NSIGHTS Version 2.41a USER MANUAL

Document Version 2.41a

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1 INTRODUCTION

1.1 Overview

nSIGHTS (n-dimensional Statistical Inverse Graphical Hydraulic Test Simulator) is a comprehensive well test analysis software package. It provides a user-interface, a well test analysis model and many tools to analyze both field and simulated data. The well test analysis model simulates a single-phase, one- or two- dimensional, radial/non-radial flow regime, with a borehole at the center of the modeled flow system.

The nSIGHTS system consists of two independent applications: nPre and nPost. The two applications differ in function, but are similar in their interface. nPre assists the user in model set-up, data pre-processing, running of the model and diagnostics of the simulation. nPost post-processes results calculated in nPre and stored in post-processing files.

This manual intends to guide the user in the use of nSIGHTS software; it does not provide a guide to the well test analysis model or to well test analysis.

The first section following the Introduction, **Using nSIGHTS**, provides an overview of the basic steps in working with nSIGHTS, examines some of the basic concepts in nSIGHTS as well as to describe the user interface.

The remaining sections of the manual detail:

- the input windows used for setting up a simulation in nPre (**nPre Input Windows**)
- nPre input windows Auto-Setup (**nPre Auto Setup**)
- running a simulation (**Running Simulations**)
- general information on data, plot, list and output objects (**Objects**)
- handling data objects for processing data (**Data Processing: Data Objects**)
- plotting data (**Plotting**)
- **nPost Lists**, and
- **nPost Output** options

The final **Tutorial** section will guide the user through detailed steps in setting up, running and post-processing an optimization simulation.

1.2 General Description

nSIGHTS is windows-based software consisting of a numeric simulator and analytic routines that support standard well-test interpretation methodologies, as well as statistical sampling/optimization and post-processing procedures enabling an analyst to quantify uncertainty in parameter estimates. nSIGHTS contains the functionality of the DOS-based well-test simulator graph theoretic field model (GTFM) Version 6.20, but is a completely new software package. nSIGHTS consists of two independent applications: nPre and nPost. The two applications differ in function, but are similar in their interface.

1) the nSIGHTS pre-processor and simulator (nPre) assists the user in model set-up, data pre-processing, running of the model, diagnostics of the simulation, well-test interpretation methodologies, and statistical sampling/optimization.

2) the nSIGHTS post-processor (nPost) post-processes results calculated in nPre and stored in post-processing files, performs graphical and arithmetic post-processing of output files, and performs special pre-processing of external data files for use by nPre. nPost enables the analyst to quantify uncertainty in parameter estimates.

The nSIGHTS approach to data visualization and data processing is based on the conceptual paradigm of pages and objects. The pages and objects are organized in an object tree. This object-oriented data-flow architecture controls the execution and movement of data between computational entities or classes.

1.2.1 Capabilities and Limitations

nSIGHTS is a well test analysis model that simulates single-phase, one-dimensional radial/non-radial flow regime or two-dimensional radial flow regime, with a borehole at the center of the modeled flow system. The system may be isotropic or anisotropic, but nSIGHTS does not currently support systems with spatially variable conductivities.

1.2.2 Mathematical Models and Assumptions

The mathematical models and assumptions used by nSIGHTS are documented within the GTFM Version 6.20 User Manual and in Appendix F. While the core of nSIGHTS is based on GTFM, additional models and assumptions for 2D and unconfined systems are described within Appendix F.

1.2.3 Error Messages

A variety of error messages are produced in nSIGHTS, including error messages on the Message Line at the bottom of the user interface, and a listing of model development errors in the list window. All errors are written to be self-explanatory, directing the user to the fix required. Once the fix has been applied, the error message will no longer appear.

1.2.4 Untested Components of nSIGHTS

The following components of nSIGHTS have not been formally tested:

- the SCEM, NL2SOL and Simulated Annealing optimization schemes
- CDF objects

1.2.5 Training Required

Users of nSIGHTS are expected to have a detailed understanding of current well test analysis techniques. Software training for nSIGHTS can be accomplished using the Tuturial included within this user manual.

1.3 User Manual Nomenclature

Within this manual, different fonts are used to indicate menu text, dialog prompts, drop-down list selections, user keyboard entry, jargon, object names, page and object identifiers and parameters. The following key describes the different items and their associated font:

Menu Text – this is text that appears on menus, dialog boxes, or menu bars. For text in dialog boxes, it is associated with the dialog heading and "frames" surrounding groups of items.

Dialog Text – this is text that appears in dialog boxes and property windows.

Drop-down List Selection – this is text that appears in a drop-down list box.

Keyboard – this is text entered by the user in text or numeric fields in dialog boxes and property windows.

Jargon – this is text that names an nSIGHTS specific concept for the first time.

Object Name – this is the name of an nSIGHTS object. Note that the object name used in the manual refers to the object name used in the **Object** menu. Object names in the object tree or object description area may differ from the object name in the **Object** menu (see Appendix E for tables of alternative object names).

Page or Object ID – this is the identifier for a specific nSIGHTS object within the object tree.

Parameter – this is the name of an nPre parameter.

1.4 Getting Help

The nSIGHTS user manual is available in both hard-copy format and through the on-line help system. To access the on-line help system, select the **Help Topics** command from the **Help** menu in the main window, or select the F1 key.

As well, context sensitive help is available for tool bar buttons and objects.

When a cursor is placed over a tool bar button, context sensitive help displays a small text window providing a short name for the tool bar button, as well as to display a message within the status bar (at the bottom of the main window).

To access help for an object, either select the  button or Shift-F1 and then the object in question. A help window will appear containing the help information for the selected object.

The  button (or **Help□About nPre/nPost...**) provides information on the software, including the software version, a link to register software complaints and a link to the manufacturer’s website.

1.5 System Requirements

nSIGHTS can be executed on a Intel compatible chipset with minimum 512 MB RAM and an OpenGL capable graphics card. nSIGHTS may be run under MS Windows NT4, 2000, XP or Windows 7. If the operating system is 64-bit then the 64-bit executables are available.

1.6 Function Requirements for nSIGHTS 2.41a

The overall functional requirements for nSIGHTS version 2.41a are as follows:

R.1	Overall	Relate to the nSIGHTS program as a whole and consist of the various modes of operation, general user-interface description, operating system requirements, and specified minimum hardware platform.
R.2	Data Functions	nSIGHTS uses several methods to define input data and/or results as functions of time, distance, or pressure. These approximations generally involve an interpolation method applied to an ordered (ascending in X) set of data values, referred to as XY points. R.2 functionality describes the methods used to interpolate functional approximations from XY points.
R.3	Simulator	R.3 category requirements describe functionality that allows nSIGHTS to simulate specific types of well-test procedures in specific types of media. Generally, simulator requirements describe the various components of physical reality that are addressed mathematically by nSIGHTS.
R.4	Analyses	R.4 requirements consist of standard data pre- and post-processing procedures that are used within the well-test interpretation community to perform diagnostic interpretations of well-test results. Within nSIGHTS, R.4 functionality is applied both to input data (well-test results obtained in the field) and to nSIGHTS simulator results so that simulator results can be compared graphically or numerically to field results.

R.5	Fit	R.5 requirements describe the procedures used to define fit metrics used for optimization and fit-surface calculations.
R.6	Statistical	R.6 requirements describe the statistical procedures used by nSIGHTS to assess parameter uncertainty. R.6 functionality includes parameter-sampling requirements, optimization-routine specification, and statistical post-processing of optimization results.
R.7	Fit surface	R.7 requirements describe data input and results-visualization requirements for fit-surface-calculation simulations.

2 USING NSIGHTS

2.1 Overview

The general steps to creating a model run, executing a model run, and viewing the output are outlined below.

(1) Open nPre. nPre is used to pre-process input data, select model run options and execute the model run.

(2) Complete input requirements through Input Windows. For all simulation modes, the following input is required:

- define general model options and physical configuration (**Configuration** input window)
- specify simulation output options (**Wells and Output** input window)
- import field data and develop constraints and diagnostic plots (**Field Data** tab of the **Plots and Data Processing** input window)
- define test sequences (**Sequences** input window)
- enter parameter values (**Parameter** input window, and if applicable, **f(x) Points Parameter** input window)
- if suite or range parameters are defined, specify related options (**Suite/Range** input window)
- specify output files to be created during simulation (**Output Files** input window)
- create plots for viewing during simulation (**Runtime** tab of the **Plots & Data Processing** input window)

Depending on the simulation mode, further input may be required:

- if optimization or forward-range mode is selected, pair field data and simulated data for comparison (**Fit** tab of the **Plots & Data Processing input window** and the **Fit Selection** input window)
- if optimization mode is selected, specify optimization options (**Optimization** input window)
- if sampling mode is selected, specify sampling options (**Sampling** input window)

(3) Execute the model. Select the **Minimal** or **Verbose** command from the **Run** menu. **Minimal** shows minimal information during the simulation, whereas **Verbose** provides detailed information, at the cost of slightly increased execution time.

(4) Examine diagnostic plots. If required, make necessary adjustments in the input and repeat step (3).

(5) Close nPre.

(6) Open nPost. nPost is a post-processor for simulation results, and contains many statistical tools to examine the results.

(7) Read simulation results into nPost. Analyze and plot the results.

(8) Examine results. If necessary, return to nPre, make necessary changes to the input, and repeat from step (3).

2.2 Basic Concepts

2.2.1 Model Runs and Simulations

Each time the well test analysis model is executed within nSIGHTS, a *model run* is created. To execute the well test analysis model (and create a model run), a command in the **Run** menu is selected (see Section 5).

Depending on the model options selected, a model run within nSIGHTS may consist of one or many *simulations* or *cases*. A simulation is the calculation of one flow solution, with one set of parameter values. A case is one or a group of simulations depending on the *simulation mode*:

- In forward mode, a case is one simulation, with one combination of suite, range or sampled parameters.

- In optimization mode, a case is a group of simulations, based on one set of non-fitting parameters, such as a set of sampled parameters or one combination of suite or range variables. Each simulation of the optimization mode case has adjusted values of fitting parameters, with the goal of providing an optimal fit between simulated results and field data.

Simulation mode indicates general model function. For example, optimization mode indicates that the model will conduct several simulations, adjusting the values of user-specified parameters for each simulation, to obtain an optimal fit between simulated and field data. Each model run has only one simulation mode. The simulation modes available are identified and described in Section 3.1.1.

2.2.2 Pages and Objects

The nSIGHTS approach to data visualization and data processing is based on the conceptual paradigm of *pages* and *objects*. These pages and objects are organized in an object tree (see Section 2.3.3).

An object has a defined function related to data input/output, data manipulation, or plot construction. For example, a data object may read a file containing a table of pressure data, while a plot object may plot pressure with respect to time. Section 6 describes object basics.

A page contains a collection of related or similar objects. nSIGHTS contains four types of pages: *data pages*, *plot pages*, *list pages* (nPost only) and *output pages* (nPost only).

Data pages are used to collect objects that do not in themselves create a visual representation. For example, table input data are represented by an object named **Read Table File**. There is always at least one data page (the default data page), however the user can add as many data pages as desired. Multiple and nested data pages are used to better organize objects (more than 15 objects to a page can be cluttered). Data objects are further described in Section 7.

Plot pages contain objects that result in a visual representation appearing upon a single plot. Plot objects may be organized within a plot page using plot object folders. Associated with each plot page is a top-level window that contains the actual plot. Only those objects on a specific plot page will appear on the plot. Plot pages and objects are further described in Section 8.

Output pages (nPost only) contain objects whose primary purpose is to write data to a file. The output page, and associated output objects are further described in Section 10.

A list page (nPost only) performs a similar function to the **List** menu in nPre. For each list page, an associated top-level window is created, displaying text information. The text information is defined by list objects. The list page and associated objects are further described in Section 9.

2.3 User Interface

The nPre or nPost user interface consists of a main window, from which the majority of controls are located. Other top-level windows in the interface include plots, the window list menu and object controls. The user interface description in this section focuses on the main window interface.

Figure 2.1 shows a typical nPre main window.

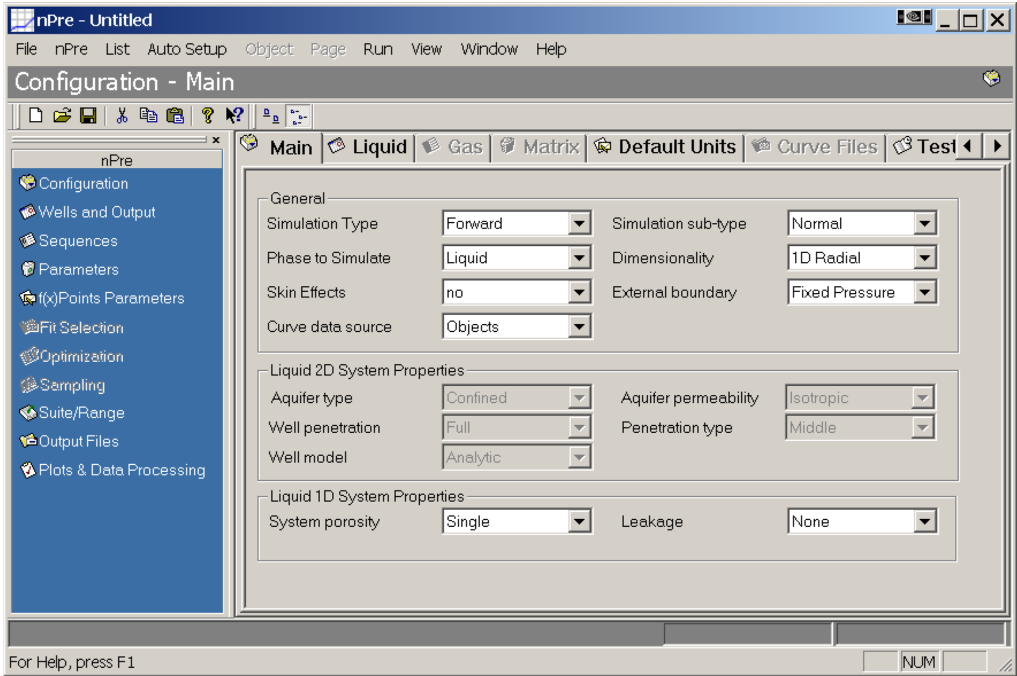


Figure 2.1 nPre Main Window Screen

Figure 2.2 shows a typical nPost main window.

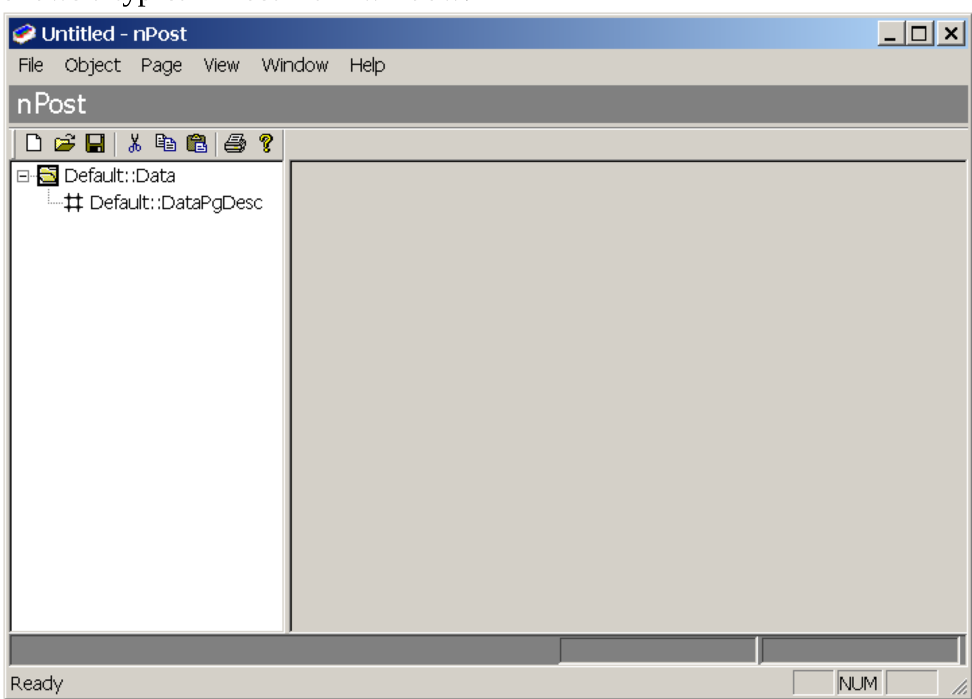


Figure 2.2 nPost Main Window Screen

The user-interface that occupies the bulk of the main window differs between nPre and nPost. In nPre, the main window consists of two main components: an *nPre control bar* (navigational pane) and an *nPre input window*. In nPost, the main window consists of two main components: an *object tree*, and the object *property window*.

Additional user-interface components for both nPre and nPost include a menu bar, a tool bar, an object description area (directly below the menu bar), a message line, a status bar and a window list menu window.

2.3.1 nPre Control Bar

The nPre control bar, shown in Figure 2.3 nPre Control Bar, displays all the nPre input windows. It is equivalent to the nPre menu.

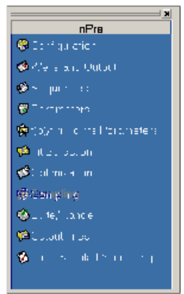
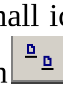


Figure 2.3 nPre Control Bar

An nPre input window is simply a means of organizing the different steps of an nSIGHTS simulation. Selection of an input window from the nPre control bar or menu will display the corresponding nPre input window.

The commands are shown as either small icons or large icons, controlled by selecting the small icon buttonor the large icon buttonin the tool bar, or by right-clicking in the control bar and selecting the corresponding command from the pop-up menu. If the control bar is too small to show all the commands, scroll buttons will appear on the right hand side of the control bar.

The nPre control bar is closed by selecting the  button on the top right hand corner of the nPre control bar, or by toggling the **Control Bar** command in the **View** menu.

2.3.2 nPre Input Window

The nPre input window contains dialog prompts, object trees and corresponding object property windows or tables to define the input data for a simulation. The input window may be organized into tabs, as shown for the **Configuration** main tab window (Figure 2.4):

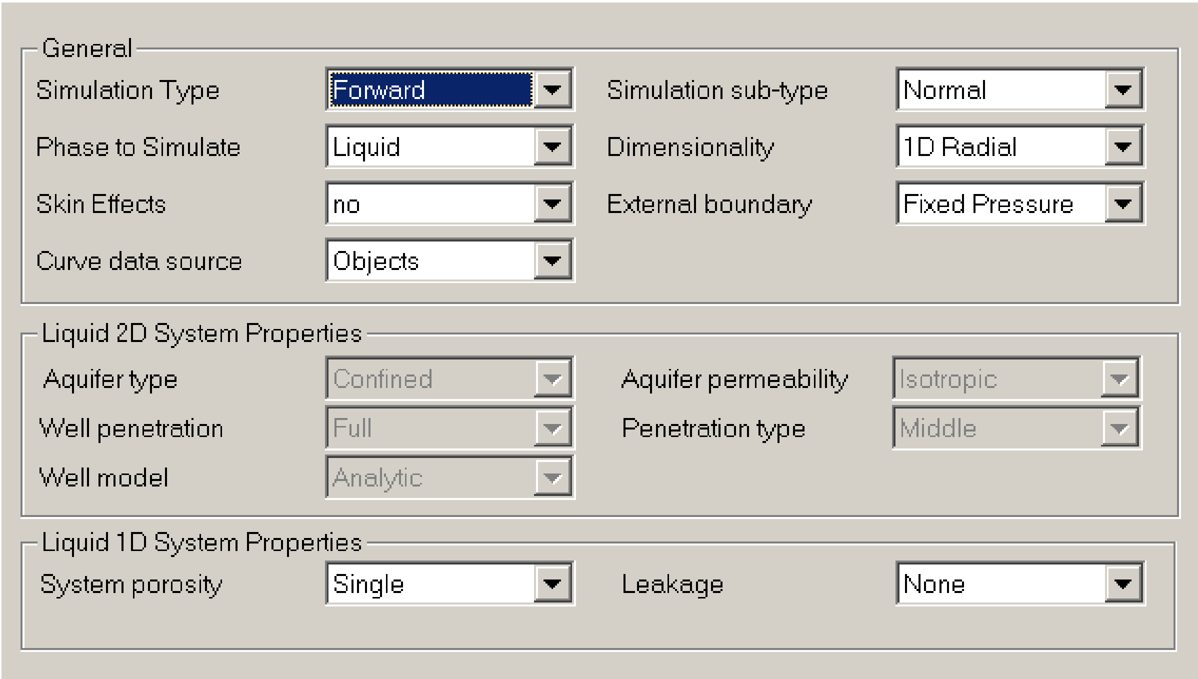


Figure 2.4 Configuration Main Tab Window

If there are too many tabs to fit within the main window, scroll buttons will appear adjacent to the tabs in the top right hand corner of the input window.

The nPre input windows for each nPre command are described in detail in Section 3.

2.3.3 Object Tree

The object tree is a means of visually organizing pages and objects.

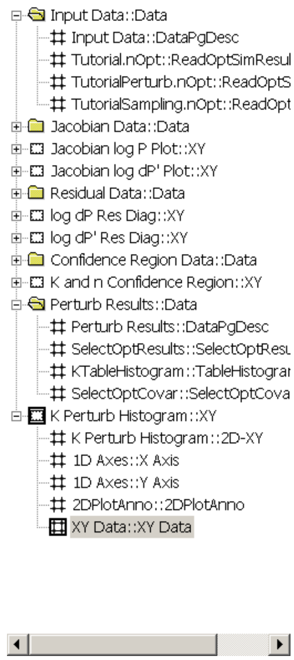


Figure 2.5 Object Tree Example

The pages in an nSIGHTS visualization are represented as first level icons or greater in the tree (nested pages can be second, third etc. level icons). The different types of pages are indicated by the following icons:

- data pages, list pages, output pages and plot object folders
- 2D plot pages
- 3D plot pages
- composite plot pages

Pages are created using the commands in the **Page** menu. Upon selecting a new page command, an icon and ID representing the page appears in the object tree and the properties of the first default object appears in the property window. For plot and list pages, a new top-level window for the plot/list is also created.

Pages can be nested into other pages by selecting a page and dragging it to any object on another page of a compatible type. Nested pages can be moved within a page in a similar manner. Data pages can only be nested into data pages, plot object folders can only be nested within plot pages, and 2D or 3D plot pages can only be nested into a composite plot page.

A plot object folder is neither a page nor an object. Used for organizing plot objects, they only exist as nested folders to a plot page, and are created using the **Create Plot Object Folder** command in the **Object** menu.

icons of the tree represent objects associated with each page. Objects can be hidden/unhidden if the tree node for the page is toggled. All objects can be hidden using the **Collapse Tree** command in the **Page** menu.

Both page and object icons are followed by a text identifier. The text identifier contains an *object ID* followed by the name of the page or object. The object ID is specified in the top left hand corner of the object property window. For pages, the object ID for the first object in the page will also be the ID for the page.

New objects are created using the **New** command in the **Object** menu. The command results in a list of available objects being presented, from which the user may pick one. An icon and ID representing the object then appears in the object tree and its properties appear in the property window.

Selecting an object causes its properties to appear in the object property window. The selected object (also known as the current object) is indicated by a black square around the icon, as shown below for the *XY Data::XY Data* object. Note that the current page also has a black square around its icon.

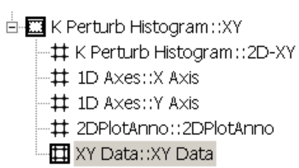


Figure 2.6 Object Selection Example

The object of type **Read XY Data** is selected in the figure above. Usually only one object is selected, but multiple objects may be selected by holding down the shift key when selecting objects. Selecting multiple objects is useful only for copy, delete, and duplicate operations (see Section 2.3.5.2). When multiple objects are selected, only the object property window for the last object selected is shown.

As with pages, objects can be moved within the current page or a page of compatible type by selecting and dragging the object.

An object's icon reflects its status. Available status indicators are as follows:

- Normal Status
- Incorrect Object Properties
- Error in Object Calculation

Exposed Properties

Object Not Used

If the object status is OK (all object properties are set correctly and all object input is satisfied) the icon will be displayed normally. Otherwise a green question mark may appear over the icon if the object properties are not set correctly, or a red X if the object calculation resulted in an error. Other status indicators are a black XP if the object contains exposed properties (see Section 6.3.2), and a green circle if the object is not used by any other object in the configuration file (only if this option is switched on, see Tree View.4.2). Some objects may appear with a pink Q overlaying the icon, indicating that the object's quality assurance status is to be verified.

2.3.4 Object Property Window

The data associated with the current object (i.e. the *object's properties*) are displayed in the property window, along with a user interface (UI) for editing the properties, and the *object buttons*. In the example below, the Read XY Data object properties consist of the *Object ID*, the name of the file, file reading options, plus status information describing the attributes of the loaded file.

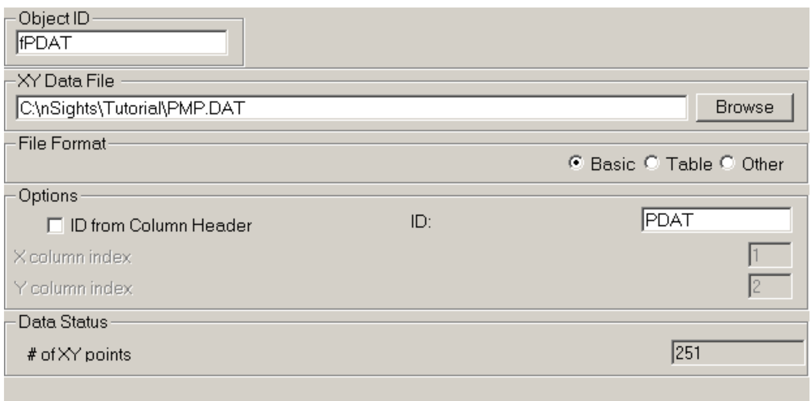


Figure 2.7 Property Window

Selecting a different object in the object tree, or creating a new object, clears the object property window display and places the properties of the new object in the property pane, where they can be modified.

The object buttons in the property window have the following effect:

Apply Processes all user input in the object property window and checks it for validity. If the data are OK, they are copied into the object and the object is re-calculated. All connected objects downstream are also re-calculated and any affected plots updated.

Cancel Replaces the data displayed in the property window with the object properties first displayed or saved with the last selection of the **Apply** button.

Clear Clears object properties (may not be available for all objects).

Default Sets object properties to a default value (may not be available for all objects).

2.3.5 Menu Bar

The menu bar for both nPre and nPost contains the following menu items: **File**, **Object**, **Page**, **View**, **Window**, and **Help**. nPre contains several additional menus items: **nPre**, **List**, **Auto Setup**, and **Run**.

2.3.5.1 File Menu

The **File** menu bar item contains the usual file operations:

New Removes the current nPre or nPost configuration file, and creates a new blank nPre or nPost configuration file.

Open Presents a file selection dialog to open an existing nPre or nPost configuration file (default extension .nPre or .nPost). Upon selection of a file, the existing configuration is cleared and the selected configuration file is loaded. A configuration file contains the nPre input data (nPre only) and all the pages, objects, and object properties and data. The main window title is then changed to the file name.

Save Replaces the contents of the current configuration file with the current input data and page/object set-up. This method will use Save As if a configuration file has not been loaded.

Save As Presents a file selection dialog (default extension .nPre or .nPost). After a file name is specified, the Save operation is performed.

Save for nPreX Saves a configuration file that can be used with the command line version of nPre, nPreX.

Update Paths Presents a dialog that changes selected paths within a configuration file to a new specified path.

Print Setup Presents the standard Windows printer selection dialog. The default printer for plots and the basic page set-up is specified.

Exit Closes nPre or nPost.

2.3.5.2 Object Menu

The **Object** menu bar item is shown in Figure 2.8

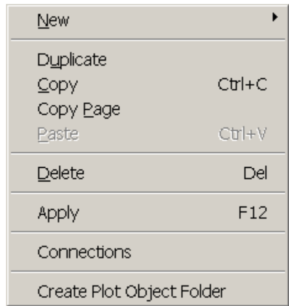


Figure 2.8 Object Menu and Pop-Up Window

Note that the same **Object** menu is also available as a pop-up menu, by right-clicking the mouse in the object tree window while an object is selected.

The menu provides the following operations for manipulating objects in an object tree:

New	Creates a new object and places it on the current page. The New menu item cascades to a second menu providing a list of objects available for the current page type. For data pages, the second menu contains categories of objects, which cascade into a third menu containing the available objects.
Duplicate	Creates a copy of the currently selected object(s) on the current page. Equivalent to **Copy** followed by **Paste.**
Copy	Clears the copy buffer and places a copy of the currently selected object(s) in the copy buffer. Note that multiple objects are selected by holding down the shift key when selecting objects.
Copy Page	Clears the copy buffer and places a copy of all objects on the currently selected page in the copy buffer.
Paste	Creates copies of all objects in the copy buffer on the currently selected page. The page does not have to be the same page as the page from which the objects were copied, however, it does have to be a page of the same type.
Delete	Removes the currently selected object from the page. Places a copy of the object in the copy buffer.
Apply	Same effect as pressing the Apply button in the current object property window.

Connections Displays a text top-level window that provides information on the connections of the currently selected object, the objects used as input, and the objects which use the currently selected object's output as input. See Sectin 6.2.3 for details.

Create Plot Object Folders Within plot pages, plot object folders can be created to organize plot objects within a page.

2.3.5.3 Page Menu

The **Page** menu bar item is used to perform operations on data, plot, list and output pages. Note that the same menu is also available as a pop-up menu, by right-clicking the mouse in the object tree window while a page is selected. Not all the commands are available in both nPre and nPost.

New 2D XY Plot Creates a new 2D plot page and window.

New 3D XYZ Plot Creates a new 3D plot page and window.

New Composite Plot Creates a new composite plot page and window.

New Data Creates a new data page.

New List Creates a new list page (nPost only).

New Output Creates a new output page (nPost only).

Duplicate Creates a copy of the currently selected page.

Copy current Places a copy of the current page and all its objects in the copy buffer.

Copy all Places a copy of all pages and all objects in the copy buffer.

Paste Creates copies of the pages in the copy buffer in the current object tree.

Delete Deletes the currently selected page.

Delete all Pages Deletes all pages in the current object tree (nPre only).

Bring Page Window Top If the currently selected page in the object tree is a plot or list page, the plot or list window is brought to the top of the window order (i.e. made visible).

All Connections Displays a text top-level window that provides information on the connections of all objects within the currently selected page. See Section 6.2.3 for details.

Collapse Tree Collapses all pages such that only first level page icons are displayed in the object tree.

There are no set limits within nPre or nPost on the number of pages in a single application.

2.3.5.4 View Menu

The **View** menu bar item has four items in nPre and three items in nPost:

Toolbar Controls the presence of the toolbar displayed below the object description area.

Status Bar Controls the presence of the status bar at the bottom of the main window.

Control Bar Controls the presence of the nPre control bar (nPre only). The nPre control bar is described in Section 2.3.1.

Settings Displays the **View Settings** dialog which specifies default settings for nSIGHTS operation. This dialog is discussed in detail in Section 2.4.

2.3.5.5 Window Menu

There are at least two items on the **Window** menu bar item:

Window List Displays the window list menu top-level window. Upon selection of any top-level nPre or nPost window (the main window, plots or control menus) in the window list menu, the selected window is brought to the top of the window order. The window list menu is further described in Section 2.3.10.

Minimize all windows Minimizes all windows.

The **Window** menu will contain one entry for each top-level window open except for the main menu. The top-level windows are identified by the nPre input window (nPre only), the window ID and the window type. Selecting an item will bring the window with the same name to the top of the window order. In the example below, there are three top-level windows in nPre. All three are 2D plots: the plots are associated with plot pages in the **Field** tab, the **Sequence** tab, and the **Runtime** tab.

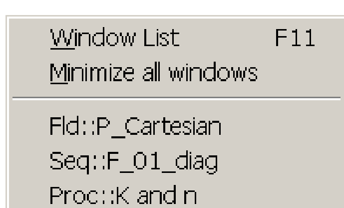


Figure 2.9 Window Menu

2.3.5.6 Help Menu

The **Help** menu bar item has two items:

Help Topics Displays the **Help** window containing the on-line help manual.

About nSIGHTS Displays the **About** dialog, containing information about the software version, and links to the developer and manufacturer.

2.3.5.7 nPre Menu

The **nPre** menu lists all the nPre input windows. It is equivalent to the nPre control bar. Selection of an input window from the nPre control bar or menu will display the corresponding nPre input window.

2.3.5.8 List Menu

The commands in the **List** menu provide a summary, in a text window, of the nPre model input data. The different input data summaries available and their corresponding menu commands are as follows:

Current Displays the model input data associated with the current nPre input window.

Current Errors Displays errors in the model input data of the current nPre input window. If the command is inaccessible, there are no errors for the input window.

Calculated Parameters Displays parameters used in the model which are calculated based on user input parameters.

All Displays all model input data.

All Errors Displays all errors in the model input data.

Messages Displays the last 300 error messages that have occurred.

In addition to the summary of input data, all list windows provide information on the nPre version including the version date and the QA status, the date the listing window was created and the configuration file name.

For example, the following figure shows the list text window for the Current command, with the **Configuration** nPre input window active:

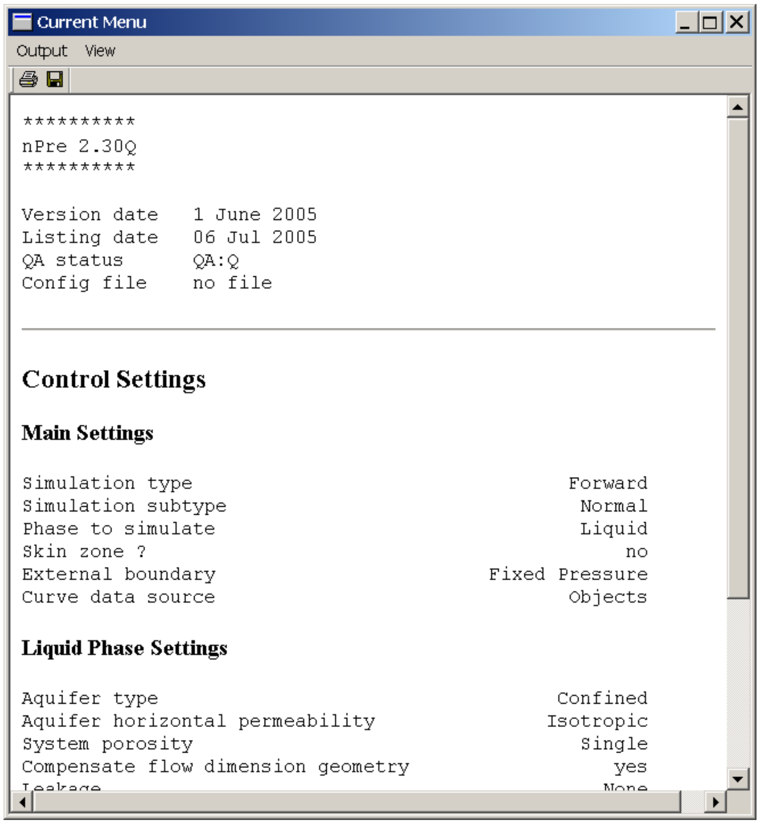


Figure 2.10 List Window Resulting From Current Command with the nPre Configuration Input Window Active

The text window has its own mini menu bar and toolbar, containing the following menus and commands:

Output

Print Presents the standard Windows print dialog.

Print Setup Presents the standard Windows printer selection dialog. The default printer for plots is specified, as well as the basic page set-up.

Print Preview Presents the standard Windows print preview screen. Select the **Close** button to return to the list window.

Save As Saves the data in the text window in a text file, with a default file extension of *.lst.

View

Toolbar Toggles the toolbar on and off.

Settings Currently unavailable.

Fonts A second menu cascades containing commands to change the size of the text font, on a relative scale (smallest to largest).

The toolbar contains two standard Windows buttons that shortcut to the **Output→Print** and the **Output→Save As** commands.

2.3.5.9 Auto Setup Menu

Since the setup of certain portions of the input data and plots are similar from test to test, the commands in the **Auto Setup** menu provide automatic generation of some input data and plots. There are three **Auto Setup** menu commands: **Field Data Plots**, **Sequence Plots**, **Basic Fits**. They are described in detail in Section 4.

2.3.5.10 Run Menu

The **Run** menu contains several commands to run the simulator:

Minimal Executes a model run with minimal run time information. A small dialog displays the elapsed simulation run time and a progress bar for multiple case model runs.

Verbose Executes a model run with maximum run time information. A dialog displays the information, including elapsed run time and fitting parameter information.

No Threads Executes the model run with no threads. Avoids problems when executing multiple simulations on multiple instance of the nPre executable, however the user is unable to cancel the model run.

Covariance Only For optimization mode, calculates the covariance matrix based on the current set of parameters, without conducting a simulation.

These three commands are described in detail in Section 5.

The **Minimize Main** command can be toggled on or off. Toggled on has the same effect as selecting the **Minimize** button in the run window. Upon selection of the **Minimize** button, the main menu, as well as the run window are minimized. Plot windows remain visible, in order to observe changes in the plots during the simulation.

2.3.6 Tool Bar

The tool bar contains icons corresponding primarily to **File** and **Help** menu items. It is displayed below the object description area, and its presence is controlled in the **View** menu.

2.3.7 Object Description Area

Displayed below the menu bar, the object description area provides information on the currently selected object, or input window and tab (nPre only).

2.3.8 Message Line

Below the nPre input window or the object property window is the message line. Error, warning, and information messages regarding nSIGHTS execution are displayed in this area.

2.3.9 Status Bar

A standard Windows status bar at the bottom of the main window. nSIGHTS does not use the status bar except to display Shift and NumLock status and context sensitive help.

2.3.10 Window List Menu Window

The window list menu window will appear if F11 is pressed or if **Window list** is selected from the **Window** menu bar item:

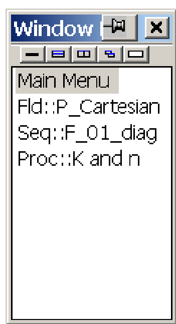


Figure 2.11Window List Menu Window

The **Window List** menu window contains a list of all currently defined nSIGHTS top-level windows. In addition to the main window, top-level windows include plots, list windows, and object controls. Selecting an item from the **Window list** menu will bring the associated window to the top of the window order.

The menu window also has a mini toolbar:

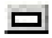
 Selection (pressed-in) of the push-pin icon causes the **Window list** menu window to float above all other top-level menus.

 Minimizes all plot windows.

 Tiles horizontal all plot windows.

 Tiles vertical all plot windows.

 Cascades all plot windows.

 Sets the **Window List** menu window as transparent.

2.4 Program Settings

Selecting **Settings** from the View menu bar item will cause the following **Settings** dialog to appear as shown in Figure 2.12

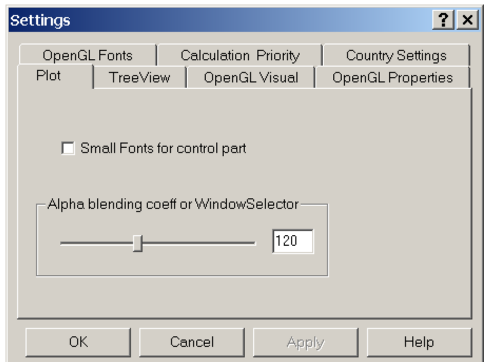


Figure 2.12 Program Settings Dialog

Settings available on the various tabs on this menu are saved in the system registry and will remain in effect until explicitly changed. They are not saved in nPre or nPost configuration files. Each tab on the menu is described in the following subsections.

2.4.1 Plot Tab

Controls the appearance of certain elements of plot windows.

Small fonts for control part — The size of font used in controls on the plot window.

Alpha blending coeff for Window Selector — Controls the transparency of the **Windows List** menu window (see Section 2.3.10). Effect depends upon the operating system and graphics hardware.

2.4.2 TreeView

Controls how objects are represented in the object tree.

Single line for menu objects — If not checked, the text labels for objects in the tree are presented on two lines. Otherwise a single line is used.

Show for single line — Options for object identification used in text labels displayed in a single line.

ID Only the object ID is displayed.

Type The object type is shown.

Both Object ID and type are both displayed.

Show unused objects If selected, objects not used by any other object in the configuration file are denoted by a green circle on top of the object icon.

Show connected objects If selected, objects upstream of the selected object are denoted by a magenta diamond on top of the object icon, and objects downstream of the selected object are denoted with a red square on top of the object icon. Upstream objects refer to objects used as input to the selected object, and downstream objects refer to objects which use the selected object as input.

2.4.3 OpenGL Visual

An ***OpenGL Visual*** describes the technical settings used for displaying 2D and 3D graphics in nSIGHTS. This menu has two formats. If a plot page has been created, the menu shows only the status of the visual as shown below in Figure 2.13:

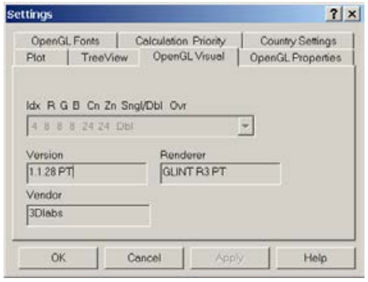


Figure 2.13 OpenGL Visual Tab with Plot Pages Defined

The first field gives the index, red, green, and blue color depth, the color planes and depth buffer depth and the buffering status. For effective use of nSIGHTS the following settings are recommended:

Idx Index - n/a as it depends upon hardware.

R/G/B Red/green/blue color depth - at least 5 is desirable, 8 is preferred.

Cn Total color depth including alpha channel (not used in nSIGHTS currently) - will usually be 4 times color depth.

Zn Z or depth buffer depth - 32 bits is preferable, at least 16 is necessary.

Sngl/Dbl Single or double buffer - usually select double buffered visuals. Single buffered visuals may flicker.

The other fields in the dialog (Version, Renderer, and Vendor) displays additional information which may be useful for debugging display problems.

If a plot page has not been defined the menu appears with a selector box available (shown with drop-down-box):

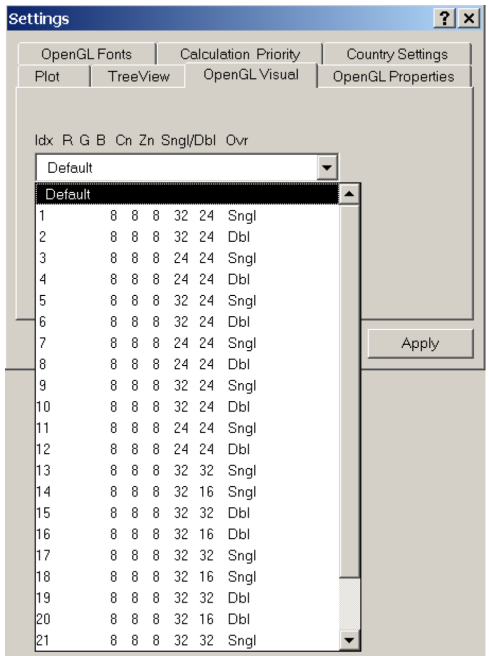


Figure 2.14 OpenGL Visual Tab with No Plot Pages Defined

Note that the number of visuals available and their properties will depend upon your graphics card and drivers. The example shown above is for an Oxygen VX1 graphics card under Windows 2000. If *Default* is selected, nSIGHTS will attempt to pick an appropriate visual. Note that the selected visual may or may not use hardware acceleration and may or may not be appropriate for technical graphics. For example, many cards have some visuals optimized for games, which have different requirements (usually smaller Z buffer).

2.4.4 OpenGL Properties

Open GL Properties control the use of anti-aliased lines (which may or may not be supported on your graphics card and selected visual). Anti-aliased lines blend pixels so that lines appear smooth. Anti-aliased lines typically are slower to draw than normal lines.

Anti-alias 2D lines If selected, lines on 2D plots are smoothed.

Anti-alias 3D lines If selected, lines on 3D plots are smoothed.

2.4.5 OpenGL Fonts

Compensates for operating system bugs in vertical or rotated text drawn on 2D plots. Change this only if your displayed fonts have mirrored or distorted letters.

2.4.6 Calculation Priority

Controls the priority of the simulation thread.

2.4.7 Country Settings

International settings.

European real delimiters	Replaces decimal place with comma in user-interface, real number display and I/O.

3 NPRE INPUT WINDOWS

The nPre input windows contain dialog prompts, object trees and corresponding object property window or tables to define the input for a model run. Different input windows are used as a means of organizing input data, and each window may be further organized into tabs. This section describes the different nPre input windows and their function, summarized in **Table 3.1 Summary of nPre Input Windows and Functions**.

The nPre input windows are accessed by selecting a command from the **nPre** menu, or the nPre control bar. Not all input commands are accessible. Input commands, as well as tabs and dialog prompts, are hidden if they are not required for the current set of selected options. For example, the **Optimization** input window remains hidden unless *Optimization* is selected as the Simulation Sub-Type in the **Main** tab of the **Configuration** input window. A hidden command or tab is either faded and cannot be selected, or completely hidden from view.

Table 3.1 Summary of nPre Input Windows and Functions

Input Windows and Tabs	**Function**
Configuration	Defines model function and general options for the model run.
Main	Sets basic model options, such as simulation mode.
Liquid	Options specific to liquid phase simulations.
Gas	Options specific to gas phase simulations.
Matrix	Options specific to the matrix of dual porosity systems.
Default Units	Sets default units for the model run.
Curve Files	Only if curve data source is a file (**Main** tab of the **Configuration** input window). Loads XY files containing time-variable boundary conditions, and pressure- or radius-variable parameters.
Test Description	Documentation of the model run.
Wells and Output	Defines the wells in the model, and the associated output for each well to be calculated by the model.
Main	Defines the wells in the model, and the associated output for each well to be calculated by the model.
Production Restart	Restarts production integration at specified times (for production output).
Superposition	Only for pressure superposition output type, the **Superposition** tab provides a table to input radii at which pressures will be summed, and related options.
Sequences	Sequence definition. Sequences are discrete time intervals representing a set of well-bore boundary conditions.

Table 3.1 Summary of nPre Input Windows and Functions	
Input Windows and Tabs	**Function**
Time-Base	Options for defining sequences.
Sequences	Defines the sequences.
TZ Curves	Associates curve data (time-variable boundary conditions) with sequences.
Dynamic Time Step	Controls for automatic adjustment of the time step during simulations.
Partial Run	Controls to simulate only a subset of the defined sequences.
Parameter	Establishes fitting and non-fitting parameters, and defines these parameter values, ranges or distributions.
Formation	Formation parameters.
Fracture	Fracture parameters, only for dual porosity systems.
Matrix	Matrix parameters, only for dual porosity systems.
Fluid	Fluid parameters, only for liquid phase simulations.
Gas	Gas parameters, only for gas phase simulations.
Leaky Layer	Leaky layer parameters, only for single leakage systems.
Upper Leaky Layer	Upper leaky layer parameters, only for upper/lower leakage systems.
Lower Leaky Layer	Lower leaky layer parameters, only for upper/lower leakage systems.
Skin Zone	Skin zone parameters, only for simulations with a skin zone.
Test-Zone	Test-zone parameters.
Numeric	Numeric parameters.
f(x) Points Parameter	Defines parameter functions that vary with pressure or radius. Only accessible if parameters are defined as points functions in the **Parameter** input window.
Points Entry	Enter XY points to define the function.
Interpolation	Defines an interpolation function for the XY points.
Units/Transform	The units and transforms of the XY points.
Optimization	Controls for the optimization of points defining the parameter function. Optimization modes only.

Table 3.1 Summary of nPre Input Windows and Functions

Input Windows and Tabs	Function
Fit Selection	Determines which field and simulated data paired are to be used for regression analysis. The pairing of field and simulated data, conducted within the **Fit** tab of the **Plots & Data Processing** input window, indicates the field data to which the regression model should fit simulation results. Only for optimization modes or forward-range mode.
Optimization	Optimization solver options. Only for optimization modes.
Main	Selection of algorithm, and general options.
Tolerances	Options for optimizer tolerances.
L-M	Options for the Levenburg-Marquardt and the MINPACK Levenburg-Marquardt algorithms.
Simplex	Options for the downhill simplex algorithm.
S-A	Options for the Simulate Annealing algorithm.
NL2SOL	Options for the NL2SOL algorithm.
SCEM	Options for the SCEM algorithm.
Perturbation	Initiates perturbation mode. Only for optimization-normal mode.
Calculated Vars	Determines the calculated variables included in output.
Sampling	Sets up the sampling of a parameter. The parameters to be sampled are defined in the **Parameter** or **Sequence** input windows. Only accessible for sampling modes.
Main	Selection of sampling options, such as the sampling procedure and the number of times a parameter is to be sampled.
Correlations	The simulation program will force the correlation between two parameters to the correlation values specified in this tab.
Samples	Provides a table of the sampled values to be used by the model.

