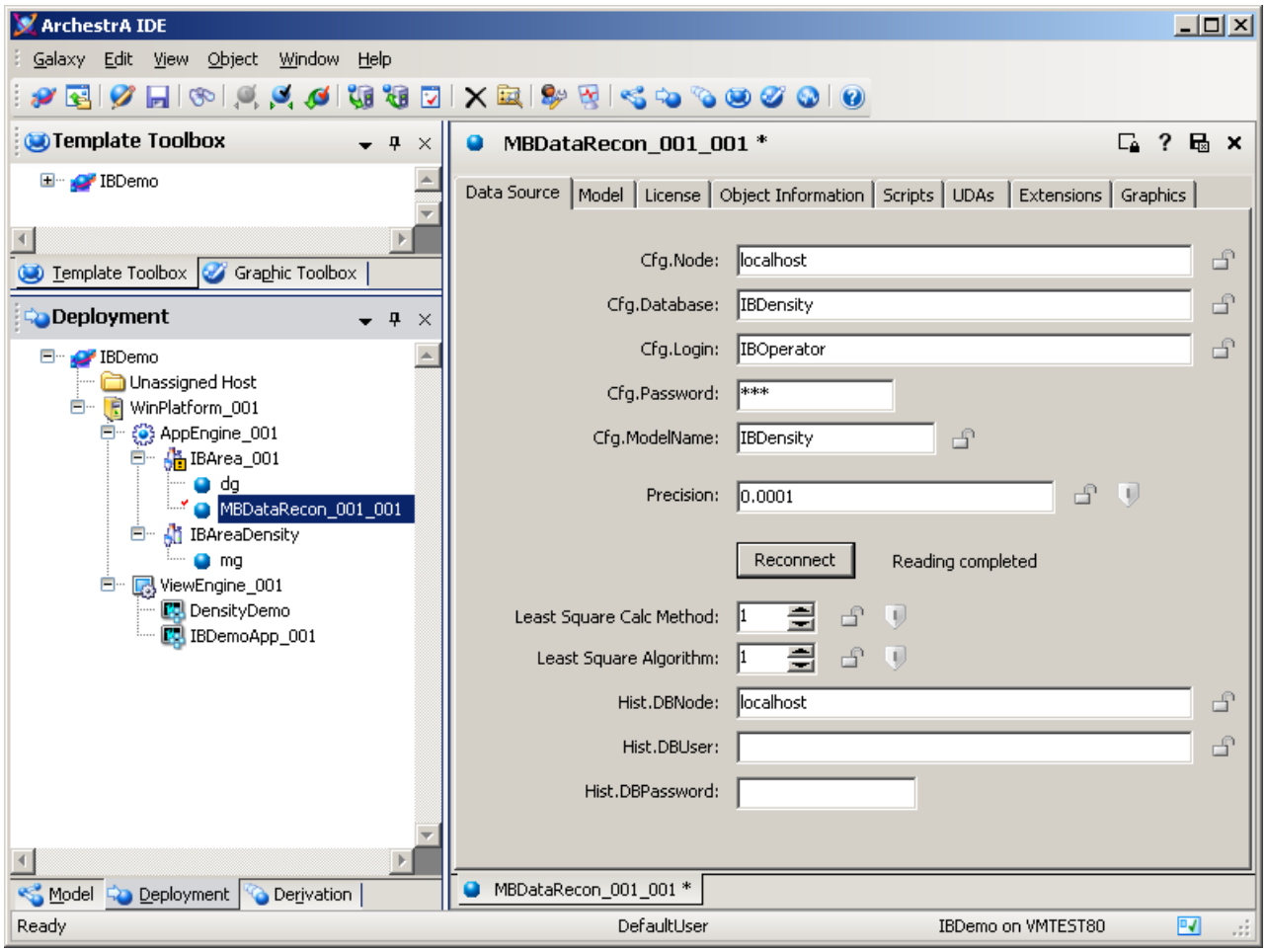
52. Close the Model Editor.

53. Start ArchestrA IDE and open the Calculator configuration editor, by double-clicking the instance MBDataRecon_001_001.

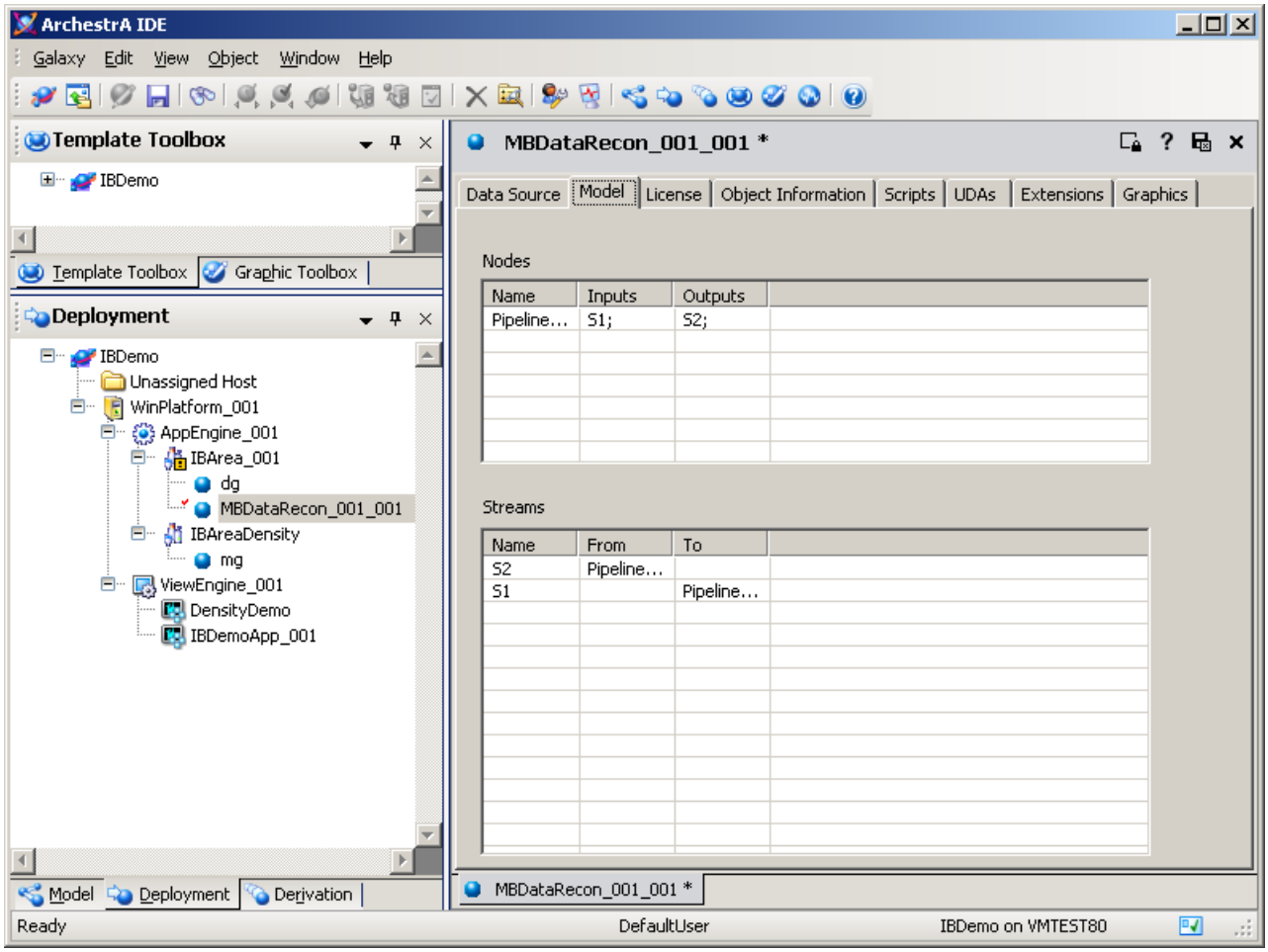
54. Enter following Calculator configuration for IBDensity model:

- Cfg.Node: enter the computer name where InBalance internal MS SQL database is located in our case (“localhost”).
- Cfg.Database: enter the model database name (“IBDensity”).
- Cfg.Login: enter the username for operator user, who has access rights to read the model (“IBOperator”).
- Cfg.Password: enter the password for operator, who has access rights to read the model (“123”).
- Cfg.ModelName: enter the model name (“IBDensity”).

Click on the “Reconnect” button to read the model configuration from internal MS SQL database.



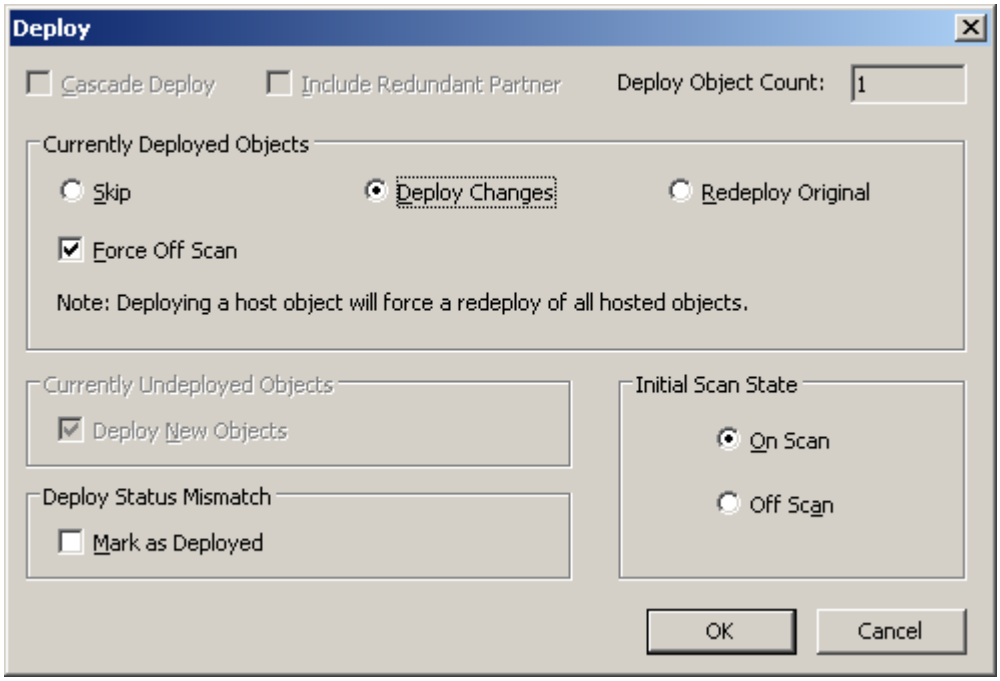
55. Check whether the model is loaded correctly – select the “Model” tab:

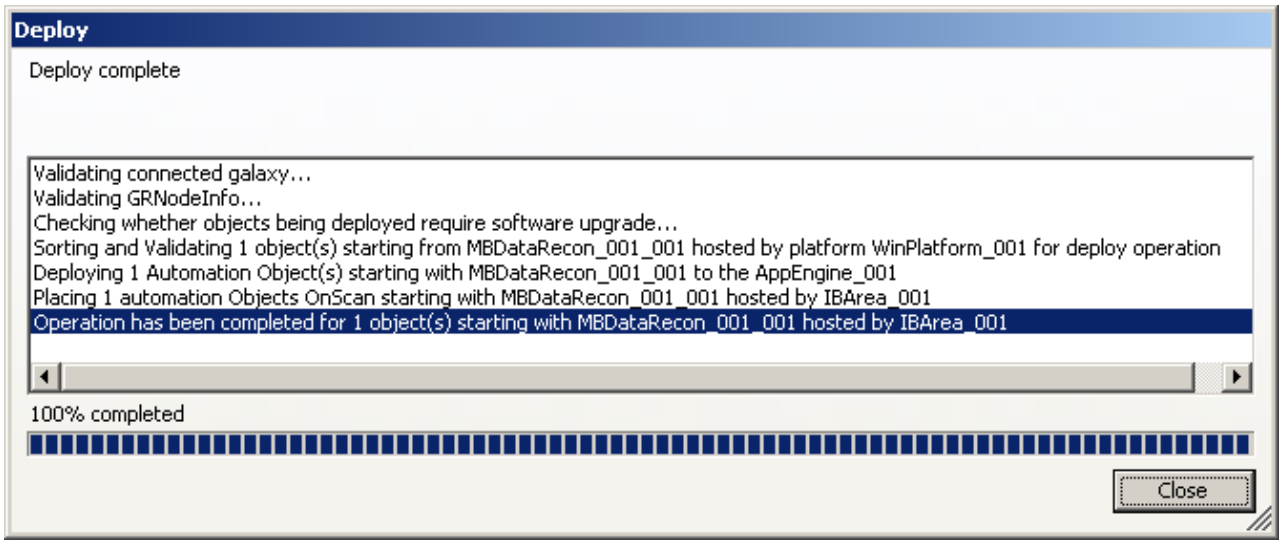


If there are no any nodes and streams loaded then check “Data source” tab configuration and Wonderware (SMC) logger for possible failure reason.

56. Save and close the MBDataRecon_001_001 configuration by clicking on the icon  , located at the top right corner of the configuration editor.