Table 3.1 Summary of nPre Input Windows and Functions	
Input Windows and Tabs	**Function**
Suite/Range	Determines the priority of suite or range parameters. Not accessible for sampling modes.
Priority	Sets the priority of suite or range parameters.
Output Files	Defines model output files.
XY Data	Determines which XY array data to output to a file. All modes except range modes.
Profile	Creates a profile output file, which outputs a grid of pressure as a function of time (X axis) and radius (Y axis). Only for forward-normal modes.
Range	Creates a range output file, which contains grid (2 range variables) or cube (3 range variables) data of residuals (between simulation and field data). Only for range modes.
Optimization	Creates a file containing fit results. May also include residuals, covariance matrices, Jacobian data and specified calculated variables. Only for optimization-normal and optimization-sampling modes.
Plots & Data Processing	Contains 4 tabs, each containing an object tree.
Field Data	Object tree to create constraints and diagnostic plots from field data.
Sequence	Object tree to create simulated data sets that correspond with the field data constraints defined in the **Field Data** tab and to create simulated data diagnostic plots.
Fit	Pairs field and simulated data, indicates the field data to which a regression model should fit simulation results.
Runtime	Object tree to create plots to monitor the real-time progress of the model.

3.1 Configuration Input Window

The configuration input window defines the basic options of the model, which define the type of simulation to occur, the model's general physical configuration, and the types of parameters that will be used to describe the physical configuration.

3.1.1 Main Tab

Defines the basic options of the model, and its basic physical configuration, as shown in Figure 3.1:

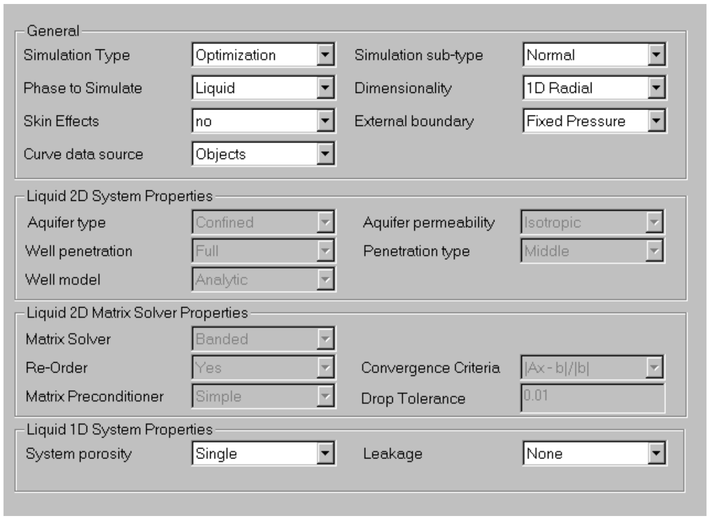


Figure 3.1 Configuration Main Tab Window

General

Simulation Type

Forward — The model simulates a hydraulic test response based on user input.

Optimization — The model adjusts the values of user-specified parameters to obtain an optimal fit to field data.

Simulation sub-type — Simulation sub-types *Normal*, *Range* or *Sampling* are accessible for both *Forward* and *Optimization* simulation types, resulting in six possible simulation modes.

Forward–Normal — The simulation is based on user-input parameter values.

Forward–Range — A range of values and the number of intervals per range is assigned to two or three input parameters. (Note that input parameters may include sequence data, such as flow rate or pressure boundary conditions.) Forward simulations are performed for each combination of range variables. For each simulation, a fit metric is calculated based on a comparison of simulated results with a user-defined constraint. A map of all these fit metrics, also called parameter-space maps or fit surfaces, is used to determine the optimal fitting-parameter combination.

Forward–Sampling — Uncertainty ranges and distributions are assigned to input parameters of interest. (Note that input parameters may include sequence data, such as flow rate or pressure boundary conditions.) The input parameter distributions are sampled a specified number of times, and a forward simulation is produced for each sample set.

Optimization–Normal — A number of simulations are conducted, in which user-specified parameters (fitting parameters) are adjusted for each simulation to obtain an optimal fit between simulated results and field data.

Optimization–Range — Two or three input parameters are specified with a range of values, and additional parameters are specified as fitting parameters. For each combination of range variables, optimization simulations are conducted (i.e. the fitting parameters are adjusted for each simulation to obtain an optimal fit). For each simulation, a fit metric is calculated in addition to optimization results.

Optimization–Sampling — Used to investigate the correlation between fitting and non-fitting parameters. Uncertainty distributions are assigned to non-fitting parameters of interest, and fitting parameters are defined. The non-fitting parameter distributions are sampled a specified number of times, and for each sample set of non-fitting parameters, optimization simulations are conducted (i.e. the fitting parameters are adjusted for each simulation to obtain an optimal fit).

Phase to Simulate

Liquid — Indicates that a liquid phase simulation will be conducted.

Gas — Indicates that a gas phase simulation will be conducted.

Dimensionality — For liquid simulations only.

1D Radial — Indicates that a 1D radial simulation will be conducted.

2D Radial — Indicates that a 2D radial simulation will be conducted.

Skin Effects — If *yes*, a zone surrounding the well-bore is differentiated from the formation, for which characteristic parameters need to be defined.

External Boundary — Specified external radius is either at *Fixed Pressure* or *Zero Flow*.

Curve data source

Objects — Curve data input is obtained from a curve object defined in an object tree. This allows the user to read, create and/or manipulate curves within nPre for use as curve input.

File — Curve data is obtained from a curve file selected as input in the **Curve Files** tab (**Configuration** input window). This option assumes pre-existing curve files for wellbore boundary conditions, f(P) parameters, f(r) parameters and/or f(t) parameters.

Liquid 2D System Properties — For 2D radial liquid simulations only.

Aquifer type

Confined — A confined solution will be conducted.

Unconfined — An unconfined simulation will be conducted. The unconfined solution assume a non-leaky, single porosity system with a flow dimension of 2.

Aquifer permeability

Isotropic — Vertical permeability is assumed to be equal to horizontal permeability.

Anisotropic — An additional parameter for vertical permeability or hydraulic conductivity is provided.

Well penetration

Full — The pumping well penetrates the full length of the formation.

Partial — The pumping well only penetrates a sub-section of the formation.

Penetration type — For partial well penetration only.

Top — The pumping well screen length extends from the water table to an offset above the bottom of the formation. The number of vertical nodes in the well and below the well are defined.

Middle — The pumping well screen length does not extend to the top or the bottom of the formation. The number of vertical nodes above the well, in the well and below the well are defined.

Bottom — The pumping well screen length extends from an offset below the water table to the bottom of the formation. The number of vertical nodes above the well and in the well.

Well model

Analytic — The hydraulic conductivity in the well is obtained from the Hagen-Poiseuille formula: $K = r^2\rho g/8\mu$, where r is the well radius.

kV Multiplier — The hydraulic conductivity in the well is obtained by multiplying the vertical hydraulic conductivity by the *Well conductance multiplier*.

Uniform — The well flow rate is distributed uniformly along each node of the well.

Liquid 2D Matrix Solver Properties For 2D radial liquid simulations only.

Matrix Solver — Selects the solver to be used.

Banded — A direct solver based on a compact band-diagonal matrix.

Cholesky — A direct solver for positive definite matrices, and is therefore limited to confined aquifers.

PCG — A Preconditioned Conjugate Gradient (PCG) numeric solver for symetric matrices, and is therefore limited to confined aquifers.

PBCG — A Preconditioned Bi-Conjugate Gradient (PBCG) numeric solver. Although slower than PCG, will work with both symmetric and non-symmetric matrices (i.e. both confined and unconfined aquifers).

Re-Order — For all matrix solvers except the banded solver, provides the option to re-oder the matrix before solving. Re-ordering the matrix can significantly shorten the time required to solve.

Convergence Criteria — For numeric solvers, the PCG amd PBCG, determines the convergence criteria:

- $\frac{|Ax-b|}{|b|}$
- Preconditioned $\frac{|Ax-b|}{|b|}$, i.e. $\frac{|A^{-1} \cdot (Ax-b)|}{A^{-1} \cdot b}$
- $\frac{|error\ in\ x|}{|x|}$
- $\frac{\max error\ in\ x}{\max x}$, where absolute values of the error in x and x are used

Matrix Preconditioner — For numeric solvers (PCG and PBCG) only.

Simple — A simple preconditioner based on the diagonal of A.

Modified Cholesky — A preconditioner based on an incomplete Cholesky factorization. A faster approach than the Simple preconditioner, the Modified Cholesky preconditioner is limited to positive definite matrices (i.e. confined aquifers).

Drop Tolerance — For the Modified Cholesky matrix preconditioner, determines the tolerance for removing small matrix elements. A drop tolerance of zero would result in a complete Cholesky factorization.

Liquid 1D System Properties — For 1D radial liquid simulations only.

System porosity

Single — The model only considers one component of the media: the formation.

Dual — The model considers two components of a fractured medium: the fracture and the matrix. Parameters need to be specified for each component.

Leakage

None — The aquifer is assumed to be confined; there are no leaky layers above or below the model system.

Single — A single leaky layer above the model system.

Upper/Lower — Layers above and below the model system are leaky.

3.1.2 Liquid Tab

The **Liquid** tab is only accessible if *Liquid* was selected as the Phase to Simulate in the **Main** tab.

Permeability/hydraulic conductivity — *Hydraulic Conductivity* can be entered directly, or calculated from *Permeability*. Values for conductivity or permeability are entered in the **Parameter** input window.

Storage Parameter

Specific Storage — Specific storage is entered directly as a parameter in the **Parameter** input window.

*Porosity*Total Compressibility* — Specific storage is calculated from porosity and compressibility, which are entered in the **Parameter** input window.

Compensate flow dimension geometry — Compensation is used in two cases: (1) for flow geometries that vary with radius (2) for flow geometries which would incorrectly calculate the area at the bore-hole. For example, a spherical flow geometry (n=3) would incorrectly calculate the area of a cylindrical borehole.

Test zone volume — For *varying* test zone volumes, curve data (volume of test zone vs. time) are required to describe the boundary conditions of pulse or flow sequences with isolated well-bore storage.

Test zone compressibility — For *varying* test zone compressibility, curve data (test zone compressibility vs. time) are required to describe the boundary conditions of pulse or flow sequences with isolated well-bore storage.

Test zone temperature — For *varying* test zone temperature, curve data (temperature vs. time) are required to describe the boundary conditions of pulse sequences with non-isothermal test zone thermal conditions.

Default temperature — The default temperature is entered in the text input box, with the temperature units, either degrees Celsius (C) or degrees Fahrenheit (F), specified in the drop-down-box.

Solution variable — *Pressure* or *Head*

Default liquid density — Unavailable unless *Head* is selected as the Solution Variable. The default liquid density is entered in the text input box, with the liquid density units (kg/m^3, g/cm^3, lb/ft^3 or lb/in^3) specified in the drop-down-box.

Allow -ve pressure/head or unconfined minimum thickness — Simulation continues with negative pressure/head or a minimum thickness if the formation is sucked dry.

3.1.3 Gas Tab

The **Gas** tab is only accessible if *Gas* was selected as the Phase to Simulate in the **Main** tab.

Klinkenburg effects — If *yes*, the effect of gas slippage on permeability (Klinkenburg effects) is calculated, requiring the parameter *Formation Klinkenburg factor*.

Viscosity as f(P) — Allows the definition of a simple function of pressure, based on a *Gas viscosity slope factor* parameter, where viscosity = *Gas viscosity* parameter + *Gas viscosity slope factor* parameter * Pressure. Complex functions of pressure are created using various parameter Types available in the **Parameter** input window (see Section 3.4).

Gas flow solution variable — *Mass flow* or *Volume@STP*. STP stands for Standard Temperature and Pressure.

STP temperature — Only required if *Volume@STP* is selected as the Gas flow solution variable. The STP temperature is entered in the text input box, either in degrees Celsius (C) or degrees Fahrenheit (F), specified in the drop-down-box.

STP pressure — Only required if *Volume@STP* is selected as the Gas flow solution variable. The STP pressure is entered in the text input box, either in kPa, MPa, psi or bar, specified in the drop-down-box.

3.1.4 Matrix Tab

The **Matrix** tab is only accessible if *Dual* is selected as the System porosity in the **Main** tab.

Matrix Geometry — The geometric relationship of the matrix and fracture.

- *Spherical* — The matrix is composed of spheres separated by fractures.
- *Prismatic* — The matrix is composed of rectangular slabs separated by fractures.

Alpha — A shape factor used in the equation to relate the matrix and fracture permeabilities.

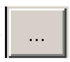
- *Entered* — The shape factor is entered using the *Geometry Factor (Alpha)* parameter.
- *Calculated* — The shape factor is calculated based on the *Matrix sphere diameter* parameter for spherical matrix geometries, and on the *Slab matrix block thickness* parameter for prismatic matrix geometries.

3.1.5 Default Units Tab

The units that appear within all other nPre input windows will correspond to the units specified in the **Default Units** tab, unless the units are specified directly in the input window. The units for each variable are selected from a drop-down list.

3.1.6 Curve Files Tab

If the Curve data source has been identified as *File* in the **Main** tab, the **Curve Files** tab allows the user to load pre-existing ***curve files*** to be used as well-bore boundary conditions or parameter functions. Curve files are XY data sets which describe time-varying boundary conditions or parameters which vary as a function of pressure (f(P)), a function of radius (f(r)) or a function of time (f(t), for 1D radial systems only). Each file may contain one or more data sets, each provided with its own ***Curve ID***. Curve files created by objects within nPre can only be used for input if *Objects* is selected as the Curve data source.

Four types of curve files can be loaded within this tab: Well-bore boundary conditions, f(P) parameters, f(r) parameters and f(t) parameters. To load each file, type the file name in the corresponding text box or use the browse button (), and then select the Load Curves button at the bottom of the dialog. The default file extension for curve files is *.nCRV, but a file of any extension may be loaded, as long as the file is in the correct format.

The files loaded in this tab will be accessed in different input window and tabs as required, as described in Table 3.2.

Table 3.2 Use of Curve Files

Curve File Type	Location of Use
Well-bore boundary conditions	**TZ Curves** tab in the **Sequence** input window
f(P) parameters	**Parameter** input window
f(r) parameters	**Parameter** input window
f(t) parameters	**Parameter** input window

.

3.1.7 Test Description Tab

The **Test Description** tab contains a text input box to allow the user to document the test to be simulated. In practice, it is a good idea to document all tests, as details of a test are forgotten with time.

3.2 Wells and Output Input Window

3.2.1 Main Tab

The **Main** tab of the **Wells and Output** input window defines the wells in the model, and the output to be calculated by the model for each well. It consists of a table where the type of output is defined:

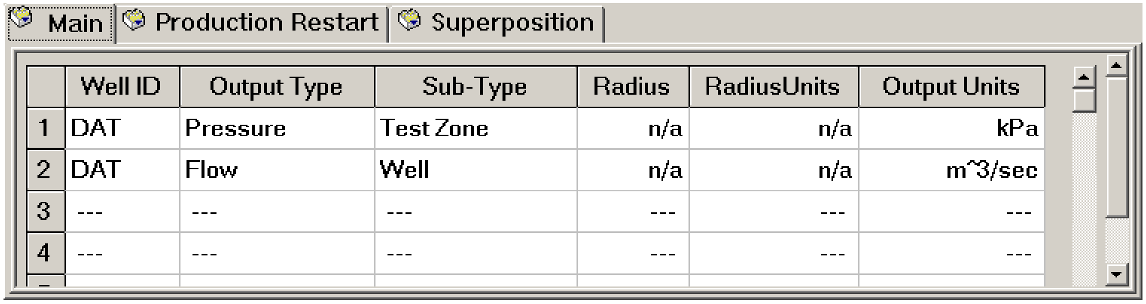


Figure 3.2 Main Tab of Wells and Output Window

Well ID	The ID identifies the well associated with the output. A default ID of *DAT* is used for the default well output.
Output Type, Sub-type	Determines the type of output to be calculated:
Pressure	
Test Zone	Pressure in the well-bore.
Observation Well	Pressure at a specified distance from the well-bore. The specified distance is input in the Radius column.
Superposition	Sums pressures at specified radii. Superposition radii and options are input in the **Superposition** tab.
Flow	
Well	Flow into or out of the well, including *Formation*, *Test-zone* and *Well-bore storage* flows. For flow sequences, the well flow is specified.
Formation	Flow into the well-bore from the formation, or out of the well-bore to the formation. Test zone and well-bore storage flows are not included.
Test Zone	Flow in the well-bore due to volume changes in the test-zone.
Well-bore Storage	Flow due to well-bore storage. For example, a pressure change will generate flow from the well-bore storage due to the change in the compressibility of the liquid or gas.

Production — Integrated flow rate (i.e. total volume). Same sub-types as *Flow*.

Test Zone

TZ Temp. — Temperature in the test zone. Simply echoes variable test zone temperature curve data.

TZ Comp. — Compressibility in the test zone.

TZ Volume — Volume in the test zone.

Water Table

Observation Well — Water table elevation (from the bottom of the formation) at a specified distance from the well-bore. The specified distance is input in the Radius column.

Radius — Determines the radius from the well-bore at which pressure/water table elevation will be output. For pressure observation wells or water table observation wells only. For partially penetrating wells, the radius is specified in the **2D Observation Well Dialog** described in Section 3.2.1.1. To access the dialog, double click in the Radius cell.

Radius Units — Units of the radius are selected from a drop-down list.

Output Units — Units for the output are selected from a drop-down list.

Table rows are inserted, deleted or duplicated using the right click pop-up menu.

3.2.1.1 2D Observation Well Dialog

For partially penetrating wells, a vertical elevation as well as a radius needs to be defined for the observation well. The inputs to the dialog are as follows:

Well radius — Same as the Radius in the **Main** tab of **Wells and Output** input window.

Well vertical specification — Determines how the vertical elevation is specified: by *Ratio* or *Actual* Z value.

Vertical offset — If the vertical specification is actual, the vertical elevation from the bottom of the formation is specified (i.e. a value of 0.0 indicates the bottom of the formation).

Normalized Z value — If the vertical specification is ratio, the vertical elevation from the bottom of the formation is specified as a value between 0 and 1. For example, a value of 0.5 will result in a vertical elevation half-way between the bottom of the formation and the water table.

3.2.2 Production Restart Tab

For production output, the production integration can be restarted at specified times. The specified times are input into the provided table.

3.2.3 Superposition Tab

Only for pressure superposition output type, the **Superposition** tab provides a table to input radii at which pressures will be summed, and related options, shown in Figure 3.3.

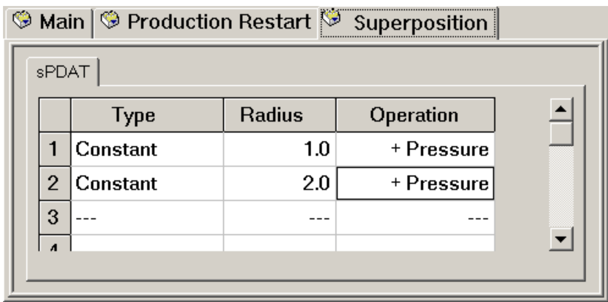


Figure 3.3 Superposition Tab

Depending on the Type, data are entered into the Radius column. For a *Constant* type, a single value is input into the Radius column. For *Optimize*, *Suite/Range*, and *Sampled*, a **Value Dialog** will appear upon double-clicking the corresponding Radius cell. The inputs to each **Value Dialog** are described in Value Dialog. Note that *Optimize*, *Range* and *Sampled* **Value Dialog**s are only available for optimization, range and sampling modes, respectively.

The Operation column determines whether the pressure at the specified radius is added (*+Pressure*) or subtracted (*-Pressure*), or whether the pressure change from static formation pressure at the specified radius is added (*+dPressure*) or subtracted (*-dPressure*).

3.3 Sequences Input Window

Sequences are discrete time intervals that divide a testing period, with one sequence representing a continuous period of consistent well-bore boundary conditions. A series of sequences allows nPre to consider the cumulative effect of changing well-bore boundary conditions as well as consecutive well tests. An unlimited number of sequences may be specified.

There are four types of sequences, each representing a different type of well-bore boundary condition:

History sequence – Time periods during which borehole pressures or heads are specified as constant or variable in time since the start of the sequence. History sequences are used to represent:

(1) the time period between drilling and initial shut-in of the test zone

(2) time periods where external factors, such as changes in packer pressures, affect test-zone pressures

(3) constant-pressure flow tests

Flow sequence – Time periods during which water is injected or withdrawn from a well. Flow rates can be constant or variable in time since the start of the sequence. For highly variable flow rates, curve data for a single flow sequence is used. For stepped flow rates, multiple flow sequences with constant flow rates are used. A zero-flow-rate flow sequence is used to represent:

(1) the recovery period following a pumping test

(2) time periods immediately after test zones are shut in for the first time

(3) pressure recovery under shut-in conditions following constant pressure flow tests (allows test-zone compressibility to be specified as a fitting parameter).

Pulse sequence – Time periods during which a test zone is shut in and pressures in the test zone and the surrounding formation are equilibrating. The initial pressure is specified, and isolated zone well-bore storage is assumed. Pulse sequences are used to represent pressure recovery periods following individual pulse injections or pulse withdrawals.

Slug sequence – Time periods during which the injection or withdrawal of a slug of water from an open well causes changes in well (or tubing string) water levels. The initial pressure is specified, and open hole (open tubing string) well-bore storage is assumed. For liquid simulations only.

For history and flow sequences, well-bore storage may also be incorporated into the boundary conditions. Two types of well-bore storage are available:

Open Hole – A tubing string of constant diameter filled with liquid is assumed to be connected to the test-zone. For liquid phase simulations only.

Isolated – The test-zone is filled with a compressible liquid or gas.

3.3.1 Time-Base Tab

This tab determines the time-based options for defining sequences:

Sequence time entry	In *Duration* mode, the duration of each sequence will need to be entered as input in the Sequences tab table. In *Start Time* mode, only the start time of each test sequence will need to be entered. For a complex series of

sequences, *Start Time* mode will generally be simpler, as duration times do not need to be calculated for every sequence.

Start time of first sequence — The start time of the first sequence needs to be specified for both *Duration* and *Start Time* mode. Note that if the time is input before the units are changed, the time will be converted to the new units.

End time of last sequence

3.3.2 Sequences Tab

The **Sequences** tab contains a table to describe the sequence type, designation and time period. The format of the table will change depending on selection of duration or start time mode in the **Time-Base** tab.

Sequences should be entered in chronological order. Table rows are inserted, deleted or duplicated using the commands in the pop-up menus (right click of the mouse).

Type — Double click on a Type cell to select one of the available sequence types from a drop-down list: *Flow*, *History*, *Pulse*, *Slug*. The different types of sequences are described in detail in Section 3.3.

Designation — Name of the sequence. It is used by objects that load, manipulate and plot the sequence data. The default naming convention consists of the first letter of the sequence type, followed by the order number for sequences of that type. For example, the first flow sequence will have a default name of F_01, and the second flow sequence will have a default name of F_02.

Duration [time units]

or

Start Time [time units] — For duration mode, the duration time is entered in the cell, and correspondingly, for start time mode, the start time is entered in the cell. Note that if the time is input before the units are changed, the time will be converted to the new units. [time units] in the table heading are specified in **Configuration→Default Units.**

Units — The time units are changed for one sequence by double-clicking on the corresponding cell and selecting the desired units from the drop-down list.

Sequence Data — Double click on the cell, and a **Sequence Setup Dialog** will appear, requiring time step and sequence type specific information. See Section 3.3.2.1 for a detailed description of this dialog.

Duration (time units)
or
Start Time (time units)

For duration mode, Start Time is the table heading, and correspondingly, for start time mode, Duration is the table heading. It is automatically calculated, based on the row above, once the Duration cell (duration mode) or the Start Time cell (start time mode) is entered. If the time information of the row above is changed, this value will only be recalculated if the Duration (duration mode) or the Start Time (start time mode) is re-entered.

Auto

A check marked box indicates that the sequence will be included in auto setup of diagnostic plots (i.e. **Auto Setup→Sequence Plots**).

3.3.2.1 Sequence Setup Dialog

The **Sequence Setup Dialog** (**Sequences** tab) provides defining details to sequences. It is sequence type dependent – each sequence type has its own **Sequence Setup Dialog**. The following example, Figure 3.4 Flow Sequence Setup Dialog, is for a flow sequence.

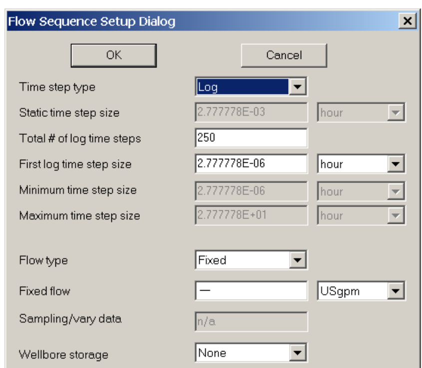


Figure 3.4 Flow Sequence Setup Dialog

The first six dialog prompts of the dialog are common to all sequence types. The availability of these prompts is dependent on the Time step type, either *Static*, *Log*, *Dynamic P* or *Dynamic Q*.

The remaining dialog prompts are specific for each sequence type, and specify the boundary conditions for each sequence type.

For flow and history sequences, the magnitude of the boundary condition is specified in one of three ways:

Fixed

Fixed values are specified in the Fixed flow or Fixed pressure text boxes.

Suite

A range of values is specified in the **Suite Values Entry Menu** box that appears upon selecting the Sampling/vary data text box.

Curve Pressure or flow values are described in curve data. Curve data associated with the sequence are identified in the **TZ Curves** tab.

The type of well-bore storage is also specified for flow and history sequences.

For pulse and slug sequences, the initial pressure is specified, or determined relative to pressures in previous sequences. The initial or offset pressures are entered in the Pulse pressure or Slug pressure text boxes.

Absolute Absolute. The initial pressure is specified.

Tubing String Rel. Relative to the pressure in the tubing string at the end of the last sequence that affected tubing string water levels. A pressure offset is specified, that will be added to the tubing string relative pressure.

Sequence Relative Relative to the pressure at the end of the previous sequence. A pressure offset is specified that will be added to the sequence relative pressure.

3.3.3 TZ Curves Tab

The **TZ Curves** tab contains a table to associate sequences with curve data. Depending on the curve data source selected in the **Main** tab of the **Configuration** input window, curve data can be obtained from curve objects created within object trees or the well-bore boundary condition curve file loaded in the **Curve Files** tab of the **Configuration** input window. The curve data describe the data-type (e.g. flow) as it changes with time, and consequently the data should have time as the X data, and the data-type for the Y data. The X and/or the Y data may be transformed by log 10.

Table rows are inserted, deleted or duplicated using the commands in the pop-up menus (right click of the mouse).

Type The curve data type is dependent on the type of sequence it relates to:

Flow for flow sequences

Pressure for history sequences

Volume Change for history, flow or pulse sequences with isolated well-bore storage

Volume for history, flow or pulse sequences with isolated well-bore storage

Compressibility for history, flow or pulse sequences with isolated well-bore storage

Temperature for pulse sequences with non-isothermal test zone thermal conditions

Curve Object/ID A drop-down list providing the available curve data. If the curve data source selected in the **Main** tab of the **Configuration** input window is *Object*, the drop-down list contains the available curve objects created within an object tree (**Plots & Data Processing**). Otherwise, if the curve data source selected is *File*, the curve data is obtained from the curve file loaded as Well-bore boundary conditions in the **Curve Files** tab of the **Configuration** input window.

Start Sequence

End Sequence The starting and ending sequences are selected from drop-down lists that contain the sequences defined in the **Sequences** tab. The curve data may span several sequences. The sequence type of the sequences selected must correspond with the curve data type.

Curve Data Double click on the cell, and a **TZ Curve Setup Dialog** will appear, as shown in Figure 3.5 Test Zone Curve Setup.

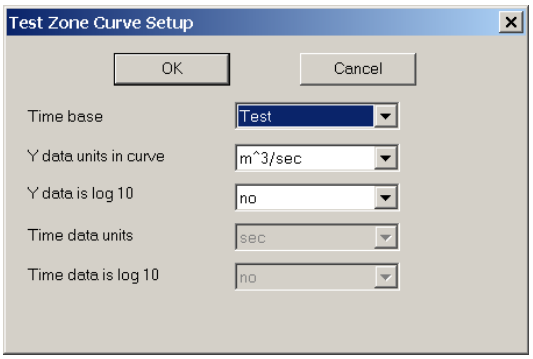


Figure 3.5 Test Zone Curve Setup

Time Base Determines where time zero begins for the curve data.

Test Curve time is consistent with test time.

Sequence Time zero is at the beginning of the sequence.

Y data units in curve Units of the Y data (e.g. flow).

Y data are log 10 *yes* if the Y data are log 10 transformed.

Time data units For *Sequence* time bases, units of the Y data (e.g. flow). For *Test* time bases, the units are assumed to be the same as those defined for the Start time of first sequence in the Time-Base tab.

Time data are log 10 For *Sequence* time bases, *yes* if the X data are log 10 transformed. For *Test* time bases, the time data cannot be log 10 transformed.

3.3.4 Dynamic Time Step Tab

The time step for each sequence is discretized in the **Sequences** tab, specifically within the **Sequence Setup Dialog**. However, the time step may be automatically adjusted as a function of the pressure change in the well for history, pulse and slug sequences, or the flow rate change in the formation for flow sequences.

The **Dynamic Time Step** tab contains the controls for the automatic adjustment of the time step. Based on maximum and minimum values, the time step is decreased if the pressure or flow change is greater than the specified maximum change, and correspondingly, the time step is increased if the pressure or flow change is less than the specified minimum change.

The Max # of TS in dynamic sequence dialog prompt controls the maximum number of time steps that will occur in any one dynamic sequence. The maximum number of time steps is used for memory allocation only and should not be changed unless run-time errors occur.

3.3.5 Partial Run Tab

A subset of the defined sequences can be simulated, according to the controls on the **Partial Run** tab.

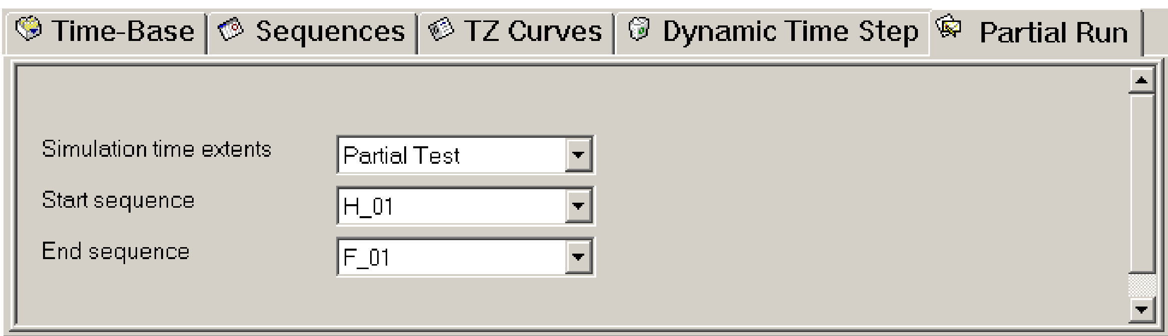


Figure 3.6 Partial Run Tab

For a partial run, select *Partial Test* for the Simulation time extents. The partial run is defined by starting and ending sequences, selected from drop-down lists that contain the sequences defined in the **Sequences** tab.

3.4 Parameter Input Window

Non-fitting and fitting parameters, including their value, range or uncertainty distribution, are defined in the **Parameter** input window.

The parameter window is divided into tabs as a means of organizing the parameter list. The list of tabs and possible parameters in each tab varies depending on the model's configuration. Table 3.3 **Model Parameter Summary**summarizes all the parameters, and the model configuration under which the parameter is available.

Table 3.3 Model Parameter Summary	
Parameter	**Notes**
Formation Tab	
Formation Thickness/ Saturated Thickness	Always required. For unconfined systems, the parameter is labelled Saturated Thickness.
Flow dimension	Always required. Refers to the geometry of the flow system. For radial systems, the flow dimension value is 2.
Static formation pressure	Always required. Units vary depending on Head Solution variable (**Configuration→Liquid**): pressure units or length units.
External boundary radius	Always required.
Formation conductivity	Required for single porosity systems if hydraulic conductivity is to be entered directly.
Formation permeability	Required for single porosity systems if hydraulic conductivity is calculated from permeability.
Formation spec. storage	Specific storage. Required for single porosity systems if specific storage is to be specified directly.
Formation specific yield	Required for unconfined systems.
Formation porosity	Required for single porosity systems if specific storage is calculated from porosity and compressibility.
Formation compressibility	Required for single porosity systems if specific storage is to be calculated from porosity and compressibility.
Formation klinkenburg factor	Required for gas phase simulations where Klinkenburg effects are considered.
Formation vertical conductivity	Required for unconfined systems if anisotropic and hydraulic conductivity is to be entered directly.
Formation vertical permeability	Required for unconfined systems if anisotropic and hydraulic conductivity is calculated from permeability.
Fracture – For dual porosity systems only.	
Fracture conductivity	Required if hydraulic conductivity is to be entered directly.
Fracture permeability	Required if hydraulic conductivity is calculated from permeability.
Fracture spec. storage	Specific storage. Required if specific storage to be specified directly.
Porosity within fracture	Required if specific storage is calculated from porosity and compressibility.

Table 3.3 Model Parameter Summary	
Parameter	**Notes**
Fracture compressibility	Required if specific storage is calculated from porosity and compressibility.
Matrix – For dual porosity systems only.	
Matrix volume factor	Always required for dual porosity systems.
Geometry factor (Alpha)	Required if the geometry factor is to be entered directly.
Matrix sphere diameter	Required for spherical matrix geometry, if the geometry factor is to be calculated.
Slab matrix block thickness	Required for prismatic matrix geometry, if the geometry factor is to be calculated.
Matrix conductivity	Required if hydraulic conductivity is to be entered directly.
Matrix permeability	Required if hydraulic conductivity is calculated from permeability.
Matrix spec. storage	Specific storage. Required if specific storage to be specified directly.
Matrix porosity	Required if specific storage is calculated from porosity and compressibility.
Matrix compressibility	Required if specific storage is calculated from porosity and compressibility.
Skin zone – Only if skin zone specified.	
Radial thickness of skin	Always required if skin zone specified.
Skin zone conductivity	Required if hydraulic conductivity is to be entered directly.
Skin zone permeability	Required if hydraulic conductivity is calculated from permeability.
Skin zone spec. storage	Specific storage. Required if specific storage to be specified directly.
Skin zone porosity	Required if specific storage is calculated from porosity and compressibility.
Skin zone compressibility	Required if specific storage is calculated from porosity and compressibility.
Fluid – For liquid phase simulations only.	
Fluid compressibility	Always required for liquid phase simulations.
Fluid density	Always required for liquid phase simulations.
Fluid viscosity	Always required for liquid phase simulations.

Table 3.3 Model Parameter Summary	
Parameter	**Notes**
Fluid thermal exp. coeff.	Fluid thermal expansion coefficient. Only used by non-isothermal pulse tests.
Gas – For gas phase simulations only.	
Atmospheric pressure [abs]	Always required for gas phase simulations.
Gas viscosity	Always required for gas phase simulations.
Gas viscosity slope factor	Required if viscosity is considered as a simple function of pressure (**Configuration→Gas→**Viscosity as f(P)).
Molecular weight	Required if mass flow is the solution variable (**Configuration→Gas→**Gas flow solution variable).
Reference temperature	Always required for gas phase simulations.
Test-zone	
Well radius	Always required.
Partial penetration bottom offset	Required for 2D radial systems with partial well penetration, with a *Middle* Penetration type.
Partial penetration screen length	Required for 2D radial systems with partial well penetration.
Test-zone compressibility	Required for liquid phase simulations if isolated well-bore storage or if a pulse sequence is defined.
Volume change from normal	Refers to the volume of equipment in the borehole, i.e. volume of test interval not occupied by fluid. Required for gas phase simulations, or liquid phase simulations if isolated well-bore storage or if a pulse sequence is defined.
Tubing string radius	Required if a slug sequence is defined.
Leaky layer – For single leakage systems only.	
Leaky layer thickness	Always required for single leakage systems.
Leaky conductivity	Required if hydraulic conductivity is to be entered directly.
Leaky permeability	Required if hydraulic conductivity is calculated from permeability.
Leaky spec. storage	Specific storage. Required if specific storage to be specified directly.
Leaky porosity	Required if specific storage is calculated from porosity and compressibility.

Table 3.3 Model Parameter Summary	
Parameter	**Notes**
Leaky compressibility	Required if specific storage is calculated from porosity and compressibility.
Upper leaky layer – For upper/lower leakage systems only.	
Upper leaky layer thickness	Always required for upper/lower leakage systems.
Upper leaky conductivity	Required if hydraulic conductivity is to be entered directly.
Upper leaky permeability	Required if hydraulic conductivity is calculated from permeability.
Upper leaky spec. storage	Specific storage. Required if specific storage to be specified directly.
Upper leaky porosity	Required if specific storage is calculated from porosity and compressibility.
Upper leaky compressibility	Required if specific storage is calculated from porosity and compressibility.
L**ower leaky layer** – For upper/lower leakage systems only.	
Lower leaky layer thickness	Always required for upper/lower leakage systems.
Lower leaky conductivity	Required if hydraulic conductivity is to be entered directly.
Lower leaky permeability	Required if hydraulic conductivity is calculated from permeability.
Lower leaky spec. storage	Specific storage. Required if specific storage to be specified directly.
Lower leaky porosity	Required if specific storage is calculated from porosity and compressibility.
Lower leaky compressibility	Required if specific storage is calculated from porosity and compressibility.
Numeric Tab	
# of radial nodes	Always required.
# of vertical well nodes	Required for 2D radial systems.
# of vertical nodes above well	Required for 2D radial systems with partial well penetration, with *Middle* or *Bottom* Penetration type.
# of vertical nodes below well	Required for 2D radial systems with partial well penetration, with *Middle* or *Top* Penetration type.

Table 3.3 Model Parameter Summary	
Parameter	**Notes**
Pressure solution tolerance	Required for non-linear solutions. Non-linear solutions are required for gas flow simulations or if parameters are defined as functions of pressure.
STP flow solution tolerance	Required for non-linear solutions. Non-linear solutions are required for gas flow simulations or if parameters are defined as functions of pressure.
# of matrix nodes	Required for dual porosity systems.
# of leaky nodes	Required for leakage systems.
# of skin nodes	Required if skin effects are considered.

All the tabs in the **Parameter** input window contain tables, listing the parameter Name, Type, Value and Units. Table column widths can be adjusted if necessary, by placing the cursor on the column title edge until the mouse changes to a double arrow, and then drag, or by double clicking on the column title, which automatically re-sizes the column.

Name — The parameter name, as listed in Table 3.3 Model Parameter Summary

Type — Determines the treatment of the variable by the model. The available types are selected from a drop-down list accessed by double-clicking on the corresponding table cell.

Constant — Indicates a non-fitting parameter.

Suite — Only available for modes other than range mode. Several values for the parameter are specified, to a maximum of nine values. A simulation will be conducted for each value of the parameter. A maximum of three parameters can by defined as type *Suite*, the priority of each parameter defined in the **Suite/Range** input window.

Range — Only accessible in range mode, a range of values is defined for the parameter. A maximum of three parameters can by defined as type *Range*, the priority of each parameter defined in the **Suite/Range** input window. It is similar to *Suite* type, except for the simulation mode (i.e. normal mode vs. range mode), and the number of real values that can be defined in the range (up to 1000).

Optimize — Only accessible in optimization mode, it indicates a fitting parameter.

Sample Only accessible in sampling mode, it is a parameter for which a sample is taken from a defined distribution.

f(x) Points Parameter is defined as a function of pressure (f(P)), radius (f(r) or time (f(t)). Note that parameters cannot be defined as a function of pressure in dual porosity or leaky systems, and parameters can only be defined as function of time for 1D radial systems. The parameter function is described in the f(x) Points Parameter input window.

f(x) Object/File Parameter is defined as a function of pressure, radius or time. The parameter function is described using curve data. If the curve data source selected in the Main tab of the Configuration input window is *Object*, the parameter Value contains the available curve objects created within an object tree (Plots & Data Processing). Otherwise, if the curve data source selected is *File*, the curve data is obtained from the corresponding f(P) parameters, f(r) parameters or f(t) parameters curve file loaded within the Curve Files tab of the Configuration input window.

Value For constant parameters, the value is simply input into the corresponding cell. For non-constant parameters (except f(x) points), double click on the corresponding cell to open the Value Dialog specific to the parameter Type (see 3.4.1). For parameters of type f(x) points, the values are entered in the f(x) Points Parameter input window. If the value input is incomplete, the parameter Value cell will display BAD. Before inserting a value, change the Units to the units of the value to be input.

Units Changed by double-clicking on the table cell, which activates a drop-down list. Units are as specified on the Configuration Default Units tab until they are explicitly overridden by the user. Note that if the Value is set before the Units are changed, the Value will be converted to the new units.

3.4.1 Value Dialog

The **Value Dialog** depends on the parameter Type. The dialog for each parameter type is described in Table 3.4 **Value Dialog inputs based on Parameter Type**

Table 3.4 Value Dialog inputs based on Parameter Type

Parameter Type	Required Inputs
Suite	The dialog contains a table, into which suite values are entered, to a maximum of nine values.

Range	The range of values is defined by specifying the minimum, maximum, and number of steps between the minimum and maximum values. Stepping is linear or logarithmic.

Table 3.4 Value Dialog inputs based on Parameter Type

Parameter Type	**Required Inputs**
Optimize	The range of possible values is defined by the minimum and maximum, and the optimization begins with a parameter value set at the best estimate value. The value stepping to find the next estimate may be linear or logarithmic. The estimate of the standard deviation is required to calculate Jacobian data, and is used to calculate the estimated covariance matrix.
Sample	The distribution of values is set as Normal, Log-Normal, Uniform, Log-Uniform, Triangular, or Log-Triangular. The distribution characteristics are also required, such as the mean and standard deviation for a normal distribution.
f(x) Object	The curve object to be used is specified in the drop-down list, containing all curve objects available. Curve objects are created within object trees of the **Plots & Data Processing** input window. The curve data should have pressure (f(P)), distance from the borehole (f(r)) or time (f(t)) as the X data, and the corresponding dependent variable as the Y data. The X and/or the Y data in the curve data may be transformed into log 10. The X and Y variable units are also specified in this dialog.
f(x) File	The curve to be used is specified by the curve ID. A drop-down list will specify the curve IDs available from the parameter curve files loaded in the **Curve Files** tab of the **Configuration** input window. The curve data should have pressure (f(P)), distance from the borehole (f(r)), or time (f(t)) as the X data, and the corresponding dependent variable as the Y data. The X and/or the Y data in the curve file may be transformed into log 10. The X and Y variable units are also specified in this dialog.

Note that for the parameter type *f(x) Points*, the values are entered in the **f(x) Points Parameter** input window.

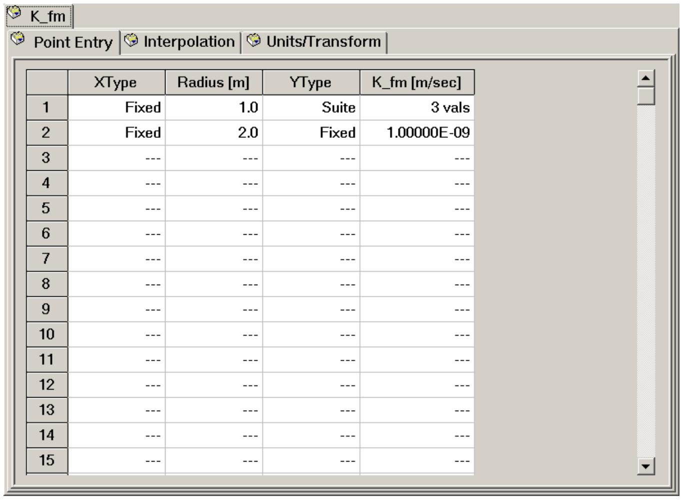
3.5 f(x) Points Parameter Input Window

Defines a parameter function for parameters that vary with pressure, radius (distance) or time. Only accessible if a parameter in the **Parameter** input window is specified as type *f(p) Points*, *f(r) Points* or *f(t) Points*. It provides the same options available for parameter curve data.
The input window will contain a tab for each parameter defined as *f(x) Points* type in the **Parameter** input window. Each tab contains at least three tabs: **Point Entry**, **Interpolation** and **Units/Transform**. In optimization mode, there is an additional **Optimization** tab.

3.5.1 Point Entry Tab

The X and Y parameters are entered into a table that varies depending on whether the simulation mode is forward or optimization. In either simulation mode, X data will be pressure, radius or time, depending on the parameter definition, and Y data will be the dependent variable values.

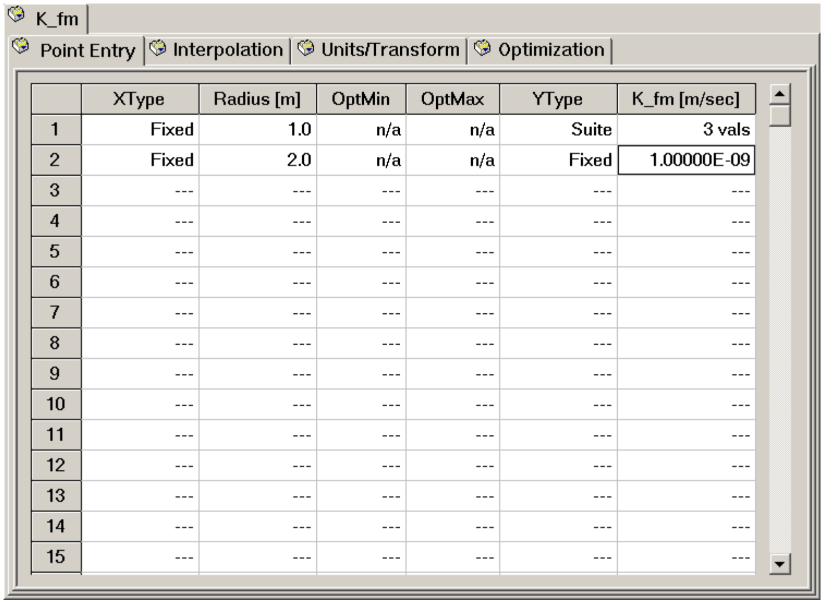
In the following example of the **Point Entry** tab, formation conductivity was set as a function of radius (forward mode):



	XType	Radius [m]	YType	K_fm [m/sec]
1	Fixed	1.0	Suite	3 vals
2	Fixed	2.0	Fixed	1.00000E-09
3	---	---	---	---
4	---	---	---	---
5	---	---	---	---
6	---	---	---	---
7	---	---	---	---
8	---	---	---	---
9	---	---	---	---
10	---	---	---	---
11	---	---	---	---
12	---	---	---	---
13	---	---	---	---
14	---	---	---	---
15	---	---	---	---

Figure 3.7 Point Entry Tab

In optimization mode, there are two additional columns in the **Point Entry** tab, OptMin and OptMax, as shown in the following example:



	XType	Radius [m]	OptMin	OptMax	YType	K_fm [m/sec]
1	Fixed	1.0	n/a	n/a	Suite	3 vals
2	Fixed	2.0	n/a	n/a	Fixed	1.00000E-09
3	---	---	---	---	---	---
4	---	---	---	---	---	---
5	---	---	---	---	---	---
6	---	---	---	---	---	---
7	---	---	---	---	---	---
8	---	---	---	---	---	---
9	---	---	---	---	---	---
10	---	---	---	---	---	---
11	---	---	---	---	---	---
12	---	---	---	---	---	---
13	---	---	---	---	---	---
14	---	---	---	---	---	---
15	---	---	---	---	---	---

Figure 3.8 OptMin and OptMax Columns in Point Entry Tab

There are three types of X and Y data, *Fixed*, *Suite*, or *Optimize*, specified by drop-down lists in the XType and YType columns. *Optimize* type is only available in optimization mode. For *Fixed* type data, data are simply entered one value per line in the data columns. For *Suite* type data, the model run will conduct a separate simulation for each suite value entered in the **Suite Value** dialog, which appears upon double clicking the corresponding cell in the data column:

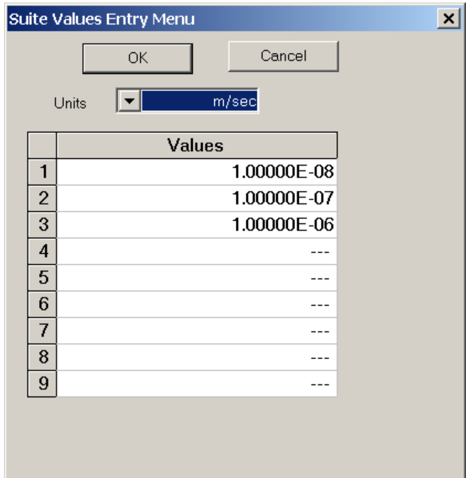


Figure 3.9 Suite Values Entry Menu Dialog

A maximum of three parameters, including those defined in the **Parameter** input window, can be of type *Suite*.

In optimization mode, the OptMin and OptMax columns provide the minimum and maximum optimization values for each defined point in the X(p), X(r) or X(t) function. They are specified here to ensure that the minimum values of one defined point in the X(x) function does not overlap the maximum value of the preceding defined point in the X(x) function.

Either or both the X and the Y data can be transformed by log 10. If data are transformed by log 10, it should be specified in the **Units/Transform** tab.

The units for the X and Y data are also specified in the **Units/Transform** tab.

Table rows are inserted or deleted using the right click pop-up menu.

3.5.2 Interpolation Tab

The interpolation tab has the same options as the **Create Curve from XY Data** object. This is not surprising, since the **f(x) Points Parameter** window has a purpose similar to curve data.

Details of the interpolation options are described in full in Section 7.1.4.

3.5.3 Units/Transform Tab

The **Units/Transform** tab determines the units of the data input into the **Point Entry** tab. An option is available to specify if data are to be transformed by log 10.

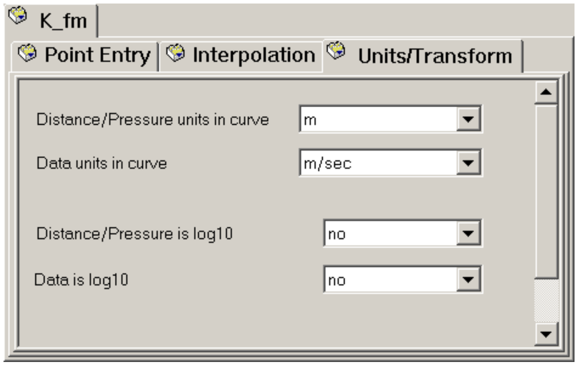


Figure 3.10 Units/Transform Tab

3.5.4 Optimization Tab

Only available in optimization mode, the dialog in the Optimization **tab is similar to the** Optimized Value Dialog **of the** Parameter **tab.**

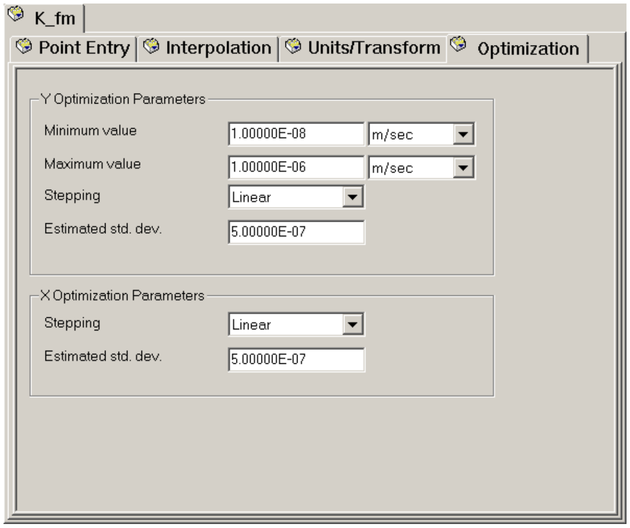


Figure 3.11 Optimization Tab dialog, only available in Optimization Mode

For a description of the dialog options, refer to Section 3.4.1.

Dialog inputs are available for both the X and Y optimization parameters. Note that X maximum and minimum values are entered in the **Point Entry** tab.

3.6 Fit Selection Input Window

In the **Fit Selection** input window, the field and simulated data pairs to be used for regression analysis are selected. The pairing of field and simulated data, conducted within the **Fit** tab of the **Plots & Data Processing** input window, indicates the field data to which the model should fit simulation results. The **Fit Selection** tab is only accessible for optimization mode or forward-range mode.

Auto Setup→Basic Fits is available to generate the fitting objects. It uses data processing objects previously generated with **Auto Setup→Field Plots** and **Auto Setup→Sequence Plots** as the pairs of data for fitting.

3.6.1 Fit Selection Tab

Once field and simulated data have been paired in fit objects within the **Fit** tab of the **Plots & Data Processing** input window, the fit specifications to be used as constraints are selected in the **Fit Selection** tab.

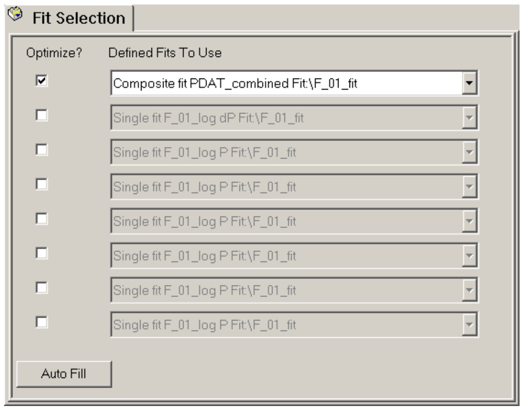


Figure 3.12 Fit Selection Tab

Fits are selected by checking the Optimize? checkbox, and selecting the appropriate fit specification object in the drop-down list. The AutoFill button will automatically select all the created fit objects.

Each line of the **Fit Selection** tab indicates an independent optimization. Consequently, if more than one line is selected, the simulation will conduct a ***multiple fit***. To optimize several parameters in one optimization (or ***single fit***), use the **Composite Fit** object in the **Fit** tab (**Plots & Data Processing**) to combine several **Single Fit**, **Sequence Fit** and/or **Composite Fit** objects.

3.7 Optimization Input Window

In the **Optimization** input window, a fitting algorithm for optimization mode simulations is selected, and algorithm options specified. The input window is only available for optimization mode simulations.

Several inverse-fitting algorithms are available, each with different advantages and disadvantages:

(1) Downhill Simplex: Generally slow, however will generally converge to a solution regardless of the initial estimates of the fitting parameters.

(2) Levenberg-Marquardt: A quick algorithm that will fail if the intial estimates of the fitting parameters are far from the solution.

(3) MINPACK Levenberg-Marquardt: The MINPACK implementation of Levenberg-Marquardt which is more stable than the previous Levenberg-Marquardt algorithm, minimizing failures for initial estimates far from the solution.

(4) Simulated Annealing: A modified simplex algorithm, the major advantage is an ability to avoid becoming trapped at local minima. It is based on the analogy of the way metal cools and freezes intoa minimum energy crytalline structure (annealing).

(5) NL2SOL: A modified Levenburg-Marquardt algorithm, well suited for highly non-linear problems that return large residual values for the initial guess.

(6) SCEM: A Shuffled Complex Evolution algorithm combining a Nelder/Mead simplex algorithm with the concepts of controlled random search, competitive evolution and complex shuffling. It is generally more efficient and more likely to find the global (rather than local) optimum than the simplex algorithm.

The inverse-fitting algorithms may also be combined, to take advantage of the robustness of one algorithm, and the speed of another once close to a solution.

Parameters are normalized to a value range of 0 to 1 before optimization.

3.7.1 Main Tab

Within this tab, basic algorithm options are selected, as shown in Figure 3.13.

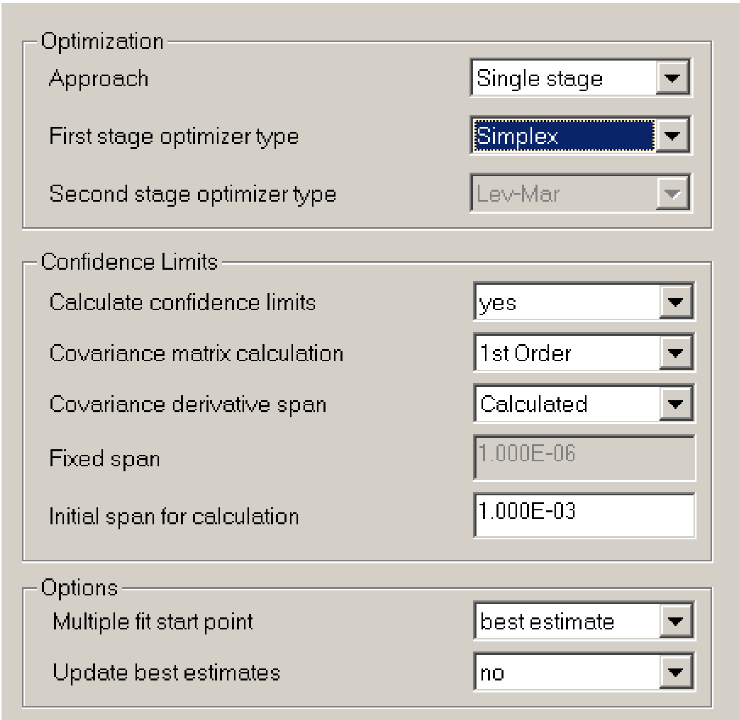


Figure 3.13 Main Tab of the Optimization Input Window

Optimization

Approach — Select a single optimizer, or select two optimizers for a two staged approach.

First stage optimizer type — Select the single optimizer, or the first stage optimizer. The algorithms are discussed in Section 3.7.

Second stage optimizer type — Select the second stage optimizer if a two-stage approach is selected. The algorithms are discussed in Section 3.7.

Confidence Limits

Calculate confidence limits — Confidence limits are calculated from the covariance matrix. The covariance matrix will not be calculated unless this toggle is set to *yes*.

Covariance matrix calculation

1st Order — Ignores the second derivative terms of the Hessian matrix (used in the calculation of the covariance matrix). Requires less simulations and guarantees a positive definite Hessian matrix.

2nd Order — Strictly correct formulation of the Hessian matrix.

Covariance derivative span — Derivative span in covariance matrix calculation may be fixed within the Fixed Span input box, or may be calculated using an iterative procedure starting at the specified intial span.

Fixed span — Value is entered if derivative span in covariance calculation is fixed.

Initial span for calculation — Value of the intial span if the covariance derivative span is calculated.

Options

Multiple fit start point — For multiple optimizations, all optimizations after the first optimization can start with parameter values based on the original *best estimate* specified for the parameter, or the *last* ***result*** values from the last optimization.

Update best estimates — If *yes*, the best estimates in the parameter tables of the **Parameter** input window will be updated with the final optimization values.

3.7.2 Tolerances Tab

Within this tab, various tolerances are set.

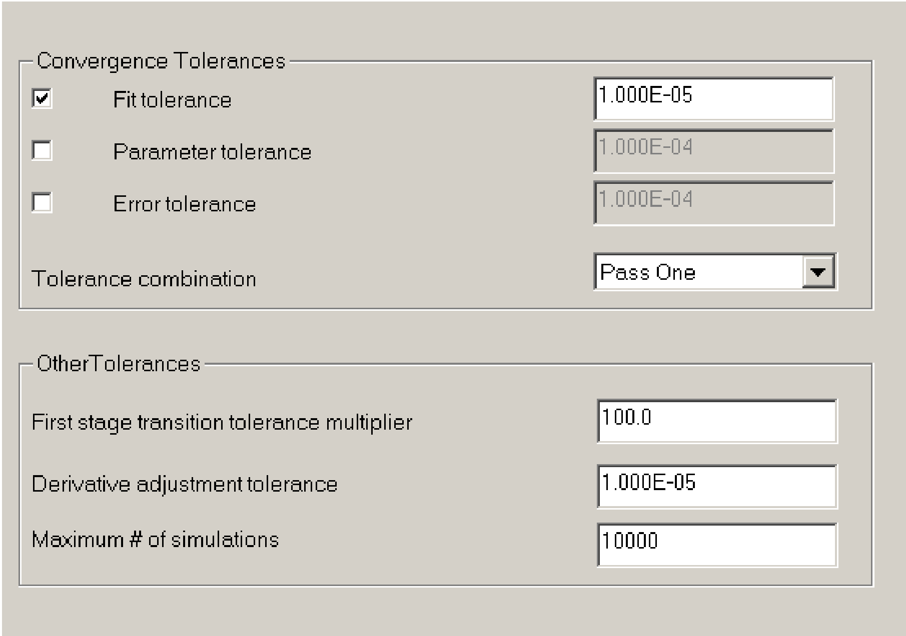


Figure 3.14 Tolerances Tab

Optimization is complete once convergence tolerances have been met. Each optimization algorithm has a maximum of three convergence tolerances: Fit tolerance, Parameter tolerance, and Error tolerance. The user may specify whether only one of these tolerances must be met, or whether all selected convergence tolerances must be met to satisfy convergence. If additional convergence tolerances are required for an algorithm, they are specifed in the algorithm specific tab.

Additional tolerances include:

First stage transition tolerance multiplier — If a two stage approach is selected, the algorithms will switch once the specified convergence tolerances multiplied by this factor are met.

Derivative adjustment tolerance — In calculating the covariance matrix, an iterative procedure is used to calculate the derivative span (if the derivative span is not fixed in the **Main** tab). The derivative span has been successfully calculated once this tolerance has been met.

Maximum # of simulations — Optimization will stop once the maximum number of simulations has been reached.

3.7.3 L-M Tab

This tab provides options for both of the Levenberg-Marquardt algorithms. The two implementations will be referred to as the basic and MINPACK algorithms.

For both algorithms**,** ***Lambda*** is a parameter in the step calculation, which in turn determines the new estimates of parameters. The smaller the value of lambda, the greater the step change in parameter values. During optimization, the step is increased if the new parameter estimates did not improve the fit, and decreased if the new parameter estimates improve the fit. The basic algorithm modifies lambda to calculate the new step, whereas MINPACK only uses lambda to calculate the initial step.

Lambda factor multiplier	A multiplier factor to lambda, for decreases in lambda on successful steps and increases in lambda on unsuccessful steps. For the basic algorithm only.
Initial lambda factor	The initial value of lambda, for the basic algorithm only.
Minimum lambda factor	As lambda changes over the optimization, lambda will never decrease below this value. For the basic algorithm only.
Relative change tolerance	A convergence tolerance that examines the difference in fit between 5 steps of the optimization. For the basic algorithm only.
MINPACK Lambda (factor)	The value of lambda for the MINPACK algorithm only.
Maximum derivative span	Limits the span of the derivative, as large spans increase the difficulty in converging towards a solution. Small spans may also result in unnecessarily long optimization times.
Calculate derivative span?	For the MINPACK algorithm, modifies the derivative span during the optimization, according to the step size. Otherwise, the derivative span remains constant at the value specified as the Maximum derivative span. The basic algorithm always calculates the derivative span.
Use final LM deriv span in covar estimates	If covariance estimates are being calculated, uses the final derivate span calculated by the optimization algorithm in the calculation of covariance estimates.

Normalize MINPACK input parameters — The original MINPACK algorithm uses non-normalized parameters. However, given the very large range of parameter values (e.g. log values versus linear values), normalizing the parameters may improve performance.

3.7.4 Simplex Tab

This tab provides options for the downhill simplex inverse-fitting algorithm.

Initial vertex span	The vertex span is used to generate the initial simplex.
Simplex algorithm	Either the NR or Nelder/Mead algorithm may be selected. The remaining controls apply to the Nelder/Mead algorithm only.
Reflection coefficient	A positive value, used to calculate a simplex point reflected on the other side of the simplex centroid.
Contraction coefficient	A value between 0 and 1, used to contract a simplex point closer to the simplex centroid.
Expansion coefficient	A value greater than 1, used to calculate a simplex point farther from the simplex centroid.
Shrinkage factor	A factor applied to each replaced simplex point. Equal to 0.5 in the NR algorithm.

3.7.5 S-A Tab

As the Simulated Annealing algorithm is based on the Nelder/Mead Simplex algorithm, this tab provides the relevant Nelder/Mead simplex options described in Section 3.7.4. As well, the temperature schedule parameters specific to the Simulated Annealing algorithm are specified:

Schedule	The cooling shedule is selected. Three of the schedules are obtained from Numerical Recipes (NR) (Pruess et al., 1992), and the remaining schedules are obtained from Luke **(http://www.btluke.com**).
Initial temperature	Intial temperature for both NR and Luke cooling schedules.
Iteration budget (N)	For cooling schedule NR#2 and all the Luke cooling schedules, the number of iterations expected to get to the final temperature.
NR m increment	In the NR cooling schedules, the number of moves in the simplex algorithm.
NR epsilon	Parameter in cooling schedule NR#1. Control parameter T is reduced by (1 - epsilon) every m moves.

NR alpha Parameter in cooling schedule NR#2. Large values of alpha spend more iterations at lower temperatures.

NR beta Parameter in cooling schedule NR#3.

NR gamma Parameter in cooling schedule NR#3. Control parameter T is never reduced by more than fraction gamma in one step.

Luke TN Final temperature in the Luke cooling schedules.

3.7.6 NL2SOL Tab

The NL2SOL tab provides an option to use non-normalized input parameters (parameters are normalized for all other algorithms), as well as three coefficients used in the algorithm:

Tuner 1 If the actual function decrease is less than or equal to Tuner1 * the predicted function decrease, the algorithm will check for false convergence and consider switching models. A value between 0 and 0.5.

Tuner2 If the actual function decrease is greater than Tuner2 * the predicted function decrease, the current step is accepted. A value between 0 and 0.5.

Tuner3 If the actual function decrease is greater than or equal to Tuner3 * the inner product of the step and the gradient, then the trust region radius is increased. A value between 0.001 and 1.

3.7.7 SCEM Tab

This tab defines the parameters required for the Shuffled Complex Evolution algorithm**.**

# of complexes (p) The number complexes, i.e. the number of individually evolving groups of data. Must be greater than or equal to 1.

# of points per complex (m) The number of points in each complex. The number of sample points used in the algorithm will be p * m. Value must be greater than the number of parameters to optimize.

# of points per sub-complex (q) The number of points in the sub-complex used by the competitive complex evolution (CCE) algorithm.

CCE alpha The competitive complex evolution (CCE) alpha determines how many offspring should be generated. Value is greater than or equal to 1.

CCE beta The competitive complex evolution (CCE) beta is the number of iterations of the CCE code. In other words, it determines how many generations of offspring are generated (how far each complex should evolve). Value is greater than or equal to 1.

Random # seed	Random number used to generate the sample points, select points for each sub-complex and mutate.

3.7.8 Perturbation Tab

Running optimization perturbations is one method of investigating parameter uncertainty. In perturbation mode, nPre randomly perturbs the initial estimates of fitting parameters (i.e. slightly increases or decreases the initial estimate) and re-optimizes the fitting parameters. nPre repeats this process for a specified number of perturbations. If each perturbation results in a fitting parameter value close to the initial estimate, the problem solution is unique and well-constrained. Note that perturbation mode is not currently compatible with optimization-range or optimization-sampling modes.

Do optimization perturbations	Check the checkbox to activate perturbation mode.
# of perturbations	The number of random perturbations within the perturbation span.
Perturbation span	The maximum span over which perturbations will be created. Note that all parameters are normalized to a range of 0 to 1, and consequently the perturbation span will be between 0 and 1.
Perturb from	The first perturbation can use the original best estimate value (*Start*) or the last optimization value (*Last Fit*) for its initial estimate of parameters.
Multiple fit start points	For each perturbation, each fit can start with the same starting values, or they can start with new random starting values.
Random # seed	A user-selected random seed number allows perturbation simulations to be reproducible.

3.7.9 Calculated Vars Tab

Calculated variables selected in this tab will be output in the optimization output file. The optimization output file setup is specified in the Output Files input window. Up to eight calculated variables may be selected.

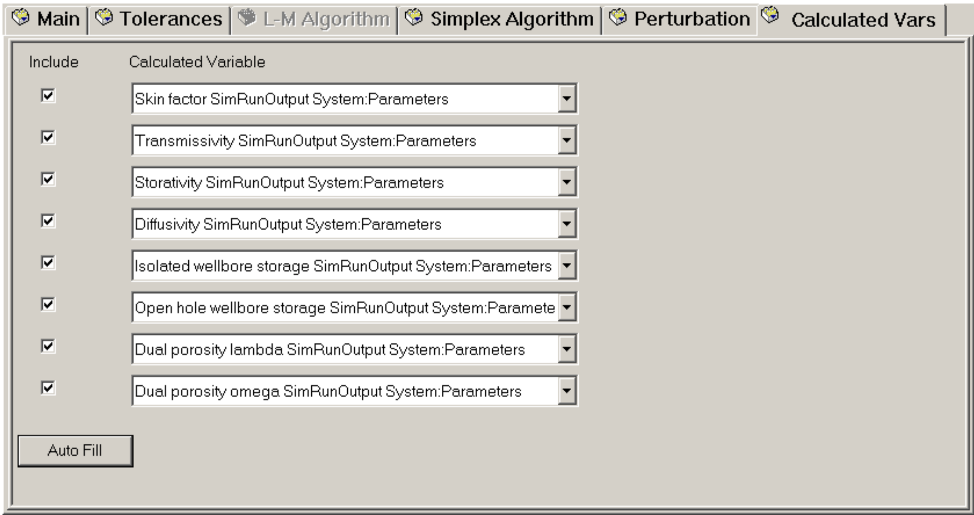


Figure 3.15 Calculated Vars Tab

Include — Variables are selected by toggling on the checkbox, and selecting a variable from the corresponding Calculated Variables drop-down-box.

Calculated Variables — All variables used in the model that are calculated based on user input parameters are listed in the drop-down-box.

Auto Fill — Selects all available calculated variables, in order of definition.

3.8 Sampling Input Window

The **Sampling** input window contains options related to the setup of the sampling of a parameter. Note that sampled parameters may include sequence data, such as flow rate or pressure boundary conditions, and superposition distances. The ranges and distributions are defined at the point of parameter or sequence definition, in the **Parameter** and **Sequence** input windows, respectively.

3.8.1 Main Tab

The **Main** tab defines the sampling procedure:

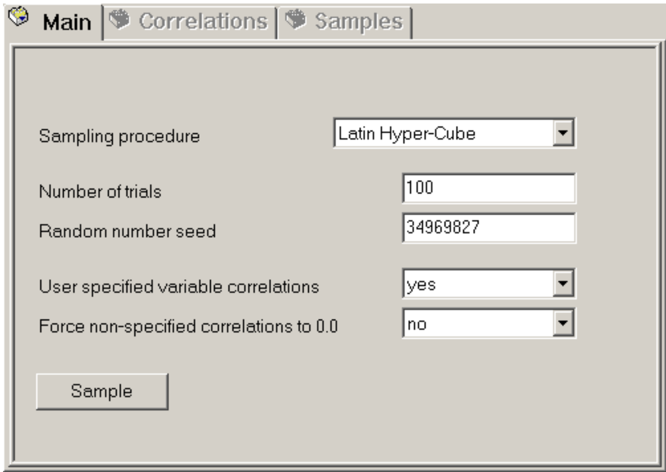


Figure 3.16 Main Tab of the Sampling Input Window

Sampling procedure — nSIGHTS supports two sampling routines: *Latin Hyper-Cube* and *Monte-Carlo*

Number of trials — Number of times input parameter distributions are sampled.

Random number seed — A user-selected random seed number allows sampling simulations to be reproducible. A random seed number is automatically provided.

User specified variable correlations

yes — The correlation between two variables will be forced to the values specified in the **Correlations** tab.

No — Correlations, if not forced to zero, will be calculated during simulation.

Force non-specified correlations to 0.0

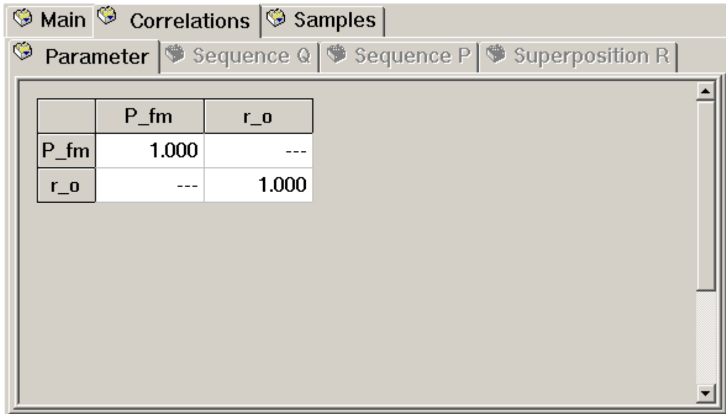
yes — Non-specified correlations will be forced to zero. If correlations are not user specified, all correlations will be forced to zero.

No — Non-specified correlations will not be forced to any value, and will be calculated during simulation.

Sample — This button re-samples the parameters, based on the current setting in this tab. Any objects or plots containing sample data will be updated with the new sampled data.

3.8.2 Correlations Tab

If more than one parameter is defined as a sampled type, a correlation between the parameters is forced to the value specified in the tables provided in this tab. This tab is only available if variable correlations are user specified (User specified variable correlations in the **Main** tab).



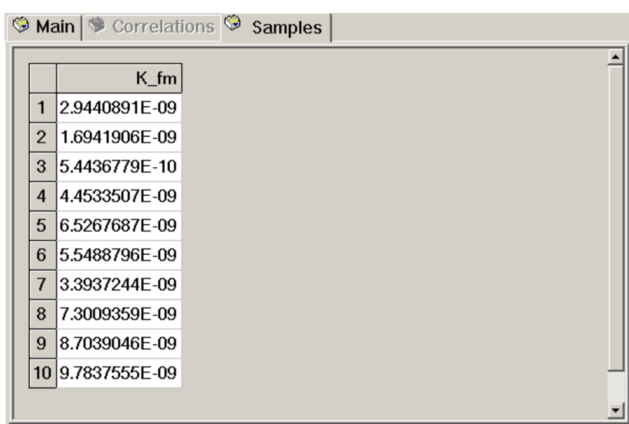
	P_fm	r_o
P_fm	1.000	---
r_o	---	1.000

Figure 3.17 Correlations Tab

Parameter correlations can only occur between variables of the same basic type. Consequently, the **Correlations** tab is divided into four tabs (**Parameter**, **Sequence Q**, **Sequence P** and **Superposition R**), each tab providing a table for the input of correlations. Tabs are hidden if there are less than two parameters for any parameter category.

3.8.3 Samples Tab

This tab contains a table of the sampled parameter values, with a column per parameter, sequence or superposition distance. The parameters are re-sampled upon activation of this tab. In the following example, 10 trials are defined for the formation conductivity:



	K_fm
1	2.9440891E-09
2	1.6941906E-09
3	5.4436779E-10
4	4.4533507E-09
5	6.5267687E-09
6	5.5488796E-09
7	3.3937244E-09
8	7.3009359E-09
9	8.7039046E-09
10	9.7837555E-09

Figure 3.18 Samples Tab

3.9 Suite/Range Input Window

3.9.1 Priority Tab

The priority of each suite and range parameter is determined in this tab and input window. For both suite and range parameters, the simulation program loops through the first parameter (Grid/Cube X (slowest grid/cube)), and for each value in its suite or range, it then loops through the second parameter (Grid/Cube Y (fastest grid/middle cube). If three suite/range parameters are defined, for each value of the second parameter, the simulation program loops through the third parameter (Cube Z (fastest cube)). For each combination of suite/range values, a simulation is performed.

3.10 Output Files Input Window

Output files from nPre can be read into nPost for visualization and post-processing. The output files are all binary.

Four output files can be created, each with its own tab:

XY Output Any XY array (a collection of XY data) created within nPre is output into a file with the default file extension *.nXYsim. The default *XYDataArray f(t) Table System:f(t)Output* consists of all the simulation output defined in the **Main** tab of the **Wells and Output** input window. Not available in range mode.

Profile A grid containing pressure as a function of time (X axis) and radius (Y axis) is output to a file with the default file extension *.nPro. The grid can contain a subset of time, by limiting the number of sequences. As grid data can be quite large, the data may be reduced according to a Time step modulus, reducing the number of X (time) points, or a Node modulus, reducing the number of Y (radius) points. Available in forward-normal mode only.

Range Outputs grid or cube data of residuals (error between simulated and field data) into a file with the default file extension *.nRng. In optimization mode, grid or cube data of optimized values and the main diagonal of the covariance matrix (if calculated) are also written to the file. If two range variables are defined, grid data are output, if three range variables are defined, cube data are output. Available in range mode only.

Optimization Fit results, residuals, covariance matrix, Jacobian data and specified calculated variables are output to a file with the default file extension *.nOpt. Available in optimization-forward or optimization-sampling mode only.

To write the file during simulation, check the checkbox at the top of each tab. For all output files, data are created in a new file, or appended to an existing file. Data can only be appended to an existing file if:

- The current run is the same mode as the runs existing within the file (e.g. all runs within the file are forward-normal).

- The data to be output for the current run is the same as the data output for the existing runs (e.g. all runs within an appended file write the *XYDataArray f(t) Table System:f(t)Output*, with the same simulation output defined).

For files containing appended data, each run is identified by the Run identifier. Within nPost, the data for any one run can be selected, with each run identified by its run identifier. For runs with multiple cases (e.g. sampling mode runs, multiple fit optimizations), each case will have an identifier in addition to the run identifier.

3.11 Plots & Data Processing Input Window

This input window organizes the object trees available within nPre. Within an object tree, users can load, view and manipulate data. Each object tree is designed to contain input data and visualizations associated with a particular step in the input process.

3.11.1 Field Data Tab

Field data are used by nPre to create model constraints and diagnostic plots.

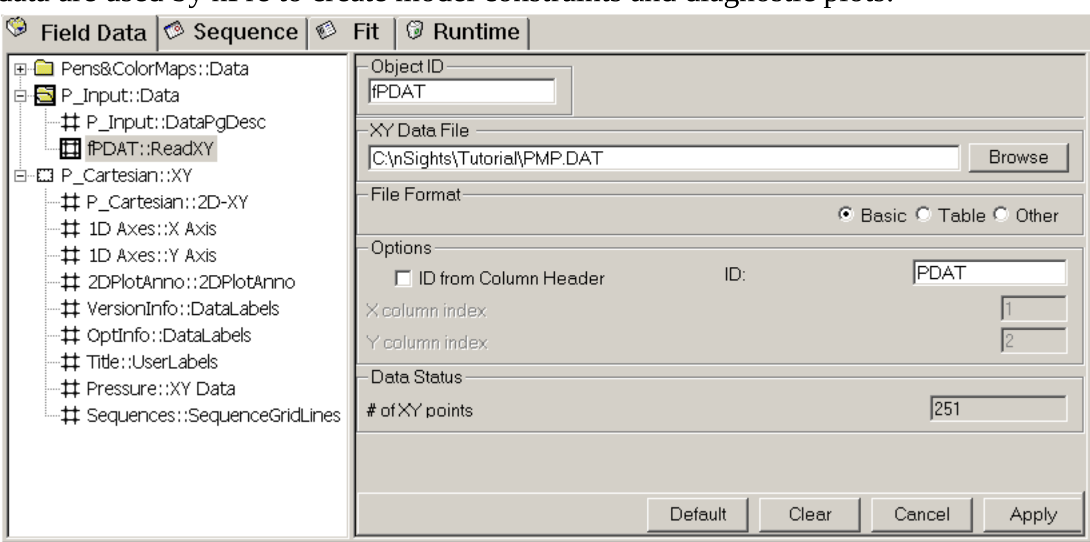


Figure 3.19 Field Data Tab

The **Auto Setup→Field Data Plots** command (see Section 4.1) is used to automatically create objects to read/process field data and to create default cartesian plots.

3.11.2 Sequence Tab

The **Sequence** tab object tree is used to create diagnostic plots of pressure and flow-rate data.

Objects and plots of data can be created automatically by the **Auto Setup→Sequence Plots** (see Section 4.2) after all sequences are specified. Note that the objects and plots of simulated data can be created before the simulation has been conducted. Error messages will appear on the message line, for example “XY data set is empty”. As the simulation is being conducted, the data sets are automatically updated.

3.11.3 Fit Tab

The **Fit** tab contains an object tree for fit specification objects. These fit objects pair field and measured data, but do not indicate which data pairs should be used as constraints by the model. Generally, the constraints defined in the **Field Data** tab are compared to the corresponding simulated data constraints defined in the **Sequence** tab. The selection of data pairs to be used as constraints is controlled in the **Fit Selection** input window.

Auto Setup→Basic Fits is available to generate the fitting objects. It uses data processing objects previously generated with **Auto Setup→Field Plots** and **Auto Setup→Sequence Plots** as the pairs of data for fitting.

There are three fit specification objects: **Single Fit**, **Composite Fit** and **Sequence Fit**. These objects are described in Appendix A.

The following example shows the fit specification objects with incorrect object properties status (), due to an empty model data set. Once the model is run, the data set will no longer be empty, and the fit object status will be normal.

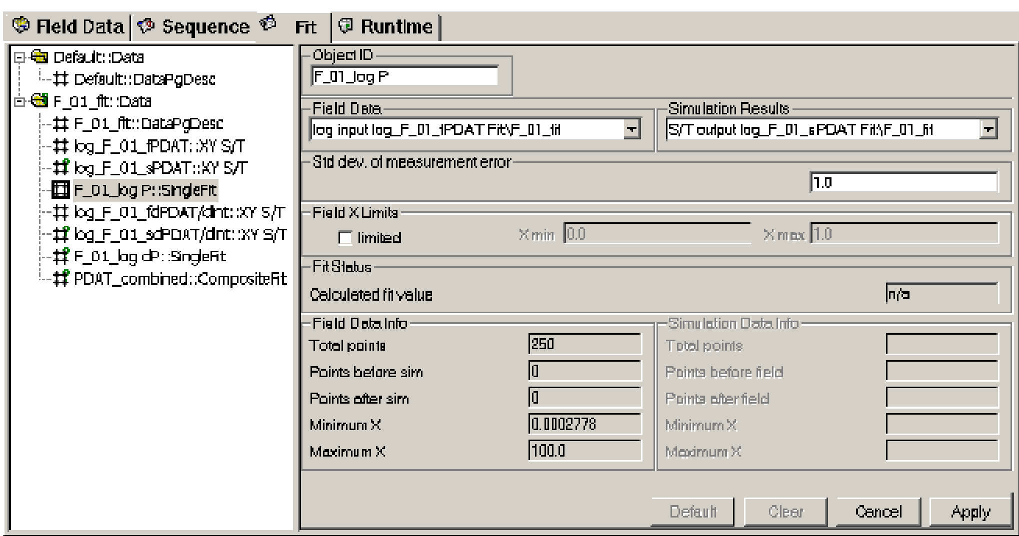


Figure 3.20 Fit Tab

3.11.4 Runtime Tab

The **Runtime** object tree allows the user to create plots to monitor the real-time progress of the model and write simulation output.

Simulated data sets can be created before the simulation has been conducted. Error messages will appear on the message line, for example "XY data set is empty". As the simulation is being conducted, the data sets are automatically updated.

A plot window is not automatically updated during the simulation. Addition of an object that forces the plot to update regularly must be used, such as a **Data Label** object with the last fit value as input.

4 NPRE AUTO SETUP

As the setup of portions of the input data and plots are similar from test to test, auto setup provides a quick way of generating certain input data and plots. There are three **Auto Setup** commands: **Field Data Plots**, **Sequence Plots**, and **Basic Fits**.

All auto setup commands create objects within object trees, and there are common aspects between the auto setup procedures:

- Auto setup is created in a tree structure, however input is still required from the user. The user must specify the input data, and input any required options in processing objects (e.g. **Scale/Transform** objects).

- Data and plot pages are created with a default naming convention for the page or object IDs:

    - The type of data are specified with a letter: *Q* for flow data, *P* for pressure data, *f* for field data, *s* for simulated data. The name of the well, defined in **Wells and Output** input window, will also be used in the default name (*DAT* is the default name of the main well). As well, the name of the sequence may be included, if applicable.

    - The type of operation occurring within the page or object is also specified: *Input* for pages that read data, *Process* for pages and objects that process data, *Diag* for diagnostic plot pages. For some process objects, the process occurring (e.g. *dP/dlnt*) is specified.

    - Examples:

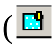
P_input	Object ID of a data page containing a read object for pressure data.
fQDAT000	Object ID of a read data object reading field flow data, for the DAT well.
F_01_fdPDAT/dlnt	Object ID for an object that calculates the derivative of field data pressure for the DAT well during a flow sequence named F_01.
log_F_01_sPDAT	Object ID of a **Scale/Transform** object that conducts a log transform on the simulated pressure data within flow sequence F_01, for the DAT well.

- All plot pages will contain:

   - A **Data Labels** object that plots a label containing the current date and the nPre version info in the top right hand corner of the plot.

   - A **Data Labels** object that plots a label containing the progress of the optimizer. This object forces the plot to be updated during a simulation.

   - A **User Labels** object that plots a default title label.

- Only 2D plots are created in auto setup procedures. The user will be required to reset the axes limits in order to view the data in a 2D plot window. This is done by selecting **Axes→Extents** in the 2D plot window pop-up menu, by selecting the **Reset View** button () in the 2D plot window toolbar, or by selecting **Standard→Reset View** in the 2D plot window menu bar.

Auto setup results should always be checked to ensure that the created pages and objects use the correct input data and the correct data transformations.

4.1 Field Data Plots Auto Setup

Selection of the **Auto Setup** command **Field Data Plots** will create data and plot objects that are typically required to create constraints and/or diagnostic plots from field data, within the object tree of the **Field Data** tab in the **Plots & Data Processing** input window.

For auto-setup, it is assumed that there is one main well, and if defined, observation wells. Data sets and plots are created for the main well and each observation well, if defined in the **Wells and Output** input page and selected in the auto-setup dialog.

Only two sets of data and plot pages can be created per well, one for pressure data, and one for flow data. Selection of the **Auto Setup→Field Data Plots** command can create one or both of these data sets at a time. If a data set is created again by auto setup, and the data sets already exist, they will be deleted, and new empty pages and objects will be created.

The dialog to facilitate the auto setup of field data plots provides the following options:

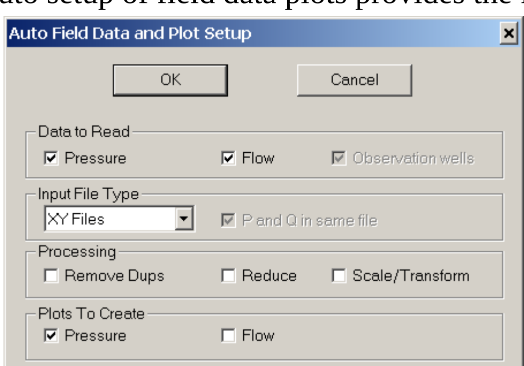


Figure 4.1 Auto Field Data and Plot Setup Dialog

Data to Read — Pressure and/or Flow data sets are created. For each data set, a data page is created with one read object. The user will need to specify the field data to be imported with the read object(s). For table input data, an additional **Select XY from XY Array** object is created, to select XY data from the table.

Observation wells — If observation wells were defined in the **Wells and Output** input page, data sets are created for each observation well, in addition to the main well, if selected.

Input File Type — The input file type, XY data, table data or Mini-Troll data, is selected in the drop-down box. This option determines the type of read object created in the input data page. Note that Mini-Troll data is converted to table data within the Read Mini-Troll Text File object.

All in Same Table File — For table and Mini-Troll input, if both pressure and flow data sets are being created, this checkbox creates one **Read Table File** object to read a table which contains both pressure and flow data, and two **Select XY from XY Array** objects. The read table object will be in one data input page, named *PQ_Input*.

Processing — If one of the processing options is selected, a new data page is created, containing the object(s) required to complete the data processing. The user is required to complete the processing options for each processing object (refer to Appendix A for details on each processing object).

Remove Dups — To remove duplicates in the data, a **Remove Duplicates** object is created.

Reduce — To reduce the data, a **Reduction** object is created.

Scale/Transform — To scale or transform the data, a **Dual XY S/T** object is created.

Plots to Create — Selection of either the Pressure or Flow checkbox will create a 2D-XY plot page, containing two objects:

- An **XY Data Series** object to plot transformed data, as well as simulated data.
- A **Sequence Grid Lines** object, which will plot grid lines to define sequences.

The example below, Figure 4.2, shows the **Auto Field Data and Plot Setup** dialog and the resulting object tree after auto setup:

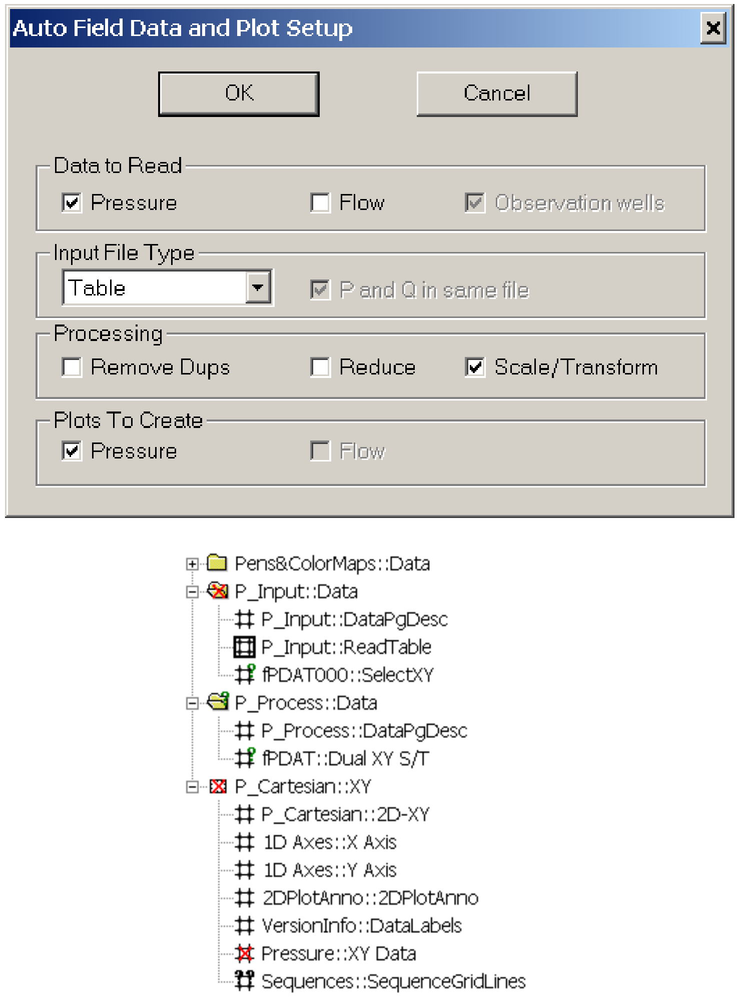


Figure 4.2 Auto Field Data and Plot Setup Dialog & Corresponding Object Tree

4.2 Sequence Plots Auto Setup

Selection of the **Auto Setup** command **Sequence Plots** will create data objects and plot objects within the **Sequence** tab of the **Plots & Data Processing** input window that are typically required to create diagnostic plots of simulated data sets. As well, a **Create XY Array** object, containing the simulated output defined in the **Sequence** tab, will be created in the **Runtime** tab of the **Plots & Data Processing** input window.

Sequence Plots auto setup cannot be selected until sequences have been defined in the **Sequences** tab of the **Sequences** input window.

The **Sequence Data and Plot Setup** dialog, which appears upon selection of the **Auto Setup→Sequence Plots** command, contains frames for each type of sequence containing checkboxes for common diagnostic plots. The frame and checkboxes for sequence types not defined will be hidden.

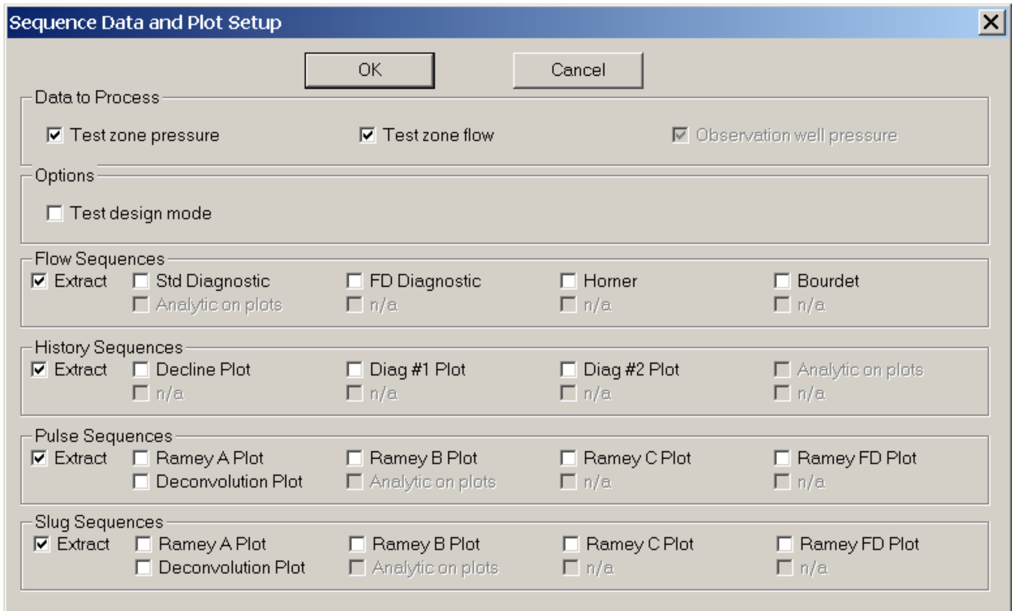


Figure 4.3 Sequence Data and Plot Setup Dialog

Within the **Data to Process** frame, the option is given to process pressure or flow data. As flow, pulse and slug sequences output pressure data, the plots associated with these sequences are only available if Test zone pressure is selected. Similarly, history sequences output flow data, and the history sequence plots are only available if Test zone flow is selected. If the observation well pressure toggle is selected, plots are created for each defined observation well, in addition to the main well.

No diagnostic plots for a sequence type will be created unless the Extract checkbox is selected. Each plot to be created is then selected with a checkbox. Plots are only created for a sequence if the Auto checkbox is selected for the sequence in the **Sequences** tab of the **Sequence** input window.

Each diagnostic plot option will create a data page and a plot page for all applicable sequences with the Auto checkbox selected. The data page will include two **Extract Sequence(s)** objects, one for field data and one for simulated data. The user is required to specify the applicable field and simulated data, but the correct sequence has been automatically chosen. If Test design mode is selected, the derivative specification for simulated data will be specified individually, instead of automatically slaved to the field data derivative specification.

All sequence types have an Analytic on plots checkbox, which is only active if at least one diagnostic plot has been selected from that sequence type. This option adds an **Analytics: Line Data** object to all 2D plots for that sequence type, allowing the user to create a straight line on a plot interactively. A corresponding legend box on the 2D plot, showing the analytic line results, is also created using a **Data Labels** object.

Table 4.1 provides the available diagnostic plots, and a brief description.