57. Right-click MBDataRecon_001_001 and deploy it, using following settings:


Deploy
Cascade Deploy
Include Redundant Partner
Deploy Object Count:
1
Currently Deployed Objects
Skip
Deploy Changes
Redeploy Original
Force Off Scan
Note: Deploying a host object will force a redeploy of all hosted objects.
Currently Undeployed Objects
Deploy New Objects
Deploy Status Mismatch
Mark as Deployed
Initial Scan State
On Scan
Off Scan
OK
Cancel

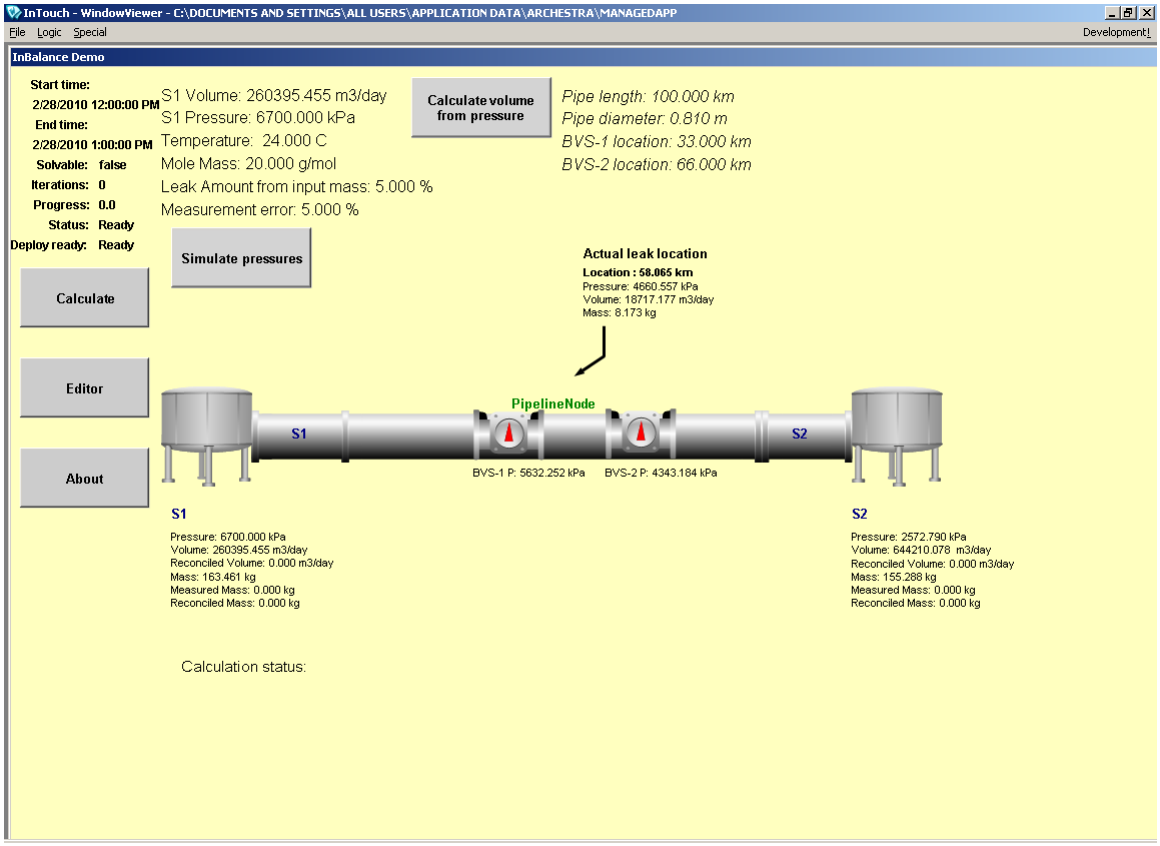

Deploy
Deploy complete
Validating connected galaxy...
Validating GRNodeInfo...
Checking whether objects being deployed require software upgrade...
Sorting and Validating 1 object(s) starting from MBDataRecon_001_001 hosted by platform WinPlatform_001 for deploy operation
Deploying 1 Automation Object(s) starting with MBDataRecon_001_001 to the AppEngine_001
Placing 1 automation Objects OnScan starting with MBDataRecon_001_001 hosted by IBArea_001
Operation has been completed for 1 object(s) starting with MBDataRecon_001_001 hosted by IBArea_001
100% completed
Close

58. Return to the InTouch application. The IBDensity demo model now is ready for use. The data reconciliation, mass and volume balance calculation, visualization now can be done from the InTouch “InBalance Demo” window.

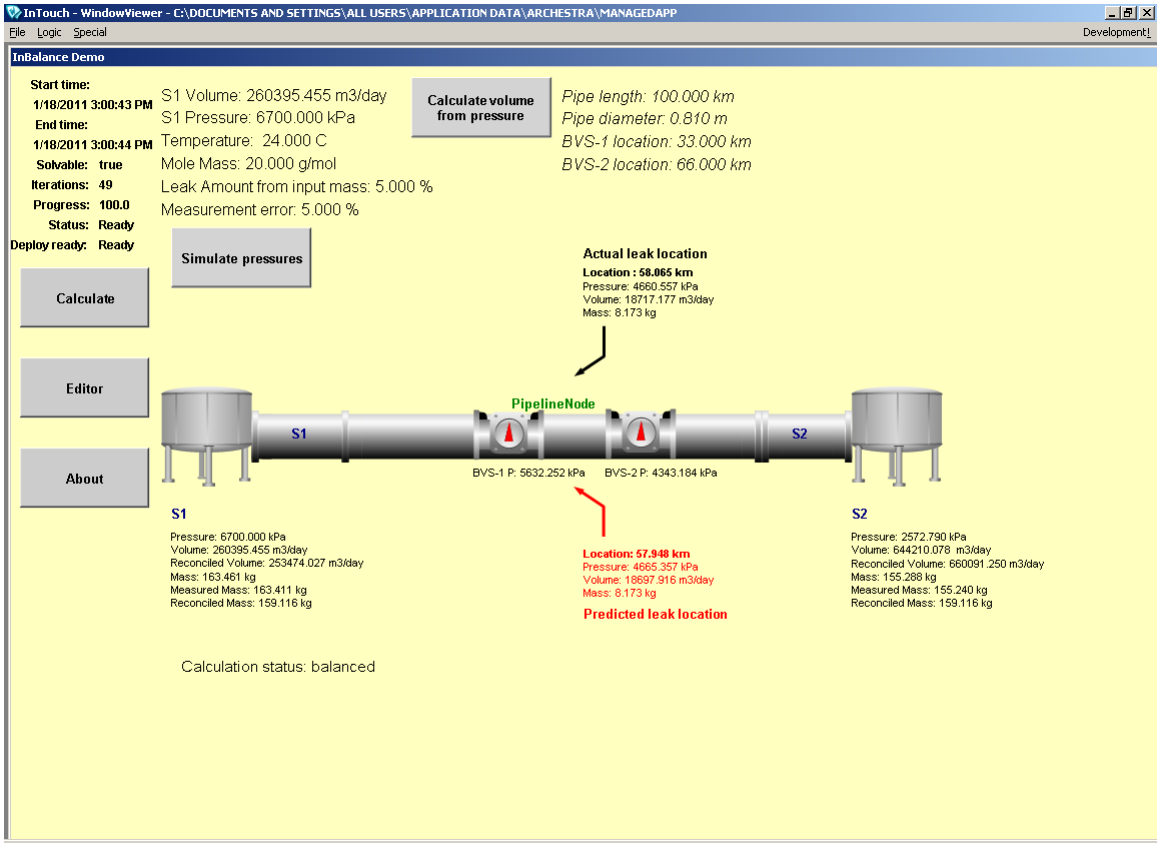
59. Click on the “S1 Pressure” field and enter value 6700 kPa.

60. Click on the button “Calculate volume from pressure”, to calculate “S1 Volume”.

61. Move the “Actual leak location” slider between the pipeline endpoints.



62. Click on the button “Calculate” to calculate reconciled gas mass and volume. Predicted leak location is displayed with red arrow under PipelineNode.


InTouch - WindowViewer - C:\DOCUMENTS AND SETTINGS\ALL USERS\APPLICATION DATA\ARCHESTRA\MANAGEDAPP
File Logic Special
Development
InBalance Demo
Start time:
1/18/2011 3:00:43 PM
End time:
1/18/2011 3:00:44 PM
Solvable: true
Iterations: 49
Progress: 100.0
Status: Ready
Deploy ready: Ready
S1 Volume: 260395.455 m3/day
S1 Pressure: 6700.000 kPa
Temperature: 24.000 C
Mole Mass: 20.000 g/mol
Leak Amount from input mass: 5.000 %
Measurement error: 5.000 %
Calculate volume from pressure
Pipe length: 100.000 km
Pipe diameter: 0.810 m
BVS-1 location: 33.000 km
BVS-2 location: 66.000 km
Simulate pressures
Actual leak location
Location : 58.065 km
Pressure: 4660.557 kPa
Volume: 18717.177 m3/day
Mass: 8.173 kg
Calculate
Editor
About
PipelineNode
S1
S2
BVS-1 P: 5632.252 kPa
BVS-2 P: 4343.184 kPa
S1
Pressure: 6700.000 kPa
Volume: 260395.455 m3/day
Reconciled Volume: 253474.027 m3/day
Mass: 163.461 kg
Measured Mass: 163.411 kg
Reconciled Mass: 159.116 kg
Location: 57.948 km
Pressure: 4665.357 kPa
Volume: 18697.916 m3/day
Mass: 8.173 kg
Predicted leak location
S2
Pressure: 2572.790 kPa
Volume: 644210.078 m3/day
Reconciled Volume: 660091.250 m3/day
Mass: 155.288 kg
Measured Mass: 155.240 kg
Reconciled Mass: 159.116 kg
Calculation status: balanced

Model Editor

The Model Editor is used to create a model consisting of nodes and streams. The Model Editor is implemented as an ArchestrA symbol (internally named IBEditor), inserted in an InTouch application.

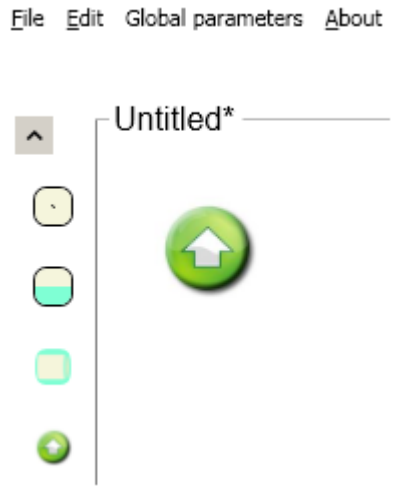
There are four node elements available (located on toolset at upper left corner of the Model Editor window):

- ”normal” node;
- ”storage” node;
- “pipeline” node;
- ”environment” node (external source or destination from/to material is coming to or moving out from system; e.g. oil well or consumer facility).

Adding model elements

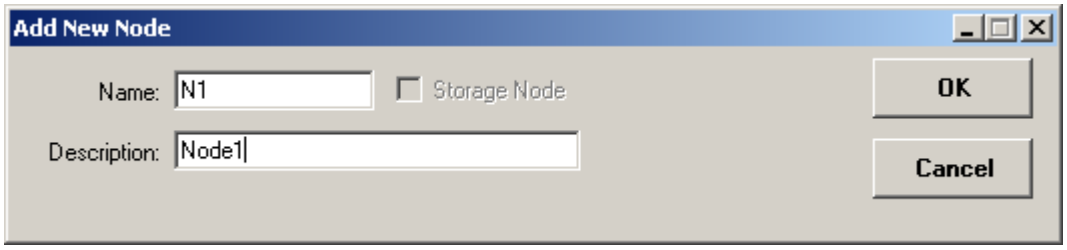
Environment node

Select the “environment” node from toolset and drag-drop it to necessary location on the model:

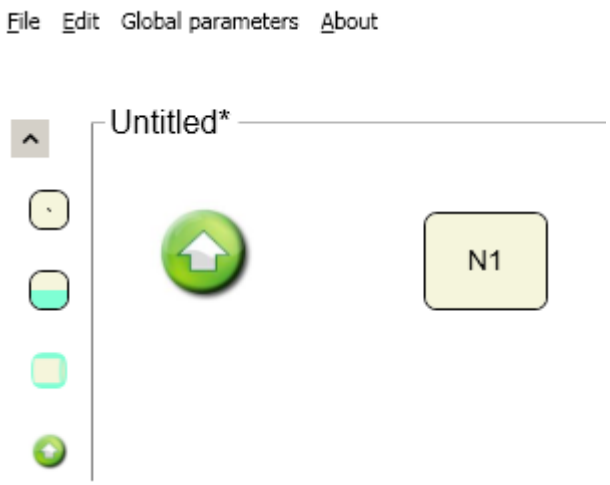


Normal node

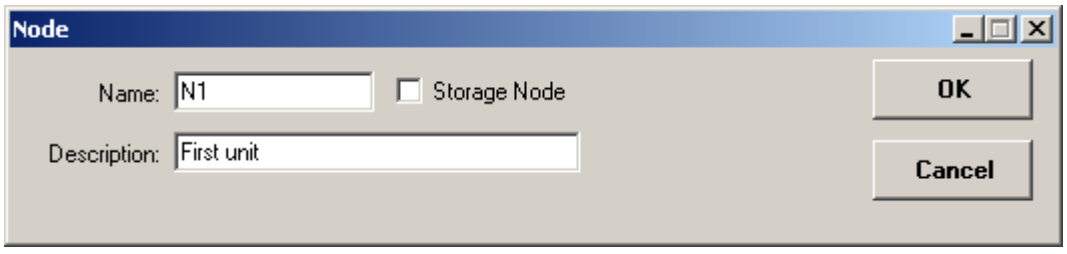
Select the “normal” node from toolset and drag-drop it to necessary location on the model. The ”Add New Node” configuration dialog will be displayed:



Enter the node **Name** and **Description** (optional) and click on the OK - new node is added to the model:

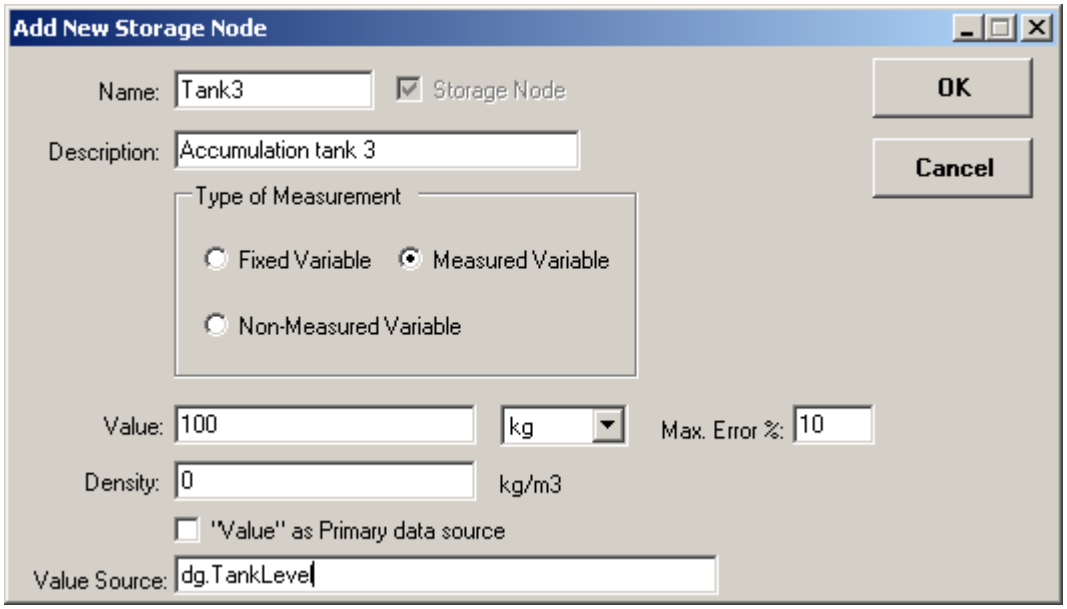


The node can be moved to other location by using mouse or keyboard arrow keys; it is also possible to resize the node object by using mouse. Already created node can be edited by double clicking on it and entering new parameters in the ”Node” configuration dialog:



Storage node

Select the “normal” node from toolset and drag-drop it to necessary location on the model. The ”Add New Storage Node” configuration dialog will be displayed:



Name
Node name.

Description
Node description (optional).

Type of Measurement
The available selections are ”Fixed” (errorless), ”Non-Measured” and ”Measured”,

Value
For ”Fixed” and ”Measured” types the accumulation value (storage difference for defined time period) can be entered manually; for ”Measured” type the ”Value” will be used in calculation only in case the””Value” as Primary data source” is checked.

Max. Error %
The measurement precision in %.

Density
Density can be used in case the measured data is not in kg, allowing to calculate the accumulation from stored in Historian measured data or from manually entered value.

”Value” as Primary data source
If checked then manually entered ”Value” will be used in calculation. If not checked then calculation will use stored in Historian measured data.

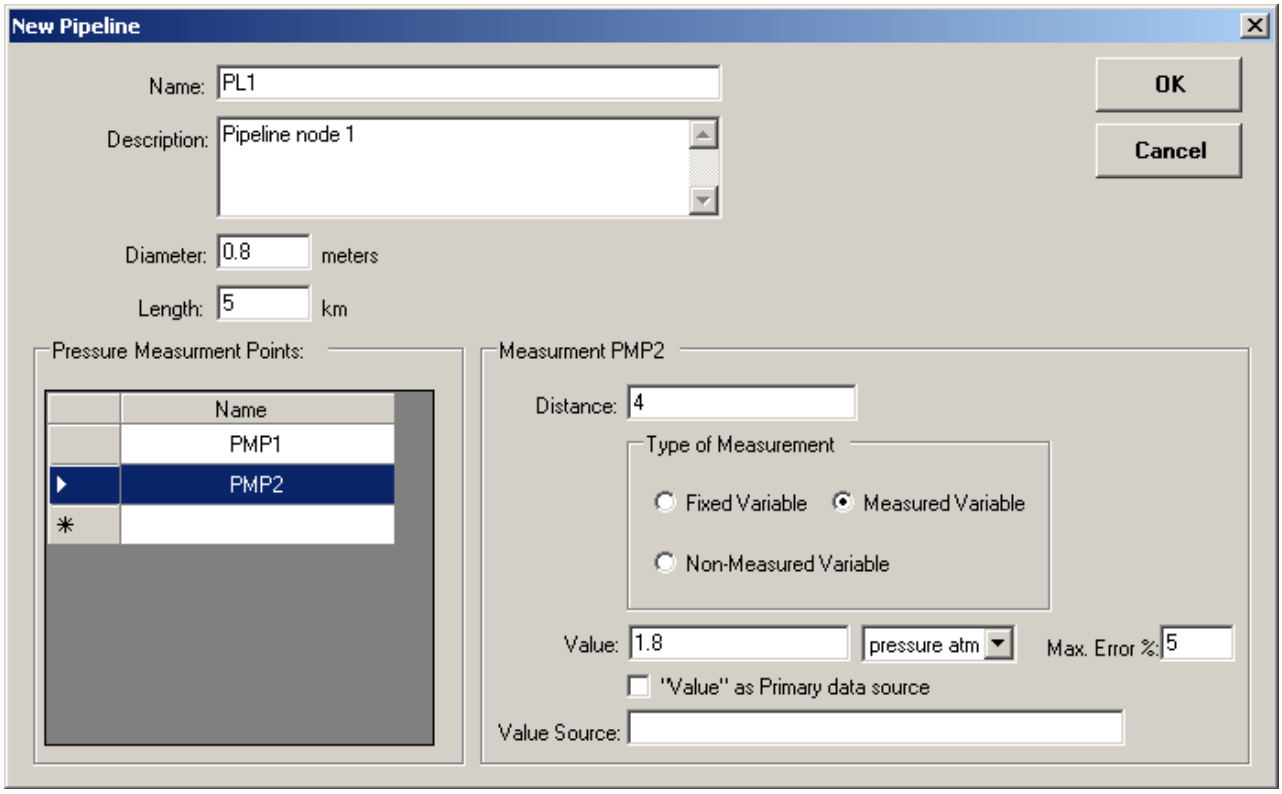
Value Source
The Historian tagname used to store the measured data for this storage node.

- After clicking ”OK” button, new ”storage” node is created and added to the model:

Pipeline node

Pipeline node is used to configure the pipeline parameters, necessary for leak location detection in gas pipelines. The pipeline node should have one incoming and one outgoing stream.

Select the “pipeline” node from the toolset and drag-drop it to necessary location on the model. A ”New Pipeline” configuration dialog will be displayed:



Name
Node name.

Description
Node description (optional).

Diameter
Pipeline diameter.

Length
Pipeline length.

Pressure Measurement Points
In order to detect a gas leak, at least 2 pressure measurement points (PMP) should be defined for a pipeline node. These PMPs should not be located at the beginning and at the end of the pipeline. The pressures for the beginning and the end of the pipeline will be obtained from the incoming and outgoing streams respectively. To define a PMP, first enter the name, then define the rest of the parameters. There are following parameters:

Distance
Distance of the PMP from the beginning of the pipeline (km).

Type of Measurement
The available selections are ”Fixed” (errorless), ”Non-Measured” and ”Measured”.

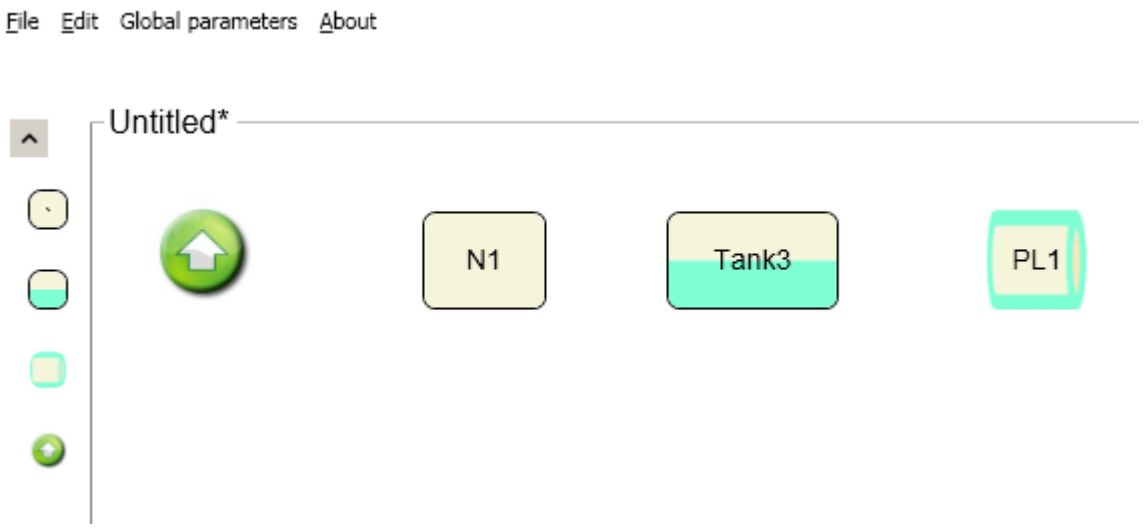
Value
For ”Fixed” and ”Measured” types the measurement value can be entered manually; for ”Measured” type the ”Value” will be used in calculation only in case the””Value” as Primary data source” is checked.

Max. Error %
The measurement precision in %.

”Value” as Primary data source
If checked, then manually entered ”Value” will be used in calculation. If not checked, then calculation will use measured data, stored in Historian.

Value Source
The Historian tagname used to store the measured data for this node.

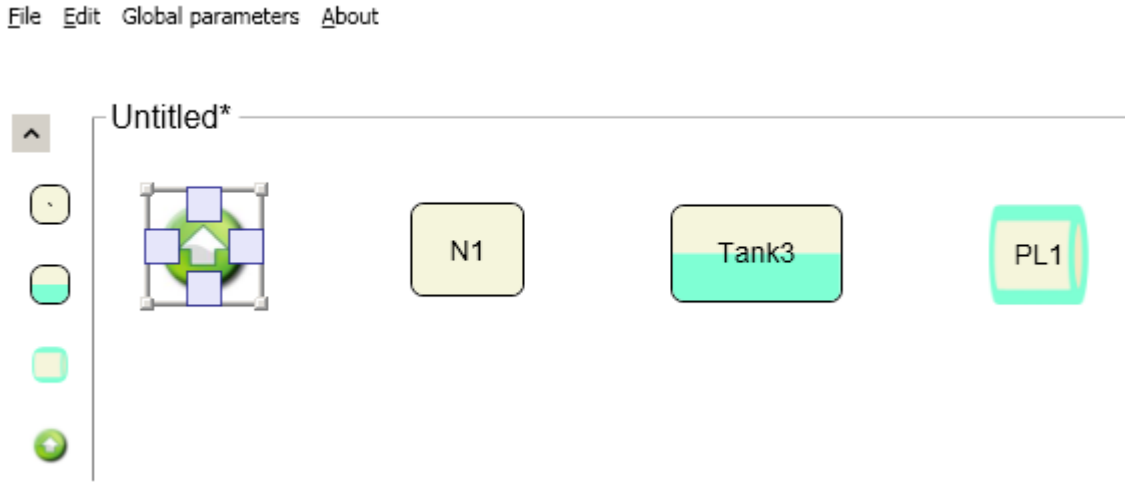
After clicking ”OK” button, new ”pipeline” node is created and added to the model.



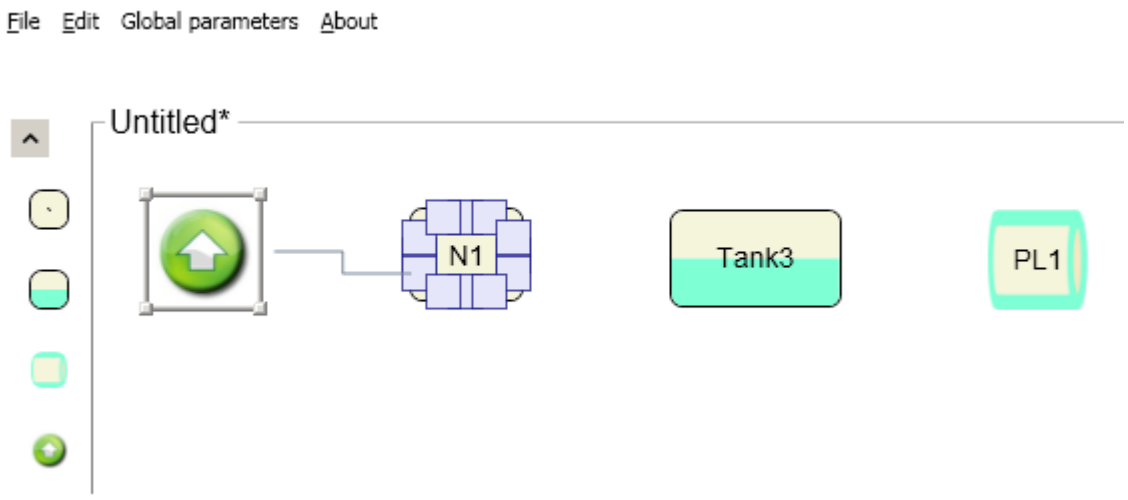
Stream

Stream is connecting two already created nodes. To create a new stream:

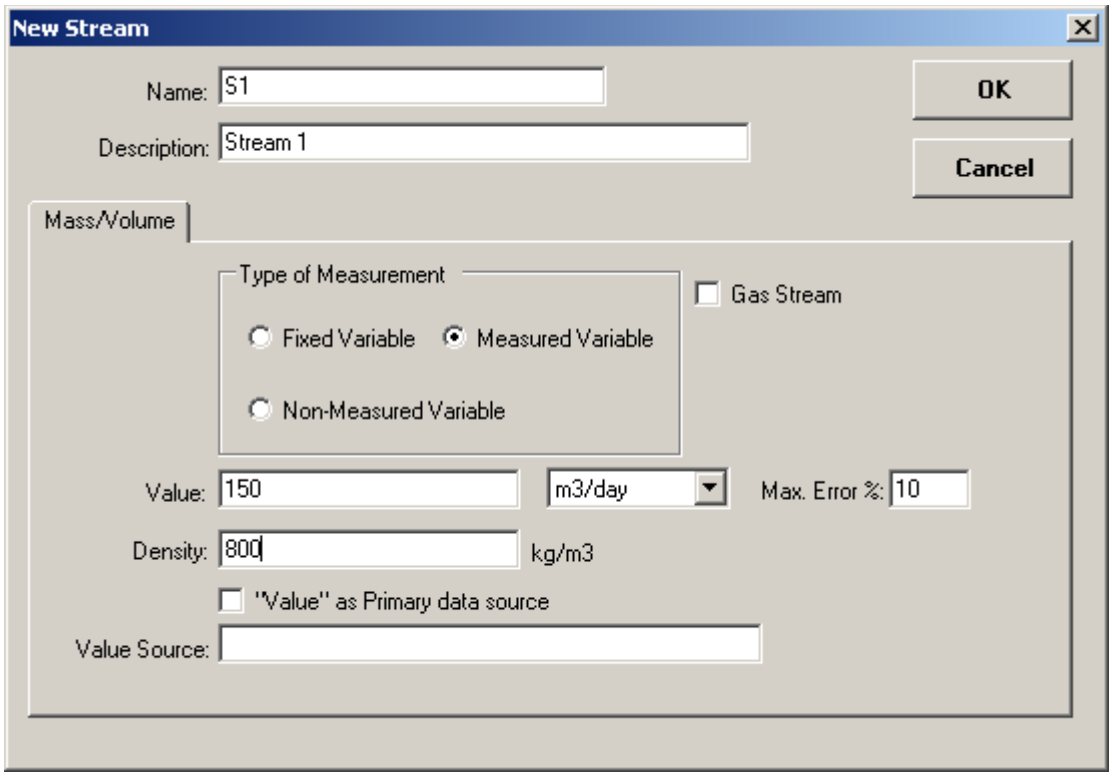
- Select source node (“environment” node in picture below) and connection points (connectors) will appear (“environment” node has 4 connectors); place mouse pointer on one of connectors and press mouse left button:



- By holding left mouse button, drag connection over the destination node:



- Select one of the connectors on the destination node and release mouse left button – the „New Stream” dialog box will be displayed:



Name
Stream name.

Description
Stream description (optional).

Type of Measurement
The available selections are ”Fixed” (errorless), ”Non-Measured” and ”Measured”,

Value
For ”Fixed” and ”Measured” types the measurement value can be entered manually; for ”Measured” type the ”Value” will be used in calculation only in case the””Value” as Primary data source” is checked.

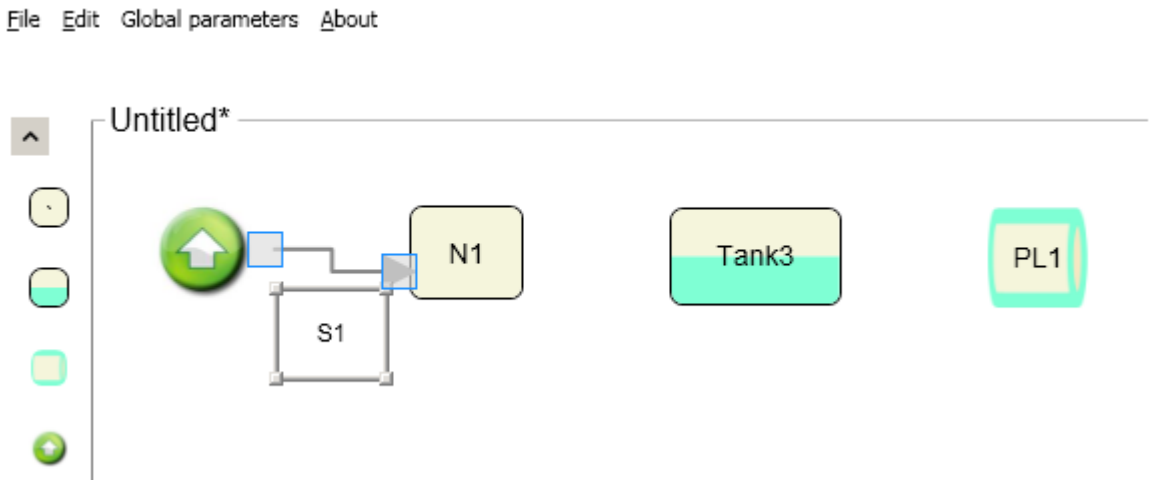
Max. Error %
The measurement precision in %.

Density
Density can be used in case the measured data is not in kg/s allowing to calculate mass from stored in Historian measured data or from manually entered data.

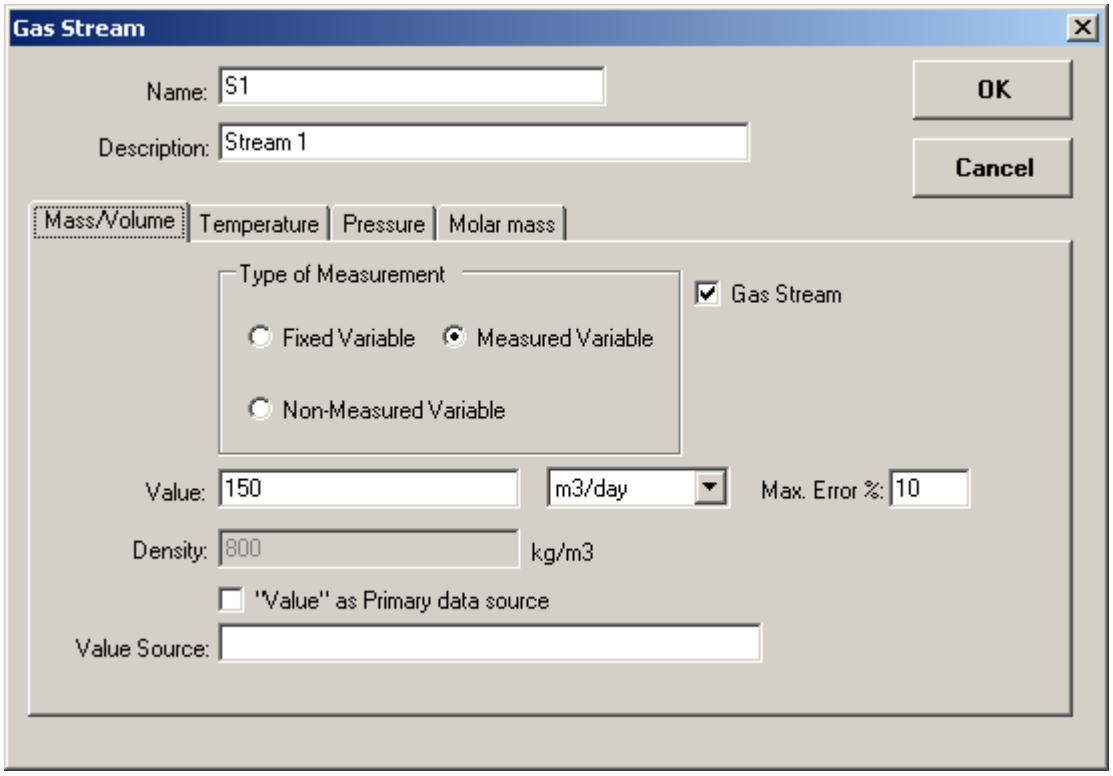
”Value” as Primary data source
If checked then manually entered ”Value” will be used in calculation. If not checked then calculation will use stored in Historian measured data.

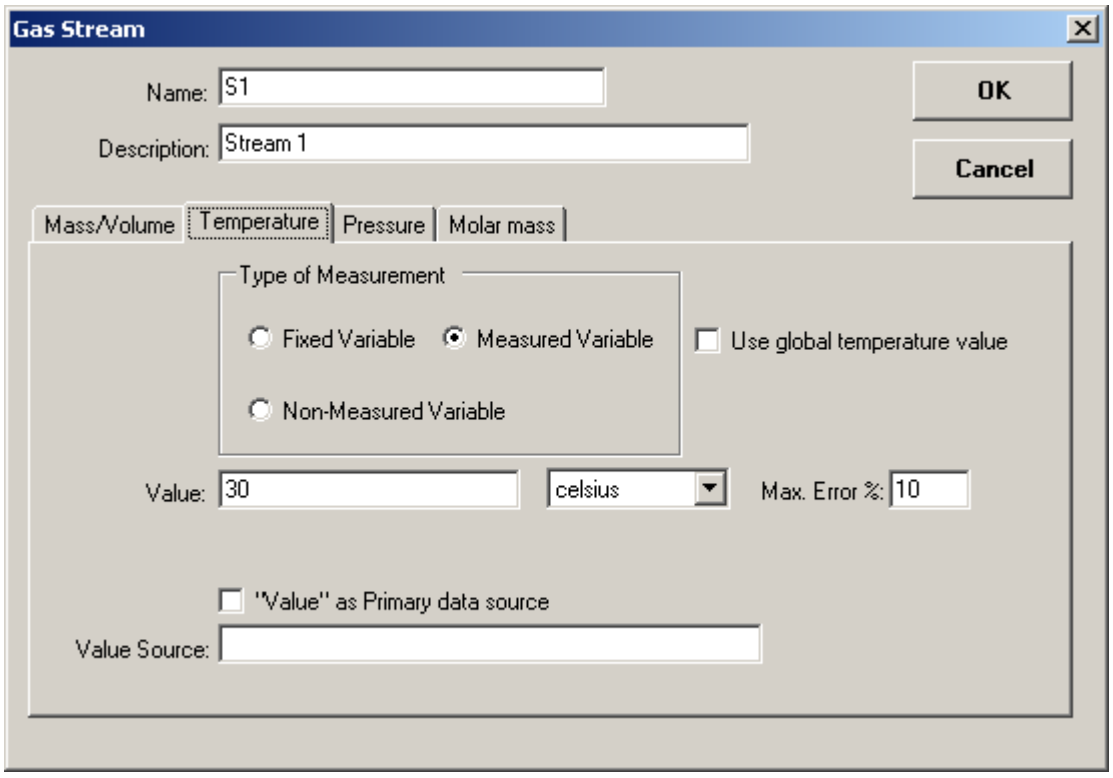
Value Source
The Historian tagname used to store the measured data for this stream.

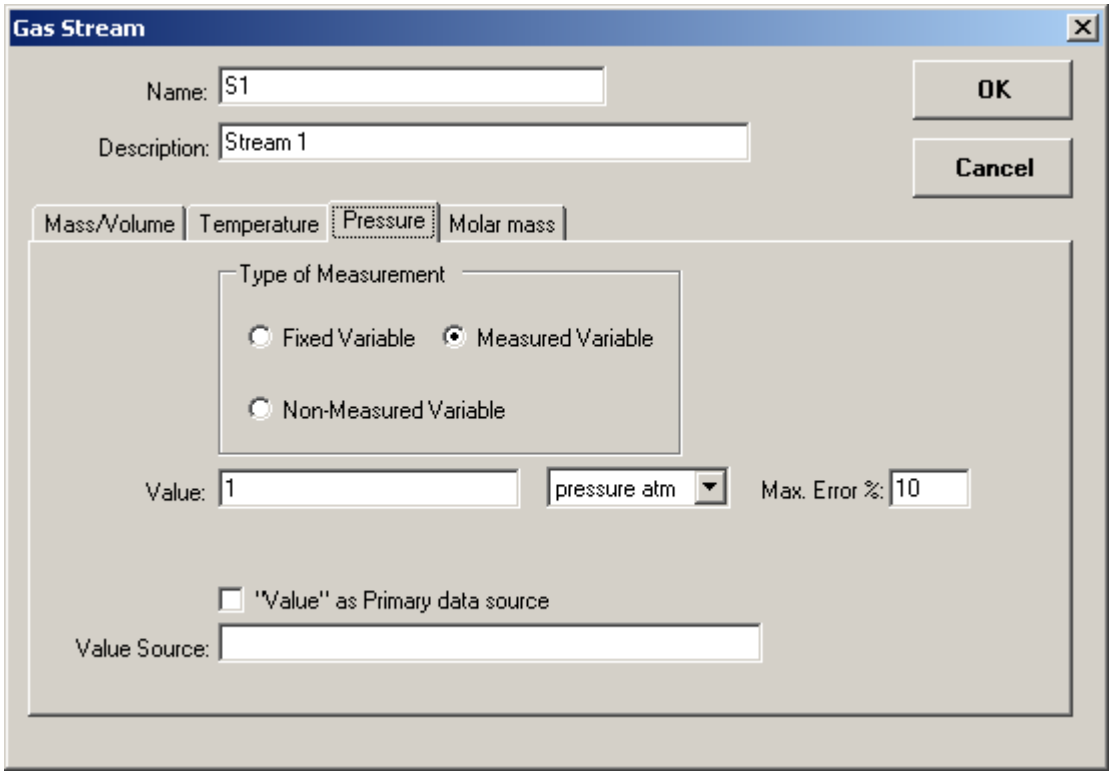
- After clicking the ”OK” button a new stream is created and added to the model:

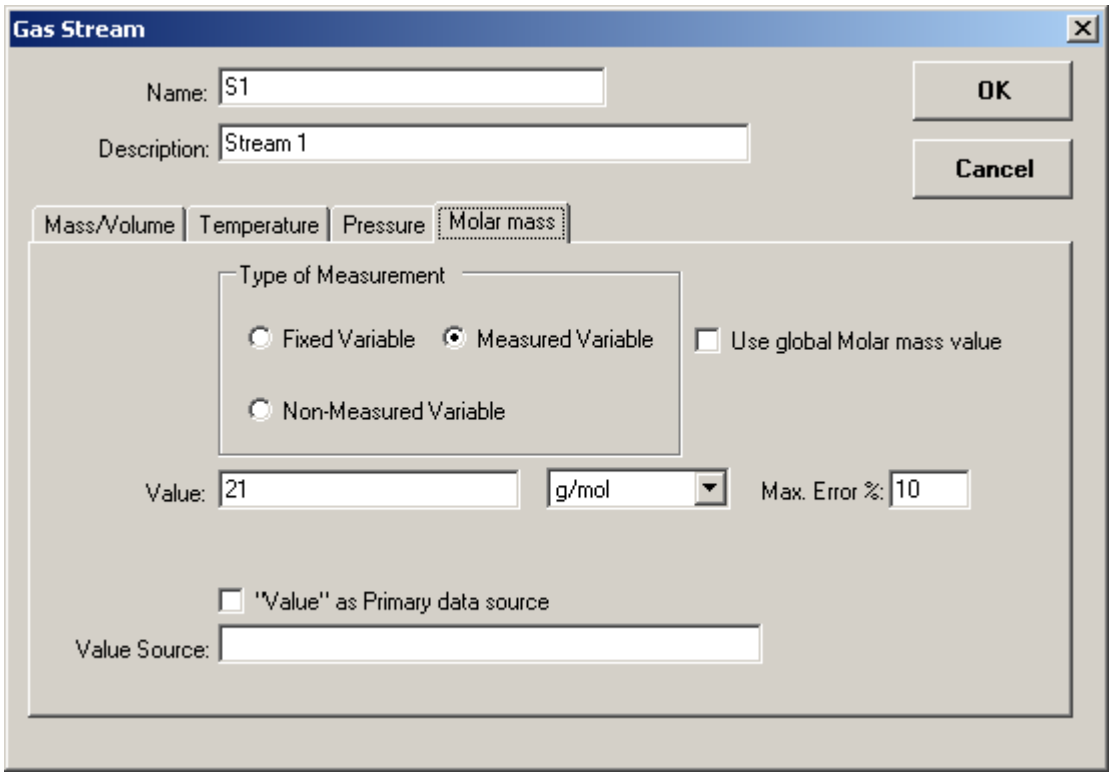


Gas Stream
Setting the “Gas Stream” checkbox enables additional configuration tabs “Temperature”, “Pressure” and “Molar mass”. These tabs allow to configure parameters, necessary for leak location detection in a gas pipeline.


Gas Stream
Name: S1
Description: Stream 1
OK
Cancel
Mass/Volume
Temperature
Pressure
Molar mass
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Gas Stream
Value: 150
m3/day
Max. Error %: 10
Density: 800
kg/m3
"Value" as Primary data source
Value Source:

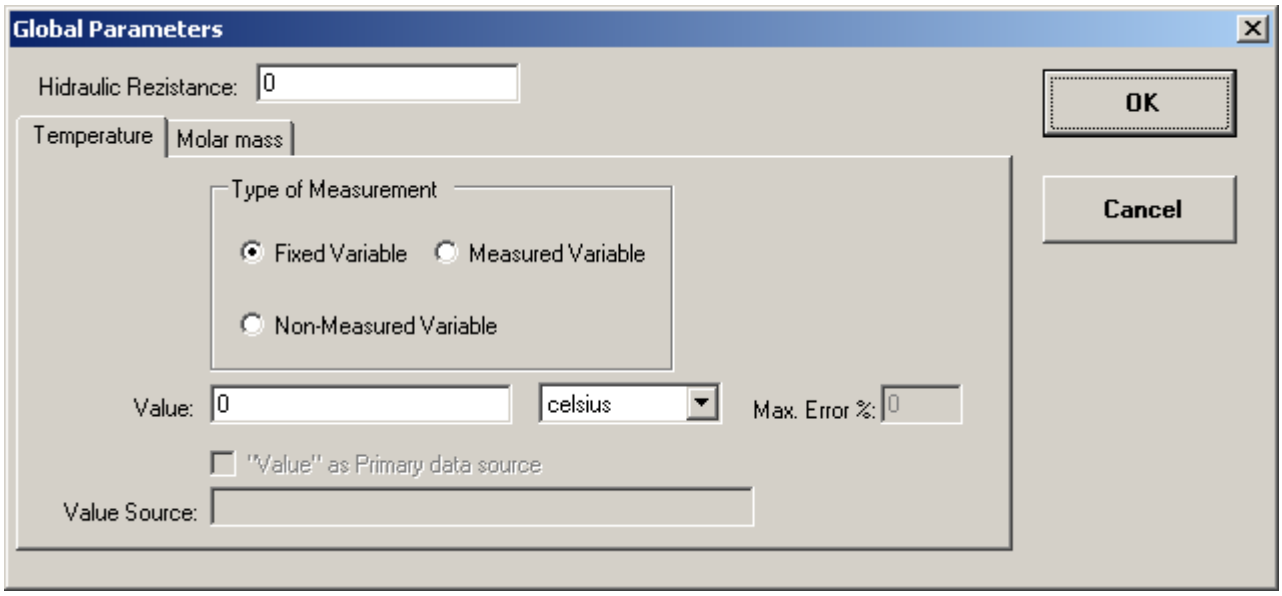

Gas Stream
Name: S1
Description: Stream 1
OK
Cancel
Mass/Volume
Temperature
Pressure
Molar mass
Type of Measurement
Fixed Variable
Measured Variable
Non-Measured Variable
Use global temperature value
Value: 30
celsius
Max. Error %: 10
"Value" as Primary data source
Value Source:

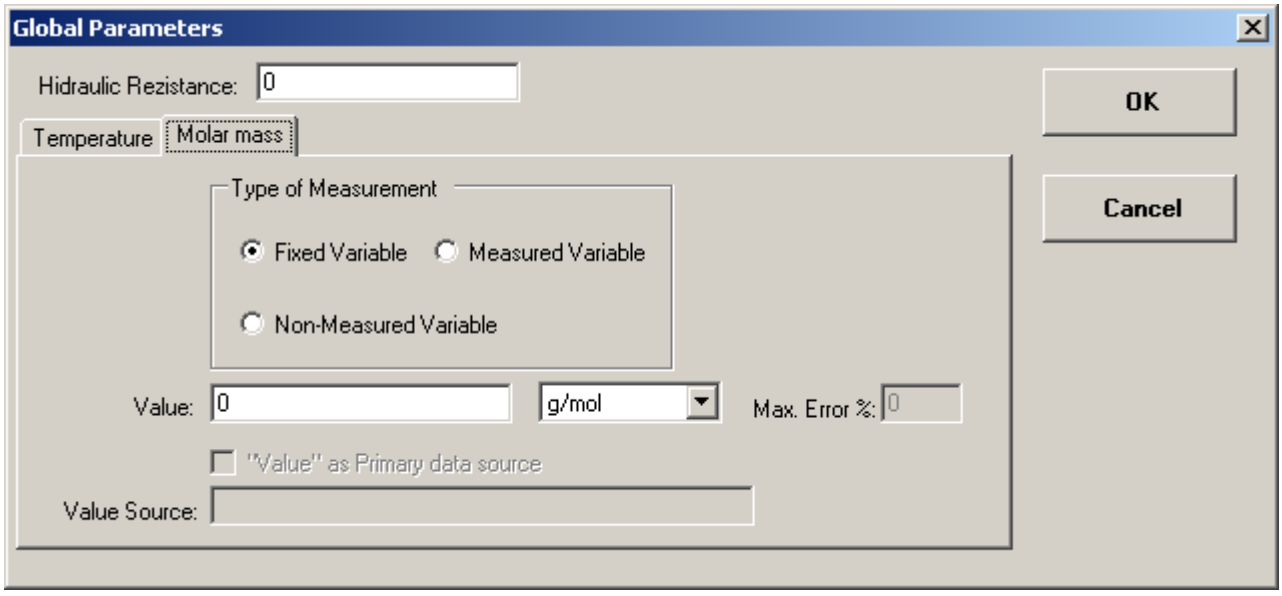




In “Temperature”, “Pressure” and “Molar mass” tabs the meaning of fields “Type of Measurement”, “Value”, “Value Source”, “”Value” as Primary data source” and “Max. Error %” is the same as in “Mass/Volume” tab described above. There are 2 additional checkboxes “Use global temperature value” and “Use global Molar mass value” in “Temperature” and “Molar mass” tabs respectively. Setting these checkboxes defines that temperature and molar mass values for the stream should be taken from global parameter

values. Global parameter values can be configured by selecting the menu command “Global parameters”. The following dialog box with tabs “Temperature” and “Molar mass” will be displayed:

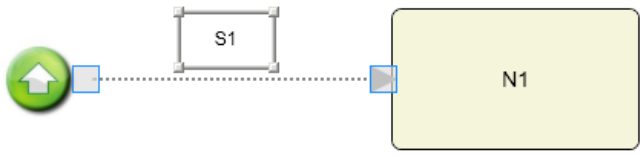




The parameter “Hydraulic resistance” is common for all streams.

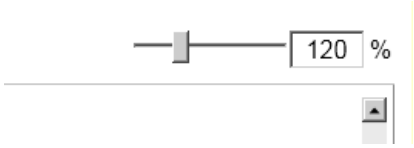
Adjusting location of elements

The connection (endpoint of a stream) can be adjusted/changed by clicking on stream name, selecting end point and dragging it to new location. The stream name location can be changed by clicking on it and dragging to any location. The resizing of nodes and stream names can be done by selecting the element and dragging any corner of the element:



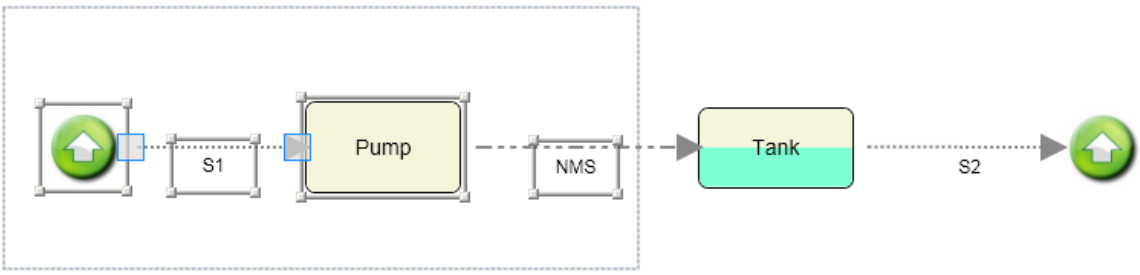
Zooming

Model Editor supports zooming from 10% to 1600% - you can select the different zooming by entering % manually or moving slider on the top-right corner of the Model Editor window:

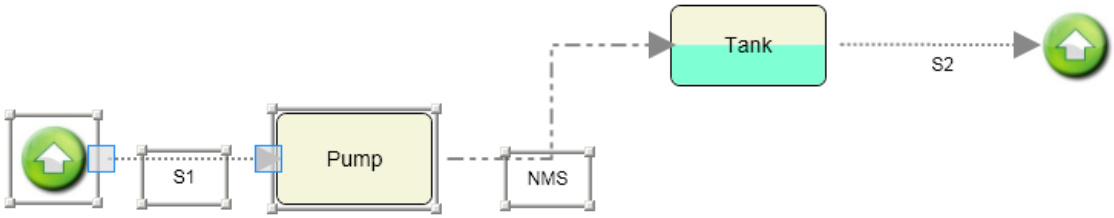


Moving selected area

Model Editor supports possibility to select area (and all elements inside this area) and drag-drop it to necessary new location. The area can be selected by placing the mouse pointer on area corner, clicking mouse left button, moving mouse without releasing left button to other corner of the area and then releasing mouse left button:

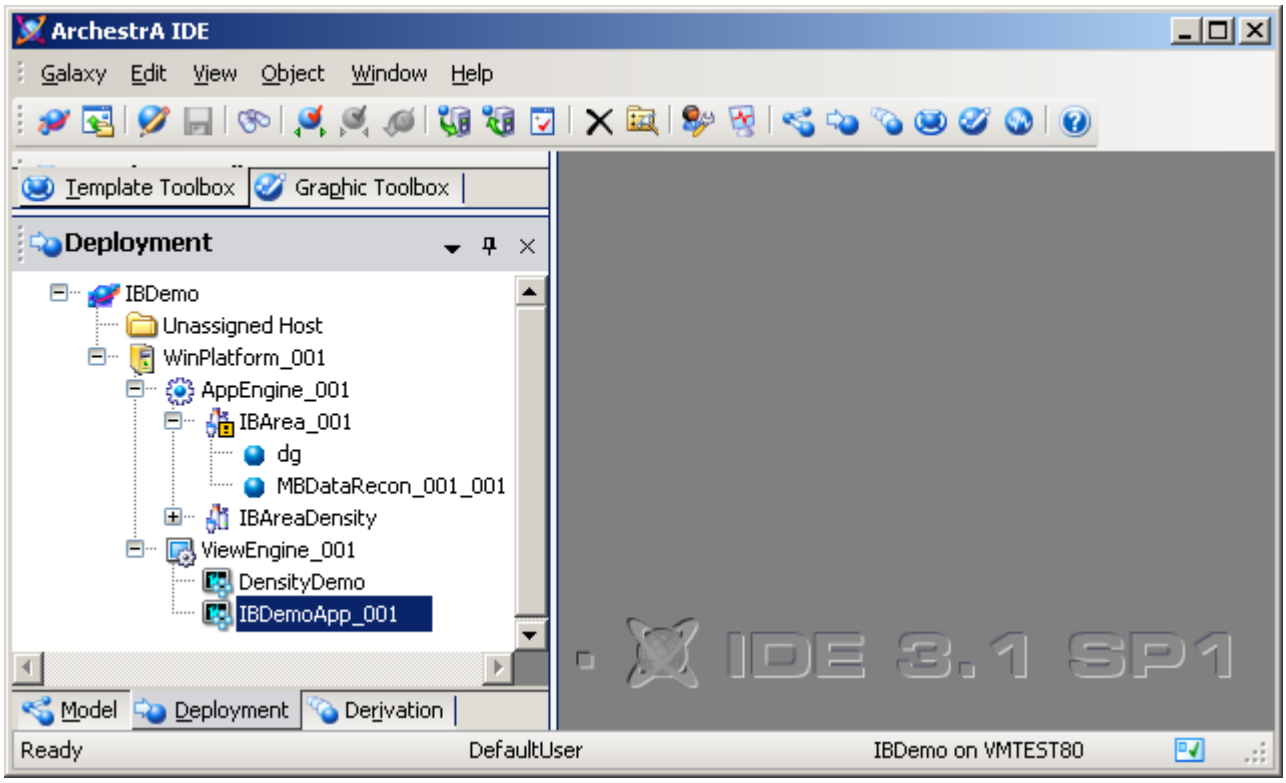


All elements inside the selected area now can be moved to new location by using the keyboard arrow keys (”up”, ”down”, ”left” and ”right”):



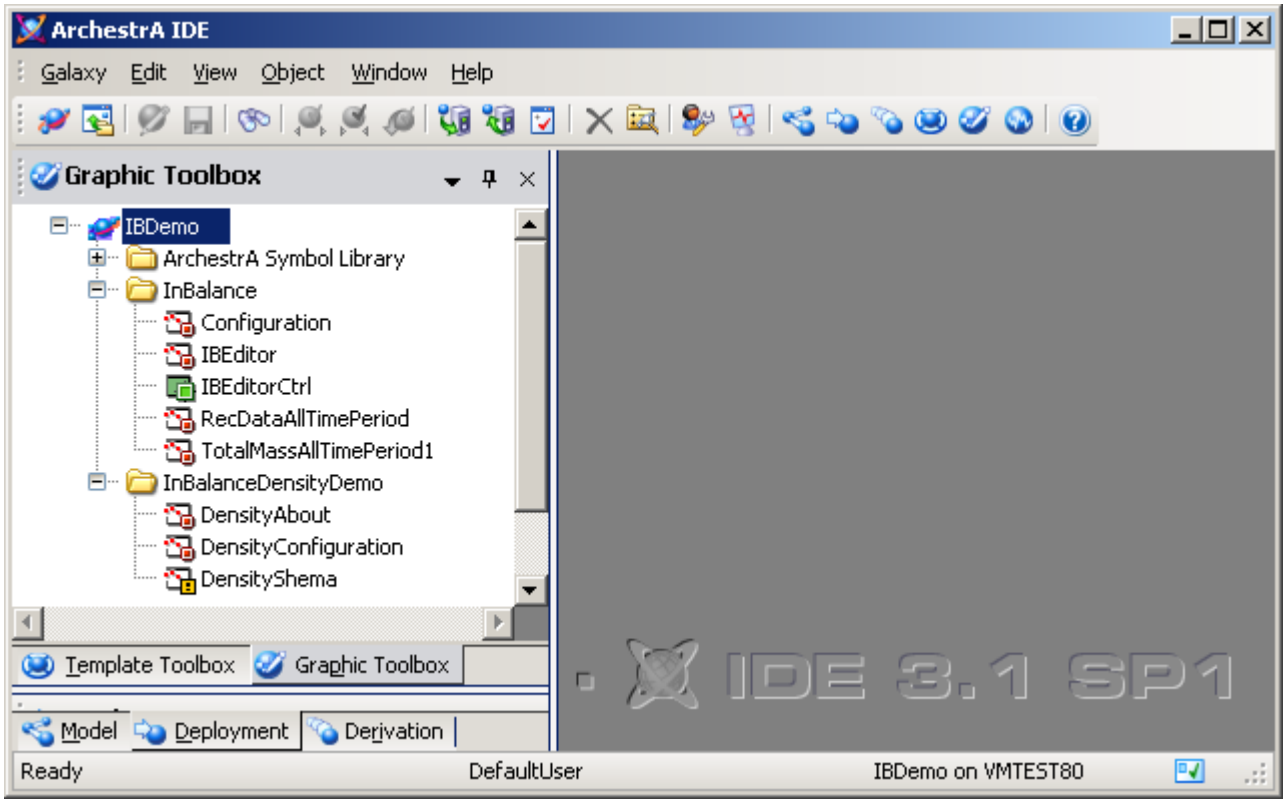
InTouch Demo application

For InBalance data visualization the InTouch demo application “IBDemoApp_001” is used:

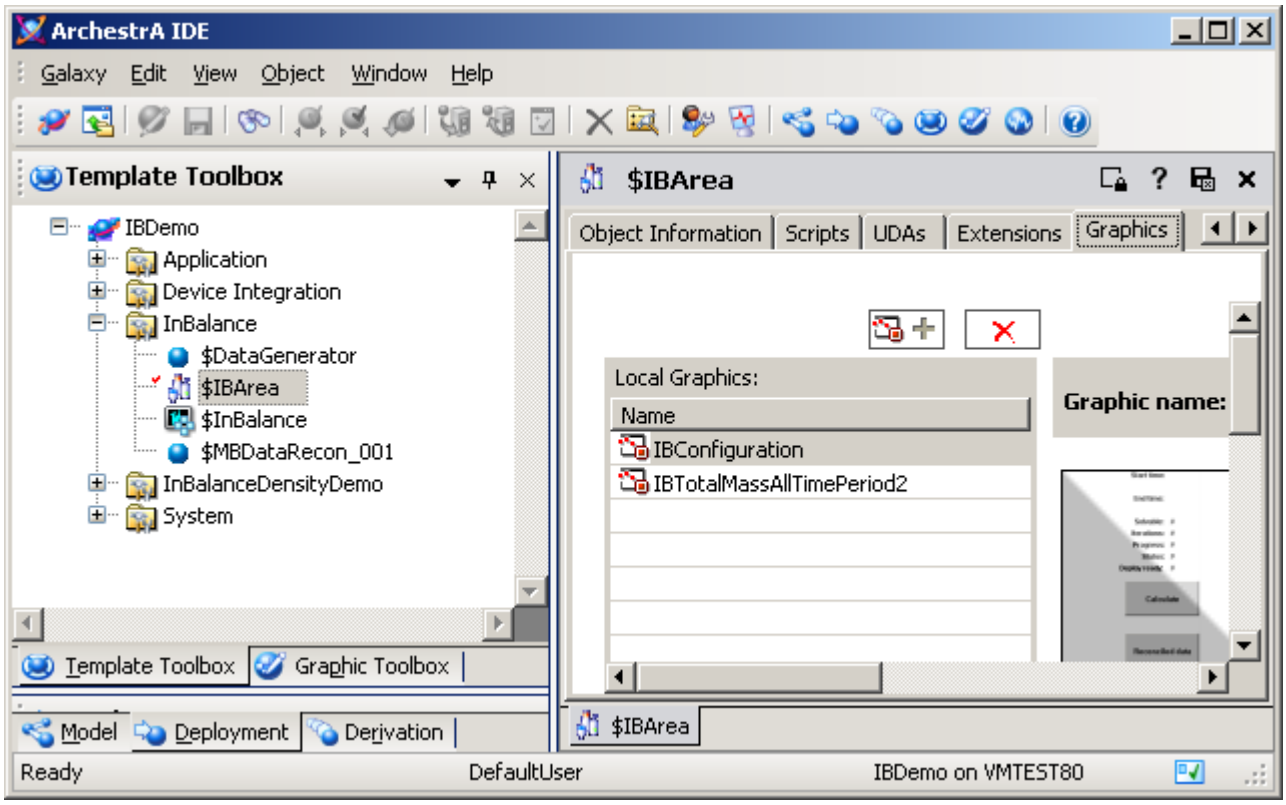


The application contains four ArchestrA Symbols (Configuration, IBEditor, RecDataAllTimePeriod and TotalMassAllTimePeriod1), that are displayed in the main window “InBalance Demo”.

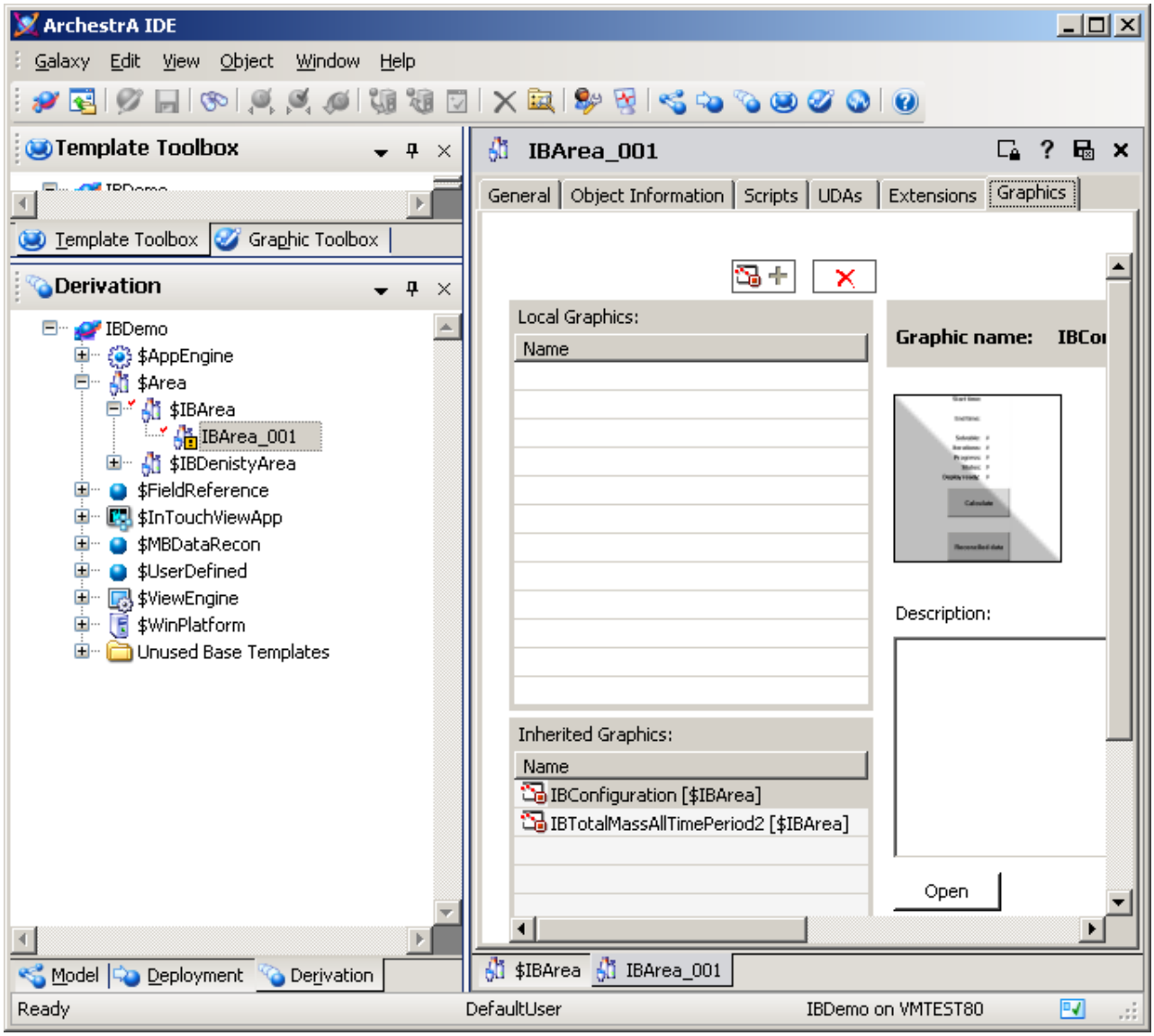
Parent Symbols are located in Graphic Toolbar under “InBalance” Graphic Toolset:


ArchestrA IDE
Galaxy Edit View Object Window Help
Graphic Toolbox
IBDemo
ArchestrA Symbol Library
InBalance
Configuration
IBEditor
IBEditorCtrl
RecDataAllTimePeriod
TotalMassAllTimePeriod1
InBalanceDensityDemo
DensityAbout
DensityConfiguration
DensityShema
Template Toolbox
Graphic Toolbox
Model
Deployment
Derivation
IDE 3.1 SP1
Ready
DefaultUser
IBDemo on VMTEST80

The Symbol (Configuration, TotalMassAllTimePeriod1) instances (IBConfiguration, IBTotalMassAllTimePeriod2) are located in $IBArea:



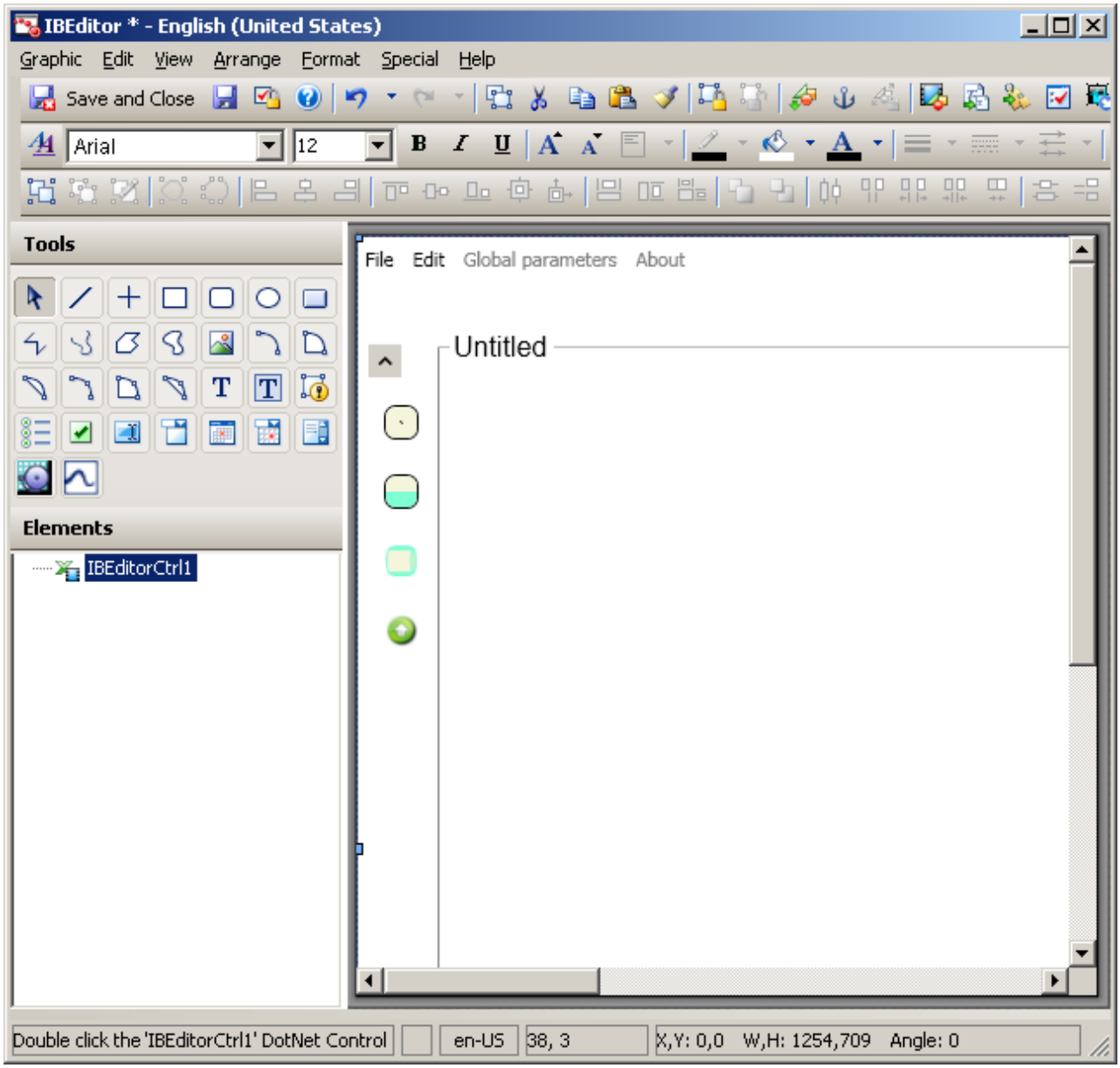
Derived from template ($IBArea) instance (IBArea_001) object contains two Inherited Graphics - (IBConfiguration and IBTotalMassAllTimePeriod2):



ArchestrA symbols

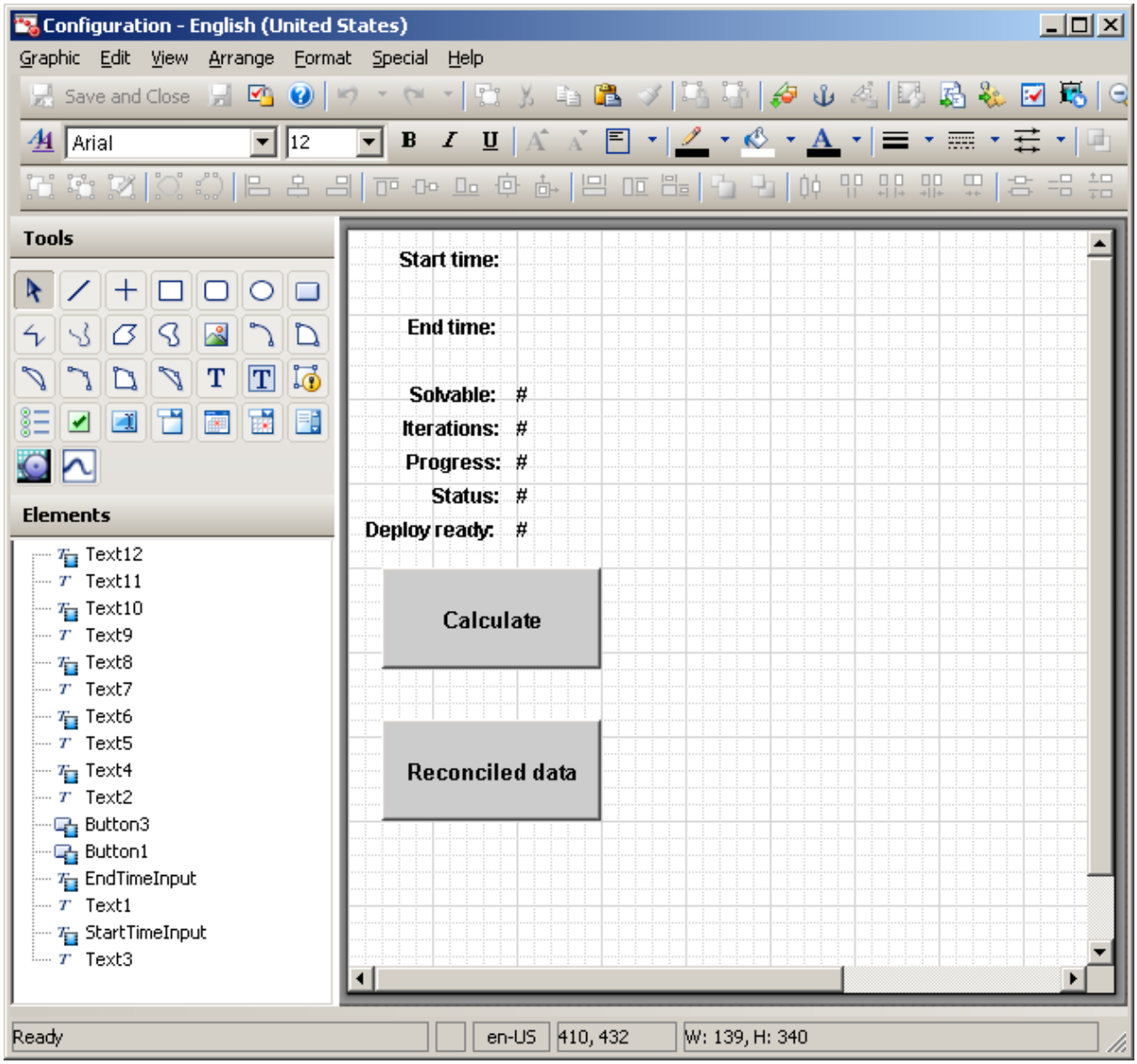
IBEditor

IBEditor symbol contains the Model Editor .NET control, used by InTouch application to display and edit the model (see chapter Model Editor for information about model editing):



Configuration

Configuration symbol is used to set calculation interval, run the calculation and display calculation progress and results:



Start time
Calculation interval start time.

End time
Calculation interval end time.

Solvable
Model solvability flag (true/false). Model is not solvable if non-measured values cannot be calculated.

Iterations
Calculation iterations counter.

Progress
Calculation progress (0 – 100 %).

Status
Shows whether object is ready for new calculation: if Me.Calc.Trigger = true then text “Not Ready” is displayed – means object is still performing the calculation); if Me.Calc.Trigger = false then text “Ready” is displayed and object is ready for new calculation.

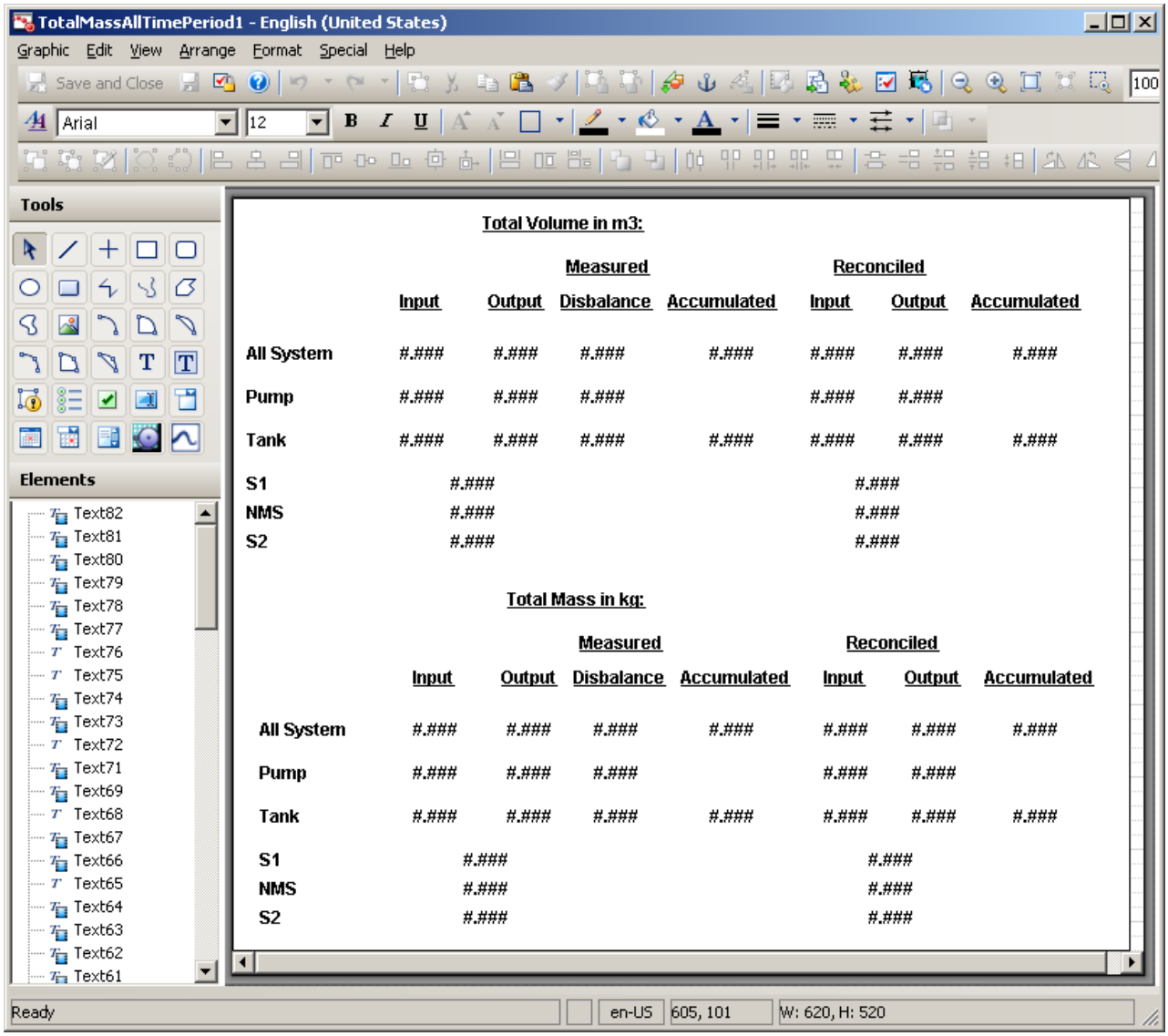
Deploy ready
If text “Ready” is displayed, then object is deployed and ready for calculation; if text “Not ready” is displayed then object is not deployed or is not fully initialized after deploy.

Calculate
Click on “Calculate” button to start the calculation (the trigger Me.Calc.Trigger is set to True).

Reconciled data
Click on “Reconciled data” button to display the ArchestrA symbol that shows Reconciled data (see section “RecDataAllTimePeriod” for symbol description).