Table 4.1 Auto Setup Sequence Diagnostics Plots	
Flow Sequences	
Standard Diagnostic	Plots field and simulated pressure data, as well as the derivative of the data (dP/dlnt) in a 2D XY plot.
FD Diagnostic	For both field and simulated data, plots 2*d2logP/dlogt2 +2.
Horner	Using the **P(t) Time Processing** object, Horner time functions are applied to the X (time) data of field and simulated for each flow sequence, except if the flow sequence is the first sequence. Individual plots are created for each flow sequence, displaying pressure versus Horner time.
Bourdet	Using the **P(t) Time Processing** object, Bourdet superposition time functions are applied to the X (time) data of field and simulated data for each flow sequence, except if the flow sequence is the first sequence. Individual plots are created for each flow sequence, displaying pressure and the derivative of pressure versus Bourdet time.
History Sequences	
Decline Plot	Plots the field and simulated flow data on a 2D XY plot.
Diag #1 Plot	For both field and simulated data, plots 2*d2logQ/dlogt2 +2.
Diag #2 Plot	For both field and simulated data, plots 2*d2log(1/Q)/dlogt2 +2.
Pulse and Slug Sequences	
Ramey A Plot	Plots normalized pressure and the derivative of normalized pressure (dP/dlogt) for both field and simulated data.
Ramey B Plot	Plots normalized pressure and the derivative of normalized pressure (dlogP/dlogt) for both field and simulated data.
Ramey C Plot	Plots (1-normalized pressure) and the derivative of (1-normalized pressure) (dlogP/dlogt) for both field and simulated data.
Ramey FD Plot	Plots two times the derivative of normalized pressure (2*dlogP/dlogt) for both field and simulated data.
Deconvolution Plot	Plots the results of deconvolution and the derivative of deconvolution for both field and simulated data. Deconvolution is calculated by integrating normalized pressure data, and dividing by (1-normalized pressure data).

4.3 Basic Fits Auto Setup

In optimization mode, the **Auto Setup→Basic Fits** command will create fit data objects in the **Fit** tab of the **Plots & Data Processing** input window, as well as to define fits to use in the **Fit Selection** input window. The **Auto Setup→Basic Fits** command is not available until sequences have been defined.

The **Fit Specification Setup** dialog, which appears upon selection of the **Auto Setup→Basic Fits** command, contains frames for each type of sequence containing checkboxes for possible fits for that sequence type. The frame and checkboxes for sequence types which have not been defined will be hidden. In addition, there is a **Cartesian Fits** frame, with associated checkboxes, which will produce fits for all defined sequences (the entire test).

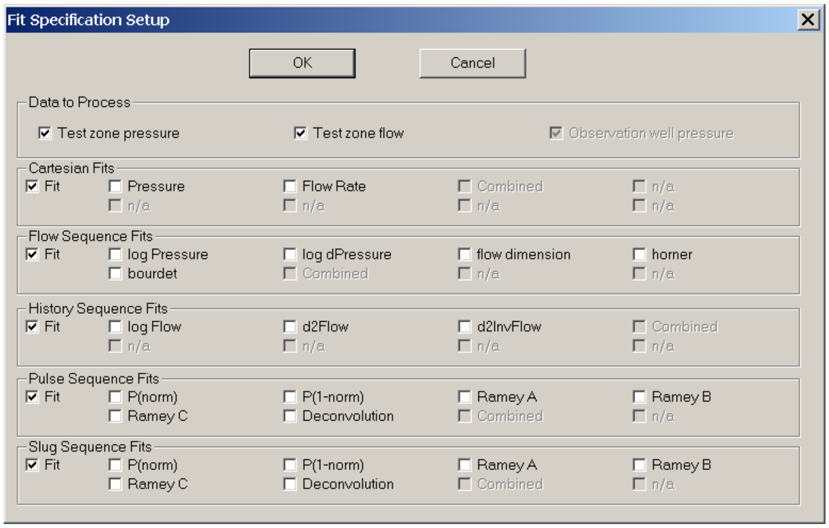


Figure 4.4 Fit Specification Setup Dialog

Within the **Data to Process** frame, the option is given to process pressure or flow data. As flow, pulse and slug sequences output pressure data, the fits associated with these sequences are only available if Test zone pressure is selected. Similarly, history sequences output flow data, and the history sequence fits are only available if Test zone flow is selected. If the observation well pressure toggle is selected, fits are created for each defined observation well, in addition to the main well.

No fit objects will be created for a sequence type or **Cartesian Fits** unless the Fit checkbox is selected. Each fit to be created is then selected with a checkbox. Fit objects are only created for a sequence if the Auto checkbox is selected for the sequence in the **Sequences** tab of the **Sequences** input window.

For each sequence type selected (i.e. Fit is check marked), a data page is created. The data page will contain a **Single Fit** object for each type of fit specified in the checkboxes. The checkbox Combined will combine all the single fits defined for each sequence type into a **Composite Fit** object.

For **Cartesian Fits**, two **Extract Sequence(s)** objects will be created for both field and simulated data, in order to extract all the sequences for the **Single Fit** object. The user is required to specify the applicable field and simulated data, but the correct sequences have been automatically selected. **Extract Sequence(s)** objects are not created for any other sequence type, as it is assumed that **Auto Setup→Sequence Plots** has been previously conducted, and the output from the **Extract Sequence(s)** objects created in the **Sequence** tab of the **Plots & Data Processing** input window will be used as required.

The type of fit (e.g. log Pressure in **Flow Sequence Fits**) refers to the data transformation of both field and simulated data before input into a **Single Fit** object. If the data transformation was not already conducted in the **Sequence** tab of the **Plots & Data Processing** input window, **Scale/Transform** objects will be created for both field and simulated data to perform the data transformation required.

In addition to the creation of fit objects, auto setup will fill the **Fit Selection** tab, in a manner similar to pressing the Auto Fill button. All fits created will be included, one per line in the **Fit Selection** tab. If composite fits were created, the single fits of those composites will not be included.

5 RUNNING SIMULATIONS

Once all required input has been entered, a model run can be executed by selecting one of the following commands from the **Run** menu:

Minimal Conducts a full model run, with a small window providing minimal information.

Verbose Conducts a full model run, with a small window providing detailed information. The information provided is dependent on the simulation mode. For example, in optimization mode, the best fit value and the current fit value are shown for each parameter to be optimized. Due to the detailed information, a verbose model run will have a slightly increased execution time compared to a minimal model run.

No Threads Conducts a full model run, with messages appearing at the bottom of the main window instead of in a dialog. The user is unable to cancel the model run, however avoids problems if there are multiple simulations being executed on multiple instances of the nPre program.

Covariance Only Calculates the covariance matrix using the current set of defined parameters, without conducting any simulations. Only available for simulation modes that calculate the covariance matrix.

A simulation can also be run through the command line using nPreX (see).

The following three figures are examples of the run window for an optimization model run with multiple fits. The title of the run window indicates the current case and/or fit of the simulation.

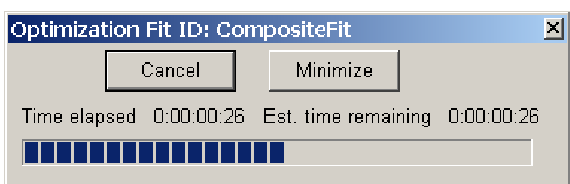


Figure 5.1 Minimal Run Simulation

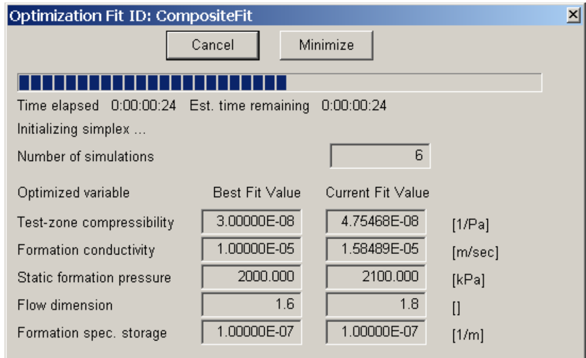


Figure 5.2 Verbose Run Simulation

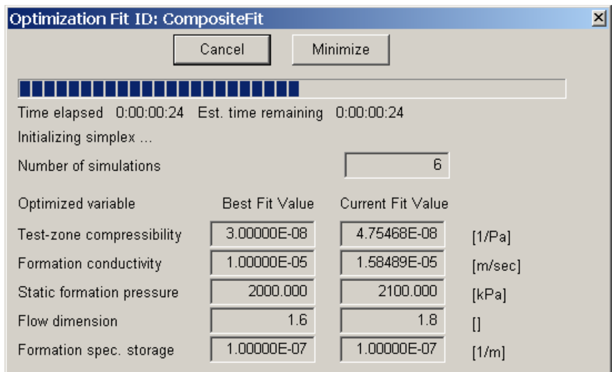


Figure 5.3 Covariance Only Run Simulation

Dialog buttons and information displayed on all the run windows include:

Cancel — Cancels the run.

Minimize — Minimizes the main menu, as well as the run window. Plot windows remain visible, in order to observe changes in the plots during the run.

Time elapsed — Time elapsed since beginning of the run.

Est. time remaining — Estimation of the time remaining for the run is only displayed once the first case is complete. For runs with single cases, it will not be displayed.

Progress Bar — For runs with multiple cases (e.g. multiple fit optimizations, perturbations, etc.), a progress bar is provided that indicates the number of cases completed.

5.1 nPreX

A model run can be executed through the command line using nPreX.

nPreX requires a working configuration file generated with nPre. Within nPre, once the configuration file is generated and tested, select **File→Save For nPreX** to generate the configuration file for nPreX. The **Save For nPreX** command removes all plot objects, listing objects, plot pages and listing pages from the configuration file. The resulting configuration file will have the letter X appended to the filename before the extension. Note that nPreX configuration files can be read by nPre.

It is recommended that the configuration file is checked for errors before creating the nPreX configuration file. While errors can be checked using **List→All Errors**, running one short simulation is the best check.

nPreX is then executed through the command line with a single argument, the configuration file. Any additional arguments will result in additional output statements.

nPreX will not exectute without an mpi driver, such as mpiexec from mpich (http://www-unix.mcs.anl.gov/mpi/mpich/). An example execution statement, using mpich2, is as follows:

mpiexec -n 2 nPreX configFileX.nPre

-n 2 refers to the number of processors. A minimum of two processors must be specified, one master and one slave, even if only one processor is available.

Under the mpi driver, nPreX will execute simulations on all available processors. Depending on how the mpi driver is configured, available processors can include as many as are available on a network of computers.

6 OBJECTS

An object has a defined function related to data input/output, data manipulation, or plot construction. A fundamental premise in nSIGHTS is that objects can be combined in many flexible ways to produce a near-infinite variety of data processing procedures and visualizations. Each page type has associated objects, specifically data objects, plot objects, list objects and output objects. In addition, there is a system object, described in Section 6.4. However, all objects have similar characteristics and controls, which are described in this section.

6.1 Object Data Types

Most objects use the output of other objects as their input. Objects may also use the output of the nPre simulator as input. Only object output of a compatible data-type can be used as input. For example, a **Table Column Scale/Transform** object can only use table data-types as input. With the nSIGHTS user interface, input objects are selected from drop-down menus that contain the names (IDs) of all available object output of the correct type. The following table provides a brief explanation of data types used by nSIGHTS:

Table 6.1 nSIGHTS Data Types

Data Type	Description
CDF	Cumulative Distribution Function. This data type is a subset of the XY data type, where the X data are the values and the Y data are the probabilities.
Color Map	An array of colors, usually smoothly varying.
Covariance Data	Calculated covariance matrices.
Cube Data	A data structure with values at regular array XYZ locations.
Cube Indices	Indexes representing the location of each value within cube data.
Curve Data	X and Y values that define a function. Input XY data and function characteristics are included in the data structure.
Extended Profile	Similar to the Grid Data type, with variable vertical node spacing with space and time, for the unconfined case.
Fit Specification	Pairs of field and simulated data.
Grid Data	A data structure with values at regular array XY locations.
Jacobian Data	Calculated Jacobian results from optimizer.
Pen Set	24 specific colors
Real Value	A single numeric value.
Sequence Time Data	Sequence start/end times and IDs.

Table 6.1 nSIGHTS Data Types	
Data Type	**Description**
Table	Rows and columns of numeric data. Each row and column also has an associated ID.
Time Value	A numeric value associated with a time setting. All time values are also real values.
XY Array	A collection of XY data.
XY Data	X and Y values.
XYZ Label	XYZ co-ordinates and associated text labels.

6.2 Object Concepts

6.2.1 Object ID

Every object that is created has an associated identifier or ID that is used to refer to the object within the nSIGHTS user interface. The ID is always located in the upper left hand corner of the object property window. All objects have a default ID, usually the name of the object, although some objects automatically change the default based on object properties.

You should usually modify the object name so that a) it is unique, and b) it reflects your usage of the object. A unique object name is important to distinguish object output, while a relevant object name makes it easier to understand complex visualizations containing many objects.

6.2.2 Object Selection

Nearly all nSIGHTS objects require input from another object. Within the object property window, these input data are selected using a drop-down menu. When not active, the drop-down menu shows the current object selection.

The drop-down menu box is activated by pressing the down arrow. After activation, a list of objects producing output of the correct data type is displayed, as shown in

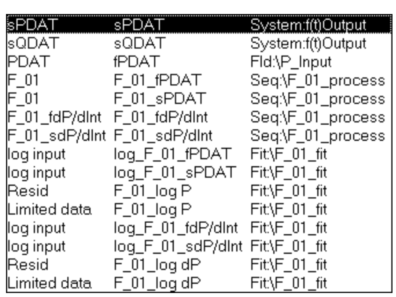


Figure 6.1 Object Selection Drop-Down List:

The listing in the drop-down menu contains:

- the object type (or output ID if there is more than one output of the same type from a single object)

- the object ID of the associated object

- the name of the page where the object is located. For nested pages, a back slash separates page names. In nPre only, the page name is preceded by the nPre object tree where the page is located. A colon separates the nPre object tree name and the page name.

6.2.3 Object Connections

The input/output connections between objects are viewed by icons in the tree, or by selecting the **Connections** command in the **Object** menu.

The icons in the tree will only display if **Settings→Tree View→Show connected objects** is selected. If selected, the tree will display a magenta diamond over the object icon of all objects used as input to the selected object, and will display a red square over the object icon of all objects using the selected object as input.

The **Connections** command will display a text top-level window that provides information on the connections of the currently selected object: the objects used as input, and the objects which use the currently selected object's output as input.

Similar to object selection, each object in the top-level window is defined by:

- the object ID

- the object type (or output ID if there is more than one output of the same type from a single object)

- the name of the page where the object is located

- in nPre only, the nPre input window where the page is located.

An example of a connection window for a **P(t) Derivative Calculation** object, named *F_01_fdP/dlnt* created in the *F_01_process* page of the **Sequence** tab (**Plots & Data Processing** input window), is provided below in Figure 6.2:

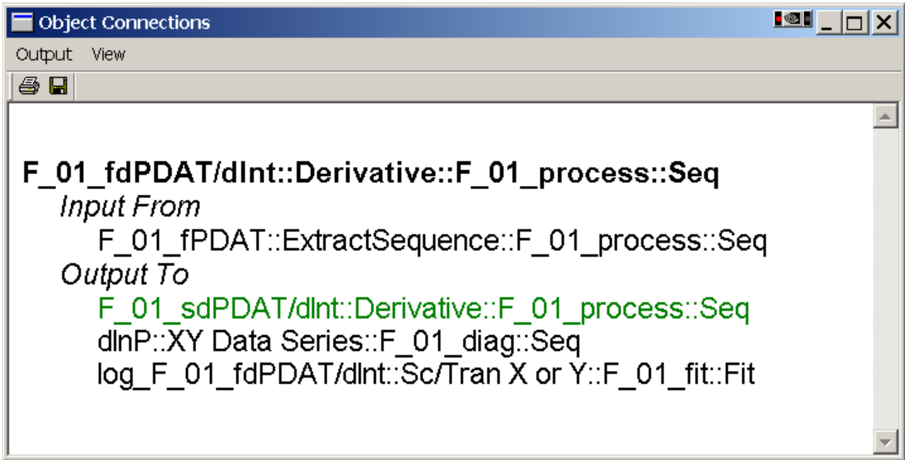


Figure 6.2 Connection Window for a P(t) Derivative Calculation Object

Based on the example object connections window, *F_01_fdP/dlnt* uses as input an **Extract Sequence(s)** object, named *F_01_fPDAT*, from the same page. Three objects use the *F_01_fdP/dlnt* object output as input:

- A **P(t) Derivative Calculation** object, *F_01_sdPDAT/dlnt*, in the same page. The connection is displayed green, to indicate that this object is a slave to *F_01_fPDAT*.
- An **XY Data Series** object, named *dlnP*, from the *F_01_diag* page in the **Sequence** tab.
- A **Single Scale/Transform** object, named *log_F_01_fdP/dlnt*, from the **Constraints** page in the nPre **Fit** tab (**Plots & Data Processing** input window).

Note that the object name used in the connections page relates to the object identifier within the object tree, which may differ from the object name in the **Object** menu (see Appendix E for tables of alternative object names). All object names used within this manual refer to the object name used in the **Object** menu.

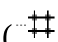
The connections for all objects within the currently selected page are similarly viewed by selecting **Page→All Connections**.

6.2.4 Object Execution

The nSIGHTS architecture includes an object execution algorithm that ensures objects are re-calculated as required. For example, changing the scale in a **Scale/Transform** object will cause all objects using the resulting data to be re-calculated and all plots dependent on those objects to be re-drawn.

The algorithm used to determine execution is fairly straightforward. A tree is built based on inter-object references. Tree connections are viewed using **Object→Connections** or **Page→All Connections** as described in Object Connections. The tree is traversed in such a manner that all input data to an object is re-calculated before an object is re-calculated.
An error occurs when a circular reference is detected: i.e. object A depends on object B for input, but the object B also depends upon object A. In this case, nSIGHTS will issue a non-fatal error message of the form **ObjCalc - Non-blank object not found - circular reference**.

6.2.5 Object Errors

Object errors are errors due to input or object property settings. Before an object is executed, its input objects and internal properties are checked. If a problem is detected, an error message is displayed in the message line portion of the screen. The error message will contain the name of the object causing the error and the error. The error must be corrected before execution can continue.
The object icon of an object with an error will be modified to reflect the object's status (i.e. the icon will appear as  or ). Once the error has been fixed, the object icon will return to normal status ().
Another type of error message causes a dialog to appear with the title **nSIGHTSInternalError** and a (usually cryptic) error message. Subsequently, nSIGHTS will abort. This is indicative of a bug. Occurrences of these errors should be reported to the author by selecting Mail complaints about program in the **Help→About nPre..**. dialog.

6.3 General Object Controls

6.3.1 Masters and Slaves

Master and slave capabilities allow the internal settings of one object (the *master*) to control those of another object (the *slave*). In many cases, data processing objects and visualizations are created that may contain several instances of a set of object properties. To compare these objects, they need to have the same object properties. For example, to compare the derivative of pressure for field data and model results, two **P(t) Derivative Calculation** objects are required, one for each set of data. To ensure both derivative objects have the same derivative specifications, the master and slave facility allows the object properties of the slave object to be automatically updated to correspond with any changes to the master object.

For example, the two **P(t) Derivative Calculation** objects described above could be linked as follow:

(1) A **P(t) Derivative Calculation** object for the field data derivative calculation is created: the Object ID is set to **dPField**, the pressure field data source is selected, and the appropriate derivative options selected. By default, the object will be a master (i.e. the Master toggle is turned on).

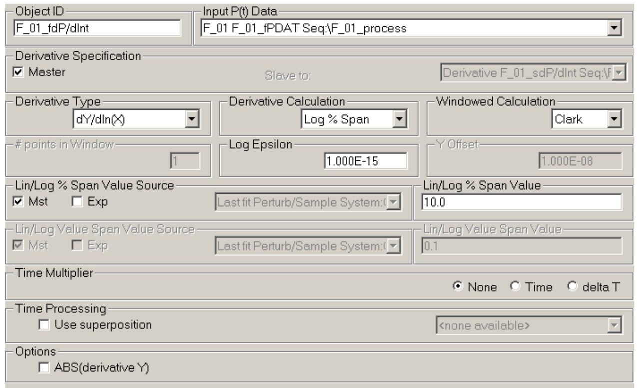


Figure 6.3 P(t) Derivative Calculation Object with Master toggle turned on.

(2) Another **P(t) Derivative Calculation** object for the model results is created: the Object ID set to **dPModel**, and the model data source is selected. The Master toggle is turned off, and the *dPfield* object is selected from the drop-down menu.

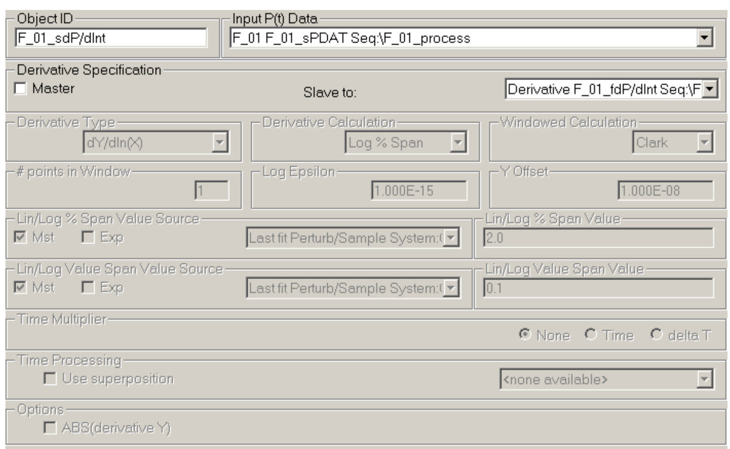


Figure 6.4 P(t) Derivative Calculation Object with Master turned off**.**

Master/Slave capability is available for most object properties where property variation is likely to be required. There are two variations of the master/slave frame depending upon the window layout. Both variations are shown in the object property of the **P(t) Derivative Calculation** object shown in the above example, and are shown in detail here, in Figure 6.5.

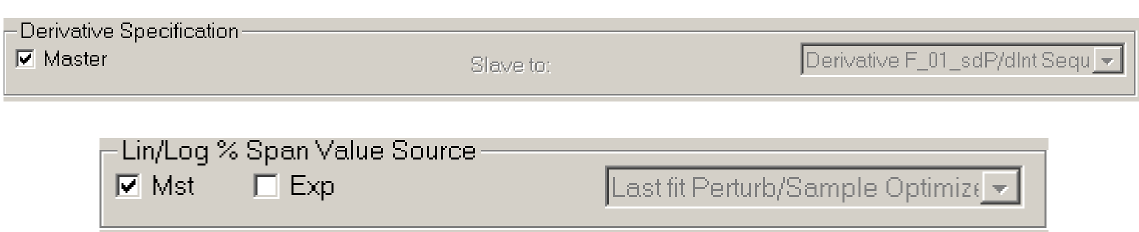


Figure 6.5 Master/Slave Frame Variations

Note that many master/slave controls also contain an Expose toggle. Selecting the Expose toggle will create an exposed version of the control as described in Exposed Controls. Only master controls can be exposed.

6.3.2 Exposed Controls

One drawback to the object property window of the nSIGHTS user-interface (UI) is that it is difficult to rapidly change properties of a plotted object or two objects. For example, to repeatedly change the selected run and/or simulation of an extract object (e.g. **Extract XY from XY Results** object) and view the change in a plot requires the following procedure:

(1) select the run and/or simulation.

(2) press **Apply**

(3) select the plot window to view results

(4) select the Main Men

(5) select the extract object in the object tree

(6) change the run and/or simulation selection

(7) press **Apply**

(8) re-select the plot window to view results.

(9) repeat steps 4 to 8

nSIGHTS offers a capability called *exposed controls* to resolve this problem. An exposed control is a UI element which has been disabled on the object property window and has been re-created in its own small top-level window. Within this top-level window are the control and additional UI elements to support other capabilities. Exposed controls are actuated by selecting the Expose toggle on selected UI components. Exposed controls are bundled with Master/Slave capabilities. Note that only master controls can be exposed.

The element remains exposed after the property pane has been changed to a different object. The exposed control will be available until it is disabled (Expose toggle switched off), or the object is deleted.

There are currently two types of exposed controls: list selections and real values.

6.3.2.1 Exposed List Selections

There are two types of exposed list selections: an animation type control and a selector type control. An example animation type exposed list selection control is shown below in Exposed List Selection Window:

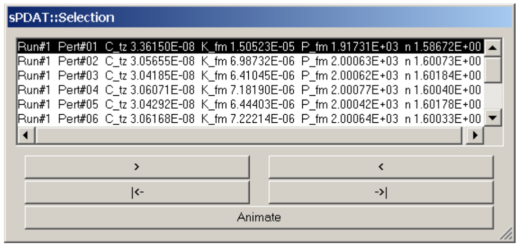


Figure 6.6 Animation Type Exposed List Selection Window

This animation control was created by exposing the **Index Selection Value Source** selection property of an **Extract XY from XY Results** object. The title of the control is constructed from the object ID and the name of the exposed property.

The animation type exposed list control has the following capabilities:

- Changing the selection with the mouse has the same effect as making the change on the unexposed control on the property window AND pressing **Apply**.
- The four direction push buttons at the bottom assist in navigating the list: > increments the selection, < decrements the selection, |<- goes to the first selection in the list, and ->| goes to the end of the list.
- The **Animate** button, when pressed, resets the selection to the start of the list, and then goes through each selection in order. While animating, the text in the button changes to **Stop**.

The selector type control is used when multiple selections are possible. An example selector type exposed list selection control is shown below in Figure 6.7

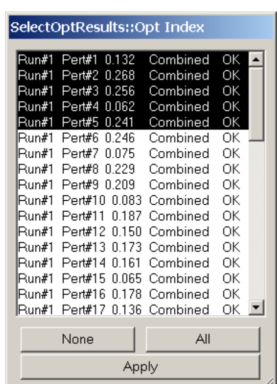


Figure 6.7 Selector Type Exposed List Selection Control

This selector type control was created by exposing the **Index Selection Value Source** selection property of an **Extract Optimizer Results Table** object. The title of the control is constructed from the object ID and the name of the exposed property.
The selector type exposed list control has the following capabilities:

- Changing the selection with the mouse has the same effect as making the change on the unexposed control on the property window. The **Apply** button must be selected to apply the changes.

- The **None** button removes the selection for all items in the list.

- The **All** button selects all items in the list.

6.3.2.2 Exposed Reals

An example of an exposed real value control shown below in Figure 6.8:

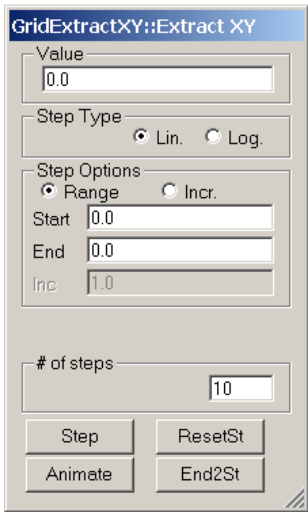


Figure 6.8 Exposed Real Value Control

This control example exposes the value of the **Extraction Constant Value Source** of an **Extract XY from Grid** object (for extracting a slice from a grid). The exposed value is entered in the top field of the control. Typing in a new value and pressing the Enter key has the same effect as making the change on the unexposed control on the property page and pressing the **Apply** button.

The additional controls are designed to support animation (see Section 8.4.3) by smoothly varying the exposed value for a specified number of steps or frames. If the **Step Options** is set to Range the increment is calculated based on the Start and End value and the **# of steps**. If it is set to Incr. the increment is entered directly.

Step Type controls the type of increment. If set to Lin, range increments are calculated as: increment = (end - start) / steps, and successive values calculated as: next = current + increment. Log range increments are calculated as: increment = (log10(end) - log10(start)) / steps, and successive values are calculated as next = 10**(log10(current) + increment).

The control buttons perform the following actions:

Step Increment the current value.

Animate Set the current value to the start value, then increment the current value # of steps times. While animating, the button text changes to Stop. Pressing the button will stop the current animation.

ResetSt Set the current value to the start value.

End2St Set the start value to the current end value.

6.3.3 Formatting Real Numbers

There are many cases where it is desirable to control the format used to convert numeric values to strings. Examples include axes increment labels, posted data points on plots, etc. nSIGHTS uses a common control for this task:

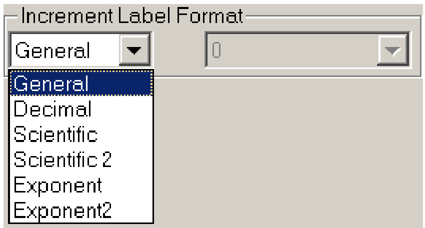


Figure 6.9 Example Real Number Format Frame

The first field is a drop-down list that specifies the general formatting type, while the second field is used to specify the number of decimal places:

General Conversion depends upon the value of the number being converted. Generally, decimal conversion is used for numbers of absolute value less than 1.0E+11 and greater than 1.0E-05 (or 0), while scientific notation is used for all others. Trailing zeroes are generally eliminated, except that integer values less than 100 have a single decimal place (e.g. 99.0). The second field is not used for general.

Decimal A fixed number of places after the decimal are specified.

Scientific A fixed number of digits precision is specified.

Scientific 2 Same as *Scientific* except uses mantissa x 10**X format in subscript/superscript notation.

Exponent Expressed as 10 to a power using subscript/superscript notation. Note that the mantissa will be dropped. This is intended primarily for log axes and log data labels. Note that 10**0 will be converted to 1.

Exponent 2 Same as *Exponent* only values with exponents between -1 and 2 will appear as 0.1, 1, 10, and 100.

Note that the *Scientific 2*, *Exponent*, and *Exponent 2* notations are only available for objects plotting labels.

The second field appears as follows in Figure 6.10:

Decimal *Scientific* *Scientific 2*

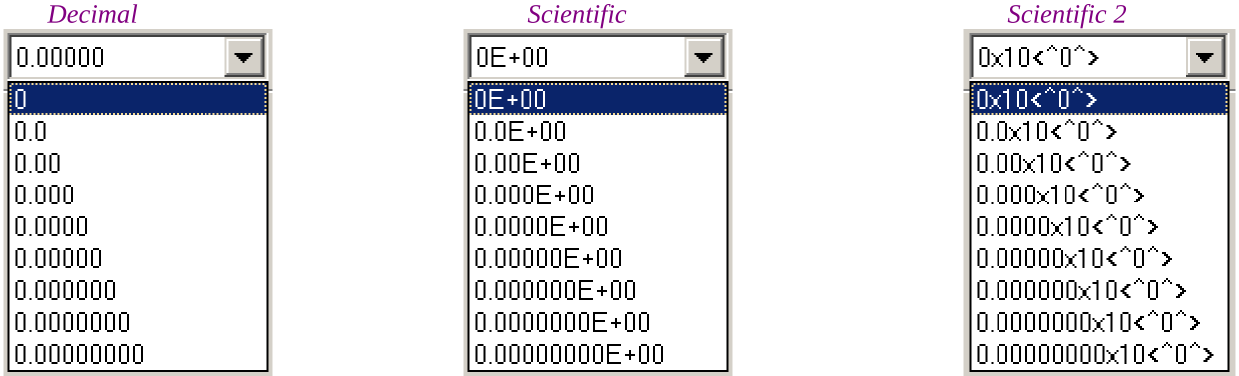


Figure 6.10 Field used to specify the number of decimal places.

6.3.4 Font Selection

nSIGHTS betrays its Unix origins by not using a standard Windows font selector. It restricts font usage to a limited number of alternatives in the interest of maintaining visual integrity. There are two main font dialogs available, differentiated by the fonts display dimension: 2D or 3D. The common font options for 2D and 3D display include:

Fam Select font family.

Arial A Helvetica Type font.

Times Conventional Times Roman.

Courier A Courier font.

Wt Font weight: either *Medium* or *Bold*.

Slnt Font slant: either *Reg.* or *Italic*.

Size Size in points.

Fonts for display in 3D have the following additional fields:

Thk Thickness - governs the depth of the font in 3D. There are five alternatives:

Flat Font is two-dimensional and will be invisible from the side.

Thin, *Med.*, *Thick*, *V. Thk.* Various qualitative degrees of depth.

A third font dialog is available for some 2D labels that can be rotated to vertical:

Rot Rotation can be *Horizontal*, *Left*, or *Right*.

6.4 System Objects

nPre and nPost contain common invisible or system objects. These objects cannot be created or deleted by the user. There are four types of system objects: system information objects, a standard pen set, default linear color maps and default nPre simulation objects.

6.4.1 System Information Objects

System information objects are intended for use with **Data Labels** plot objects. It provides a mechanism of identifying output graphics for QA and documentation purposes.

There are four system information object types:

Version The current nSIGHTS version identifier.

Version date The release date of the version.

Today The current date.

Time The current time.

In drop-down lists, system information objects are identified as follows in Figure 6.11:

Version	SysInfo	System:System
Version date	SysInfo	System:System
Today	SysInfo	System:System
Time	SysInfo	System:System

Figure 6.11 System Information Object Drop-down List

6.4.2 Standard Pen Set and Linear Color Maps

Pen Set and **Linear Color Map** objects are required by most object tree setups, and are frequently the only pen set and linear color map objects required. Consequently, one pen set and two color map objects are available by default as system objects.

The default **Pen Set** object has an object ID of *Standard*. Likewise, the default **Linear Color Map** objects have an object ID of *Cold*➔*Hot* and *Greyscale*. The *Cold*➔*Hot* linear color map provides a rainbow color range from blue to red, where as the *Greyscale* linear color map provides a range of grey colors.

6.4.3 nPre Simulation Objects

nPre also contains a number of system objects which are created automatically by the simulator. These include tables of sample values and optimizer results, and XY data for each defined simulation output.

nPre simulation objects are identified in the same manner as all objects, with an object tree identifier of *System*. For example, simulation pressure XY output would be identified as *sPDAT sPDAT Sytem:f(t)Output*.

7 DATA PROCESSING: DATA OBJECTS

The data page contains data objects, which are objects that process data. For example, data can be input, scaled or transformed. Visualization of data objects is accomplished using plot pages and plot objects (see Section 8).

This section does not intend to detail every data object. It will discuss some data object concepts, and provide a summary of the available data objects and their function. Each data object is described in detail in Appendix A.

7.1 Data Object Concepts

This section is provided to describe the default data objects, data object controls, and the input for some of the more complex data objects.

7.1.1 Default Data Objects

All data pages have one default object: a default data page description (*Default::DataPgDesc*). This data object contains an object ID that is used as the identifier for the page in the object tree. It also contains an empty text box that allows the user to document the collection of objects in the page.

7.1.2 Tables in the Object Property Window

Two objects, **Enter Table** and **Enter XY**, contain spreadsheet-type tables within the object property window. An example **Enter Table** object property window is shown below in Figure 7.1:

Figure 7.1 Enter Table Object Property Window

Values are entered into the cells. The Update button and the pop-up menu (accessed by right-clicking the mouse over the table) can be used to fill in the table with values.

Selecting an object in the input-data drop-down-box and clicking the Update button displays the values from the selected object in the table of the **Enter Table/XY Data** object. When the **Apply** button is clicked, the values are stored in the **Enter Table/XY Data** object. The values can then be modified. Reselecting the Update button will refresh the values in the table, and all modifications will be lost.

The pop-up menu contains the commands outlined below. Selected rows and columns are based on the cursor location upon activation of the pop-up menu.

Insert Before	Inserts a row above the selected row. For XY data only.
Insert After	Inserts a row below the selected row. For XY data only.
Delete	Deletes the selected row. For XY data only.
Insert Row Before	Inserts a row above the selected row. For table data only.
Insert Row After	Inserts a row below the selected row. For table data only.
Delete Row	Deletes the selected row. For table data only.
Insert Column Before	Inserts a column before the selected column. For table data only.
Insert Column After	Inserts a column after the selected column. For table data only.
Delete Column	Deletes the selected column. For table data only.
Paste from Clipboard	Pastes the contents of the clipboard into the table. For example, data in a spreadsheet can be copied and then pasted into the table.
Copy to Clipboard	Copies the entire contents of the table to the clipboard. The table can then be pasted into a spreadsheet or text editor.

7.1.3 Scale/Transform Objects

Scale/transform objects perform mathematical operations on input data. Common options include:

Operation Order

Scale→Transform	The object will perform the scale operation, then the transform, in this order.
Transform→Scale	The object will perform the transform, then the scale operation, in this order.

Scale Operation	Drop-down list containing four different equations that determine the scale operation, where *D* is the data, *Sc* is the **Scale Value** and *Off* is the **Offset Value**.
Transform	Drop-down list containing several transform functions (e.g. *ln(Data)*, *1/Data*, *Abs(Data)*, etc.)

Scale Value Source	Master and expose controls for the scale value. See Section 6.3.1 for details.
Scale Value	Text box for input of a scale value.
Offset Value Source	Master and expose controls for the scale value.
Offset Value	Text box for input of an offset value.
Null Processing	
set to constant	When active, will set all null values to the constant specified in the constant text box.
Constant	Text box to input a constant value that will replace all null values.
Minimum Thresholding	
None	Does not apply a minimum threshold.
Null	Sets all values below the text box value as null.
Clamp	Sets all values below the text box value at the text box value.
Maximum Thresholding	
None	Does not apply a maximum threshold.
Null	Sets all values above the text box value as null.
Clamp	Sets all values above the text box value at the text box value.
Output Description	Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

7.1.4 Interpolation Methods

Interpolate XY data from Curve, **Time Limits Extraction/Interpolation** and **Sequence Fit** use common interpolation methods, described below:

Linear Conducts a linear interpolation of the Y data for a specified number of X points, within specified X limits.

Log (Absolute) Conducts a linear interpolation of the Y data for a specified number of log X points, within specified X limits.

Log (Relative) Conducts a linear interpolation of the Y data for a specified number of newly created log X points, within specified X limits. X points are created using log steps starting from a specified start value.

Input X Conducts a linear interpolation of the Y data for given X values from XY input data. For **Time Limits Extraction/ Interpolation** and **Sequence Fit**, this method results in no interpolation.

The **Interpolate Table Column** object uses different interpolation methods (note that X data must be in ascending order):

Linear Linearly interpolates a Y value corresponding to an X value equal to the specified interpolant value.

Previous Obtains the Y value corresponding to the X value of the row above the specified interpolant value.

Next Obtains the Y value corresponding to the X value of the next row below the specified interpolant value.

Closest Obtains the Y value corresponding to the X value closest to the specified interpolant value.

The interpolation methods used by **Create Curve from XY Data**, are described in Section 7.1.5.

7.1.5 Curve Data Functions

When creating curve data (**Create Curve from XY Data**), several data functions or interpolation methods are available. Examples based on the same set of XY data, are shown for each data function.

Cubic Spline A piece-wise polynomial approximation of XY data, continuous in the first and second derivatives, provides a smooth approximation. Parameters are available for this curve type to influence the function slopes at the extremes of the function and the spline tension.

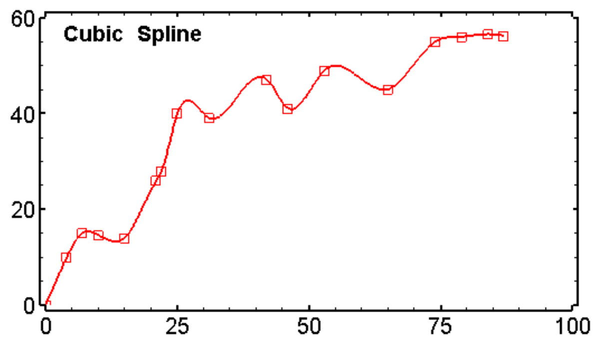


Figure 7.2 Cubic Spline Curve Function XY Data

Polynomial Linear regression of XY data at a specified polynomial order. A polynomial order, between 1 to 10, is specified.

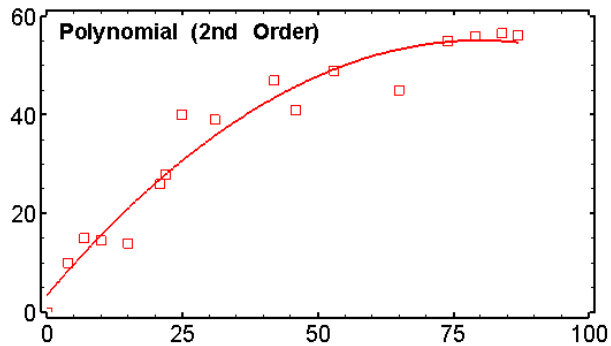


Figure 7.3 Polynomial (2nd Order) Curve Function of XY Data

Linear A series of straight lines joining consecutive XY points.

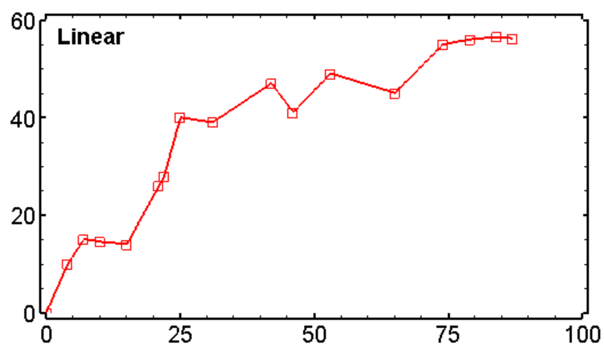


Figure 7.4 Linear Curve Function of XY Data

StepMid Step function with value change at the linear midpoint between adjacent points.

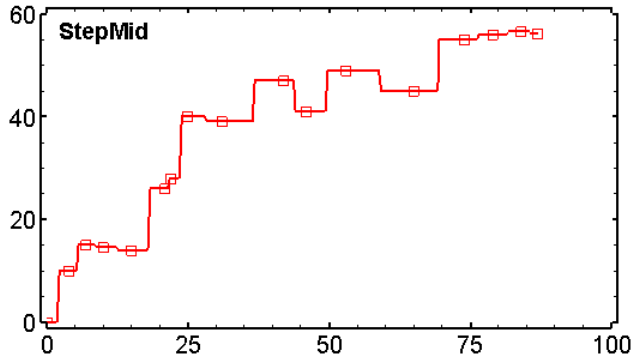


Figure 7.5 StepMid Curve Function of XY Data

StepFull Step function with value change at each XY point.

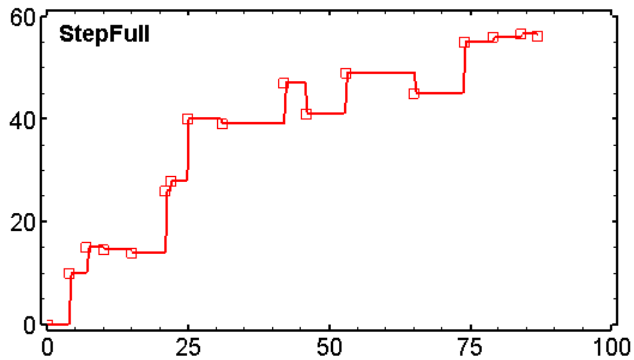


Figure 7.6 StepFull Curve Function of XY Data

7.2 Data Object Summary

Due to the large number of data objects, it is not possible to list all data objects in a single selection menu. Consequently, nSIGHTS categorizes data page objects and requires an additional step (category selection) to get the actual object selection menu. The data object category menus in nPre and nPost are as follows in Figure 7.7:

nPre nPost

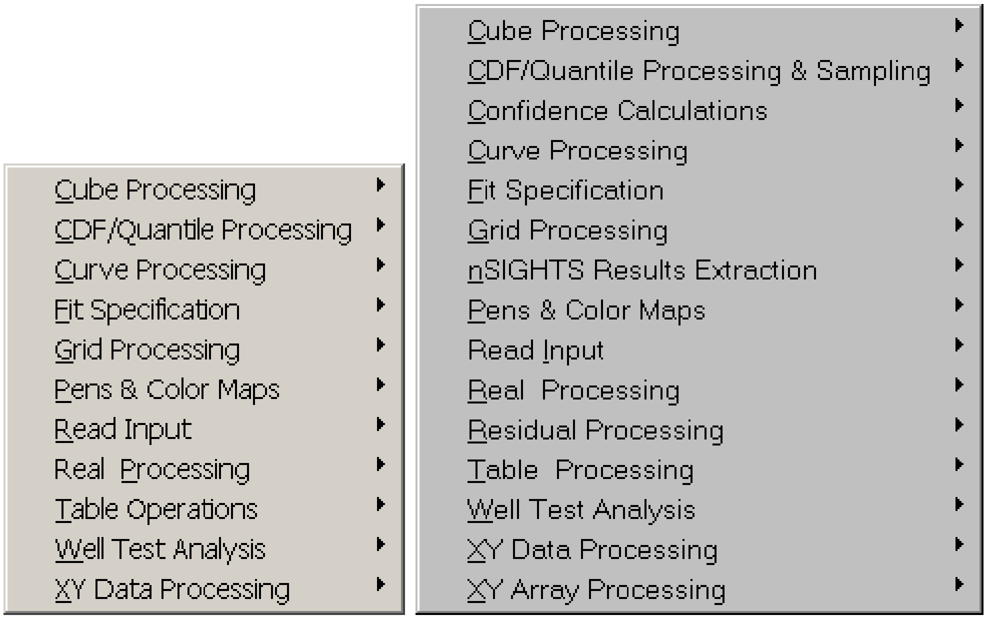


Figure 7.7 nPre and nPost Data Object Category Menus

Objects in each category are listed in Table 7.1 Data Object Summary below. Note that some objects appear in more than one category (for example, **Read Table File** appears in both **Read Input** and **Table Operations** categories).

Table 7.1 Data Object Summary

Category	Objects	nPre Objects	nPost Objects
Cube Processing	Extract Cube Indexes Extract Grid Histogram Matrix Math Normalize Scale/Transform Statistics	Select Range Cube	
CDF/Quantile Processing	Calculate CDF of Table Column Calculate CDF of XY Data Extract Values from CDF Validate XY Data as CDF		Create Discrete & Step-wise Uniform CDFs Create Sampled Table Data
Confidence Calculation			Calculate Joint Confidence of Opt Results Calculate Joint Confidence of Grid Calculate Joint Confidence of Table

Table 7.1 Data Object Summary			
Category	**Objects**	**nPre Objects**	**nPost Objects**
Curve Processing	Create Curve from XY Data Interpolate XY Data from Curve Read Curve File Select Curve from File	Write Curve File	
Fit Specification	(Basic) Single Fit Composite Fit	Sequence Fit	
Grid Processing	Extract XY from Grid Histogram Matrix Math Normalize Scale/Transform Statistics View Grid Data	Select Range Grid	Convert Table To Grid Interpolate
nSIGHTS Results Extraction			Extract Covariance Matrices Extract Extended Profile from Case Extract Jacobian Extract Optimizer Results Table Extract Profile Grid/Case Extract Range Cube Extract Range Grid Extract Residuals Extract XY from XY Results Scale/Transform Extended Profile
Pen and Color Maps	Linear Color Map Merge Color Maps Create Pen Set Read Color Map	Write Color Map	
Read Input	Read Curve File Read Mini-Troll Text File Read Table File Read XY Data Read XY Data Array Read XYZ Label Data		Read Color Map Read Cube Data Read Grid Data Read nSIGHTS Optimizer Results Read nSIGHTS Profile Results Read nSIGHTS Range Results Read nSIGHTS XY Results Read Sequence Time Interval Data

Table 7.1 Data Object Summary			
Category	**Objects**	**nPre Objects**	**nPost Objects**
Real Processing	Create Real Value Scale/Transform		
Residual Processing			Calculate Basic Residual Calculate Residual Diagnostic Calculate Residual Histogram Extract Residuals
Table Operations	Enter Table Data Extract Real from Table Extract Table Rows Full Table Correlations Interpolate Table Columns Read Table File Real Value(s) To Table Sum Tables Table Column CDF/Quantile (Calculate CDF of Table Column) Table Column Correlations Table Column Math Table Column Scale/Transform Table Column Statistics Table Column To Histogram Table Columns To XY Table Row Index Logic Table Row Statistics View Table Data	Write Table File	Concatenate Tables Create Sampled Table Data Jacobian to Table Transpose Table
Well Test Analysis	Create BE/ET Response Function Extract Sequence(s) P(t) Barometric Compensation P(t) BE/ET Compensation P(t) Derivative Calculation P(t) Time Processing Pulse Normalization Time Limits Extraction/Interpolation		

Table 7.1 Data Object Summary			
Category	**Objects**	**nPre Objects**	**nPost Objects**
XY Data Processing	Add Noise CDF/Quantile (Calculate CDF of XY Data) Dual Scale/Transform Enter XY Data Extract Range Fourier Transform on Y Histogram Integrate Single Scale/Transform Smooth/Filter Statistics Read XY Data Reduction Remove Duplicates Transpose Vector Math View XY Data	Create XY Array Read XY Data Array Select XY from XY Array Write XY File Write XY Data Array	
XY Array Processing			Add XY to Array Array Scale/Transform Read XY Data Array Select XY from XY Array Write XY Data Array

7.3 Data Object Function Summary

Table 7.2 Data Object Function Summary summarizes the function of all the data objects available. In addition, the required input object or data type and the created output data type is specified. If the input or output is not an object or external file (e.g. input from user), the input or output will be specified as none. Note that for read objects, the default file extension is not required when opening a file.

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Add Noise	Adds noise to Y data randomly based on a *Uniform* or *Normal* distribution. Used to create synthetic data. **Input:** XY data **Output:** XY data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Add XY to Array	Creates a collection of XY data from a single XY data object. Each time a change is made in the specified XY data object, the new XY data are added to the array. For example, if an **Extract XY from Grid** object (extracts XY data from a grid) is used as input, each time the Extraction Constant Value in the **Extract XY from Grid** object is changed (including pressing the **Apply** button), the new XY data will be added to the array. **Input:** XY data **Output:** XY array
Array Scale/Transform	Performs mathematical operations on XY array data types. **Input:** XY array **Output:** XY array
(Basic) Single Fit	Pairs field and simulated data to be selected as a constraint by the **Fit Selection** tab in the **Fit Selection** nPre input window. Typically used in the **Fit** tab of the **Plots & Data Processing** nPre input window. **Input:** XY data **Output:** fit specification
Calculate Basic Residual	Processes residuals from selected residual data. Residuals can be sorted in ascending (Up) or descending (Down) order, plotted versus the X Value or the data Index, and/or standardized to make the data comparable to a standard normal probability distribution. **Input:** **Extract Residuals** **Output:** XY data
Calculate CDF of Table Column	Creates a cumulative distribution function from the specified table column data. **Input:** table data **Output:** CDF
Calculate CDF of XY Data	Creates a cumulative distribution function from either X or Y data. **Input:** XY data **Output:** CDF
Calculate Joint Confidence of Opt Results	Calculates confidence of optimization results by the F-test method or Log-Likelihood method, relative to a best fit case. **Input:** **nSIGHTS Optimizer Results** **Output:** Table data
Calculate Joint Confidence of Grid	Calculates confidence of grid points, where the value of each grid point is the fit result, by the F-test method or Log-Likelihood method, relative to a best fit case. **Input:** grid data **Output:** Table data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Calculate Joint Confidence of Table	Calculates confidence of points in a table containing fit results by the F-test method or Log-Likelihood method, relative to a best fit case. **Input:** table data **Output:** Table data
Calculate Residual Diagnostic	Creates data to plot a Quantile Normal or Standard normal residual plot. **Input: Extract Residuals** **Output:** Two XY data sets, one containing the manipulated data, the second a diagnostic line (Quantile Line or CumNormDist)
Calculate Residual Histogram	A special case of the **Histogram** object, creates the input data for a histogram plot based on residual data. The actual histogram is plotted using an **XY Series** plot object on a plot page, with this object as the input. **Input: Extract Residuals** **Output:** XY data
CDF/Quantile	See Calculate CDF of XY Data
Composite Fit	Combines fit specification objects to be selected as one constraint by the **Fit Selection** tab in the **Fit Selection** nPre input window. A fit specification object contains a pair of field and simulated data to be selected as constraint. Typically used in the **Fit** tab of the **Plots & Data Processing** nPre input window. **Input: Single Fit** or **Composite Fit** **Output:** fit specification
Concatenate Tables	Joins multiple tables into one table. Tables may be joined to the base table by adding columns or rows to the base table. Each table must have the same number of rows, if adding columns, or the same number of columns, if adding rows. **Input:** table data **Output:** table data
Convert Table To Grid	Converts a table with at least 3 rows and 3 columns into a grid. The column headers or the first row and the first column contains the grid coordinate data. **Input:** table data **Output:** grid data
Create BE/ET Response Function	Creates a response function based on baseline pressure measurement data, and barometric pressure and/or earth tide data. The response function can be used to correct pressure data for barometric and earth tide effects. **Input:** XY data **Output:** response function (XY data plus additional relevant data)

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Create Curve from XY Data	Creates functional approximations of XY data sets. The functions available include: *Linear*, *Cubic Spline*, *Polynomial*, *Step Mid* and *Step Full* (see Section 7.1.5 for details). **Input:** XY data **Output:** curve data
Create Discrete & Step-wise Uniform CDFS	Converts XY data representing step-wise uniform or discrete data probability distribution functions to cumulative distribution functions. **Input:** XY data **Output:** CDF
Create Real Value	Outputs a single user-specified value, which can be used as input for many other objects. **Input:** none **Output:** real value
Create Sampled Table Data	Creates a single table column containing values sampled according to a specified probability distribution (Normal, Truncated normal, Log-normal, Truncated lognormal, Uniform, Log-uniform, Triangular, Log-triangular, Exponential, Poisson, Weibull, Beta, Student t, User CDF or Tabulated discrete). The column forms the only column of table or is added to an existing table (with the same number of rows). **Input:** table data (optional existing table to append new column), CDF (if User CDF is selected distribution), table data (if Tabulated discrete is selected distribution) **Output:** table
Create XY Array	Creates a collection of XY data. **Input:** XY data **Output:** XY array
Dual Scale/Transform	Performs mathematical operations on both the X and the Y of XY data. **Input:** XY data **Output:** XY data
Enter Table Data	Allows the user to input or modify table data. Table data can be input or modified by hand, pasted from the clipboard, or updated from another table data-type object (see 7.1.2 Tables in the Object Property Window for details). **Input:** none or table data **Output:** table data
Enter XY Data	Allows the user to input or modify XY data. XY data can be input or modified by hand, pasted from the clipboard, or updated from another XY data-type object (see Section 7.1.2 for details). **Input:** none or XY data **Output:** XY data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Extract Covariance Matrices	Extracts covariance matrices from one or multiple simulations of an **nSIGHTS Optimizer Results** object. Estimated covariance matrices use the estimated standard deviation specified by the user for each parameter. The confidence limits of the covariance matrix can be plotted using the **Confidence Limits** plot object. **Input: nSIGHTS Optimizer Results** **Output:** covariance data
Extract Cube Indexes	Extracts cube indices from cube data within set limits. Cube indices are used to define the cube data to be plotted in a 3D plot. **Input:** cube data **Output:** cube indices
Extract Extended Profile from Case	Extracts an extended profile from a case (i.e. select the time step to extract the extended profile). **Input: Extract Profile/Grid Case** **Output:** extended profile, XY data containing water table height with radius, real value of extracted time
Extract Grid	Extracts a grid from cube data such that every point of the grid represents a specified constant value. **Input:** cube data **Output:** grid data
Extract Jacobian	Extracts Jacobian data from one or multiple simulations of an **nSIGHTS Optimizer Results** object. **Input: nSIGHTS Optimizer Results** **Output:** Jacobian data
Extract Optimizer Results Table	Extracts a table containing optimized values, case parameters and/or optimization status from one or multiple simulations of an **nSIGHTS Optimizer Results** object. **Input: nSIGHTS Optimizer Results** **Output:** table data
Extract Profile Grid/Case	Extracts a grid or case of extended profiles from one or multiple simulations of an **nSIGHTS Profile Results** object. **Input: nSIGHTS Profile Results** **Output:** grid data or case of extended profiles
Extract Range	Extracts XY data within a specified range. **Input:** XY data **Output:** XY data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Extract Range Cube	Extracts cube data from one or multiple simulations of an **nSIGHTS Range Results** object. **Input:** **nSIGHTS Range Results** **Output:** cube data
Extract Range Grid	Extracts a grid from one or multiple simulations of an **nSIGHTS Range Results** object. **Input:** **nSIGHTS Range Results** **Output:** grid data
Extract Real from Table	Extracts a table column property (number of rows, minimum value, maximum value, last row value, or specified row value) and converts it to a real data-type. The real value is displayed in the object property window, in the **Current Value** frame. **Input:** XY data **Output:** real value
Extract Residuals	Extracts residuals (XY data) from one or multiple simulations of an **nSIGHTS Optimizer Results** object. **Input:** **nSIGHTS Optimizer Results** **Output:** XY data
Extract Sequence(s)	Extracts XY data for one or multiple sequences, based on the sequences defined by sequence time data. **Input:** XY data and **Sequence Time Interval Data** **Output:** XY data
Extract Table Range	Extracts a range of rows from a table column based on specified limits. **Input:** table data **Output:** table data
Extract Values from CDF	Extracts a single data value or probability from a CDF, given the corresponding probability or data value. **Input:** CDF **Output:** Two real values: the input value or probability, and the output value or probability
Extract XY from Grid	Extracts all X data from a grid corresponding to a specified constant Y value, or all Y data for a specified constant X value. **Input:** grid data **Output:** XY data
Extract XY from XY Results	Extracts one set of XY data from one or multiple simulations of an **nSIGHTS XY Results** object. **Input:** **nSIGHTS XY Results** **Output:** XY data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Fourier Transform on Y	Conducts a forward or inverse Fourier transform on Y data. **Input:** XY data **Output:** XY data
Full Table Correlations	Calculates the Pearson R or Spearman R correlation coefficients between all column pairs within a table. **Input:** table data **Output:** table data
Histogram	Creates the input data for a histogram plot based on cube, grid or XY data. The actual histogram is plotted using an **XY Series** plot object on a plot page, with this object as the input. Note there are separate objects for each data type. **Input:** cube, grid or XY data **Output:** XY data
Integrate	Takes the integral of XY data. **Input:** grid data **Output:** grid data
Interpolate Grid	Interpolates the data from one grid onto the grid coordinates of another grid. **Input:** table data **Output:** real value
Interpolate Table Columns	Interpolates Y values based on a given value for X (the interpolant value value). Values in the X table column must be in order of increasing values. **Input:** table data **Output:** real value
Interpolate XY Data from Curve	Interpolates XY values based on curve data, for a specified number of points and specified limits. This allows curve data to be plotted. **Input:** curve data and if *input X* interpolation method, XY data **Output:** XY data
Jacobian to Table	Converts Jacobian data to table data. **Input:** Jacobian data **Output:** table data
Linear Color Map	Creates a color map with a linear variation between starting and ending RGB or HSV values. **Input:** none **Output:** color map

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Matrix Math	Basic array mathematics (+,-,*,/) can be applied to two sets of cube data or grid data. Note there are separate objects for each data type. **Input:** cube or grid data **Output:** cube or grid data
Merge Color Maps	Combines two color maps. **Input:** color map **Output:** color map
Normalize	Normalizes cube and grid data within specified data limits, based on a power value or both. Note there are separate objects for each data type. **Input:** cube or grid data **Output:** cube or grid data
P(t) Barometric Compensation	Subtracts barometric fluctuations from well pressures. **Input:** XY data **Output:** XY data
P(t) BE/ET Compensation	Removes fluctuations in pressure data caused by barometric data and earth tide data. Requires a unit response function. **Input:** XY data and response function (**Create BE/ET Response Function**) **Output:** XY data
P(t) Derivative Calculation	Calculates the derivative of a pressure function (P(t)). **Input:** XY data **Output:** XY data
P(t) Time Processing	Applies one of four time functions to X data (Horner, Agarwal, Horner Super or Bourdet Super). Used to create plots that require a time function for the X axis, such as a Horner plot. **Input:** XY data **Output:** XY data
Pen Set	Creates a set of pens that can be used in plotting. Normally, the default Standard Pen Set is all that is required. **Input:** none **Output:** pen set
Pulse Normalization	Normalizes pressure XY data based on one of two equations: (Pi-P(t)) / (Pi-Po) and 1-(Pi-P(t)) / (Pi-Po), where Pi is the static pressure and Po is the initial pulse pressure. Both Pi and Po are to be specified in the object property window. **Input:** XY data **Output:** XY data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Read Color Map	Reads a color map from a specially formatted text file (default file extension: *.cmap). This allows creation of color maps outside nSIGHTS (for example, in an Excel spreadsheet) to meet special requirements. **Input:** external file **Output:** color map
Read Cube Data	Reads cube data from an input file (default file extension: *.cube). **Input:** external file **Output:** cube data
Read Curve File	Reads a curve data file (default file extension: *.nCRV). A curve file may contain several curve data sets. **Input:** external file **Output:** curve data file for **Select Curve File**
Read Grid Data	Reads grid data from an input file (default file extension: *.grd). **Input:** external file **Output:** grid data
Read Mini-Troll Text File	Reads a Mini-Troll text file and converts it to a table file. **Input:** external file **Output:** table data
Read nSIGHTS Optimizer Results	Reads an nSIGHTS optimizer simulation results file (default file extension: *.nOpt), specified in the **Output Files** nPre input window. **Input:** external file **Output:** optimizer results file to be used by **Extract Covariance Matrices**, **Extract Jacobian**, **Extract Optimizer Results Table** and **Extract Residuals**
Read nSIGHTS Profile Results	Reads an nSIGHTS profile simulation results file (default file extension: *.nPro), specified in the **Output Files** nPre input window. **Input:** external file **Output:** profile results file used by **Extract Profile Grid/Case**
Read nSIGHTS Range Results	Reads an nSIGHTS range simulation results file (default file extension: *.nRng), specified in the **Output Files** nPre input window. **Input:** external file **Output:** range results file used by **Extract Range Cube** and **Extract Range Grid**
Read nSIGHTS XY Results	Reads an nSIGHTS XY simulation results file (default file extension: *.nXYSim), specified in the **Output Files** nPre input window. **Input:** external file **Output:** XY results file used by **Extract XY from XY Results**

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Read Table File	Reads tabular data from a file. **Input:** external file **Output:** table data
Read XY Data	Reads a list of XY points from a file (default file extension: *.dat). **Input:** external file **Output:** XY data
Read XY Data Array	Reads XY array data from a file (default file extension: *.nXYA). **Input:** external file **Output:** XY array
Read XYZ Label Data	Reads a list of XYZ co-ordinates and associated text labels from a file. **Input:** external file **Output:** XYZ label
Real Value(s) To Table	Converts real values into table data. **Input:** real value **Output:** table data
Reduction	Reduces the number of XY points by skipping points or by only keeping points with a change in value greater than a specified maximum. **Input:** XY data **Output:** XY data
Remove Duplicates	Removes duplicate values from X data, Y data or both. Duplicates can be considered values that have differences less than a specified value. **Input:** XY data **Output:** XY data
Scale/Transform	Performs mathematical operations on a single real input value, cube data or grid data. Note there are separate objects for each data type. **Input:** real value, cube data, or grid data **Output:** real value, cube data, or grid data
Scale/Transform Extended Profile	Performs mathematical operations on an extended profile. **Input:** extended profile **Output:** extended profile
Select Curve from File	Selects a curve from a curve file. A curve file may contain several sets of curve data. **Input:** **Curve File** **Output:** curve data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Select Range Cube	Used in real-time processing, allows the selection of a range cube data set available during a run. Only for range mode simulations with three variables specified as range variables. **Input:** cube data **Output:** cube data
Select Range Grid	Used in real-time processing, allows the selection of a range grid data set available during a run. Only for range mode simulations with two variables specified as range variables. **Input:** grid data **Output:** grid data
Select XY from XY Array	Select an XY data set from an XY array. An XY array is a collection of XY data sets. **Input:** XY array **Output:** XY data
Sequence Fit	Similar to **(Basic) Single Fit**, except the fit can be limited to a range of time or sequences. The Y data may also be interpolated based on synthetic X data (See 7.1.4 Interpolation Methods for details). No interpolation occurs if *Input X* is selected as the Interpolation Method. **Input:** XY data **Output:** fit specification
Sequence Time Interval Data	Reads a sequence time data file (default file extension: *.seqt). **Input:** external file **Output:** sequence time data file for **Extract Sequence(s)**
Single Fit	See (Basic) Single Fit
Single Scale/Transform	Performs mathematical operations on either the X or the Y of XY data. **Input:** XY data **Output:** XY data
Smooth/Filter	Filters and smoothes XY data using one of the following methods: *FFT smooth*, *Median smooth*, *low pass* and *high pass*. **Input:** XY data **Output:** XY data
Statistics	Calculates basic statistics (e.g. sum, mean, minimum, maximum, etc.) for X, Y, cube or grid data. Four basic statistics are selected for output as real values, typically used as data labels on a plot. **Input:** XY, cube or grid data **Output:** 4 real values

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Sum Tables	Sums the values between multiple tables. For example, the value in column 2, row 1 of Table A will be added to column 2, row 1 of Table B. A specified X column will not be summed. **Input:** table data **Output:** table data
Table Column CDF/Quantile	See Calculate CDF of Table Column
Table Column Correlations	Calculates the Pearson R and Spearman R correlation coefficients between two specified columns of a table. **Input:** table data **Output:** real values
Table Column Math	Basic mathematics (+,-,*,/) are applied to two table columns. **Input:** table data **Output:** table data
Table Column Scale/Transform	Performs mathematical operations on a specified column of a table. **Input:** table data **Output:** table data
Table Column Statistics	Displays basic statistics (e.g. sum, mean, minimum, maximum, etc.) for a specified column of a table. Four basic statistics are selected for output as real values, typically used as data labels on a plot. **Input:** table data **Output:** 4 real values
Table Column To Histogram	Creates the input data for a histogram plot based on a specified column of a table. The actual histogram is plotted using an **XY Series** plot object on a plot page, with this object as the input. **Input:** table data **Output:** XY data
Table Columns To XY	Extracts two specified columns from a table to create XY data. **Input:** table data **Output:** XY data
Table Row Index Logic	Conducts Boolean Logic (AND, OR, XOR) between two sets of table rows. **Input:** **Extract Table Rows** **Output:** table data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Table Row Statistics	Displays basic statistics (e.g. sum, mean, minimum, maximum, etc.) for a specified row of a table. Four basic statistics are selected for output as real values, typically used as data labels on a plot. **Input:** table data **Output:** 4 real values
Time Limits Extraction/Interpolation	Extracts XY data for a range of sequences or time and within specified data limits, and interpolates the extracted data. **Input:** XY data and **Sequence Time Interval Data** if Sequence Range Time Data selected. **Output:** XY data
Transpose	Switches the X and Y data (i.e. output X = input Y and output Y = input X). **Input:** XY data **Output:** XY data
Transpose Table Columns and Rows	Switches the column and row data (i.e. output rows = input columns and output columns = input rows). **Input:** table data **Output:**t table data
Validate XY Data as CDF	Checks XY data to see if it fulfils the criteria of a CDF, and outputs that CDF. **Input:** XY data **Output:** CDF
Vector Math	Basic array mathematics (+,-,*,/) can be applied to two sets of XY data. **Input:** XY data **Output:** XY data
View Grid Data	Allows the user to view grid data created in another object. **Input:** grid data **Output:** grid data
View Table Data	Allows the user to view table data created in another object. **Input:** table data **Output:** table data
View XY Data	Allows the user to view XY data created in another object. **Input:** XY data **Output:** XY data

Table 7.2 Data Object Function Summary	
Object	**Function/Input**
Write Color Map	Writes a color map to a file. **Input:** color map **Output:** external file
Write Curve File	Writes single or multiple curve data to a file. **Input:** curve data **Output:** external file
Write Table File	Writes a table to a file. **Input:** table data **Output:** external file
Write XY File	Writes XY data to a file. **Input:** XY data **Output:** external file
Write XY Data Array	Writes XY array data to a file. **Input:** XY array **Output:** external file

8 PLOTTING

nSIGHTS supports two basic types of plots: a 2D XY Plot and a 3D XYZ Plot. When a plot page is created through the page menu, several things happen:

(1) A new page is created in the object tree.

(2) Default objects are added to the new page tree.

(3) A new top level window is created containing the basic plot. At creation the plot will contain only axes and axes increment labels.

As well, nSIGHTs supports composite plots. A composite plot page contains 2D XY and/or 3D XYZ plots within a single plot page.

This section will provide a basic overview of nSIGHTS's plotting capabilities. Plot objects and their function will be discussed, as well as user interaction with plots, creation of composite plots and plot output.

8.1 Plot Objects

Plot objects are objects that are placed on a plot page and create a visual representation on the plot window. It is necessary to add plot objects before any meaningful visualization (other than bare axes and axes/increment labels) is produced.

This section does not intend to detail every plot object. It will discuss plot object types, general plot object concepts and summarize the available plot objects and their associated function. Each plot object is described in detail in Appendix B.

8.1.1 Plot Object Types

Plot objects are categorized into the following object types:

Default Plot objects that are automatically created upon the creation of a plot page. They control the general layout of the plot and provide a user-interface for setting axes and formatting options.

Data display Plot objects that provide a visual representation of input objects using the co-ordinate system defined by the plot axes. Visual output is clipped within this co-ordinate system. Data display objects cannot be selected with the cursor, although some data display objects report values based on the cursor location.

Annotation Plot objects that help explain the data display, such as a title or a legend. Using a non-spatial 0 to 100 co-ordinate system for placement, annotation objects can be located anywhere within the plot window. When the cursor is over an annotation object, it will be outlined with a red rectangle. After selecting the rectangle with the left mouse button, the rectangle can be dragged to a new position on the plot. nSIGHTS will not allow the rectangle to be dragged out of the plot window.

Selection or Active Plot objects used to select, enter and/or modify data on the plot with the mouse.

The different object types are differentiated by the available options in the **Plot Settings** box in the upper-right corner of the object property window. All non-default plot object types have a Plot toggle in the **Plot Settings** box, that determines whether the object is to be visible on the plot or not.

For ***2D Data Display*** objects, a Layer drop-down box is used to set visibility (see Section 8.1.2.1 below). For data display objects with reporting capabilities, a Report toggle enables the object's reporting function (see Section 8.1.2.2).

Figure 8.1 2D Data Display Object Plot Settings Box

For ***3D Data Display*** objects, the Poly Off value is used to fine-tune 3D object visibility (see Section 8.1.2.1 below).

Figure 8.2 3D Data Display Object Plot Settings Box

For ***Annotation*** objects, there are no options in the Plot Setting box except for the Plot toggle box.

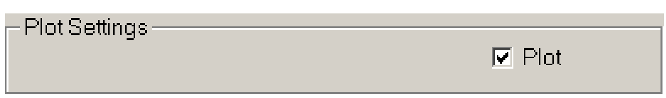


Figure 8.3 Annotation Object Plot Settings Box

For ***Selection/Active*** objects, a Layer drop-down-box is used to set visibility, as with 2D data display objects. If the Active toggle box is selected, the plot object will respond to mouse-clicks when a plot is in selection mode. For example, for a Modify: Enter/Edit XY object, an XY point will be created at the location of the mouse-click on the 2D window.

Figure 8.4 Selection/Active Object Plot Settings Box

8.1.2 Plot Object Concepts

8.1.2.1 Plot Object Visibility

Objects are drawn on the plot in the order that they are created (the order that initially appears in the object tree). If objects are reorganized in the object tree by dragging and dropping, the plot order can be refreshed by selecting the **Refresh** button in the plot window.

On a 2D plot, any object plotted before and in the same location as an object that produces a solid color fill, such as **Color Block** or **Grid Color Fill**, will be visually obliterated by the solid color fill. For example, if a contour object (**Grid Contour** object) is located above a fit surface object (**Grid Color Block** object), the contours will be hidden by the solid color fill on the plot. If the fit surface object is located above the contours, both objects will be visible on the plot.

For 2D plots, plot object visibility is also controlled with *Plot Layers*. Every data display and selection/active object in a 2D plot is assigned to a layer from 0 to 7. Objects are plotted by ascending layer index (i.e. all layer 0 objects are plotted, followed by layer 1, followed by layer 2, etc.). Within a layer, objects are plotted in order of definition, except if 2D anti-aliasing is effective (see Section 2.4.4). In this case, solid objects are plotted first, followed by lines.

Annotation plot objects do not have a layer assignment. Conceptually, all annotation objects are viewed as existing on layer 8. They are the last objects plotted, and they are plotted in order of definition on each page.

For a 3D plot, object visibility is governed by geometry. An exception occurs when two objects are plotted in the same place. In this case, the last object plotted will be visible. Another exception occurs when lines are plotted at the edges of, or over, polygons. Because of imprecisions in the OpenGL renderer, the lines may appear stitched, with intermittent visibility. These stitched lines can be rectified through the use of a polygon offset (PolyOff in the Plot Settings box).

Figure 8.5 Plot Settings Box for 3D Data Display Objects that Plot Polygons

This field is only available for 3D plot objects that plot polygons. It slightly modifies the position of the polygon, allowing the user to ensure that lines are visible. The effect of specific values depends upon the version of OpenGL (1.0 or 1.1) and the depth in bits of the Z buffer. Generally, if a polygon offset is required, a PolyOff value of 1.0 is acceptable.

There are special concerns for plot object visibility when producing Postscript output. These are described in 8.4.1 Postscript Output. These are described in Section 8.4.1.

8.1.2.2 2D Plot Object Reporting

Many data display plot objects on 2D plots have a *report* capability. With the report capability active (Report toggle checked in the **Plot Settings** frame), the object will display values associated with the cursor position in the *report area* of the 2D plot window. For example, the **Table Series** object will report the XY values of the data point closest to the cursor.

The *report area* is located in the control bar at the bottom of the 2D plot window, adjacent to the XY cursor location display. The report area for an object will be framed and includes the object's ID at the top. The control bar, including the XY cursor location display and the report area, can be turned off by selecting **View→Control Bar** in the 2D plot window menu bar, or turning off the Show Report Area toggle box in the **Format** frame of the **2D XY Main Menu** object's property window.

8.1.3 Plot Object Summary

Available plot objects are summarized by type and availability in the following table

Table 8.1 Summary of Plot Objects

Type	Objects	2D Objects	3D Objects	Composite Objects
Default		X Axis Y Axis 2D-XY 2D Plot Anno	3D-XYZ X Axis Y Axis Z Axis 3D Axes Label 3D Axes Format 3D Lighting	Composite Composite Layout
Annotation	Color Legend Data Labels Series Legend User Labels	Extra Grid Lines Label Axis Sequence Grid Lines Table Labels Time Axis XY Labels	XYZ Labels	
Data Display	Confidence Limits - Two Parameter (nPost) Grid Color Block Grid Color Fill Grid Color Point Grid Contour Grid Fishnet Profile Color Fill (nPost) Profile Contour (nPost) Table Color Series XY Series	Confidence Limits - Multiple Single Parameter (nPost) Confidence Limits - Multiple Dual Parameter (nPost) Multiple Table Series Single Table Series Table Histogram Table Horsetail (nPost only) XY Array Horsetail (nPost) XY Data Array Series (nPost) XY Histogram	Cube Color Block Cube Color Isovolume Cube Color Point Table Series	

Table 8.1 Summary of Plot Objects				
Type	**Objects**	**2D Objects**	**3D Objects**	**Composite Objects**
Selection/ Active		Modify: Enter/Edit XY Analytics: Line Data		

8.1.4 Default Plot Objects

Default plot objects control the general layout of the plot and provide a user-interface for setting axes and formatting options. Default object property windows vary slightly according to plot type, and are described in detail in Appendix B. Table 8.2 summarizes the default plot objects.

Table 8.2 Default Plot Objects Function Summary	
Object	**Function**
2D Plots	
2D XY Main Menu	Controls the general layout and characteristics of 2D XY plots.
2D XY Axes	Defines the plot axes. There is one object for the X axis and one for the Y axis, each with identical object property windows.
2D Plot Annotation	Provides control over axes labelling and the general appearance of all 2D XY plots.
3D Plots	
3D XYZ Main Menu	Controls the general layout and characteristics of 3D XYZ plots.
3D XYZ Axes	Defines the plot axes. There is one object for the X axis, one for the Y axis and one for the Z axis, each with identical object property windows.
3D Axes Labels	Provides control over axes labelling for 3D plots.
3D Axes Format	Provides control over general formatting of 3D plot axes.
3D Lighting	Provides control over Open GL lighting used on all 3D plots.
Composite Plots	
Composite	Controls the general layout and characteristics of composite plots.
CompositeLayout	Controls the layout of the nested plots. Layout can be rows/columns or free-form, as specified in the **Composite** default object.

8.1.5 Data Display Plot Objects

Table 8.3 summarizes the function of all the data display plot objects available. In addition, the object input required for each object is specified.

Table 8.3 Data Display Plot Objects Function Summary

Object	Function/Input
Confidence Limits - Two Parameter	Plots cross-hair or ellipse dual confidence limits of two parameters from a covariance matrix. **Input:** **Extract Covariance Matrices**
Confidence Limits - Multiple Single Parameter	Plots a symbol representing the best estimate and/or a single vertical line repesenting the confidence limits of a single parameter for each parameter and for each selected covariance matrix. Each parameter is plotted at its associated index along the x axis, and results on the y axis are normalized. **Input:** **Extract Covariance Matrices**
Confidence Limits - Multiple Dual Parameter	Plots a symbol representing the best estimate and/or an ellipse repesenting dual confidence limits of each combination of two parameters for each selected covariance matrix. Results are normalized, and plotted in a grid according to parameter index, such that each grid square contains the symbols and ellipses for only two parameters. **Input:** **Extract Covariance Matrices**
Cube Color Block	Plots color blocks around each cube data value for specified cube indices within specified cube value limits. **Input:** cube data, cube indexes and color map
Cube Color Isovolume	Plots a smooth color volume of a specified cube isovalue. **Input:** cube data and color map
Cube Color Point	Plots color points at each cube data value for specified cube indices within specified cube value limits. **Input:** cube data, cube indexes and color map
Grid Color Block	Plots color blocks around each node of the grid within specified grid value limits. **Input:** grid data and color map
Grid Color Fill	Plots color filled contours of the nodes of a grid within specified grid value limits. **Input:** grid data and color map
Grid Color Point	Plots color points representing each node of the grid within specified grid value limits. **Input:** grid data and color map
Grid Contour	Plots single color contours of the nodes of a grid at specified grid values. **Input:** grid data

Table 8.3 Data Display Plot Objects Function Summary	
Object	**Function/Input**
Grid Fishnet	Plots grid lines of the grid, connecting all nodes of the grid. The number of grid lines can be reduced, based on an X and Y modulus. **Input:** grid data
Multiple Table Series	Plots one X and one Y column from multiple selected tables using symbols and/or lines. **Input:** table data
Profile Color Fill	Plots color filled contours of the nodes of an extended profile within specified data value limits. **Input:** extended profile and color map
Profile Contour	Plots single line contours of the nodes of an extended profile at specified data values. **Input:** extended profile
Single Table Series	Plots selected columns from single table using symbols and/or lines. Only one column is selected as the X data column. Multiple columns can be selected for the Y data. **Input:** table data
Table Color Series	Plots selected columns from single table using colored symbols. Only one X, Y and Z data column is selected, and one column is selected as the Color Data Column. The color of the symbols varies according to the value in the Color Data column. **Input:** table data and color map
Table Histogram	Plots two columns of table data as bars in a standard histogram format. **Input:** table data
Table Horsetail	Plots all table columns within a table, using one of the columns as the X value. Within the **Horsetail Color** frame, selection of Pen will draw all data set lines in the same color, whereas selection of Color Map will draw each data set line in a different color. **Input:** table data
Table Series	Plots selected columns from single table using symbols and/or lines in a 3D plot. Only one column is selected for each the X, Y and Z data columns. **Input:** table data
XY Array Horsetail	Plots all XY data sets contained within an XY array. Within the **Horsetail Color** frame, selection of Pen will draw all data set lines in the same color, whereas selection of Color Map will draw each data set line in a different color. **Input:** XY array
XY Data Array Series	Plots selected XY data series within an XY data array using symbols and/or lines. **Input:** XY array
XY Histogram	Plots XY data as bars in a standard histogram format. **Input:** XY data

Table 8.3 Data Display Plot Objects Function Summary	
Object	**Function/Input**
XY Series	Plots multiple XY data sets using symbols and/or lines. **Input:** XY data

8.1.6 Annotation Plot Objects

Table 8.4 summarizes the function of the annotation plot objects available. In addition, the object input required for each object is specified. If the input is none, the input required for the object is to be typed by the user.

Table 8.4 Annotation Plot Objects Function Summary	
Object	**Function/Input**
Color Legend	Plots a color bar to indicate the color associated with each value. **Input:** **Color Cube Block**, **Color Cube Point**, **Color Grid Block**, **Color Grid Fill**, **Color Cube Point**, **XY Array Horsetail**
Data Labels	Creates a label block showing the status/value of selected object parameters. For real valued labels, the label format can be specified. **Input:** many objects produce one or more label outputs
Extra Grid Lines	Plots a grid line at a specified X or Y value. The grid line may also be labelled. **Input:** none
Label Axis	Creates an X or Y axis with XYZ labels in place of numeric increments. The X and Y values of the labels are used to determine label location along the axis. Used when the X or Y axis is not displayed (**Control** in the **2D Plot Annotation** default object). **Input:** **Read XYZ Labels**
Sequence Grid Lines	Plots grid lines to define sequence intervals. **Input:** **Sequence Time Interval Data**
Series Legend	Creates a legend block containing line/symbol information from one or more input objects. **Input:** **Confidence Limits**, **Grid Contour**, **Grid Fishnet**, **Multiple Table Series**, **Single Table Series**, **Table Series**, **XY Array Horsetail**, **XY Series**
Table Labels	Plots table data in the plot window, such that each table value is plotted with an x location corresponding to the table row index, and a y location corresponding to the table column index. For example, correlation matrix values can be plotted in the plot window. **Input:** table data
Time Axis	Creates an X axis with time and date labels. Used when the X axis is not displayed (**Control** in the **2D Plot Annotation** default object). **Input:** none

Table 8.4 Annotation Plot Objects Function Summary	
Object	**Function/Input**
User Labels	Creates a text block containing user entered text. **Input:** none
XY Labels	Plots 3D labels in a 2D data space. **Input:** **Read XYZ Labels**
XYZ Labels	Plots 3D labels in a 3D data space. **Input:** **Read XYZ Labels**

8.1.7 Plot Labels

Plot labels are generally created using annotation plot objects, although certain default and data display objects contain plot label options. Within these plot object property windows, text boxes are available for the user to type specific labels (e.g. a legend title).

nSIGHTS supports special formatting of labels by embedding non-printing codes in the text used to create the labels. This allows for subscripts, superscripts, and special characters and formatting control. The codes are outlined in Table 8.5

Table 8.5 Special Formatting Codes		
Special Formatting	**Code**	**Description**
Superscripts	<^text^>	Text will appear as superscript. Superscripts cannot be nested.
Subscripts	<_text_>	Text will appear as subscript. Subscripts cannot be nested.
Superscript and Subscript Control	\SSSNNN	Subscript/superscript size ratio where NNN is ratio to base font size (100 = 1.00). NNN must be between 030 and 100. Default is 060.
	\SPONNN	Superscript offset. Position above baseline that superscript starts where NNN is ratio to base font size (100 = 1.00). NNN must be between 050 and 100. Default is 060.
	\SBONNN	Subscript offset. Position below baseline that subscript starts where NNN is ratio to base font size (100 = 1.00). NNN must be between 010 and 050. Default is 030.
Line Spacing Control for multi-line labels	\LSNNN	Position between baselines of adjacent lines where NNN is ratio to base font size (100 = 1.00). NNN must be between 020 and 900. Default is 130. This control remains in effect until another LS control is encountered.
Special Characters	\C=NNN	NNN is character code between 000 and 255.

Table 8.5 Special Formatting Codes		
Special Formatting	**Code**	**Description**
New Lines	\n	Single line text fields can produce multiple line labels by embedding new-line codes. This is useful for axes labels.

For example, the following shows the text entered in a **User Label** object, and the resulting display on the plot, shown in Figure 8.6:

\LS200Analysis Results:\nK=6.1 x 10<^-12^> m/s

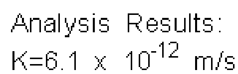


Figure 8.6 Example User Label Input and Corresponding Display

8.1.8 Selection/Active Plot Objects

Selection/active plot objects use the mouse to select, enter and/or modify data. They are only available for 2D plots.

In order to select, enter or modify data on a 2D plot using a selection/active plot object, the cursor must be in *selection mode* and the selection/active object must be in active mode.

Selection mode is enabled if the selection button  in the 2D plot window toolbar is selected. Active mode for a selection/active object is enabled by a check marked Active toggle in the object's **Plot Settings** frame.

Once in selection mode, the pop-up menu for the 2D plot window is modified to an object specific pop-up menu.

Table 8.6 summarizes the function of the selection/active plot objects available. In addition, a description of the object pop-up window and the required object input is provided. If the object input is none, the input required for the object is based on mouse actions in the 2D plot window.

Table 8.6 Selection/Active Plot Objects Function Summary	
Object	**Function/Input**
Analytics: Line Data	Allows the user to create a straight line on a 2D plot interactively. A line with 5 points is automatically created upon creation of the object. Each point in the line can be dragged to move, rotate, extend or shrink the line. The location of the line, in addition to its length, slope and Y intercept, are provided in the object property window. Apply and Reset commands are available on the pop-up menu (right-click on the 2D window to access this menu). **Input:** none

Table 8.6 Selection/Active Plot Objects Function Summary	
Object	**Function/Input**
Modify: Enter/Edit XY	Allows the user to create a new XY data set or add and delete points from an existing data set interactively. Use the update button to refresh the points to the specified XY data. To switch from enter to delete mode, use the commands in the pop-up menu (right-click on the 2D plot window to access this menu). The pop-up menu also includes Apply, Cancel and Delete All commands. **Input:** none or XY data

8.2 Plot Interaction

8.2.1 Plot Cursor

2D plots display a small cross-hair cursor:  . If the control bar is enabled, the current cursor location is given in the lower left corner of the window. If reporting is enabled for a plot object, the report values for the current cursor position are also shown in the control bar.

The cursor on 3D plots is used only to adjust the position of plot annotation data.

8.2.2 Zoom and Selection mode

The cursor can be in one of two modes, zoom or selection. *Zoom mode* allows the user to change the plot view (see Section 8.2.3), whereas *selection mode* allows the user to enter, modify or delete data from selection/active objects interactively. Currently, selection mode has no significance within a 3D view, as there are no selection/active objects available within a 3D view.

Each cursor mode has a button on the 2D plot window toolbar:

Selecting the  button enables zoom mode.

Selecting the  button enables selection mode.

The last selected button will remain pressed in, indicating the current cursor mode.

8.2.3 Plot View

Both 2D and 3D plots use the concept of a *view*.

For a 2D plot, the view is defined by the axes limits of the plot. In zoom mode, the user can change the view by dragging the mouse to outline a rectangle within the axes area (the cursor will change to a magnifying glass), and releasing the mouse button. The view will zoom in on the rectangle, with the axes maximizing to fit the available window space. The 2D plot window pop-up menu also provides zoom and pan options, based on the location of the cursor upon activation of the menu (see Section 8.2.4).

In a 3D plot, the view includes the axes limits, plus the attitude and translation of the plot. Plot attitude describes the viewer's perspective in the plot co-ordinate system and is defined in terms of:

elevation The angle above the plot of the viewer co-ordinate. An elevation of 90 degrees means the viewer is looking directly down on the plot.

azimuth The rotation of the plot. Azimuth 0 means the plot is not rotated and (assuming +x is east and +y is north) the viewer is looking due north. For example, azimuth -45 means the viewer is looking NW and +22.5 is NNE.

scale The size of the plot data in the window. The absolute values of scale are plot projection and data limits dependent. Small values of scale mean the plot looks far away, larger values zoom-in on the plot.

Plot translation moves the position of the looked at point within the plot co-ordinate system. The effect of absolute values are plot dependent.

All 3D plots have a control bar at the bottom of the window that contains sliders and buttons used to change the view:

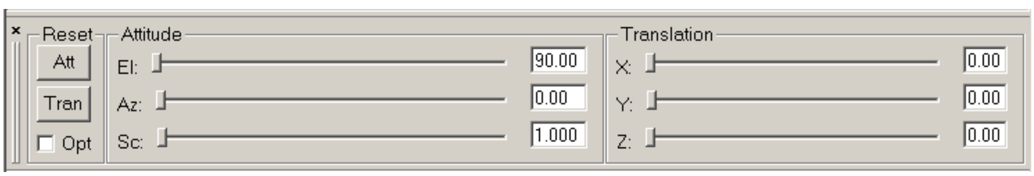


Figure 8.7 3D Plot Control Bar

Attitude and **Translation** are controlled by the sliders shown in the figure above. The **Reset** buttons are used to set attitude (Att button) and translation (Tran button) to default values. Att sets El/Az/Sc to 90/0.0/1.0, while Tran sets X/Y/Z to 0.0/0.0/0.0.

Normally the plotted view updates as the sliders are adjusted. This can be a slow process in complex plots. If the Opt toggle is selected, the view will not update until the slider stops moving.

8.2.4 Plot Pop-Up Menus

Right clicking the mouse on a 2D plot (assuming the mouse is in zoom mode), or anywhere on the screen in a 3D plot, will bring up the menu shown below in Figure 8.8:

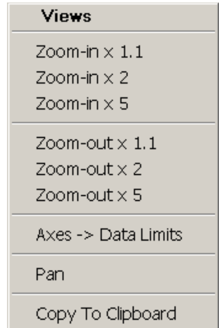


Figure 8.8 Plot Pop-Up Menu

For a 2D plot, the available zoom-in and zoom-out options will make the current cursor position the centre of the new axes and then perform the selected action. The axes aspect ratio will remain the same. On a 3D plot, the axes limits will be adjusted according to the zoom selection and offset according to the current translation.

Other options on the pop-up menu are:

Axes→Data Limits The axis limits are set to display all data associated with plot objects.

Pan Redraws the plot with the axes centred on the current cursor location.

Copy to Clipboard Places a bitmap containing the plot in the clipboard, where it can be pasted into other applications such as Power Point or Word.

If a plot is in selection mode, the right click pop-up menu may be selection/active object specific. For example, the **Modify: Enter/Edit XY** object produces the following menu, in Figure 8.9, when active:

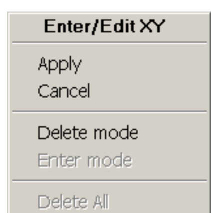


Figure 8.9 Modify: Enter/Edit XY Menu

See individual descriptions of selection/active objects for details on these pop-up windows in Appendix B.

8.2.5 Plot Tool Bar

Both 2D and 3D plot windows contain a tool-bar for performing common plotting functions.

Figure 8.10 Plot Window Tool Bar

The first three buttons help manage plot views. As the view is changed through zooming or panning for 2D plots, and zooming or attitude/translation for 3D plots, nSIGHTS remembers previous views, in a view stack.

These views are accessed through the tool bar buttons:

Initial view	Returns to the first view in the view stack.
Previous view	Restores the previous view.
Reset view	Re-checks the limits of each object on the plot and performs an auto scaling operation to reset the axes limits. Also clears the view stack. **This button needs to be used as you add new objects to a plot with axes auto-scaling that are outside the current axes range.**

The next two buttons set and reset *preferred views*:

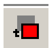
Set axes	Sets the current plot axes to manual and sets the manual axes limits to the current plotted axes limits.
Reset axes	Resets the axes limits to the preferred limits. This button will not be available until Set axes has been pressed at least once.

The next three buttons help manage plot animation and bitmap file output (see Section 8.4):

Set Auto/Manual dump	When pressed in, the bitmap output method is set to Auto and a new bitmap file will be created every time the plot is redrawn. When toggled out, the bitmap output method is Semi-Auto.
Plot Dump	Outputs the current plot as a bitmap file, and increments the bitmap file counter. Note that multiple files will be created if the mode is Semi-Auto and **Dump frame count** on the **Bitmap Output Files** dialog is greater than 1.
Reset increment	Resets the next output increment to 0. Useful for restarting an animation sequence after a mistake.

The next group of three buttons have special purposes:

 Propagate view — Updates other plot windows of the same type with the current view.

 Propagate size — Changes the horizontal and vertical size (in pixels) of all other plot windows to match that of the current window.

 Full screen — Toggles the plot window between full-screen mode and normal mode.

The next two buttons toggle the plot between zoom and selection mode. At any time, only one of the two buttons will be pressed in:

 Zoom — Mouse actions are zoom/unzoom.

 Select — Mouse actions depend on active selection objects.

The final two buttons are:

 Print — Sends the plot bitmap to the default printer. Use **File→Print Setup** on the main nSIGHTS window to select the printer and corresponding settings.

 Refresh — Redraws the plot.

8.2.6 Plot Object Control

Selecting the Plot Control item in the **Control** menu of the plot window will cause a new dialog window to appear, as shown in Figure 8.11

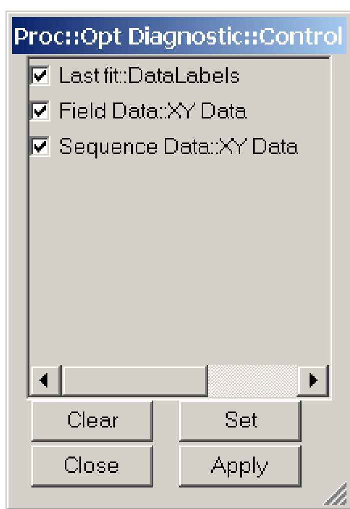


Figure 8.11 Plot Object Control Menu

This dialog allows the user to change the Plot toggle setting of all plot objects on a single plot without using each object's property window. The plot control dialog lists all objects defined for a plot and specifies their current Plot setting with a toggle box control. This provides an easy method for turning multiple objects off or on simultaneously. Other button usage is as follows:

Clear Turns off all defined plot objects.

Set Turns on all defined plot objects.

Close Closes the dialog menu.

Apply Applies changes within the control dialog.

8.3 Composite Plots

A composite plot contains multiple 2D XY and/or 3D XYZ plots within a single plot window. For example, Figure 8.12 Composite Plot Example shows a composite plot window containing four plots, with the layout grid displayed as light grey lines.

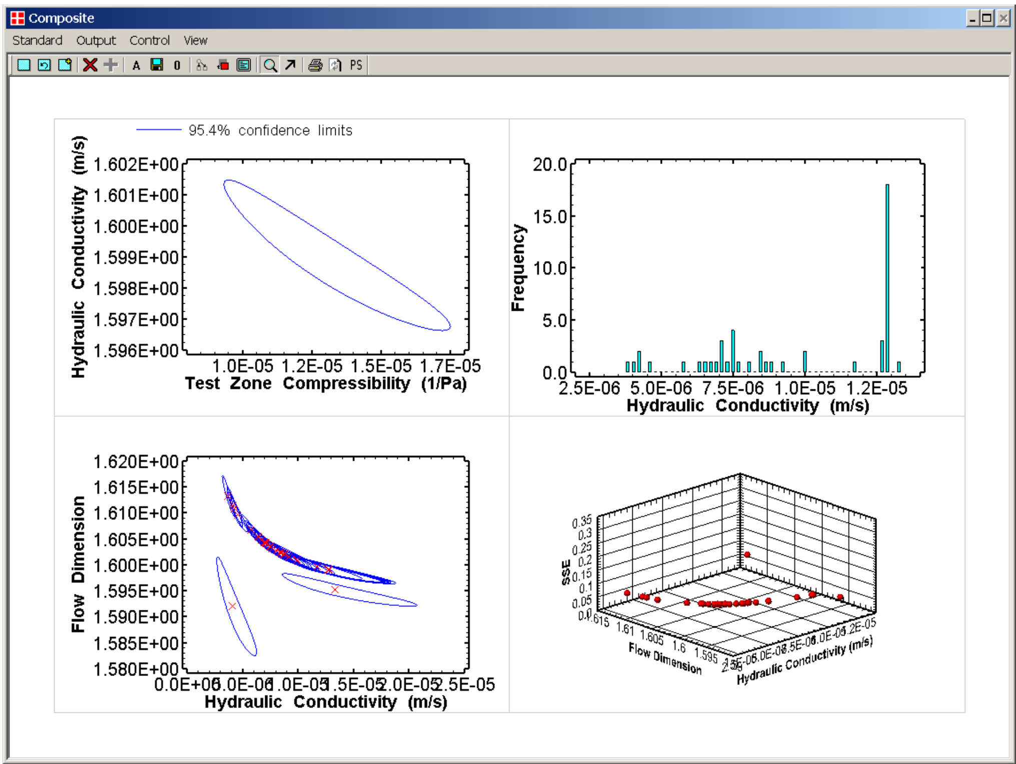


Figure 8.12 Composite Plot Example

Once a composite plot page is created, plots are added to the composite plot page by nesting 2D XY and 3D XYZ plot pages within the composite plot (i.e. plot pages are dragged and dropped into the composite page).

By default, the composite plot layout is formatted to include four plots in row/column format, as shown in Up to 10 rows and 10 columns can be specified for row/column format in the **CompositeLayout** property window. The location of each plot within the row/columns is based on the order of the plot pages within the object tree (i.e. first plot page in the tree is in the first row, first column (top left corner), the second plot is in the first row, second column, etc.).