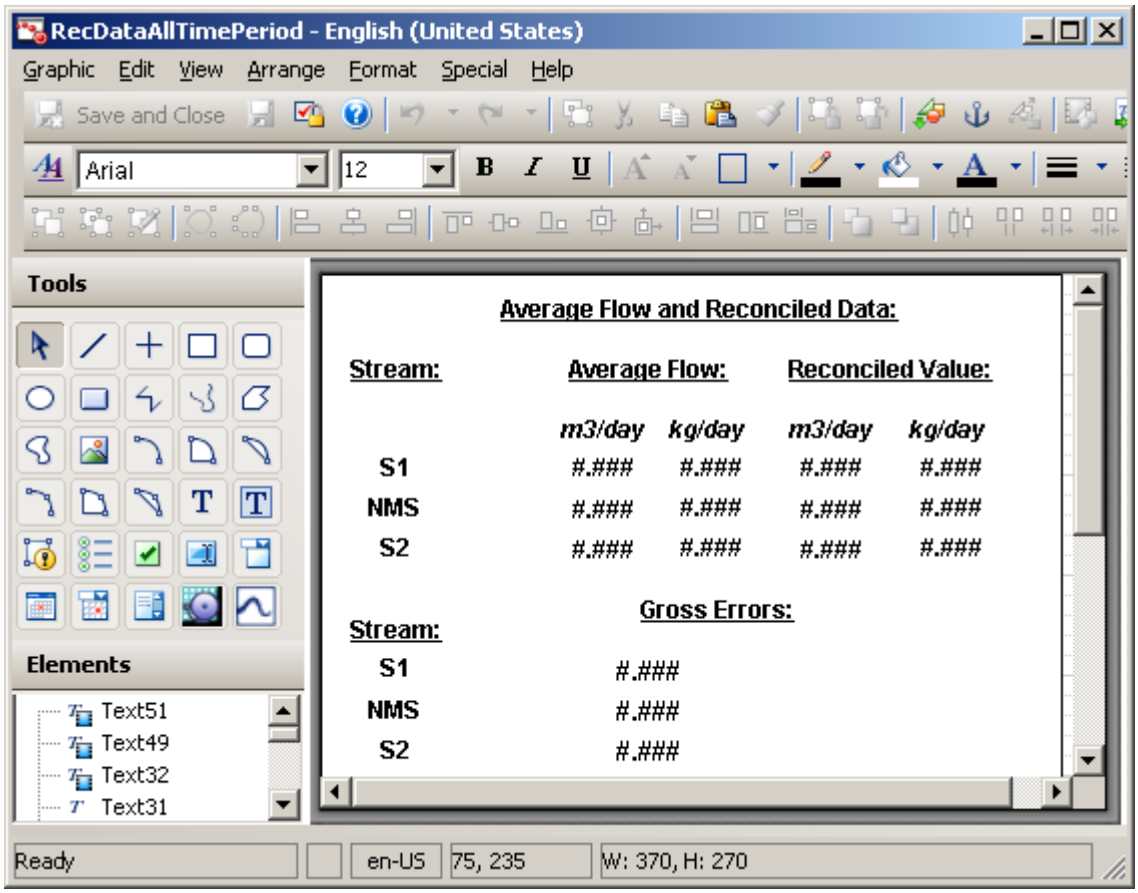
TotalMassAllTimePeriod1

TotalMassAllTimePeriod1 symbol shows measured and reconciled volume (m^3) and mass (kg) for selected calculation period:


TotalMassAllTimePeriod1 - English (United States)
Graphic Edit View Arrange Format Special Help
Save and Close
Arial
12
Tools
Elements
Text82
Text81
Text80
Text79
Text78
Text77
Text76
Text75
Text74
Text73
Text72
Text71
Text69
Text68
Text67
Text66
Text65
Text64
Text63
Text62
Text61
Total Volume in m3:
Measured
Reconciled
Input
Output
Disbalance
Accumulated
Input
Output
Accumulated
All System
Pump
Tank
S1
NMS
S2
#.###
Total Mass in kg:
Measured
Reconciled
Input
Output
Disbalance
Accumulated
Input
Output
Accumulated
All System
Pump
Tank
S1
NMS
S2
#.###
Ready
en-US
605, 101
W: 620, H: 520

RecDataAllTimePeriod

RecDataAllTimePeriod symbol shows measured and reconciled volume (m^3/day) and mass (kg/day) and displays gross errors, if there are any detected in the model:



InBalance security

InBalance is integrated in the Wonderware environment, therefore its security level is the same as for Wonderware ArchestrA IDE and Wonderware Historian.

Additionally InBalance has the following security features:

- audit trail functionality: reports are created, showing who has accessed InBalance system and what operations he/she has performed during a given period of time; audit trail reports are stored in the InBalance internal MS SQL database (same data base as used for interface between InBalance Model Editor and Calculator);

- anti-counterfeit functionality, supported by the Wonderware Application Object Toolkit, used to develop InBalance – all Dynamic Link Libraries (.DLL files), created by the toolkit, are digitally signed.

Please, see the InBalance Security Guide (PR0016xSG10.pdf) for detailed information.

Appendix A. Calculator object attributes

The tables below contain the description of most important Calculator object attributes. Note, that internal name for the Calculator object is MBDataRecon.

General attributes

Attribute	Data Type	Access Type	Description
Calc.Duration	Elapsed Time	Calculated	Calculation time interval (Calc.TimeEnd - Calc.TimeStart)
Calc.Iterations	Integer	Calculated	Number of iterations executed to found least squares
Calc.LeastSquare	Double	Calculated	Minimum least squares value found
Calc.LsqAlgorithm	Integer	Cfg Runtime	Least squares method algorithm: 0 – searches minimum for streams separately; 1 (default) – searches minimum for all streams
Calc.LsqMethod	Integer	Cfg Runtime	Least squares method parameter: 0 – minimizes absolute difference between measured and reconciled data; 1 (default) – minimizes relative difference between measured and reconciled data
Calc.Precision	Double	Cfg Runtime	Least squares calculation precision (default - 0.0001)
Calc.Progress	Double	Calculated	Calculation progress (%)
Calc.RowCount	Integer	Calculated	Total number of Historian values within defined time interval
Calc.Solvable	Boolean	Calculated	Model solvability flag: True – yes, False – no (model is not solvable if non-measured values cannot be calculated)
Calc.Status	String	Calculated	Current status of reconciliation
Calc.SwKey	String	Cfg Runtime	Software license string
Calc.TimeEnd	Time	Runtime	Calculation time interval end time
Calc.TimeStart	Time	Runtime	Calculation time interval start time
Calc.TotalMeasAccum	Double	Calculated	System total measured accumulated mass in kg (sum of measured mass in all Storage Nodes)
Calc.TotalMeasInput	Double	Calculated	System total measured input (kg)
Calc.TotalMeasOutput	Double	Calculated	System total measured output (kg)
Calc.TotalRecAccum	Double	Calculated	System total reconciled accumulated mass (kg) (sum of reconciled mass in all Storage Nodes)
Calc.TotalRecInput	Double	Calculated	System total reconciled input (kg)
Calc.TotalRecOutput	Double	Calculated	System total reconciled output (kg)
Calc.Trigger	Boolean	Runtime	Setting to True starts the calculation, setting to False cancels the calculation; change back to False indicates that the calculation process is complete.
Cfg.DBName	String	CFG	Name of the internal MS SQL database (contains the system model)
Cfg.DBNode	String	CFG	Computer node name where internal MS SQL database is located
Cfg.DBPassword	String	CFG	User name for accessing internal MS SQL database
Cfg.DBUser	String	CFG	Password for accessing internal MS SQL

			database

Node attributes

Attribute	Data Type	Access Type	Description
Node.InputMass	Double[]	Calculated	Array of total mass (kg) for each input stream
Node.InputStreams	String[]	Calculated	Array of names of all input streams
Node.OutputMass	Double[]	Calculated	Array of total mass (kg) for each output stream
Node.OutputStreams	String[]	Calculated	Array of names of all output streams
Node.Solvable	Boolean	Calculated	Node solvability flag (indicates possibility of finding values for all connected streams) (True – yes, False –no)
Node.TotalMeasInput	Double	Calculated	Node total measured input mass (kg)
Node.TotalMeasOutput	Double	Calculated	Node total measured output mass (kg)
Node.TotalRecInput	Double	Calculated	Node total reconciled input mass (kg)
Node.TotalRecOutput	Double	Calculated	Node total reconciled output mass (kg)

The following additional attributes are created for **Storage Nodes** only:

Attribute	Data Type	Access Type	Description
Node.Meas.BadValueCount	Integer	Calculated	Number of Historian values with bad quality or out of range (within defined time interval)
Node.Meas.Category	String	Calculated	Storage node category (e.g. “measured”)
Node.Meas.ConfidenceInterval	Double	Calculated	Confidence interval for measured accumulation (= Node.Meas.ReconMass * Node.Meas.ReconError)
Node.Meas.Density	Integer	User R/W Runtime	Density (kg/m3) is required for mass calculation that is used in reconciliation calculation in case measurement data is not mass (kg).
Node.Meas.Failed	Boolean	Calculated	Calculation failure flag. Indicates impossibility to calculate non-measured accumulation (True – yes (impossible) , False –no (possible))
Node.Meas.GoodValueCount	Integer	Calculated	Number of good measured values, stored in Historian, within defined time interval
Node.Meas.GrossError	Boolean	Calculated	Gross error flag for storage node: True – yes; False – no
Node.Meas.ManulValue	Double	Cfg Runtime	User can set Manual entered value at runtime for calculation.
Node.Meas.MeasType	Integer	Cfg Runtime	User can set Measurement type (0 - fixed, 1 - measured, 2 – non-measured) at runtime for calculation.
Node.Meas.MeasuredMass	Double	Cfg Runtime	Measured total accumulation (kg) for defined time interval (= Node.Meas.EndValue - Node.Meas.StartValue)
Node.Meas.ReconError	Double	Calculated	Reconciliation error for this storage node (%)
Node.Meas.ReconMass	Double	Calculated	Reconciled accumulation for defined time interval (kg)

The following additional attributes are created for **Pipeline Nodes** only:

Attribute	Data Type	Access Type	Description
Node.Leakage.Location	Double	Calculated	Gas pipeline leak location (km).
Node.Leakage.Pressure	Double	Calculated	Gas pipeline pressure at leak location.

Node.Leakage.Volume	Double	Calculated	Gas pipeline leak volume.

Stream attributes

Attribute	Data Type	Access Type	Description
Stream.Meas.BadValueCount	Integer	Calculated	Number of Historian values with bad quality or out of range (within defined time interval)
Stream.Meas.Category	String	Calculated	Stream category (e.g. “measured/calculated”)
Stream.Meas.ConfidenceInterval	Double	Calculated	Confidence interval for measured total mass passed through stream within defined time interval
Stream.Meas.Density	Integer	User R/W Runtime	Density (kg/m3) is required for mass calculation that is used in reconciliation calculation in case measurement data is not mass (kg).
Stream.Meas.Failed	Boolean	Calculated	Calculation failure flag. Indicates impossibility to calculate non-measured value (True – yes (impossible) , False –no (possible))
Stream.Meas.GoodValueCount	Integer	Calculated	Number of good measured values stored in Historian within defined time interval
Stream.Meas.GrossError	Boolean	Calculated	Gross error flag for this stream: True – yes; False – no
Stream.Meas.ManualValue	Double	Cfg Runtime	User can set Manual entered value at runtime for calculation.
Stream.Meas.MeasType	Integer	Cfg Runtime	User can set Measurement type (0 - fixed, 1 - measured, 2 – non-measured) at runtime for calculation.
Stream.Meas.MeasuredMass	Double	Cfg Runtime	Measured total mass passed through stream within defined time interval (kg)
Stream.Meas.ReconError	Double	Calculated	Reconciliation error for this stream (%)
Stream.Meas.ReconMass	Double	Calculated	Reconciled total mass passed through stream within defined time interval (kg)
Stream.NodeFrom	String	Calculated	Name of source node (or empty string, if source is “environment” node)
Stream.NodeTo	String	Calculated	Name of destination node (or empty string, if destination is “environment” node)
Stream.ReconFlow	Double	Calculated	Calculated reconciled flow (kg/s) (= Stream.ReconMass / defined time interval)
Stream.ReconFlowConfInt	Double	Calculated	Confidence interval for reconciled flow (= Stream.ReconFlow * Stream.Meas.ReconError)

Appendix B. Warning and error messages

InBalance writes warning and error messages to the System Management Console Logger. The messages have “InBalance.Editor:”, “InBalance.Config:” or “InBalance.Runtime:” header, referring to the InBalance component, producing the message. The most important messages with explanations are listed below.

Cannot read database [database name]

Either database PC node name, database name, user name or password is invalid. Please, check the contents of the Cfg.Node, Cfg.Database, Cfg.Login, Cfg.Password fields in the Data Source tab for the Calculator (MBDataRecon object) configuration.

Invalid calculation time period

The end time for the calculation time period is specified before start time of the calculation time period.

Number of streams in model exceeds limit

Number of streams in model exceeds the limit set for the Product ID. Check the contents of the ProductID field in the License tab for the Calculator (MBDataRecon object) configuration. Please, contact your local InBalance distributor for an appropriate software key, if larger models should be processed.

Node [node name] is not solvable

Mass balance equation cannot be solved for the node. Increase the number of measured surrounding streams and nodes.

Invalid Software Key for ProductID:[Product ID] CustomerID: [Customer ID]

The software key does not match the Customer ID and the selected Product ID. Check the contents of the Software Key field in the License Server tab for the Calculator (MBDataRecon object) configuration. Please, contact your local InBalance distributor for a valid software key.

Selected calculation time period exceeds demo license time period

The calculation time period should not start before and/or end after the demo license time period.

WONDERWARE FINLAND
InBalance Module
Revision History

Feb 2010	Rev 1.0	First Release
Mar 2010	Rev 1.1	Beta release 0.642. Beta release expiration prolonged till 16th of April 2010. The MBDataRecon object editor “Node History” tab disabled and .TotalRecInput, .TotalRecOutput, .TotalRecInput and .TotalRecOutput attributes for nodes now should be configured in ”Extensions” tab.
Jun 2010	Rev 1.2	Document structure modified.
Jan 2011	Rev 1.3	Chapters “Using model for gas leak detection” and “Pipeline node” added. Chapter “Node attributes” modified, to include pipeline node attributes.
Apr 2012	Rev 1.4	“Licensing agreements” section modified. License tab description modified in “Configuring Calculator” section.