The composite plot layout can also be free-form (specified within the **Composite** default object), with the X and Y location of the bottom left corner and width of each plot specified. Locations and widths are specified in a 0-100 co-ordinate system, similar to annotation objects, within the **CompositeLayout** property window.

Objects are added to each individual plot page, in the same manner as if the plot page was not part of the composite. As well, annotation objects can be added to the composite plot, such as a legend or plot title.

Zoom and pan capabilities are available for each plot, once the cursor is place over the plot. However, for 3D plots, the plot view is changed using the original 3D plot attitude control bar (see Section 8.2.3). The 3D plot attitude control bar for a plot within a composite plot is accessed by selecting the original plot from the Window menu; the top-level window will contain the plot window, including the control bar, without the plot view. Reporting in 2D plots can be accessed in the same manner.

8.4 Plot Output

nSIGHTS provides two basic types of graphics output: resolution independent postscript, and bitmap files. Still output images are produced using either PostScript or bitmap files, and animations are recorded using bitmap graphics output.

For all types of plot output, the plot window below the button bar and above the reporting area (2D plot) or attitude control area (3D plot) is extracted.

8.4.1 Postscript Output

Postscript output consists of Postscript (PS) or Encapsulated Postscript (EPS) commands written to an output file which can then be printed or imported into another application. For convenience sake, in this manual all resolution independent output will be described as Postscript.

Postscript output is created by selecting Postscript from the **Output** menu bar item on any plot window:

File Format		The specific output file format.
	PS	Vanilla postscript. This format can be read by most postscript viewers and can be converted to pdf by Adobe Distiller. It also prints cleanly on tested PostScript printers. PS format input has been tested successfully with Corel Draw. Note that PS input files do not contain a preview image.
	EP	Encapsulated postscript. Imports cleanly into Adobe Distiller and Corel Draw. No preview image.
	EPS/Win	Encapsulated postscript with Windows compatible preview image. Imports cleanly into MS Word and Corel Draw. Contains preview image. Note that the preview image may be distorted. This is a known bug.

Orientation

Portrait — Plot is not rotated. The horizontal dimension of the plot (in pixels) is mapped to the page width (minus left and right margins) and the vertical to the page height (minus top and bottom margins). Aspect ratio of the plot is preserved with the plot window origin at the bottom left of the page.

Landscape — Plot is rotated 90 degrees counter-clockwise. The horizontal dimension of the plot (in pixels) is mapped to the page height (minus top and bottom margins) and the vertical to the page width (minus left and right margins). Aspect ratio of the plot is preserved with the plot window origin at the bottom right corner of the page.

Output Size and Margins Controls — The defined size (in inches) of the plot mapping area.

Line Width Multiplier — Maps OpenGL line widths specified in pixels to Postscript line widths specified in points (1 point = 1/72 inch). The default setting is usually OK for 8.5 x 11 inch output. Larger output may require a larger value.

Gamma Correction — Corrects color for the differences between printed and displayed output. Values in the range of 1.0 to 4.0 seem to produce acceptable output.

Z Buffer Multiplier — The postscript routines reduce the size of Postscript files by removing hidden polygons. The algorithm used to do this relies upon a software Z buffer. In some cases, small polygons may be missed during the sorting process. They will appear as dropouts on the final image. If this happens, a message will be written to the terminal window of the form: **Possible occlusion culling dropouts - check output.** In this case, the value of the Z buffer multiplier should be increased by a factor of 2 to 4. Note that increasing this parameter uses a lot of extra memory. Using a value of -1.0 will disable hidden polygon removal.

Text Multiplier — Occasionally, there are minor differences between the metrics of the bitmapped fonts displayed with OpenGL and the Postscript fonts. nSIGHTS will ensure that font heights are correct (i.e. same ratio to window size). However, font widths may differ slightly.

These differences will manifest typically as annotation text which may exceed the enclosing frame size of an annotation object or runs off the page. This parameter can be adjusted until text output in the Postscript file looks correct.

Output File The file that the postscript is written to when the Print button is pressed.

Notes on Object Visibility in Postscript Output:
For 2D output, you cannot rely on the plot order of objects within a layer to maintain object visibility in the Postscript output. Use separate layers to ensure visibility is correct.

For 3D plotting the postscript routines do not support polygon offset. With the exception of outlines around symbols and polygons, plot objects must be specified to be unambiguously visible if Postscript output is to be created correctly. All 3D data display plot objects have a field called Offset where an offset value can be added to the X, Y, and/or Z components of a plot object. The user-entered value is added to the normal plotted values after all co-ordinate system transformations have been completed. The smallest possible values to overcome renderer-induced stitching effects should be used.

8.4.2 Bitmap Output

Bitmap output can be written to a file, or copied to the clipboard. Copying the plot image to the clipboard, using the **Copy To Clipboard** command in the plot pop-up window, places a bitmap containing the plot in the clipboard, where it can be pasted into other applications such as Power Point or Word.

Bitmap file output is supported as TGA file or JPEG file format. The output set-up dialog is accessed by selecting **Bitmap** from the **Output** menu bar item on the plot window:

Output File Format Specifies the output format for the bitmap file:

TGA — TGA output is primarily used to create Windows AVI animations (see below).

JPEG — JPEG (or JPG) output is useful for e-mailing example results as it generally results in smaller file size, and is more commonly used.

BMP — BMP (bitmap) output is another common format, generally of a higher quality and larger file size than a JPEG.

Output Method For animation support. The method used to animate output is to create successive frames of an animation in nSIGHTS and then to convert the frames to an animation using a third party tool (see Section 8.4.3). For example, to create a five frame animation called test.avi, the third party tool requires a sequence of files as follows: test0000.tga, test0001.tga, test0002.tga, test0003.tga, test0004.tga.

Auto — Creates a new bitmap file after each plot redraw. The file name is created from the base file name in the box **Root File Name** and the increment number, right justified with leading zeroes in a 4 digit field. After the file is written, the increment number is incremented by 1.

Semi-Auto — File name and increment as for auto, however the file is created when the **Plot Dump** button on the plot window tool bar is pressed.

Manual — Pressing the **Plot Dump** button will bring up a file selection box where the output file name can be entered.

Root File Name — The first portion of the file name and (optionally) the file directory.

Next increment — The value used in constructing the numeric component of the next file name generated.

Dump frame count — The number of identical bitmap files created when the **Plot Dump** button is pressed in Semi-Auto mode. This is useful for displaying a fixed image for a specified time period in an animation.

Special Note For Bitmap Output:

Bitmap output is created by extracting data from the plot window below the button bar and above the reporting area (2D plot) or attitude control area (3D plot). The output routine will extract whatever appears within this area, including overlapping windows and screen-savers. Before creating animations, make sure that the window is clear of obstructions and that the screen saver is turned OFF.

8.4.3 Plot Animations

The method used to animate output is to create successive bitmap frames of an animation in nSIGHTS (see Section 8.4.2) and then to convert the frames to an animation using a third party tool. For example, to create a five frame animation called test.avi, the third party tool requires a sequence of files as follows: test0000.tga, test0001.tga, test0002.tga, test0003.tga, test0004.tga.

Currently, the best available tool is a shareware product called VideoMach. VideoMach reads sequences of TGA files and produces AVI animations. The shareware product is available at: http://www.gromada.com.

In general, lossless AVI coder/decoders (codecs) such as Microsoft Video 1 (with 100% compression quality and temporal quality ratio of 1.0) produce the best quality animations, albeit with larger output file sizes. Lossy compressors, such as MPEG, frequently leave unattractive visual artifacts. The most effective lossless animation format (in terms of smallest file sizes) is the proprietary HAV format created by VM. However, it is not supported for use in other third-party tools such as Director or Power Point and requires use of the freeware HAV file player (also available from www.gromada.com). The HAV file play is superior to the Windows Media player in many ways.

8.4.4 View Animation Control

For 3D plot windows, selecting the **View Animation** item on the **Control** menu will cause a new top-level dialog window to appear, as shown in Figure 8.13. This menu is used to control the view-related aspects of the 3D display independently of the slider bars, including smooth transitions from one view to another. This feature, shown in Figure 8.13, is useful for animations.

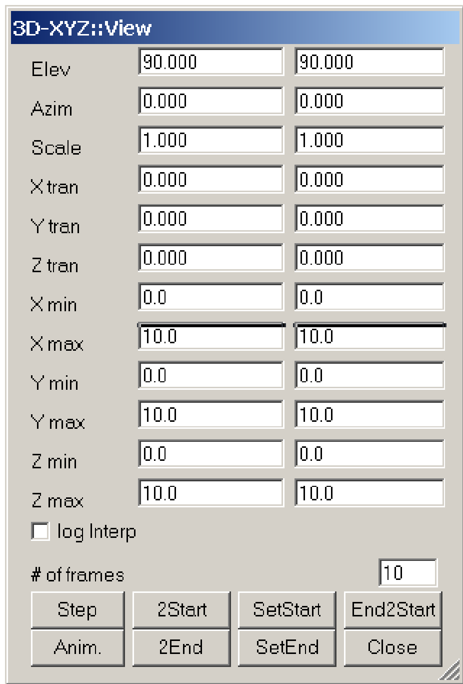


Figure 8.13 View Animation on the Control Menu

Each row on the menu gives two values for one element of a view. These correspond to the start and end values for the view transition.

A toggle box item specifies whether log (on) or linear (off) increments are to be used for the scale component of the view.

The other data item on the menu, **# of frames**, controls the size of the increment used in each step of the transition.

The push buttons perform the following:

Step Add one increment to each element of the current view. Increments are calculated as increment = (end value - start value) / # of frames. Step is most often used with a small # of frames (20 or less) to verify the view transition before performing an animation.

Anim. Set the current view to the start view then perform # of frames steps as described above. This is most often used in conjunction with automatic TGA output (see Section 8.4.2) to produce individual frames for creating an animation. While animating, the text on the button will change to Stop. Pressing the button will stop the current animation.

2Start Changes the current view to the start view.

2End Changes the current view to the end view.

Set Start Sets the start view in the dialog to the current plot view.

Set End Sets the end view in the dialog to the current plot view.

End2Start Copy all end values to start values. This feature is useful when performing multiple view change animations.

Close Closes the dialog.

9 NPOST LISTS

nPost has a list page with functionality similar to the **List** menu in nPre (see Section 2.3.5.8). The list page has an associated top-level window, which displays text information regarding the list objects within the list page. Whereas the list window in nPre displayed input information, in nPost, the list window displays output information.

Table 9.1 provides a summary of the available list objects, and the type of information displayed in the **List** window. List objects are described in detail in Appendix C.

Table 9.1 List Objects Function Summary

Object	Description
Covariance List	Provides the values of the covariance matrix. **Input: Extract Covariance Matrices**
Jacobian List	Displays Jacobian data, as well as each parameter's and each fit's percentage of the total sensitivity. **Input: Extract Jacobian Data**
Optimization Results	Details optimizer results output, including a summary of the simulation, fit value data, fitted parameter values, parameter correlation values and 95% confidence intervals. **Input: nSIGHTS Optimizer Results**
Table	Displays a table in a list window. **Input:** table data
Full Table Statistics	Displays full statistics for each table column of a table in a list window. **Input:** table data
XY Data	Displays XY data in a list window. **Input:** XY data
XY Data Array	Displays XY array data in a list window. **Input:** XY array data

10 NPOST OUTPUT

nPost also has an output page, with its own set of objects. Some of these objects are available as data objects in nPre. The page and its objects are for the sole purpose of exporting nSIGHTS data into a text file, for use with nSIGHTS or other software packages.

Table 10.1 provides a summary of the available output objects, the type of data exported, and if applicable, the nSIGHTS default file extension. Output objects are described in detail in Appendix D.

Table 10.1 Output Objects Function Summary

Object	Description
Write Color Map	Writes a color map to a file. **Input:** color map **File Extension:** *.cmap
Write Curve	Writes single or multiple curve data to a file. **Input:** curve data **File Extension:** *.nCRV
Write Grid	Writes grid data to a file in standard, surfer or xyz format. **Input:** table data **File Extension:** *.grd
Write Table	Writes a table to a file. **Input:** table data
Write XY Data	Writes XY data to a file. **Input:** XY data **File Extension:** *.dat
Write XY Data Array	Writes XY array data to a file. **Input:** XY array **File Extension:** *.nXYA

11 TUTORIAL

The tutorial in this section provides a guide to the process of developing an nSIGHTS application for well test analysis. There are many ways nSIGHTS may be used to conduct well test analysis, and this tutorial will use the optimization of a constant-rate pumping test as an example.

It should be noted that the focus of this tutorial is accessing the many tools available in nSIGHTS, and not the interpretation of well-test results. The tutorial covers the following topics:

- The set up of a model run and the creation of diagnostic plots (**Entering Model Input**).
- The execution of the model (**Executing the Model**).
- Evaluating model results, through a variety of different types of plots and text output (**Evaluating Model Results**).

Field data for the tutorial is required, and is provided as a text file (PMP.DAT).

11.1 Test Description

The tutorial will use the draw-down period of a constant-rate pumping test for analysis. Details of the test are summarized below.

- Pressure units are kPa
- Time units are hours
- Duration of test is 100 hours
- Test zone is isolated by packers
- Test zone length (or formation thickness b) is 10 m
- Pumping rate is -5 gpm (i.e. withdrawal of water)
- Static formation pressure is 2000 kPa.

11.2 Entering Model Input

The first step in conducting well test analysis within nSIGHTS is to enter the well test characteristics. nPre is the nSIGHTS module where data are input, and the model executed.

Start nPre. The nPre main menu will appear, as shown in Figure 11.1

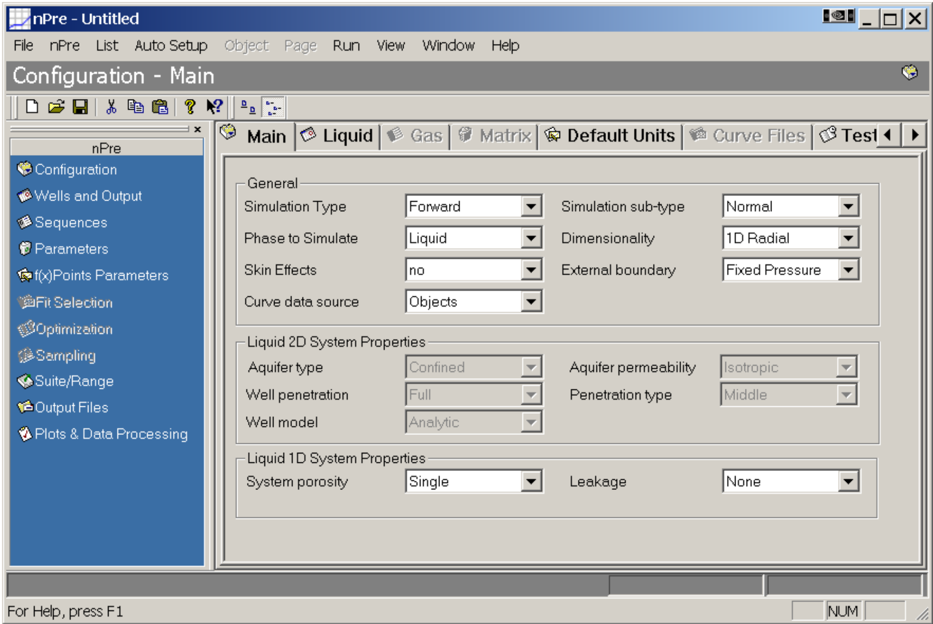


Figure 11.1 Entering Model Input on nPre Main Menu

The main menu contains a list of nPre input windows within the nPre control bar. Each input window contains dialogs for data input that describe the well test model. The default input window is the **Configuration** input window. Note that the object description area displays "Configuration – Main".

The tutorial will now proceed through the different input windows requiring input for this example. Some windows have defaults that are sufficient for this example, and are therefore not described.

11.2.1 Configuration Input

As most of the defaults apply to the well test, changes only need to be made in the **Main** tab and the **Default Units** tab:

(1) **Main** Tab: Select *Optimization* as the Simulation Type.

(2) **Default Units** Tab: Select *hour* for the Time units, and *USgpm* for the Volumetric flow rate.

It is also wise to enter a description of the model run in the **Test Description** tab.

Save the model configuration as Tutorial.nPre, using the standard Windows save button, or **File→Save**. Remember to save the configuration file from time to time.

11.2.2 Field Data Input

At this point, existing field data are imported and plotted using the **Auto Setup→Field Data Plots** command.

(1) Select the **Auto Setup→Field Data Plots**.

(2) A dialog will appear as shown in Figure 11.2:

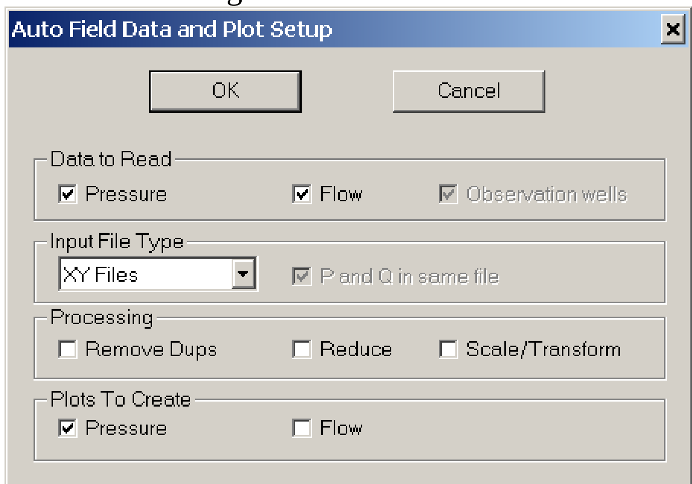


Figure 11.2 Automated Field Data and Plot Setup Dialog

Toggle off Flow in the **Data to Read** frame, and then select **OK**.

(3) Two pages will be created in the **Field Data** tab of the **Plots & Data Processing** input window: one data page and one plot page. In the first data page, *P_input*, select the **Read XY Data** object, *fPDAT*.

- Use the browse button to find the file "PMP.DAT".
- Select the **Apply** button. **Data Status** will indicate that 251 point have been read.

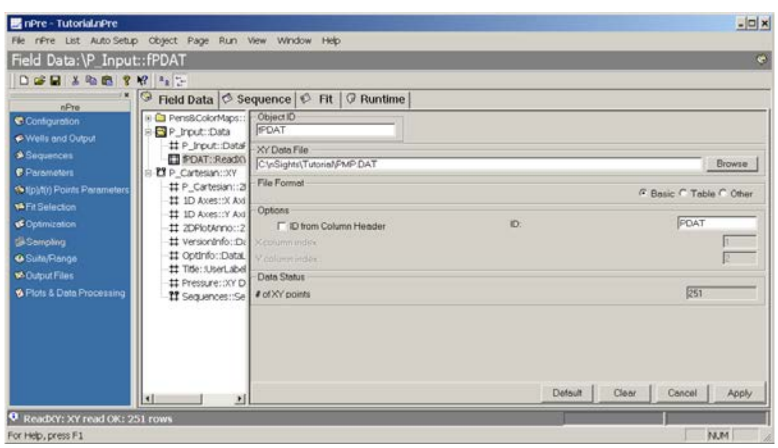


Figure 11.3 Read XY Data

(4) Within the *P_Cartesian* plot page, select the *Pressure* **XY Data Series** object. Auto setup has already selected the field data pressure and the simulated data pressure. Upon selection of the object, its status will be updated to normal (due to the successful reading of data within the *fPDAT* object in step 3).

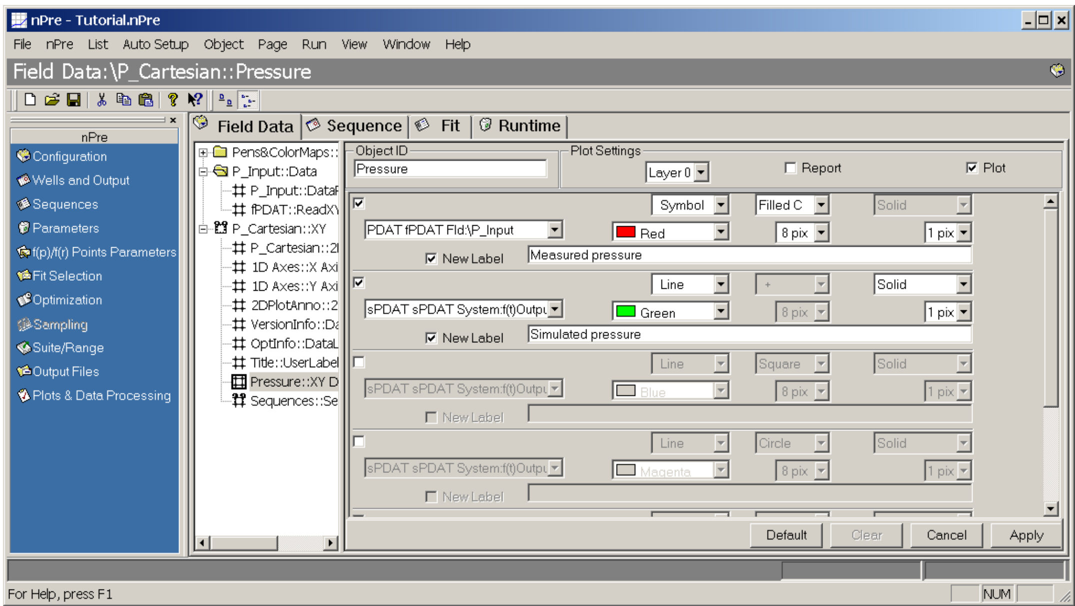


Figure 11.4 XY Data Series for Cartesian Plot

(5) The *Sequences* **Sequence Grid Lines** object will plot grid lines defining the beginning/ending of all sequences, once sequences are defined.

(6) To view the field data plot, select the 2D plot window (**Window→Fld::P_Cartesian**). The window should appear blank, with both axes set at a scale of 0 to 10. To re-scale the axes, select the **Reset View** button (), or **Axes->Data Limits** from the 2D pop-up menu (right click within the 2D plot window).

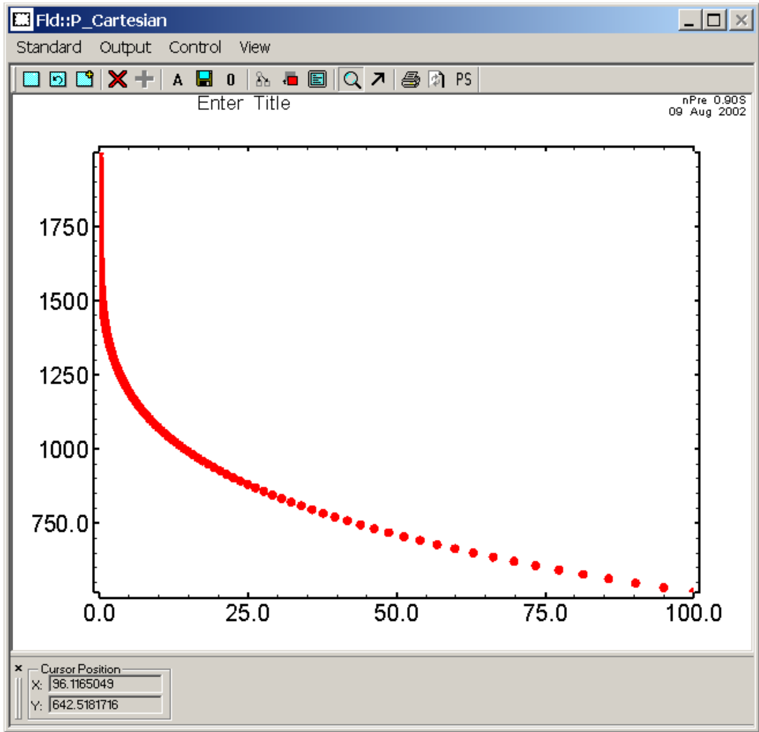


Figure 11.5 P_Cartesian 2D Plot Window

(7) To add axes labels to the plot, select the **2DPlotAnno** object in the *P_Cartesian* 2D plot page. In the **Format** frame, toggle on the Axis Labels checkbox. In the **Labels** frame, type **Time (hours)** for the X Axis label, and **Pressure (kPa)** for the Y Axis label. Select the **Apply** button. For the Y axis labels to fit within the plot window, the left margin may need to be increased in the **2D-XY** object.

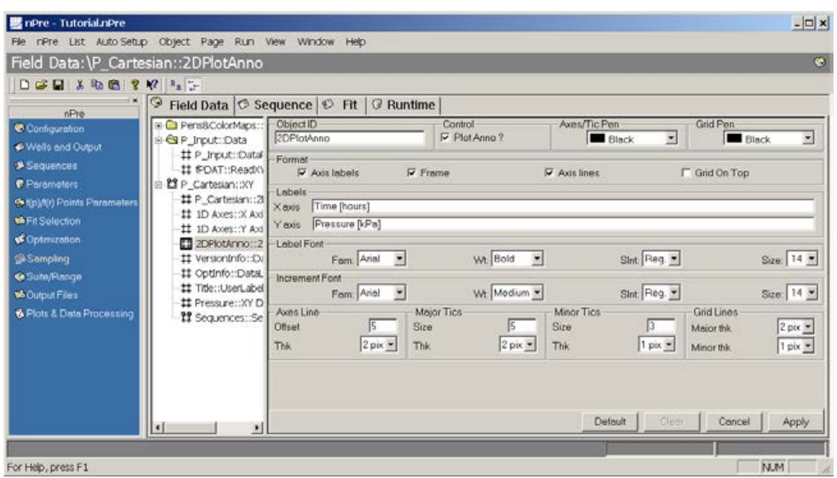


Figure 11.6 2D Plot Annotation for Cartesian Plot

(8) To change the title of the plot, select the *Title* **User Labels** object in the *P_Cartesian* 2D plot page. Change the **Enter Title** text to **Field Pressure Data Time Series**. Select the **Apply** button.

11.2.3 Sequence Input

Sequences define a time period that describes one set of well-bore conditions. For the example test, only one sequence occurred: the draw-down period (a flow sequence). Sequence input options are located under **Sequence** in the UI window (nPre control bar).

Once sequences are defined, diagnostic plots of the simulated data can be generated (using **Auto Setup→Sequence Plots**). These plots can be defined even though the simulation output does not yet exist. The display of simulation output objects will remain empty and plot objects will show incorrect object properties status ( ), until a simulation has been executed.

11.2.3.1 Defining the sequence

(1) In the **Sequences** input window under the **Sequences** tab, keep the default sequence type and designation. Click in the **Duration** cell, and type **100**. The sequence duration is therefore 100 hours.

(2) Double click on the **Sequence Data** cell (currently says "BAD"). A dialog will appear in a separate window, as shown in Figure 11.7:

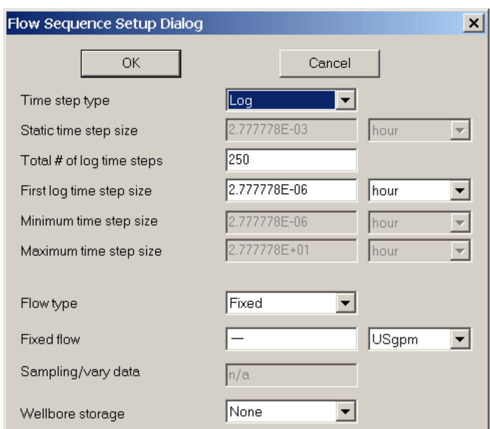


Figure 11.7 Flow Sequence Setup Dialog

This dialog describes the time stepping to occur within the sequence, as well as the sequence well-bore boundary conditions:

- Type **-5** in the Fixed flow text box.
- Change the Wellbore storage to *Isolated*.
- Keep the remaining defaults and select the **OK** button.

(3) The **Sequence Data** cell should now read “OK”. The sequence has now been defined.

11.2.3.2 Generating diagnostic plots

(1) Select **Auto Setup→Sequence** Plots.

(2) A dialog will appear as shown in Figure 11.8.

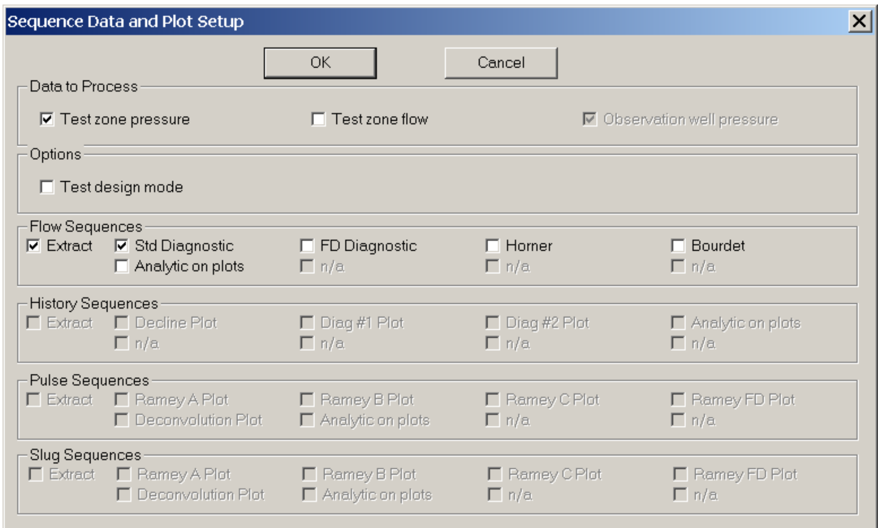


Figure 11.8 Sequence Data and Plot Setup Dialog

- In the **Flow Sequences** frame, select the Extract checkbox, then the Std Diagnostic checkbox.
- Select **OK**.

(3) One data page and one plot page will be created in the **Sequence** tab of the **Plots & Data Processing** input window.

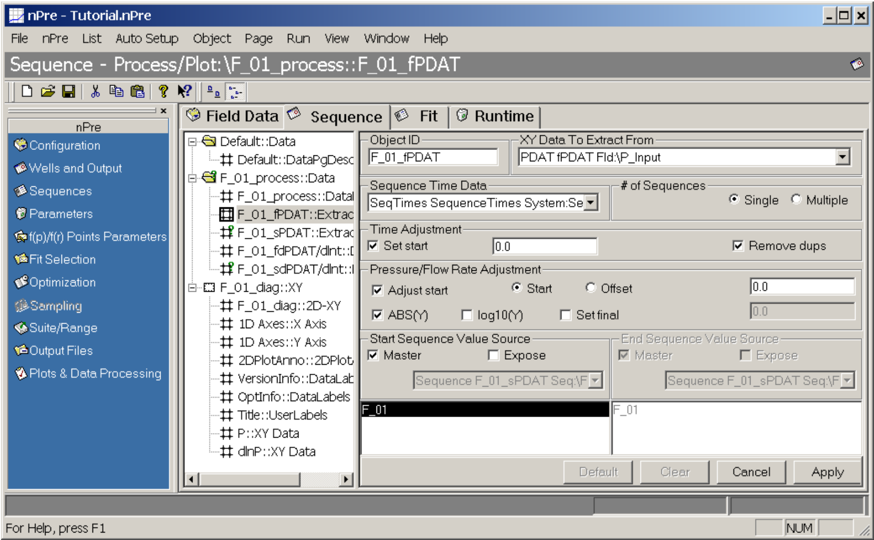


Figure 11.9 Extract Sequence Interval Property Window

(4) The data page, *F_01_process*, will contain two **Extract Sequence(s)** objects:

- *F_01_fPDAT* contains the field pressure data for the flow sequence F_01.
- *F_01_sPDAT* contains the simulated pressure data for the flow sequence F_01.

The data page *F_01_process* will also contain two **P(t) Derivative Calculation** objects, *F_01_fdP/dlnt* and *F_01_sdP/dlnt*, which calculate the derivative of the field and simulated pressure changes, respectively, for the F_01 flow sequence.

(5) The plot page, *F_01_diag*, plots field and simulated pressure, as well as their derivatives.

(6) To increase the line width of the simulated pressure:

- Select the *P* object.
- Change the line width of the simulated data to *3 pix*.
- Select **Apply**.

(7) As well, the colors for the derivative objects should be changed, in order to differentiate between pressure and the derivative of pressure. The line width of the simulated derivative will also be increased, to correspond with the line width of the simulated pressure data.

- Select the *dlnP* object.
- In the first color drop-down list (currently selecting *Red*), select *Blue*.
- In the second color drop-down list (currently selecting *Green*), select *Magenta*.
- Change the line width of the simulated data to *3 pix*.
- Select **Apply**.

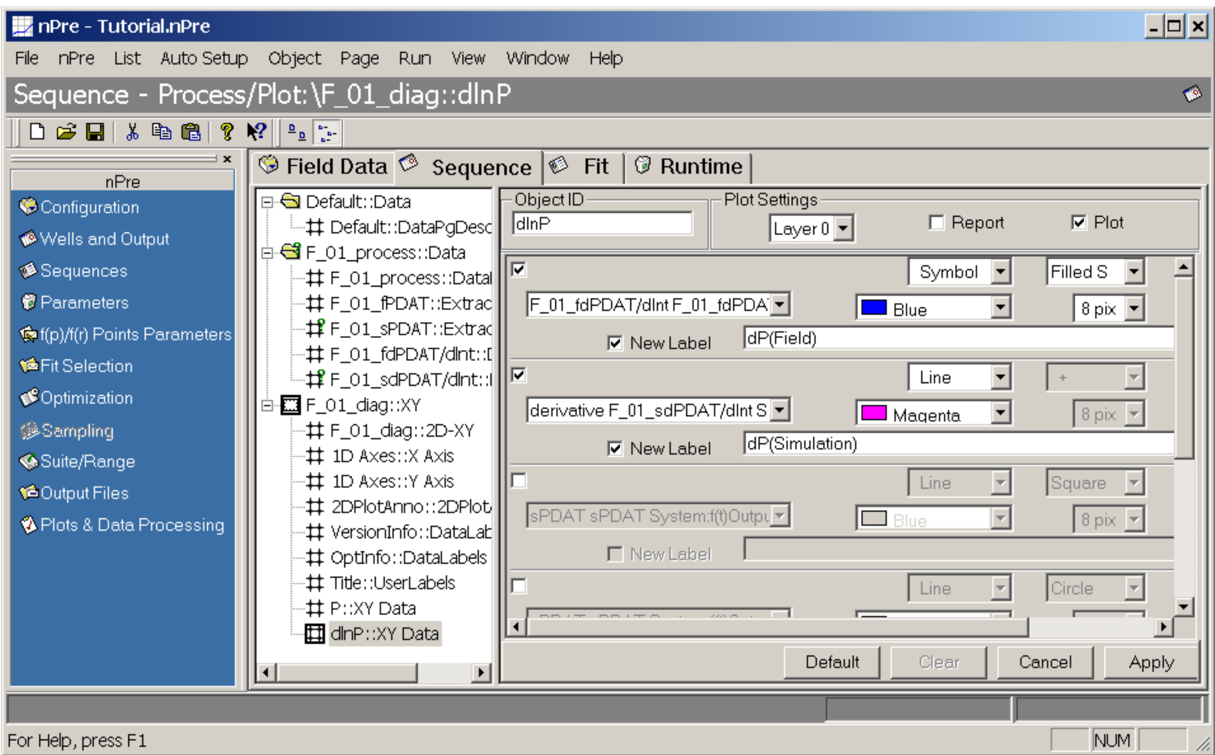


Figure 11.10 New Colors for Derivative XY Data Series

(8) To add a legend to the plot, create a new object in the *F_01_diag* plot page. Select **Object→New□Anno: Series Legend**. The **Object** menu is accessed by selecting any of the objects in the *F_01_diag* plot page, and right-click to bring up the **Object** pop-up menu. Alternatively, use the **Object** menu in the menu bar.

- Check the top toggle box, and select *Series Legend P Seq:\F_01_diag* from the drop-down list. Check the second toggle box, and select *Series Legend dlnP Seq:\F_01_diag* from the drop-down list.
- Select the **Apply** button.

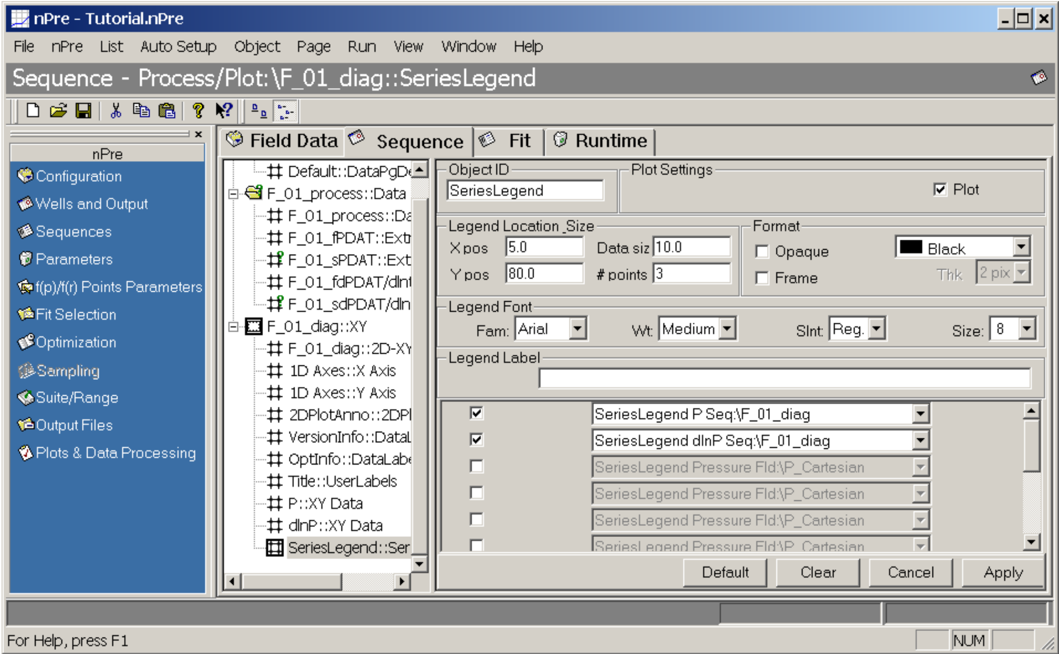


Figure 11.11 Series Legend for Diagnostic Plot

(9) To add axes labels to the plot, select the **2DPlotAnno** object in the *F_01_diag* plot page. In the **Format** frame, toggle on the Axis Labels checkbox. In the **Labels** frame, type **Log Elapsed Time (hours)** for the X Axis label, and **Log Pressure (kPa) and Derivative** for the Y Axis label. Select the **Apply** button. For the Y axis labels to fit within the plot window, the left margin may need to be increased in the **2D-XY** object.

(10) To change the title of the plot, select the *Title* **User Labels** object in the *F_01_diag* 2D plot page. Change the **Enter Title** text to **Standard Diagnostic**. Select the **Apply** button.

(11) The *OptInfo* **Data Labels** object in the *F_01_diag* plot page will force the plot to be updated with each step of the optimization. By default, this label is not plotted (i.e. the Plot toggle is off).

(12) To view the plot, select the plot window using the **Window→Seq::F_01_diag** command. Alternatively, select **Window→Window List** (or F11), which brings up a window containing a menu of all available windows, shown in Figure 11.12 Window List Menu Window

Figure 11.12 Window List Menu Window

Select **Seq::F_01_diag** in the menu, and the window will be brought to the top. The window list menu window is a convenient way to switch between the main and plot windows.

(13) The plot window should appear blank, with both axes set at a scale of 0 to 10. To re-scale the axes, select the **Reset View** button (), or **Axes->Data Limits** from the 2D pop-up menu (right click within the 2D plot window). The legend and data labels may be moved by selecting the objects within the window, and dragging. Note that only field data is plotted, since simulation data has not yet been created.

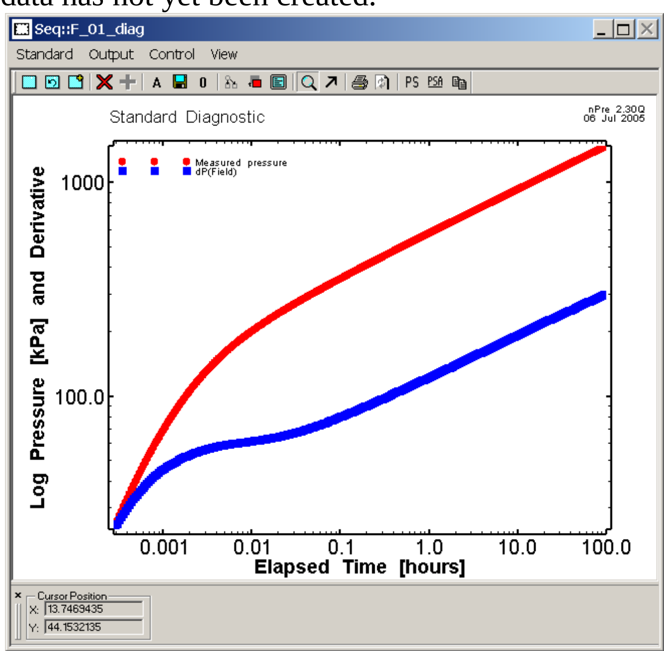


Figure 11.13 Standard Diagnostic Plot Window

11.2.4 Parameter Input

Parameter values are entered into the tables provided in the tabs of this input window. Only parameters required (based on the current model configuration) will be shown.

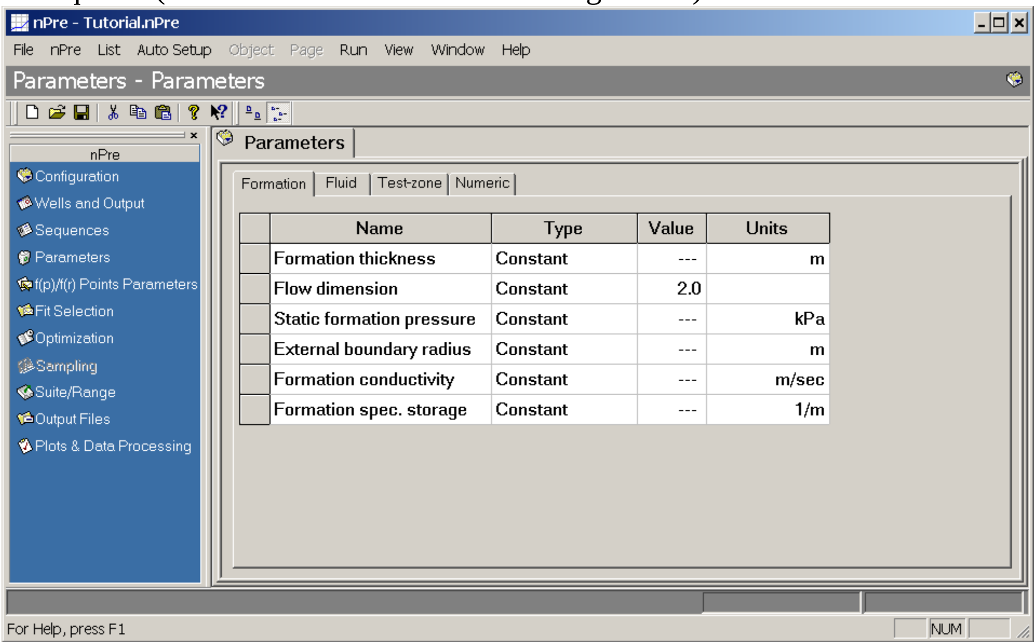


Figure 11.14 Parameter Input Window

The parameter value is entered into the Value cell. Before entering the parameter value, the units should be defined in the Units cell. Changing the Units cell after the Value cell will cause the value to be converted to the new units.

Enter the parameter values, as specified in the following table (check the units!). For parameters not specified, keep the default values.

Tutorial Parameter Input Values and Units		
Parameter	**Value**	**Units**
Formation tab		
Formation thickness	10	m
Flow dimension	1.6	
Static formation pressure	2000	kPa
External boundary radius	1.0e+05	m
Formation conductivity	1.0e-05	m/sec
Formation spec. storage	1.0e-07	1/m

Tutorial Parameter Input Values and Units		
Parameter	**Value**	**Units**
Test-zone tab		
Well radius	4	in
Volume change from normal	0.0	m^3
Test-zone compressibility	3.0E-08	1/Pa

While entering the parameters, the width of the Value column may need to be adjusted in order to view the value. Place the cursor on the table heading of the Value column, and double click. The column will be automatically adjusted to fit the values entered within the column.

Each parameter also has a type, specified in the Type column. The default type is *Constant*. For an optimization simulation, fitting parameters are specified by changing the parameter type to *Optimize*. Fitting parameters are the parameters the model adjusts in order to obtain an optimal fit to field data.

Once a parameter type has been changed to *Optimize*, the Value cell will read "BAD". Double clicking on the Value cell will bring up an **Optimized Value Dialog**, containing the input fields required for the parameter. Once the optimized parameter inputs are completed correctly, and the dialog **OK** button selected, the Value cell will read "OK".

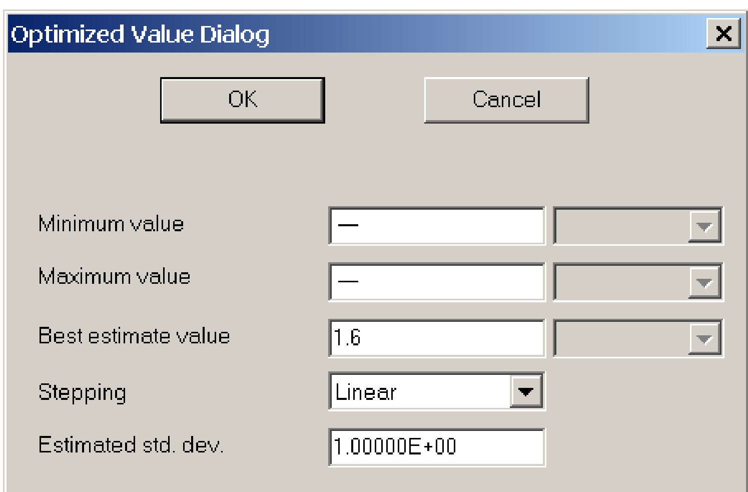


Figure 11.15 Optimized Value Dialog

For this tutorial, change the parameter Type to *Optimize* for the parameters specified in Table 11.2 Tutorial Optimized Parameter Value Input below. Then for each fitting parameter, double click on the corresponding Value cell, and complete the required inputs of the **Optimized Value Dialog**, also specified in the table below. Note that the Best Estimate Value is automatically the parameter value that was previously entered.

Table 11.2 Tutorial Optimized Parameter Value Input					
Parameter	**Minimum Value**	**Maximum Value**	**Best Estimate Value**	**Stepping**	**Estimated std. dev.**
Formation Tab					
Flow dimension	1.0	3.0	1.6	Linear	1.0
Formation conductivity	1.0E-6 m/s	1.0E-4 m/s	1.0E-5 m/s	Logarithmic	1.0
Formation specific storage	1.0E-8 1/m	1.0E-6 1/m	1.0E-7 1/m	Logarithmic	1.0
Test-zone tab					
Test-zone compressibility	1.0E-9 1/Pa	1.0E-7 1/Pa	3.0E-8 1/Pa	Logarithmic	1.0

11.2.5 Fit Specification Input

The fit specification options are only available when the simulation type is set to *optimization* and/or simulation sub-type to *range*. The field and simulated data sets to be compared are specified using the **Auto Setup→Basic Fits** command. These specified fits between field and simulated data are also called constraints. The nSIGHTS model will adjust the specified fitting parameters in order to achieve a match between the field and simulated data.

In general, multiple constraints will reduce the uncertainty of parameter estimates. However, to give each constraint equal weight in the regression process, the range of Y values for each constraint must be equal or very similar. For a set of constraints that varies over several orders of magnitude, the log of the constraint may be used.

Two constraints will be used in this example: pressure and the derivative of pressure. As the Y value of the two constraints vary over several orders of magnitude, the log of each constraint will be used.

(1) Select **Auto Setup→Basic Fits.**

(2) A dialog will appear as shown in Figure 11.16 Fit Specification Setup Dialog:

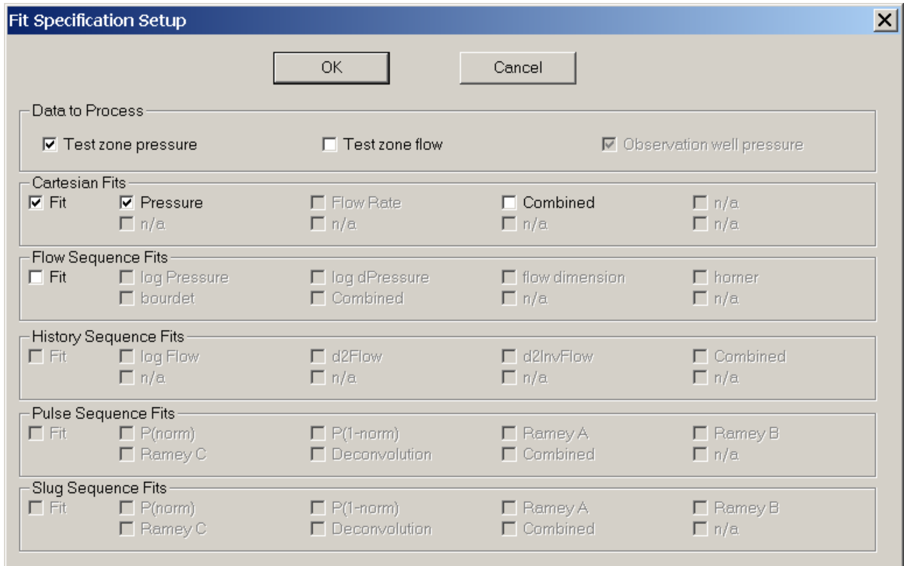


Figure 11.16 Fit Specification Setup Dialog

- In the **Cartesian Fits** frame, select Fit and Pressure checkboxes.
- Select **OK**.

(3) One data page will be created in the **Fit** tab of the **Plots & Data Processing** input window, containing the following objects:

- Two **Extract Sequence** objects, which extract all or a portion of the sequences from field and simulated XY data. Here there is only one sequence, so the entire XY data set is extracted.
- One **Single Fit** object pairs field and simulated pressure data.

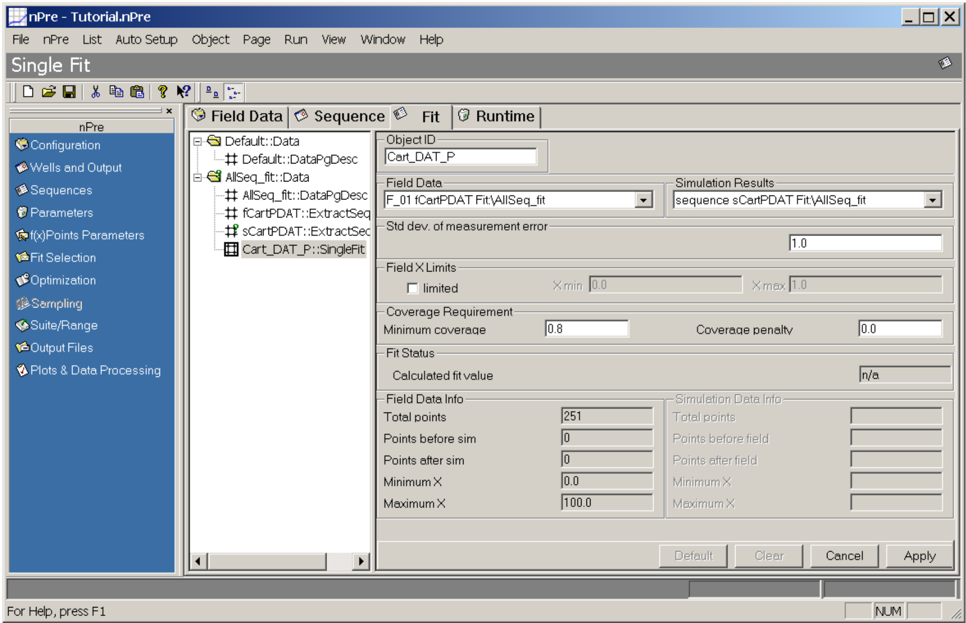


Figure 11.17 Fit Tab of the Plots & Data Processing Input Window

(4) Within the **Fit Selection** tab of the **Fit Selection** input window, one Optimize? checkbox will be selected, and the adjacent drop-down list selects the single fit created in the above steps.

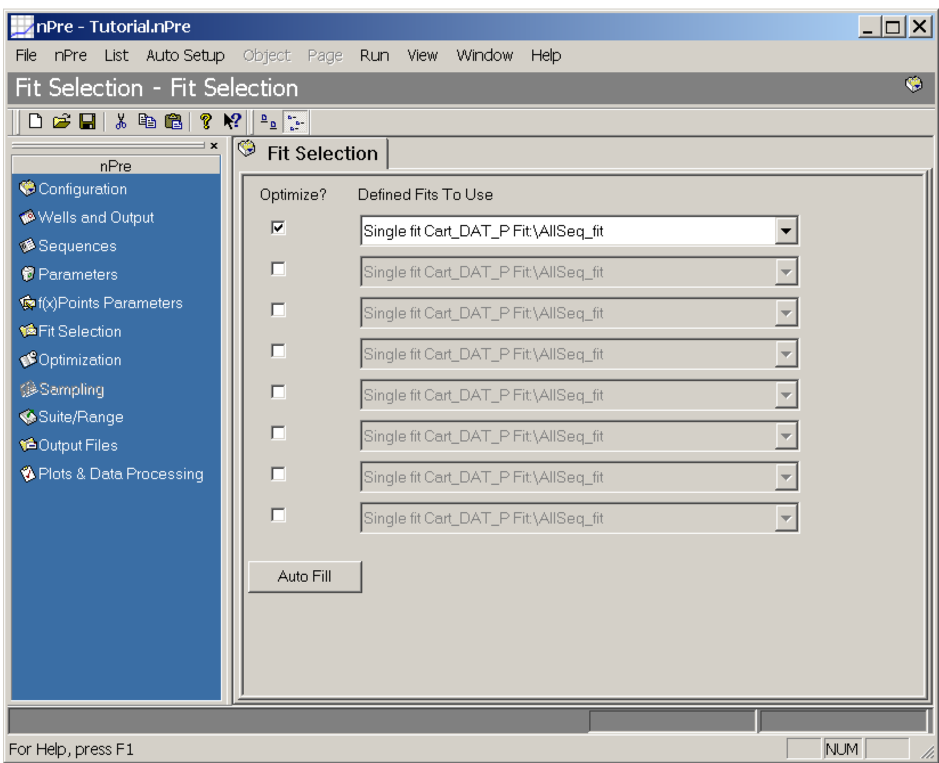


Figure 11.18 Fit Selection Tab with Combined Fit Selected

11.2.6 Output Files Input

The **Output Files** options are located on the UI window (nPre control bar). Within this tab, the available output files are specified.

(1) In the **Optimization** tab, select the checkbox Write optimization output.

(2) In the File name box, use the browse button to specify the output file location. Name the file **Tutorial.nOpt**.

(3) Select *yes* for Store residuals, Store covariance matrices and Store Jacobian data drop-down-boxes.

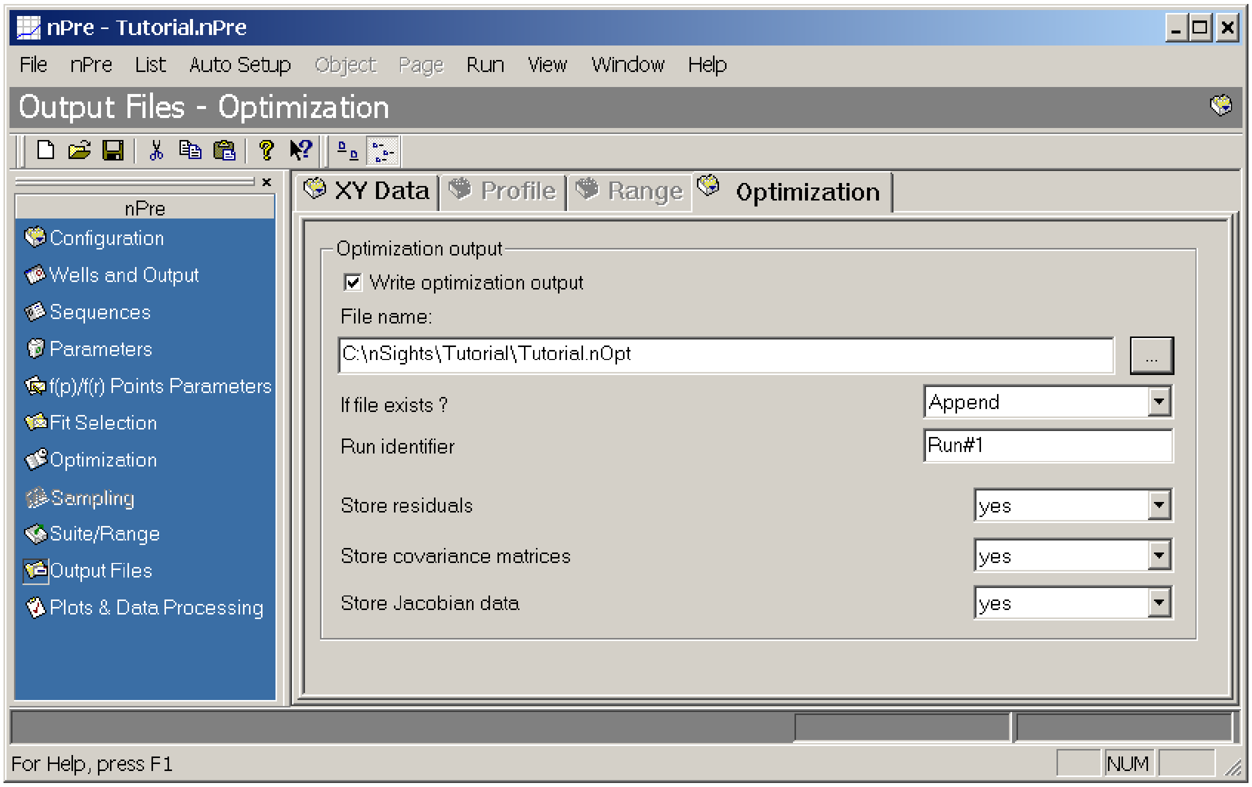


Figure 11.19 Output Files Tab with Optimization Output Specifications

11.3 Executing The Model

Before executing the model, save the nPre configuration file.

To execute the model, select the **Verbose** command from the **Run** menu. A window will appear, tracking the model as it conducts the simulations.

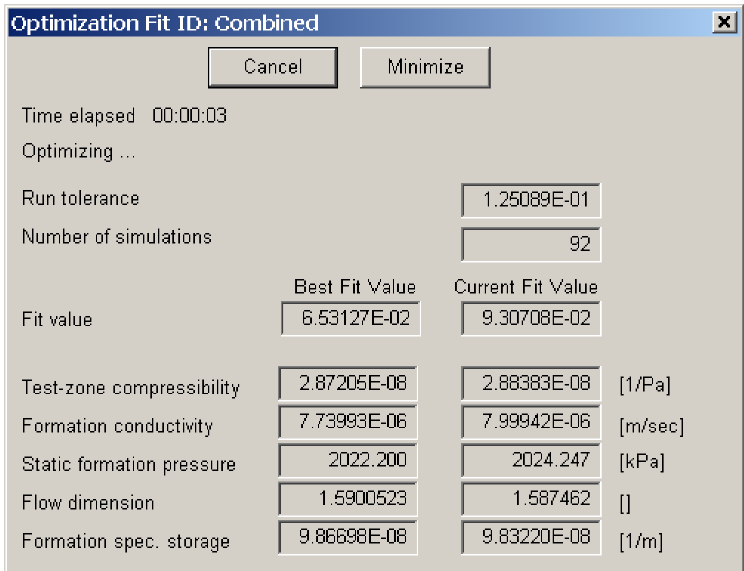


Figure 11.20 Verbose Run Window

As there is only one case in this example, there is no progress bar (a progress bar tracks the number of cases completed for runs with multiple cases).

To view the real-time progress of plots developed in the **Runtime and Post-Processing Setup** input window, select the **Minimize** button. The run window and the main window will be minimized, leaving only plot windows on the screen.

The model run should take less than a minute. Once it is finished, look at the *Seq:F_01_diag* plot, which should now show data for simulated pressure and its derivative:

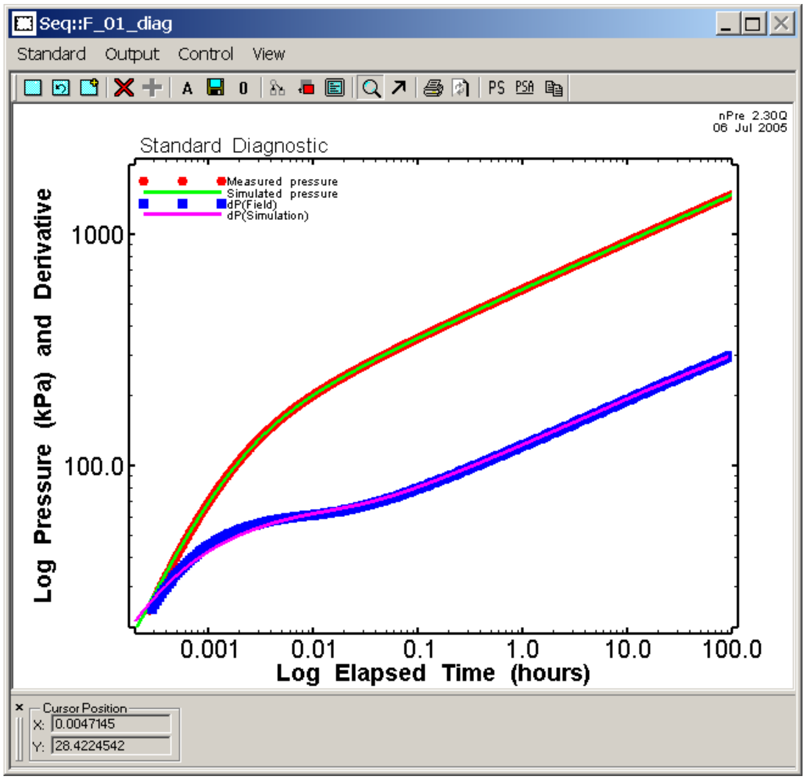


Figure 11.21 Diagnostic Plot with Simulated Results

After examining this plot, close nPre.

11.4 Evaluating Model Results

Many tools are available in nSIGHTS to evaluate test results. The simulation mode used dictates a test's output and consequently has a bearing on the analysis tool used. For example, a range grid is only output for range runs. Due to the great number of tools, and the myriad of ways of implementing these tools, only a few analysis tools will be examined in this tutorial. As the tutorial model ran in optimization mode, the model results evaluation will be specific to optimization mode.

Within this tutorial, a process for evaluating uncertainty in the well test simulation developed in nSIGHTS will be followed, as described in an article by R. M. Roberts, R. L. Beauheim and J. D. Avis (Quantifying Parameter Uncertainty in Well Test Analysis, In Proceedings of International Groundwater Symposium, pg 238-239, Lawrence Berkeley National Laboratory, Berkeley, CA, March 25-28, 2002). The focus of the tutorial will be the steps required to produce the various plots, and not on interpretation of the results. The user is referred to the article above for details on interpretation of results.

The steps in the uncertainty analysis are summarized as follows:

- Evaluation of constraints and fitting parameters based on the sensitivity of fitting parameters to the chosen constraints.

- Residual analysis to determine whether the conceptual model adequately reproduces observed data.

- Quantifying uncertainty in the estimates of fitting parameters, through:

    - evaluation of joint confidence regions
    - perturbation analysis
    - uncertainty distributions for non-fitting parameters

Most of this analysis is conducted in nPost, designed as a post-processor for the nSIGHTS model. The last two methods, perturbation analysis and uncertainty distributions for non-fitting parameters, require the model to be run again under different conditions, and therefore are partly conducted in nPre.

11.4.1 Evaluation of Constraints and Fitting Parameters

Within nPost, a plot of the Jacobian matrix is used to evaluate the sensitivity of fitting parameters to the constraints. The sensitivity of a fitting parameter to a constraint indicates the effectiveness of a constraint in providing an estimate of that fitting parameter.

(1) Open nPost.

(2) Rename the default data page **Input Data** (by changing the object ID of the **DataPgDesc** object).

(3) Create a new object**: Object→New→Read Input→Read nSIGHTS Optimizer Results.**

The **Object** menu is accessed by selecting any of the objects in a page, and right-click to bring up the **Object** pop-up menu. Alternatively, use the **Object** menu in the menu bar. Note that the **Object** menu is page type specific.

(4) The optimization results output file of the model run will be imported within this object.

- Select the file Tutorial.nOpt using the browse button.

- Select **Apply**.

(5) Create a new data page. Rename the page **Jacobian Data**.

(6) In the *Jacobian Data* data page, create a new object: **Object→New→nSIGHTS Results Extraction→Extract Jacobian**. Select **Apply**.

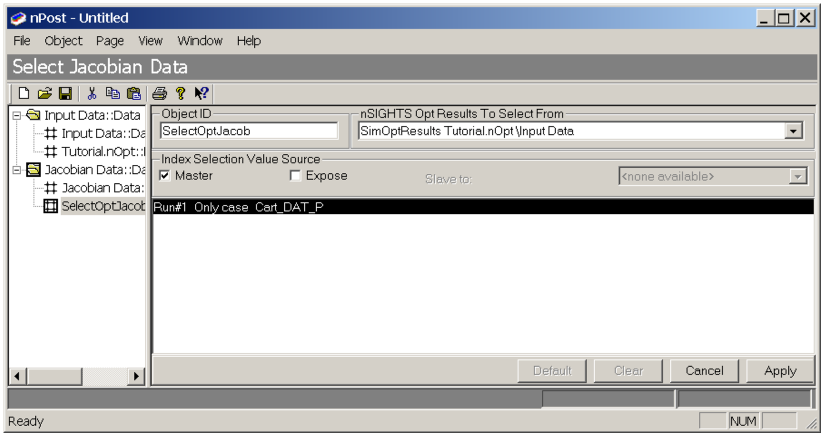


Figure 11.22 Extract Jacobian Property Window

(7) Create a new object: **Object→New→Table Processing→Jacobian to Table.**

- Change the **Object ID** to **Jacobian Cart**.
- In the **Fit(s)** drop-down-box, select *Cart_DAT_P*.
- Select **Apply**.

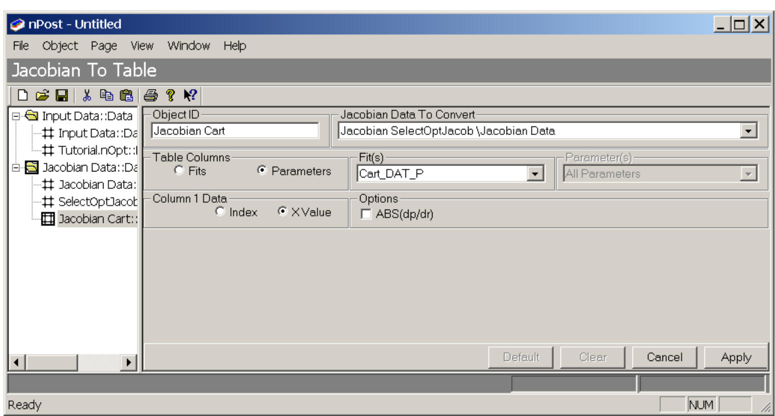


Figure 11.23 Jacobian to Table Property Window

(8) Create a 2D plot page (**Page→New 2D XY Plot**).

- In the **2D XY** object, change the name of the page to **Jacobian Cart Plot**, and change the left margin to **100**. Select **Apply**.
- In the **X Axis** object, change the **Axis Type** to Logarithmic. Select **Apply**.

- Select the **2D Plot Anno** object. Check the Axis Labels box, and type **Elapsed Time (hours)** for the X axis and **Sensitivity** for the Y axis labels. Select **Apply**.

(9) Create a new object in the *Jacobian Cart Plot* plot page: **Object→New→Data: Single Table Series**.

- The **Table Data** should already select *Jacobian Cart*.

- Select the first five check boxes. The five fitting parameters should be automatically selected in the drop-down-boxes (e.g. *Test-zone compressibility*).

- Select **Apply**.

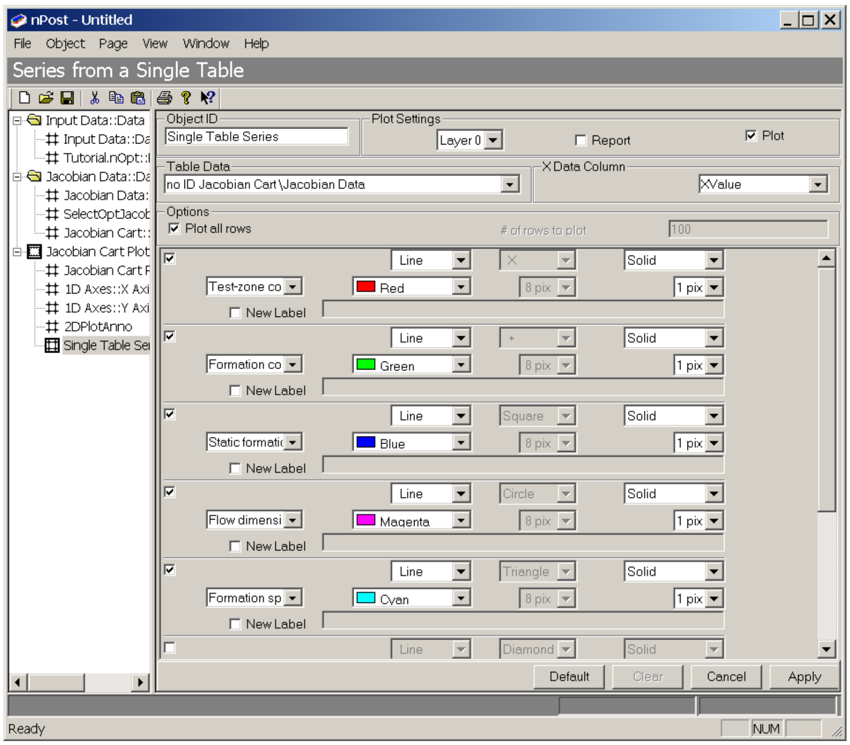


Figure 11.24 Table Data Series Property Window for Jacobian Cart Plot

(10) Create a legend for the plot: **Object→New→Anno: Series Legend**.

- Select the first checkbox. The table series should already be selected in the adjacent drop-down-box (*Series Legend Single Table Series \Jacobian Cart Plot*).

- Change the **Legend Font** Size to *12* point.

- Select **Apply**.

(11) View the plot by selecting the *Jacobian Cart Plot* plot page from the **Window** menu, or from the **Window List** window. The axes limits will need to be reset (select **Axes->Data Limits** in the 2D window pop-up menu), and the legend moved to an appropriate location (simply drag with the mouse).

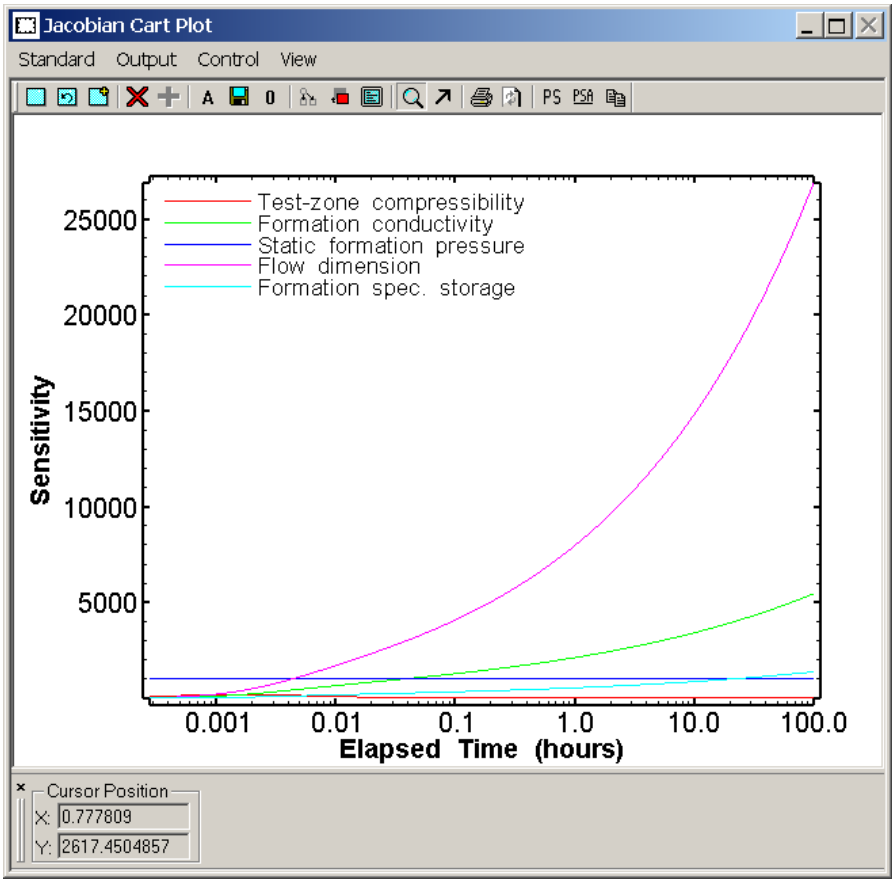


Figure 11.25 Jacobian Cart Plot

Now is a good time to save the nPost configuration file. Name the file **Tutorial.nPost**.

11.4.2 Residual Analysis

Residuals are analyzed to determine whether the conceptual model sufficiently describes the observed data. Residuals should reflect random noise in the data, and be approximately randomly distributed (assuming the random noise to have a normal distribution). If the data are not normal, the conceptual model needs to be re-examined, or a reason for the non-normal behavior found (e.g. equipment problems that cannot be included in the conceptual model).

(1) Create a new data page. Rename the page **Residual Data**.

(2) In the *Residual Data* page, create a new object: **Object→New→nSIGHTS Results Extraction→Extract Residuals**. Residuals are obtained from the optimization results file, already imported into nPost.

- Change the **Object ID** to **Cart Residuals**.
- Select the first fit, Run #1 Only Case Cart_DAT_P OK Cart_DAT_P.
- Select **Apply**.

(3) Create a new object: **Object→New→Residual Processing→Calculate Residual Diagnostic.**

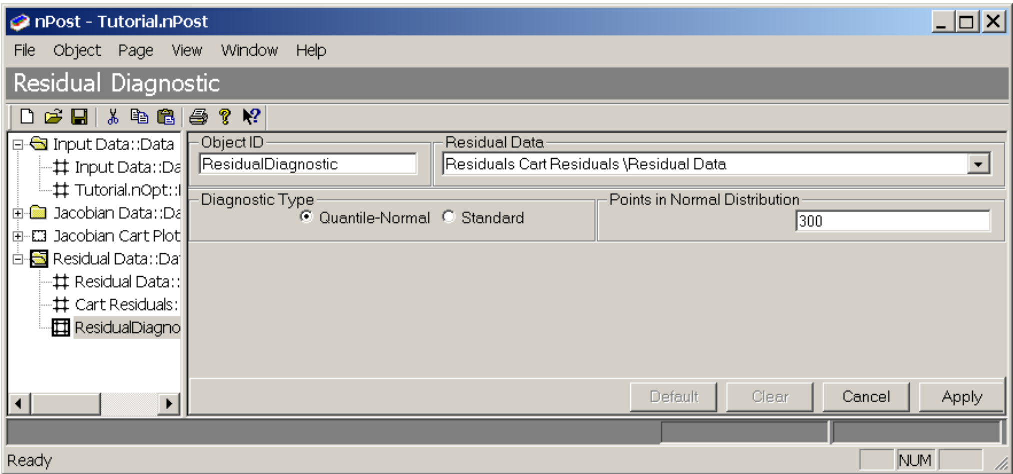


Figure 11.26 Residual Diagnostic Calculation Property Window

- Change the **Object ID** to **Cart Res Diag**.
- Keep the default input and settings, and select **Apply**.

(4) Create a 2D plot page (**Page→New 2D XY Plot**).

- Change the name of the page to **Cart Res Diag** and change the left margin to 125. Select **Apply**.
- In the **X Axis** object, change the **Increment Label Format** to *Decimal* and *0.000*, and select **Apply**.
- In the **Y Axis** object, change the **Increment Label Format** to *Decimal* and *0.000*, and select **Apply**.
- Select the **2D Plot Anno** object. Check the Axis Labels box, and type **Normal Distribution** for the X axis and **Residuals** for the Y axis labels. Select **Apply**.

(5) Create a new object in the *Cart Res Diag* plot page: **Object→New→Data: XY Series**.

- Select the first two check boxes. Select *Quantile-Normal Cart Res Diag* and *QuantileLine Cart Res Diag* in the adjacent drop-down-boxes.

- Change the *Quantile-Normal Cart Res Diag* XY Data representation from *Line* to *Symbol*.

- Select **Apply**.

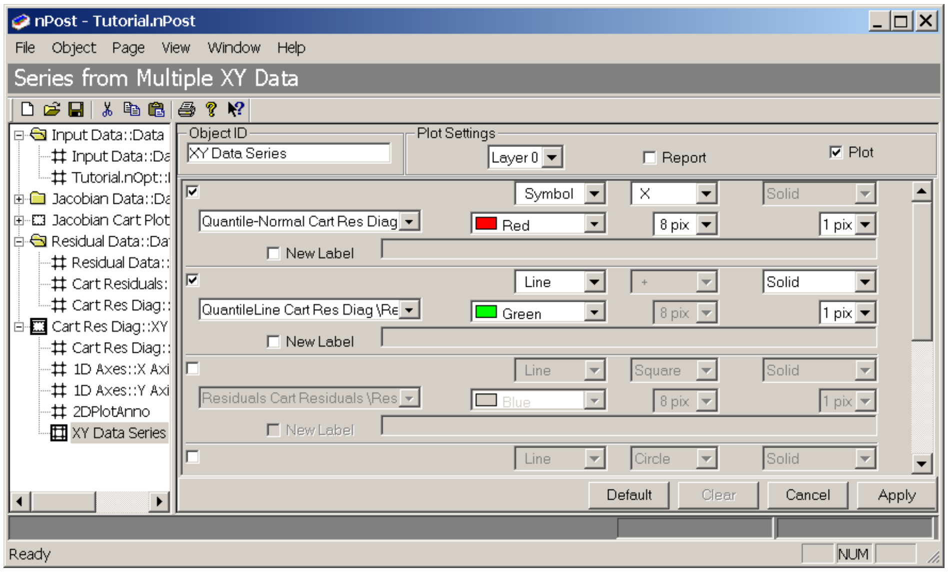


Figure 11.27 XY Data Series Object Property Window for Cart Res Diag Plot

(6) Create a legend for the plot: **Object→New→Anno: Series Legend**.

- Select the first checkbox. Select *SeriesLegend XY Data Series \Cart Res Diag* from the adjacent drop-down-box.

- Change the **Legend Font** Size to *12* point.

- Select **Apply**.

(7) View the plot by selecting the *Cart Res Diag* plot page from the **Window** menu, or from the **Window List** window. The axes limits will need to be reset (select **Axes->Data Limits** in the 2D window pop-up menu), and the legend moved to an appropriate location (simply drag with the mouse).

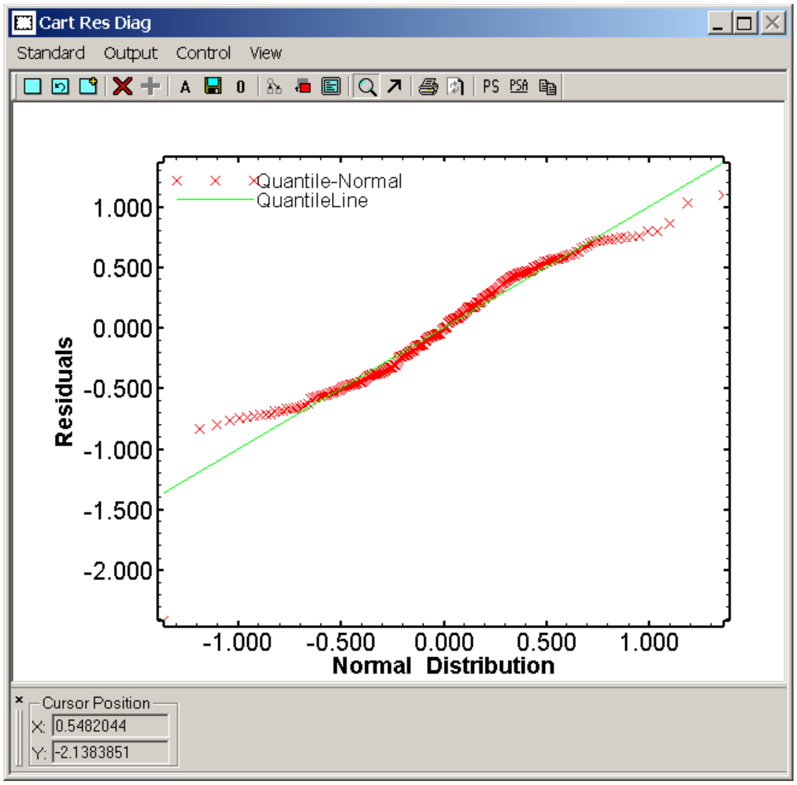


Figure 11.28 Cart Residual Dialog Plot

11.4.3 Evaluation of Joint Confidence Regions

Joint confidence regions delineate areas that have a specified probability of containing the true parameter values. They evaluate the uncertainty in fitting parameter values due to fitting parameter correlations and data noise. This section will describe how confidence regions are plotted. Correlation coefficients are only calculated if there are multiple cases (e.g. perturbation analysis or sampling mode), and the viewing of correlation coefficients will be shown in Section 11.4.4 on perturbation analysis.

(1) Create a new data page. Rename the page **Confidence Region Data**.

(2) Within the *Confidence Region Data* data page, create a new object: **Object→New→nSIGHTS Results Extraction→Extract Covariance Matrices**. Joint confidence regions are obtained from the covariance matrix, stored in the optimization results file already imported into nPost.

- Keep the defaults, and select **Apply**.

(3) Create a 2D plot page (**Page→New 2D XY Plot**).

- In the **2D-XY** object, change the name of the page to **K and n Confidence Region**, change the left margin to **100**. Select **Apply**.

- In the **X Axis** object, change the **Increment Label Format** to *Scientific* and *0.00E+00*, and select **Apply**.

- In the **Y Axis** object, change the **Increment Label Format** to *Decimal* and *0.0000*, and select **Apply**.

- Select the **2D Plot Anno** object. Check the Axis Labels box, and type **Hydraulic Conductivity (m/s)** for the X axis and **Flow Dimension** for the Y axis labels. Select **Apply**.

(4) Create a new object in the K and n Confidence Region plot page: **Object→New→Data: Confidence Limits Two Parameter**.

Select *Formation Conductivity* for the **X Variable** and *Flow Dimension* for the **Y Variable**.

Select *Dual* as the **Limit Type**. This will create an ellipse surrounding the confidence region. *Single* will display an error bar for each axes.

Select **Apply**.

(5) Create a legend for the plot: **Object→New→Anno: Series Legend**.

- Select the first checkbox. Select *SeriesLegend Covar Limits K and n Confidence Region* from the adjacent drop-down-box.

- Change the **Legend Font** Size to *12* point.

- Select **Apply**.

(6) View the plot by selecting the *K and n Confidence Region* plot page from the **Window** menu, or from the **Window List** window. The axes limits will need to be reset (select **Axes->Data Limits** in the 2D window pop-up menu), and the legend moved to an appropriate location (simply drag with the mouse). As well, the plot may need to be resized in order to see the X axis increments (simply drag a corner of the plot window).

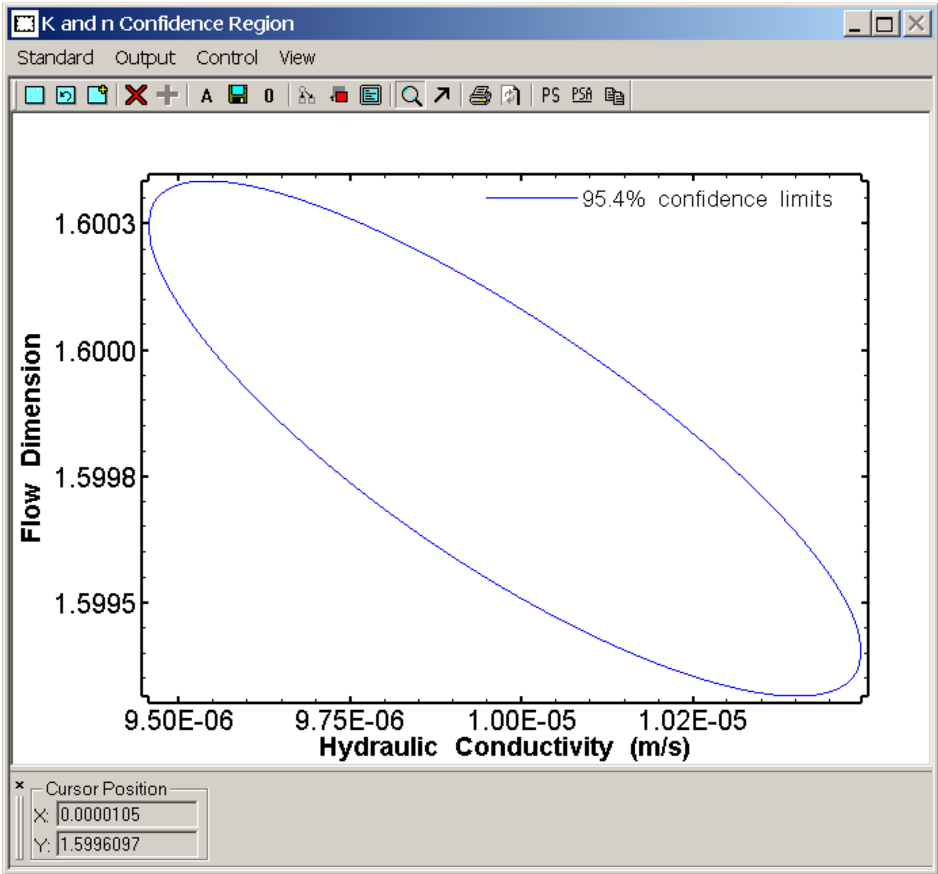


Figure 11.29 K and n Confidence Region Plot

(7) Steps (3) to (6) can be repeated for other parameter combinations.

11.4.4 Perturbation Analysis

Perturbation analysis consists of executing a model run in nPre with many simulations; the initial estimates of fitting parameters for each simulation are randomly perturbed (i.e. initial estimate is slightly increased or decreased) and the model re-optimizes the fitting parameters from these perturbed estimates. If each perturbation simulation results in a fitting parameter value close to the initial estimate, the problem solution is unique and well-constrained.

In this tutorial, it will be demonstrated how to conduct a perturbation model run, and to create three useful plots for analyzing perturbation results: a histogram, XY scatter plot and XYZ scatter plot. As well, it will be shown how to view the correlation coefficients in a list page window.

It should be noted that the execution of the model for this example will take considerably more time than the simple optimization run (e.g. approximately 20 minutes on a 1GHz dual-processor Pentium III equipped with 2GB of RAM).

11.4.4.1 To conduct a perturbation model run

(1) Open nPre.

(2) Open the configuration file Tutorial.nPre (**File→Open** or the standard Windows open file button).

(3) Select the **Optimization** input window. Select the **Perturbation** tab.

- Check the Do optimization perturbation box.
- Change the Perturbation span to **0.40**.

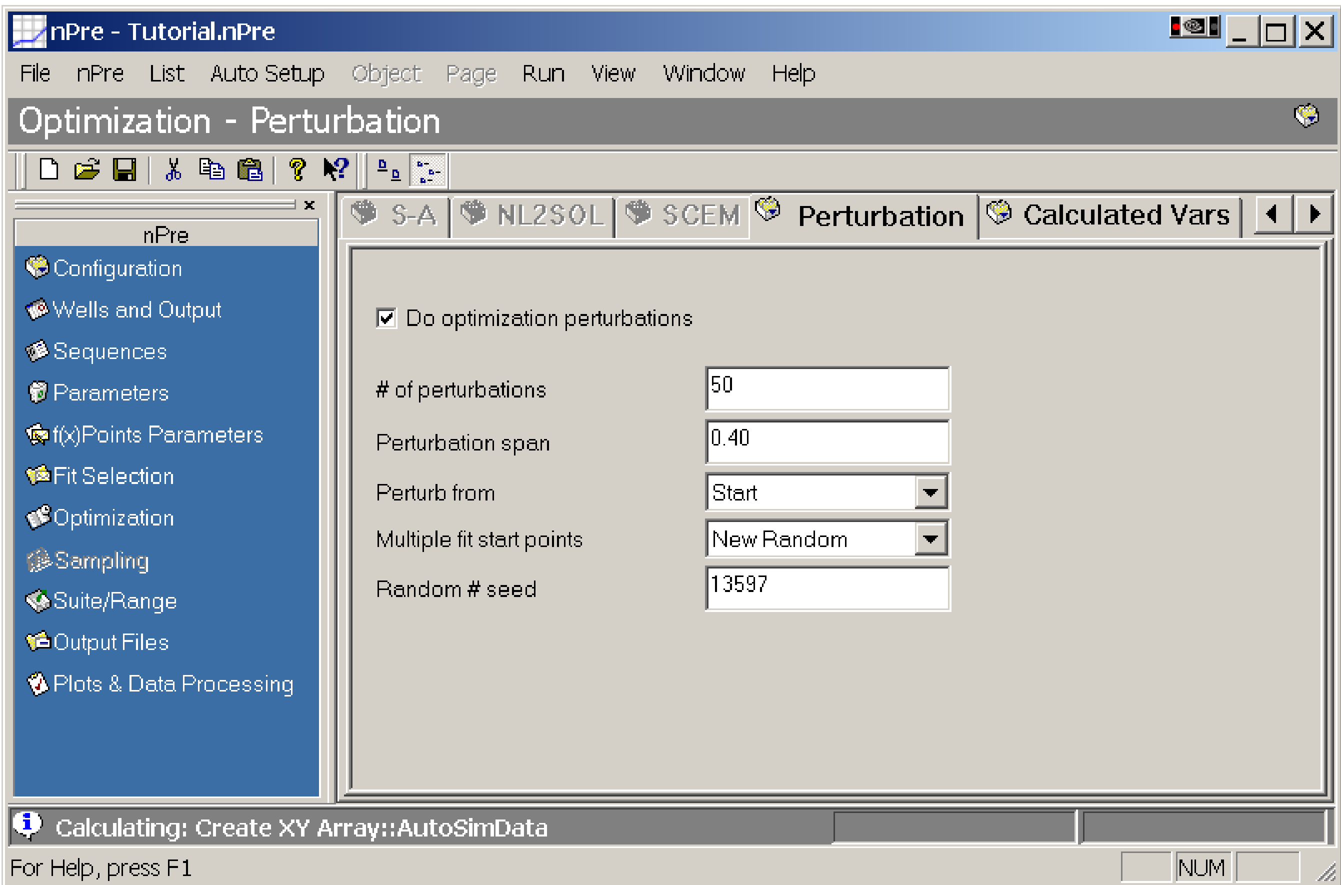


Figure 11.30 Perturbation Tab of Optimization Input Window

(4) In the **Output Files** input window, **Optimization** tab, change the file name to **TutorialPerturb.nOpt**.

(5) Select the **Verbose** command from the **Run** menu. As the model executes, a window will track the progress of the model. Note that the estimated time remaining will fluctuate considerably until several perturbation simulations have been conducted.

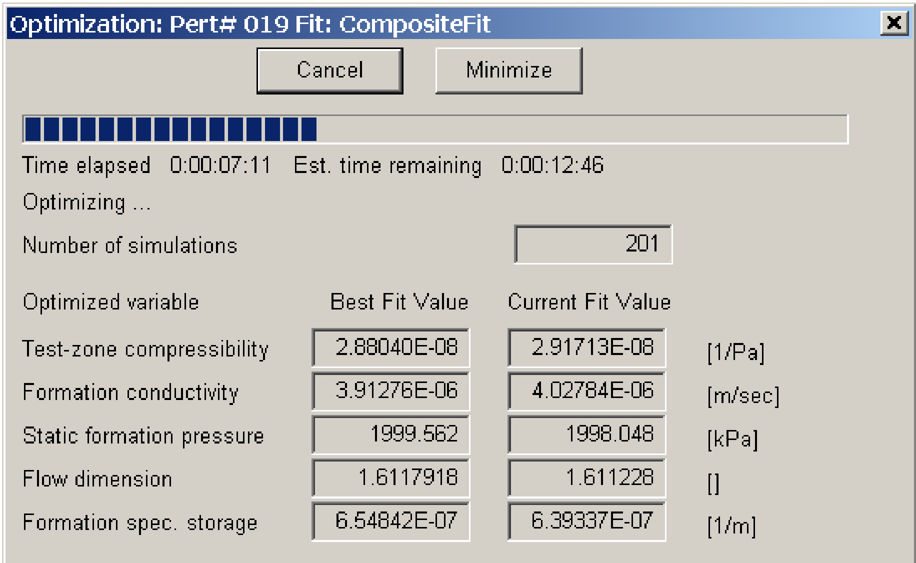


Figure 11.31 Verbose Run Window for Perturbation Analysis

(6) Exit nPre.

11.4.4.2 To create a histogram plot

(1) Within nPost, and the *Input Data* page, create a new object: **Object→New→Read Input→Read nSIGHTS Optimizer Results**. The optimization results output file of the perturbation model run will be imported within this object.

- Select the file TutorialPerturb.nOpt using the browse button.
- Select **Apply**.

(2) Create a new data page. Rename the page **Perturb Results**.

(3) Within the *Perturb Results* data page, create a new object: **Object→New→ nSIGHTS Results Extraction→Extract Optimizer Results Table.**

- Select *SimOptResults TutorialPerturb.nOpt* as the **nSIGHTS Opt Results to Select From**.
- At the bottom of the property input window, select the **All** button. All cases included within the optimizer results file will be selected.
- Select the Opt status checkbox. This will include fit value data within the table (e.g. SSE).
- Select **Apply**.

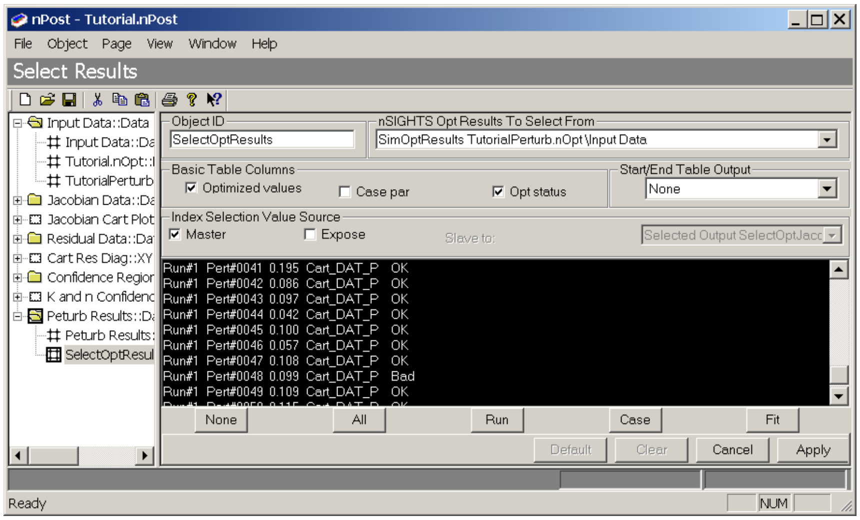


Figure 11.32 Extract Optimizer Results Table Property Window

(4) Within the *Perturb Results* data page, create a new object: **Object→New→Table Processing→Table Column To Histogram**.

- Change the **Object ID** to **KTableHistogram**.
- Select *Output table SelectOptResults \Perturb Results* as the **Table Data To Use**.
- Select *Formation conductivity* from the **Table Column** drop-down-box.
- Select **Apply**.

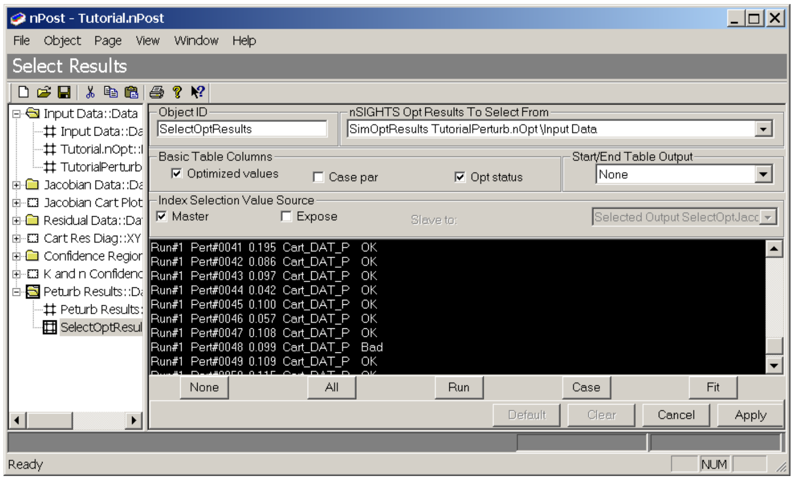


Figure 11.33 Table Column to Histogram Property Window

(5) Create a 2D plot page (**Page→New 2D XY Plot**).

- In the **2D-XY** object, change the name of the page to **K Perturb Histogram**. Select **Apply**.

- In the **X Axis** object, change the **Increment Label Format** to *Scientific* and *0.0E+00*, and select **Apply**.

- Select the **2D Plot Anno** object. Check the Axis Labels box, and type **Hydraulic Conductivity (m/s)** for the X axis and **Frequency** for the Y axis labels. Select **Apply**.

(6) Create a new object in the *K Perturb Histogram* plot page: **Object□New□Data: XY Histogram**.

- Select *K Table Histogram \Perturb Results* from the XY Data to Plot drop-down-box.

- Select *%Avail* for Histogram Width. Check Plot in the **Edges** frame.

- Select **Apply**.

(7) View the plot by selecting the *K Perturb Histogram* plot page from the **Window** menu, or from the **Window List** window. The axes limits will need to be reset (select **Axes->Data Limits** in the 2D window pop-up menu).

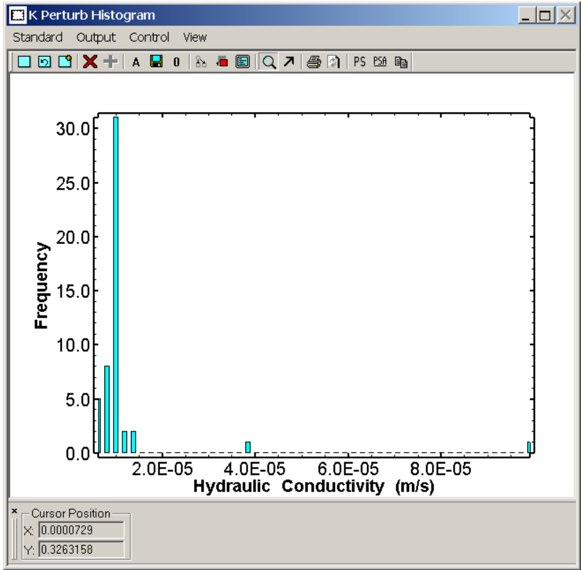


Figure 11.34 K Perturb Histogram

(8) Histogram plots can be created for other parameters, by repeating steps (4) to (7).

11.4.4.3 To create an XY scatter plot

(1) Create a 2D plot page (**Page→New 2D XY Plot**).

- Change the name of the page to **K and n Perturb Scatter** and change the left margin to 100. Select **Apply**.
- In the **X Axis** object, change the **Increment Label Format** to *Scientific* and *0.0E+00*, and select **Apply**.
- In the **Y Axis** object, change the **Increment Label Format** to *Decimal* and *0.000*, and select **Apply**.
- Select the **2D Plot Anno** object. Check the Axis Labels box, and type **Hydraulic Conductivity (m/s)** for the X axis and **Flow Dimension** for the Y axis labels. Select **Apply**.

(2) Create a new object in the *K and n Perturb Scatter* plot page: **Object→New→Data: Single Table Series**.

- Select *Output table SelectOptResults \Perturb Results* as the **Table Data**.
- Select *Formation conductivity* as the **X Data Column**.
- Select the first checkbox, and select *Flow Dimension* from the corresponding drop-down-box.
- Change the *Line* to *Symbol*.
- Select **Apply**.

(3) View the plot by selecting the *K and n Perturb Scatter* plot page from the **Window** menu, or from the **Window List** window. The axes limits will need to be reset (select **Axes->Data Limits** in the 2D window pop-up menu).

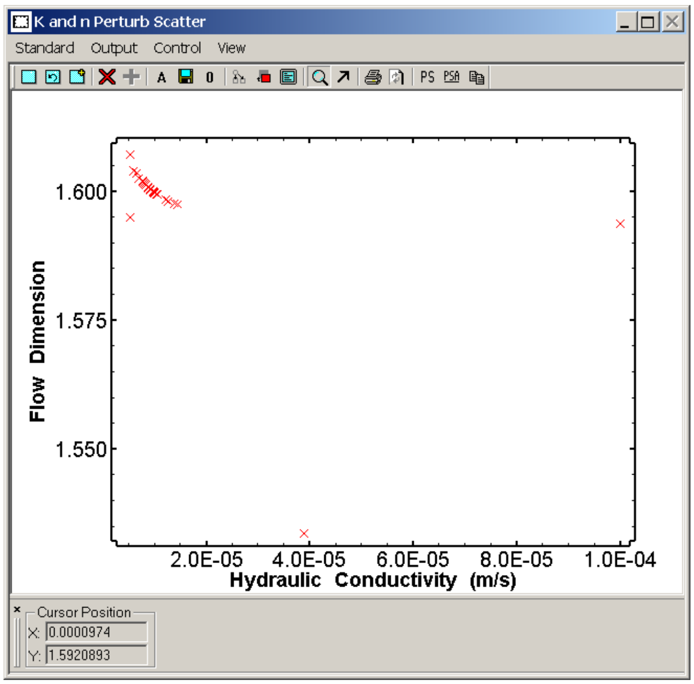


Figure 11.35 K and n Perturbation Scatter Plot

(4) A useful addition to the XY data plot are the confidence regions for each perturbation. Return to the *Perturb Results* data page, and add an **Extract Covariance Matrices** object (**Object→New→nSIGHTS Results Extraction→Extract Covariance Matrices**).

- Select *SimOptResults TutorialPerturb.nOpt* from the **nSIGHTS Opt Results To Select From** drop-down list.

- Check the Multiple checkbox in the **Index Selection Value Source** frame.

- Press the **All** button.

- Select **Apply**.

(5) Return to the *K and n Perturb Scatter* plot page, and add **Object□New□Data: Confidence Limits - Two Parameter**.

- Select *Covar Array SelectOptCovar \Perturb Results* as the **Covariance Data**.

- Select *Formation conductivity* as the X variable, and *Flow dimension* as the Y variable.

- Select **Limit Type** *Dual*.

- Select **Apply**.

(6) View the *K and n Perturb Scatter* plot page again.

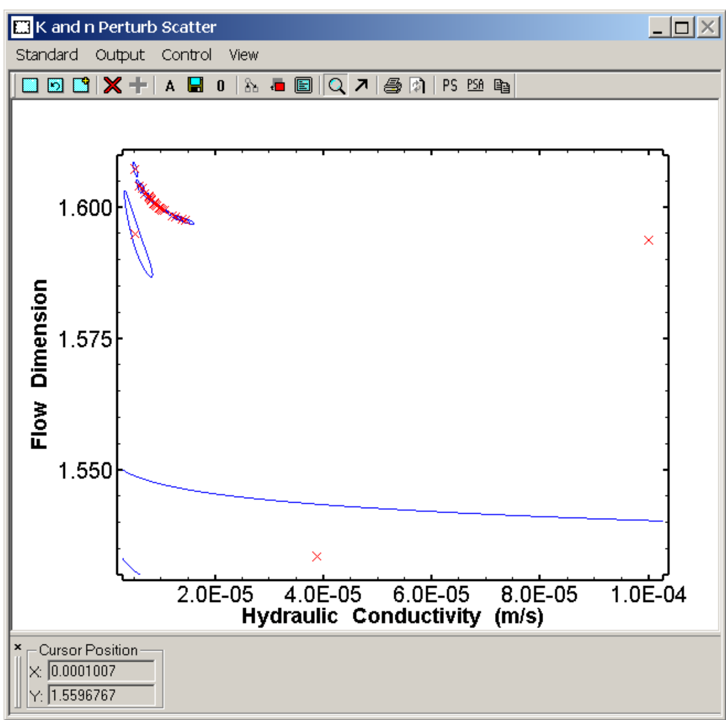


Figure 11.36 K and n Perturbation Scatter Plot with Confidence Limits

(7) XY scatter plots can be created for other parameter combinations, by repeating steps (1) Create a 2D plot page (to (6) View the:

11.4.4.4 To create an XYZ scatter plot

(1) Create a 3D plot page (**Page□New 3D XY Plot**).

- Change the name of the page to **K and n XYZ Scatter**. Select **Apply**.
- In the **X Axis** object, change the **Increment Label Format** to *Scientific* and *0.0E+00*, and select **Apply**.
- In the **Z Axis** object, change the **Increment Label Format** to *Scientific* and *0.0E+00*, and select **Apply**.
- Select the **3D Axes Label** object. Check the Axis Labels box, and type **Hydraulic Conductivity (m/s)** for the X axis, **Flow Dimension** for the Y axis labels and **SSE** for the Z axis labels. Select **Apply**.

(2) Create a new object in the *K and n XYZ Scatter* plot page: **Object□New□Data: Table Series**.

- Select *Output table SelectOptResults \Perturb Results* as the **Table Data**.
- Select *Formation conductivity* as the **X Data Column**, select *Flow Dimension* as the **Y Data Column**, and select *SSE* as the **Z Data Column**.
- Change the *Line* to *Symbol*. Change the symbol to *Filled C*.
- Select **Apply**.

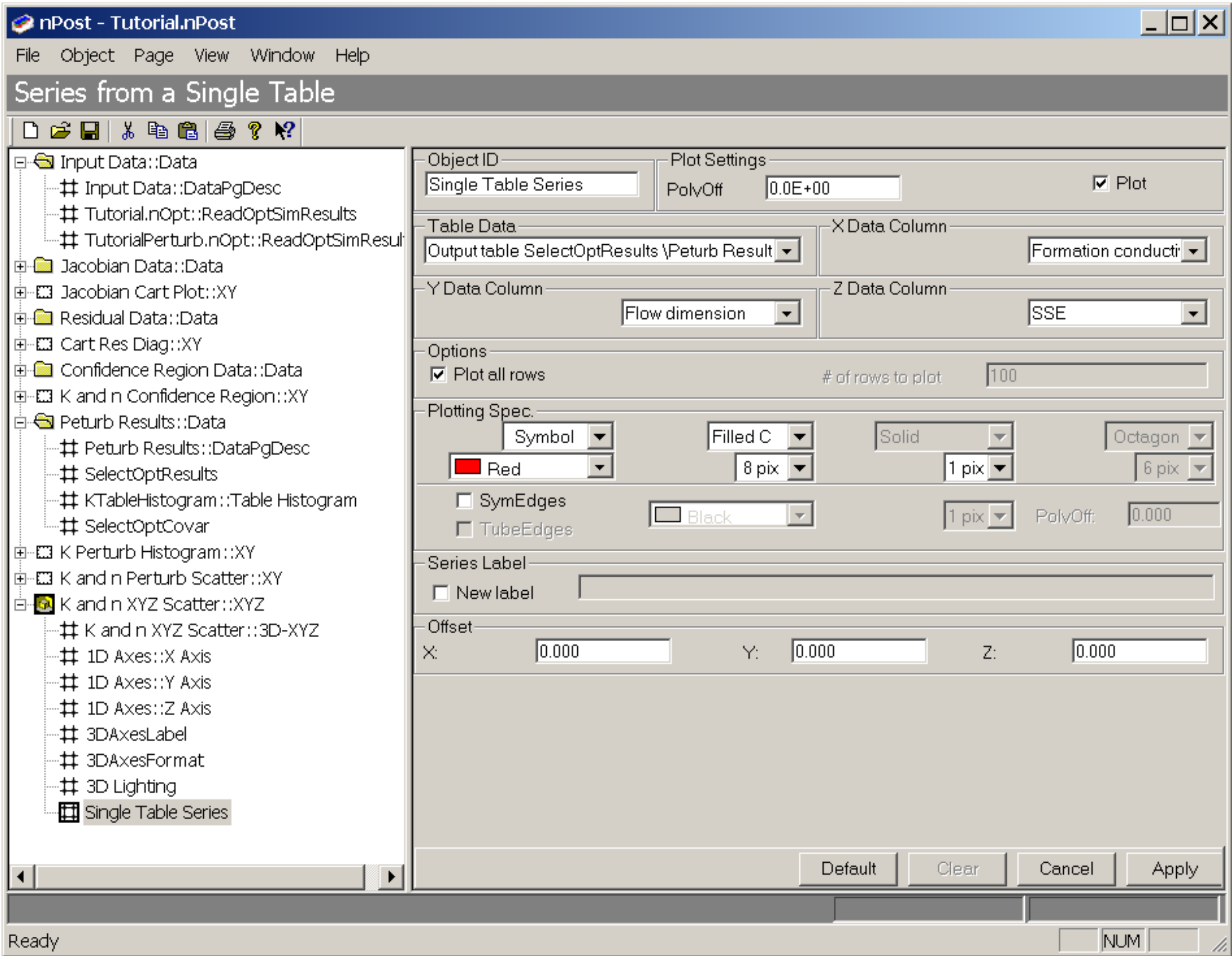


Figure 11.37 3D Table Series Property Window

(3) View the plot by selecting the *K and n XYZ Scatter* plot page from the **Window** menu, or from the **Window List** window. The axes limits will need to be reset (select **Axes->Data Limits** in the 2D window pop-up menu).

As well, the plot's view can be adjusted, using the slider controls at the bottom of the window.

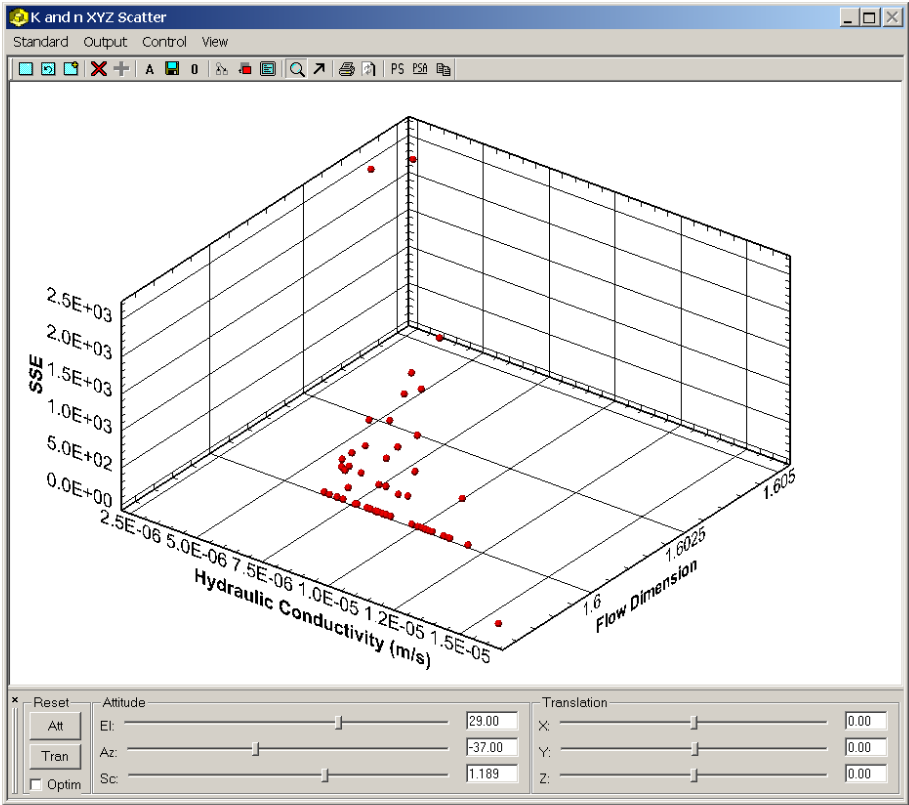


Figure 11.38 K, n and SSE Perturbation XYZ Scatter Plot

(4) XYZ scatter plots can be created for other parameter combinations, by repeating steps (1) to (3). Confidence limits may also be added, if all three parameters are fitting parameters.

11.4.4.5 Viewing Correlation Coefficients

To view a table showing the correlation coefficients between parameters:

(1) Create a list page (**Page→New List**).

(2) Within the list page, create a new object: **Object→New→Optimization Results**. The page will automatically be named the object ID of this object.

- Select the *SimOptResults TutorialPerturb.nOpt* from the **Optimization Results to List** drop-down-box.
- Select *Run#1* in the **Selected Runs to List** frame.
- Select only the Parameter correlations checkbox in the **Listing Selections** frame.
- Select **Apply**.

(3) View the list page by selecting the *OptRun:List* page in the **Window** menu or the **Window List** window menu. The list page will contain text, providing the correlation coefficients between parameters.

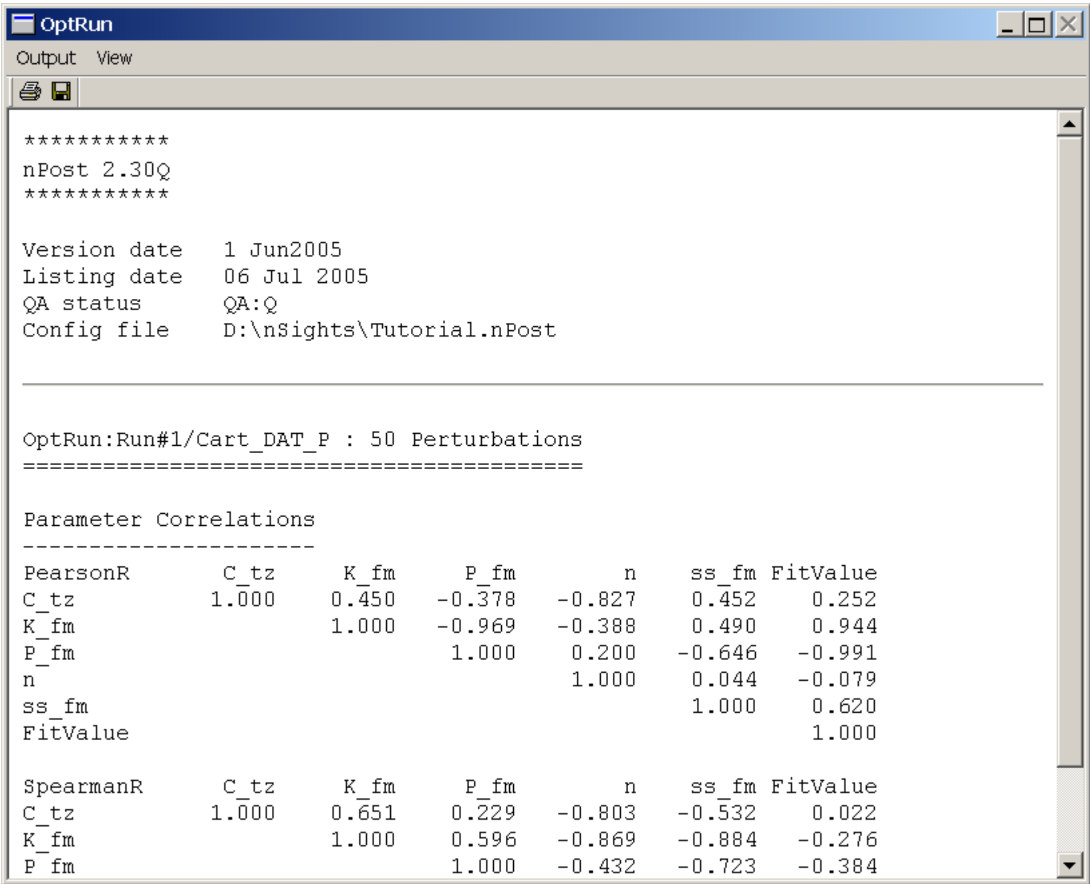


Figure 11.39 List Window Showing Optimization Results

11.4.5 Uncertainty Distributions for Non-fitting Parameters

As with perturbation analysis, examining the uncertainty in fitting parameter uncertainty due to non-fitting parameter estimates requires running many simulations in nPre. For each simulation, a set of non-fitting parameters are determined randomly from an uncertainty distribution (i.e. optimization-sampling mode) and the model re-optimizes the fitting parameters. Correlations between non-fitting and fitting parameters can be observed from the results.

In this tutorial, it will be demonstrated how to conduct an optimization-sampling model run. As with perturbation analysis, a useful plot is the XY or XYZ scatter plot. Variables in an XY or XYZ scatter plot may be optimized parameters or sampled parameters. Extraction of results and creation of XY scatter plots is described in the perturbation analysis section. During extraction of the optimization results table (**Extract Optimizer Results Table** object), the Case Parameters checkbox should be selected in order to include sampled parameters in the resulting table data.

It should be noted that the execution of the model for this example will take considerably more time than the simple optimization run (e.g. approximately 10 minutes on a 1GHz dual-processor Pentium III equipped with 2GB of RAM).

To conduct an optimization-sampling model run:

(1) Open nPre.

(2) Open the configuration file Tutorial.nPre (**File→Open** or the standard Windows open file button).

(3) Select the **Optimization** input window. Select the **Perturbation** tab.

- Uncheck the Do optimization perturbation box.

(4) Select the **Configuration** input window. In the **Main** tab, select *Sampling* as the Simulation sub-type.

(5) In the **Parameter** input window, select non-fitting parameters to be sampled. For the parameters outlined in the following table, select *Sample* in the Type cell, and double click on the Value cell to bring up the **Sample Value Dialog**. The dialog inputs are also provided in the table below.

Tutorial Sampled Parameter Value Input			
Parameter	**Distribution**	**Distribution Definition**	
Formation thickness	Uniform	Low limit 8 m	Upper limit 15 m
External boundary radius	Normal	Mean 1E5 m	St.dev. 100m
Well radius	Normal	Mean 4 in	St.dev. 0.5 in

(6) In the **Sampling** input window, select *no* for User specified variable correlations.

(7) In the **Output Files** input window, **Optimization** tab, change the file name to **TutorialSampling.nOpt**.

(8) Select the **Verbose** command from the **Run** menu. As the model executes, a window will track the progress of the model. Note that the estimated time remaining will fluctuate considerably until several perturbation simulations have been conducted.

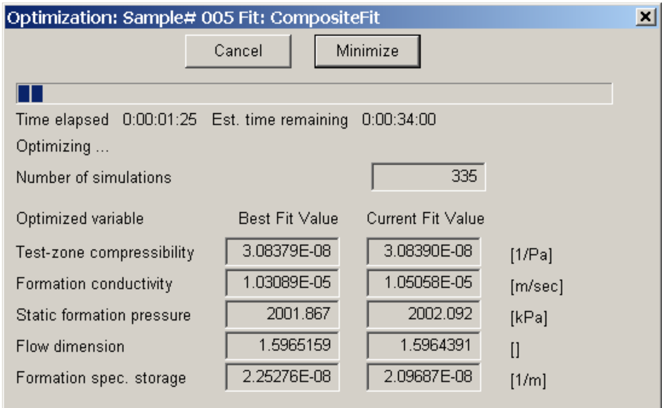


Figure 11.40 Verbose Run Window for Optimization-Sampling Mode

(9) Exit nPre.

To create XY and XYZ scatter plots in nPost, refer to Section 11.4.4. The following is an example of an XYZ plot based on the optimization-sampling run:

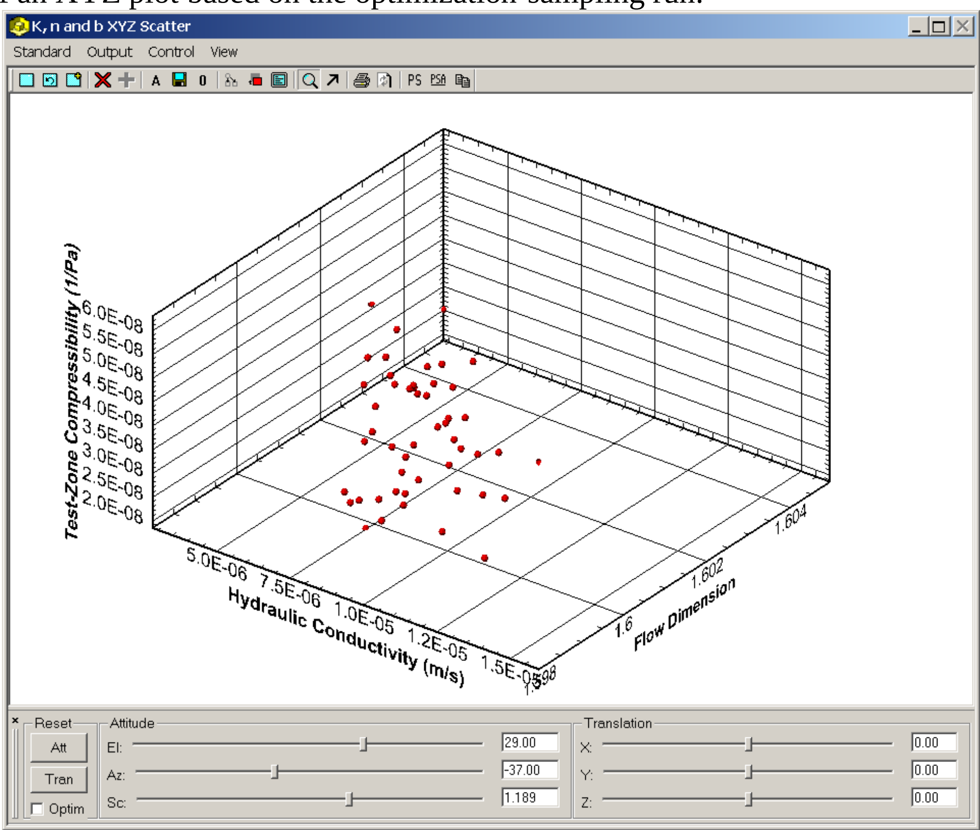


Figure 11.41 Hydraulic Conductivity, Flow Dimension and Test-Zone Compressibility XYZ Scatter Plot

12 REFERENCES

Nuclear Waste Management Program. August 15, 1996. *GTFM User Documentation Version 6.0: Functional Description, Theoretical Development, and Software Architecture*. ERMS 240244. Albuquerque, NM: Sandia National Laboratories.

13 APPENDIX A – DATA OBJECT DESCRIPTIONS

13.1 Add Noise

What: Adds noise to Y data randomly based on a *Uniform* or *Normal* distribution.

Why: Used to create synthetic data.

Used By: Any object using XY data.

Appearance:

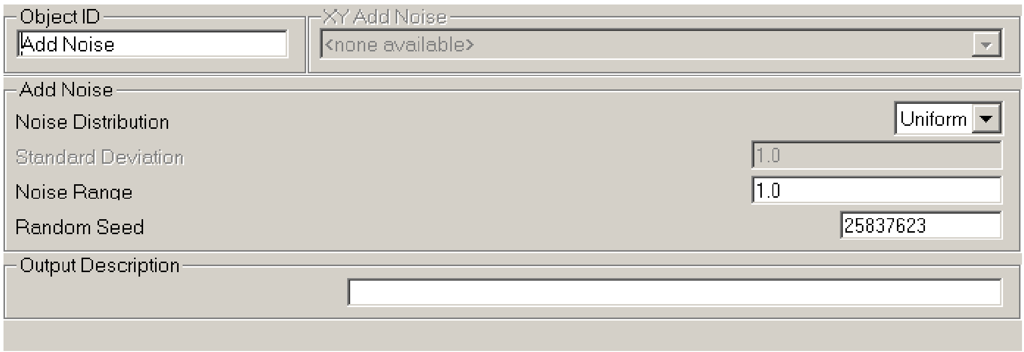


Figure 13.1 Add Noise Property Window

Input Data: XY data

Output Data: XY data

Properties:

Add Noise

Noise Distribution — A *Uniform* or *Normal* distribution can be selected.

Standard Deviation — For a normal noise distribution, the standard deviation limits the range of the added noise.

Noise Range — For a uniform distribution, the noise added to the data is limited to the entered range.

Random Seed — The random seed used to generate the noise in the data is entered, in order to be able to reproduce the added noise.

Output Description — Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

13.2 Add XY to Array

What: Creates a collection of XY data from a single XY data object. Each time the **Apply** button is selected within the specified input XY data object, new XY data are added to the array. For example, if an **Extract XY from Grid** object (extracts XY data from a grid) is used as input, XY data for different Extraction Constant Values can be added to the array by changing the Extraction Constant Value in the **Extract XY from Grid** object and pressing the **Apply** button.

Why: To create an XY array from a data source containing many sets of XY data, but not in an XY array format (e.g. a grid, a curve file or a table).

Used By: Any object using an XY array, such as **Array Scale/Transform** or **XY Array Horsetail**.

Appearance:

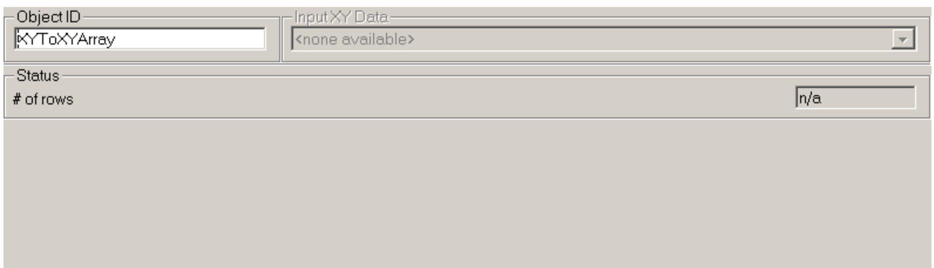


Figure 13.2 Add XY to Array Property Window

Application: nPost

Input Data: XY data

Output Data: XY array

Properties:

Input XY Data Select the input XY data source for the array. Each time the input XY data source is changed (i.e. the **Apply** button is selected for the input XY data object), the new XY data will be added to the array.

Status

# of rows Indicates the number of XY data sets in the array. Each XY data set is one row within the array.

13.3 Array Scale/Transform

What: Performs mathematical operations on XY array data types.

Why: Unit conversions or other data manipulations.

Used By: Any object using an XY array, such as **XY Array Horsetail** or **Select XY from XY Array**.

Appearance:

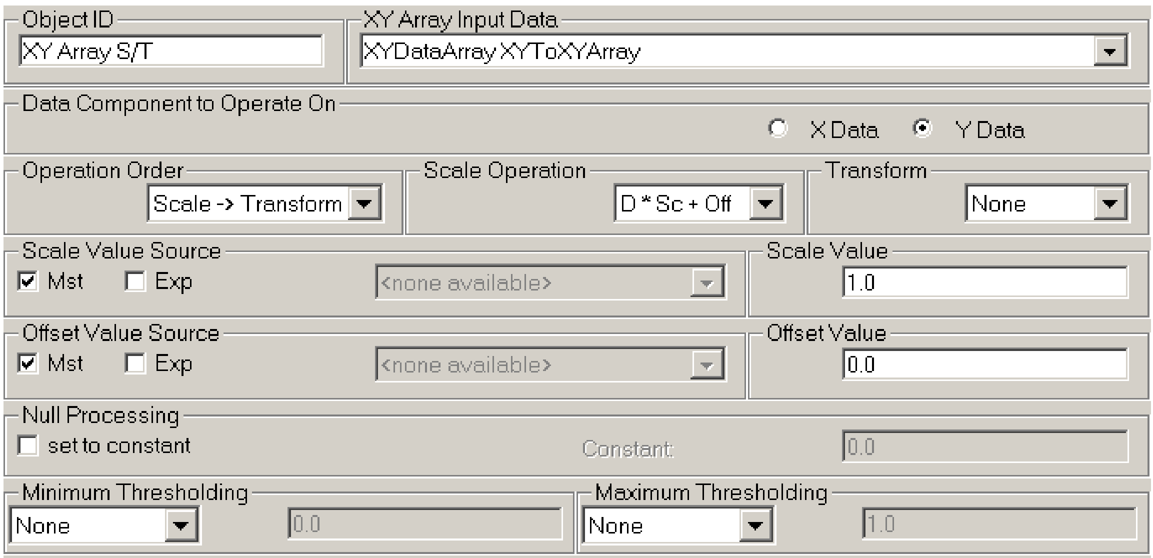


Figure 13.3 Array Scale/Transform Property Window

Application: nPost

Input Data: XY array

Output Data: XY array

Properties:

XY Array Input Data The input XY array data set that is scaled and/or transformed is selected.

Data Components to Operate On

X Data If selected, the X data of the array are scaled and/or transformed.

Y Data If selected, the Y data of the array are scaled and/or transformed.

The remaining scale/transform options are described in Section 7.1.3.

13.4 (Basic) Single Fit

What: Pairs field and simulated data to be selected as a constraint. Typically used in the **Fit** tab of the **Plots & Data Processing** nPre input window.

Why: Used to determine the field data that simulated data should be compared to during an optimization or range simulation.

Used By: **Fit Selection** tab of the **Fit Selection** nPre input window.

Appearance:

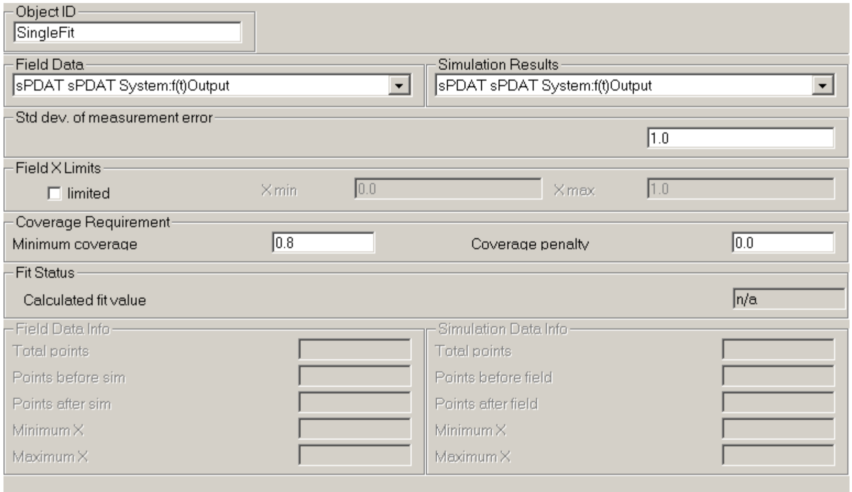


Figure 13.4 (Basic) Single Fit Property Window

Input Data: XY data

Output Data: fit specification

Properties:

Field Data Select XY or table data representing field data.

Simulation Results Select XY or table data representing simulation data.

Std dev of measurement error The standard deviation is used in the calculation of the Chi-squared minimization function.

Field X Limits The X limits of the data, usually time, can be limited between X min and X max if the limited checkbox is selected.

Coverage Requirement

Minimum Coverage After data processing, the number of simulated data points may be less than the number of field data points. If the number of simulated data points multiplied by the minimum coverage value is less than the number of field data points, an error will result for the fit.

Coverage penalty — The fit value is adjusted by multipling the fit value by: 1.0 + coverage penalty / actual coverage value.

Fit Status

Calculated Fit Value — Once simulation results have been generated, the calculated fit value for the specified field and simulated data will be displayed.

Field Data Info — Provides basic information about the field data selected, including the total number of points, points before and after the simulation, and the minimum and maximum X values.

Simulation Data Info — Provides the same information as **Field Data Info**, but for the selected simulation data. Will not be active until simulation results have been generated.

13.5 Calculate Basic Residual

What: Processes residuals from selected residual data. Residuals can be sorted in ascending or descending order, plotted versus the X Value or the data Index, and/or standardized to make the data comparable to a standard normal probability distribution.

Why: To manipulate residuals for the creation of specific plots.

Used By: **XY Series** plot object.

Appearance:

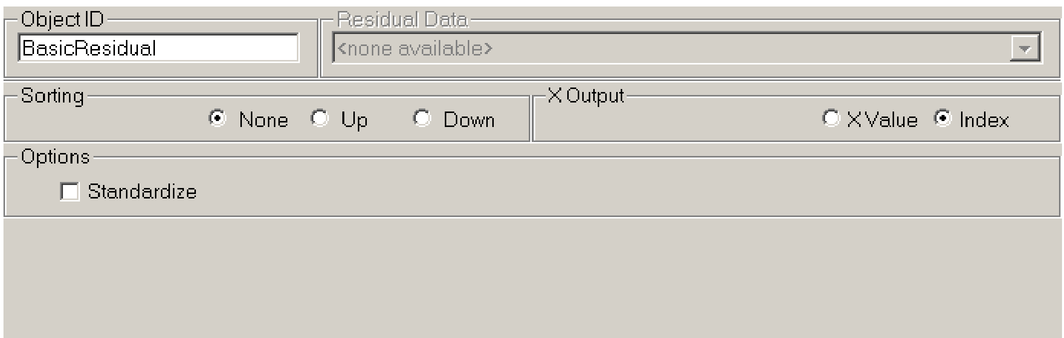


Figure 13.5 Calculate Basic Residual Property Window

Application: nPost

Input Data: Extract Residuals

Output Data: XY data

Properties:

Residual Data Select the residual data to be processed.

Sorting

None The residual data are not sorted.
Up The residual data are sorted in ascending order.
Down The residual data are sorted in descending order.

X Output

X Value The X value of the resulting residuals will be equal to the X value of the input.

Index The X value of the resulting residuals will be equal to the index of the input.

Options

Standardize — If selected, the residuals will be standardized to make the data comparable to a standard normal probability distribution.

13.6 Calculate CDF of Table Column

What: Creates a cumulative distribution function from the specified table column data.

Why: To create a cumulative distribution function.

Used By: Any object using CDF or XY data. Note that once a CDF is processed by an object with XY data as output, it is no longer a CDF. Use the **Validate XY Data** as CDF object to re-create the CDF.

Appearance:

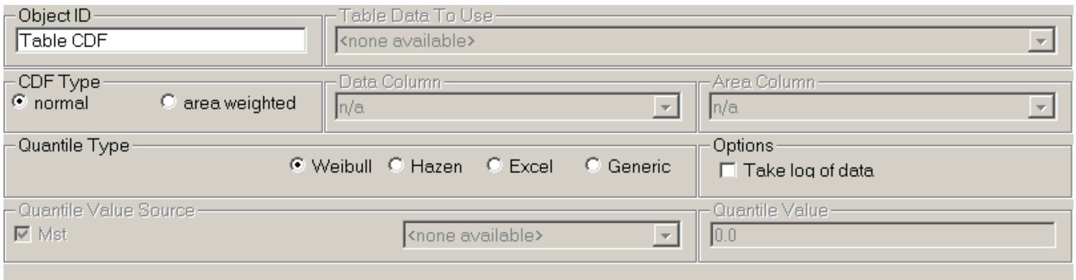


Figure 13.6 Calculate CDF of Table Column Property Window

Input Data: table data

Output Data: CDF

Properties:

Table Data To Use The table data set containing the column used for the CDF calculation is selected.

CDF Type

normal The CDF is calulated using the **Data Column** and the plotting position formula (based on the **Quantile Type**).

area weighted The CDF is determined by sorting the table based on the **Data Column**, and calculating the quantile from a cumulative normalized **Area Column** value.

Data Column The table column used to calculate the CDF is selected in the drop-down box.

Area Column The table column used in the area weighted CDF calculation is selected in the drop-down box.

Quantile Type The following formula is used to determine the plotting position: (i + 1 - **Quantile Value**)/(n + 1 - 2***Quantile Value**). The **Quantile Value** may be a standard value (0 for Weibull, 0.5 for Hazen, 1.0 for Excel), or may be specified (Generic type).

Options

Take log of data The log of the data is taken before the CDF is created.

Quantile Value Source Master/Slave and expose controls for the **Quantile Value**. See Section 6.3 for more information on these controls.

Quantile Value For Generic **Quantile Type** only.

13.7 Calculate CDF of XY Data

What: Creates a cumulative distribution function from either X or Y data.

Why: To create a cumulative distribution function.

Used By: Any object using CDF or XY data. Note that once a CDF is processed by an object with XY data as output, it is no longer a CDF. Use the **Validate XY Data** as CDF object to re-create the CDF.

Appearance:

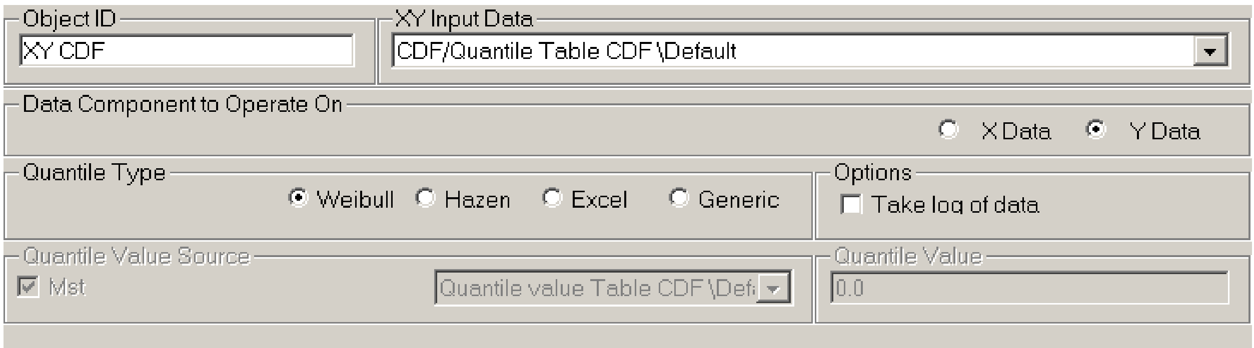


Figure 13.7 Calculate CDF of XY Data Property Window

Input Data: XY data

Output Data: CDF

Properties:

XY Input Data	The XY data set used to calculate the CDF is selected in the drop-down box.
Data Component to Operate on	Either the X or the Y data are used to calculate the CDF.
Quantile Type	The following formula is used to determine the plotting position: (i + 1 - **Quantile Value**)/(n + 1 - 2***Quantile Value**). The **Quantile Value** may be a standard value (0 for Weibull, 0.5 for Hazen, 1.0 for Excel), or may be specified (Generic type).
Options	
Take log of data	The log of the data is taken before the CDF is created.
Quantile Value Source	Master/Slave and expose controls for the **Quantile Value**. See Section 6.3 for more information on these controls.
Quantile Value	For Generic **Quantile Type** only.

13.8 Calculate Joint Confidence of Opt Results

What: Calculates confidence of optimization results by the F-test method or Log-Likelihood method, relative to a best fit case.

Why: To estimate confidence regions.

Used By: Any object using table data.

Appearance:

Figure 13.8 Calculate Joint Confidence of Opt Results Property Window

Input Data: **nSIGHTS Optimizer Results**

Output Data: table data

Properties:

nSIGHTS Opt Results To Select From Confidence is calculated for each opimization result found in the optimizer results selected.

Options

automatically determine best fit case — If selected, the best fit case with the smallest SSE will be selected as the best fit case. Otherwise, the case selected in the **Select Best Fit Case** list will be used as the best fit case.

F-test method — If selected, confidence is calculated using the F-test method.

Log-likelihood method — If selected, confidence is calculated using the Log-likelihood method.

Select Run — Confidence calculations are performed on a single run, selected from the optimization results here.

Select Fit — Confidence calculation are performed on a single fit (may be composite).

Select Best Fit Case — If not automatically determined, the best fit case is selected here.

13.9 Calculate Joint Confidence of Grid

What: Calculates confidence of grid points, where the value of each grid point is the fit result, by the F-test method or Log-Likelihood method, relative to a best fit case.

Why: To estimate confidence regions.

Used By: Any object using table data.

Appearance:

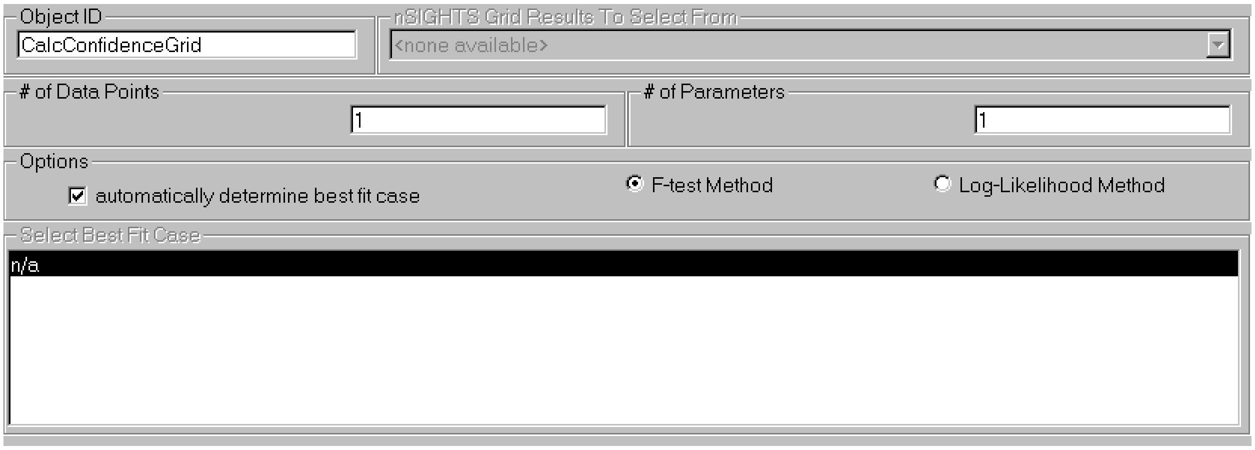


Figure 13.9 Calculate Joint Confidence of Grid Property Window

Input Data: grid data

Output Data: table data

Properties:

nSIGHTS Grid Results To Select From Confidence is calculated at each point on the grid selected.

# of Data Points Number of data points used for SSE calculation (i.e. number of field points in the fit).

# of Parameters Number of parameters optimized.

Options

automatically determine best fit case — If selected, the best fit case with the smallest SSE will be selected as the best fit case. Otherwise, the case selected in the **Select Best Fit Case** list will be used as the best fit case.

F-test method — If selected, confidence is calculated using the F-test method.

Log-likelihood method	If selected, confidence is calculated using the Log-likelihood method.
Select Best Fit Case	If not automatically determined, the best fit case is selected here.

13.10 Calculate Joint Confidence of Table

What: Calculates confidence of points in a table containing fit results by the F-test method or Log-Likelihood method, relative to a best fit case.

Why: To estimate confidence regions.

Used By: Any object using table data.

Appearance:

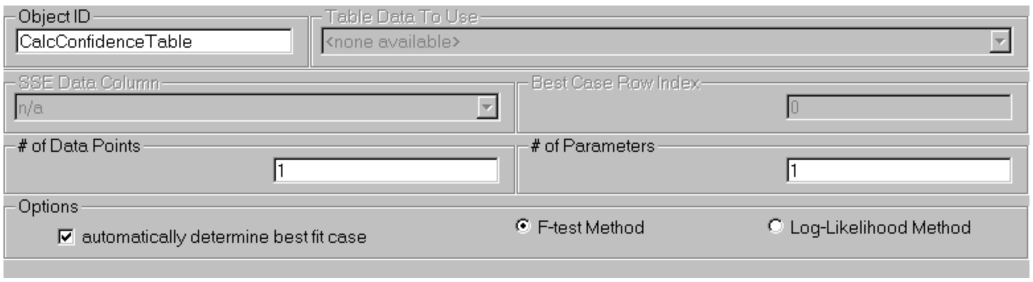


Figure 13.10 Calculate Joint Confidence of Table Property Window

Input Data: table data

Output Data: table data

Properties:

Table Data To Use Confidence is calculated for each row of data in the selected table.

SSE Data Column The column containing the fit results, sum-squared-error (SSE), is selected.

Best Case Row Index If not automatically determined, the row index of the best fit case is entered.

# of Data Points Number of data points used for SSE calculation (i.e. number of field points in the fit).

# of Parameters Number of parameters optimized.

Options

automatically determine best fit case If selected, the best fit case with the smallest SSE will be selected as the best fit case. Otherwise, the case selected in the **Select Best Fit Case** list will be used as the best fit case.

F-test method If selected, confidence is calculated using the F-test method.

Log-likelihood method	If selected, confidence is calculated using the Log-likelihood method.

13.11 Calculate Residual Diagnostic

What: Manipulates selected residual data for a Quantile Normal or Standard normal residual plot.

Why: To plot a quantile normal or standard normal residual plot.

Used By: **XY Series** plot object.

Appearance:

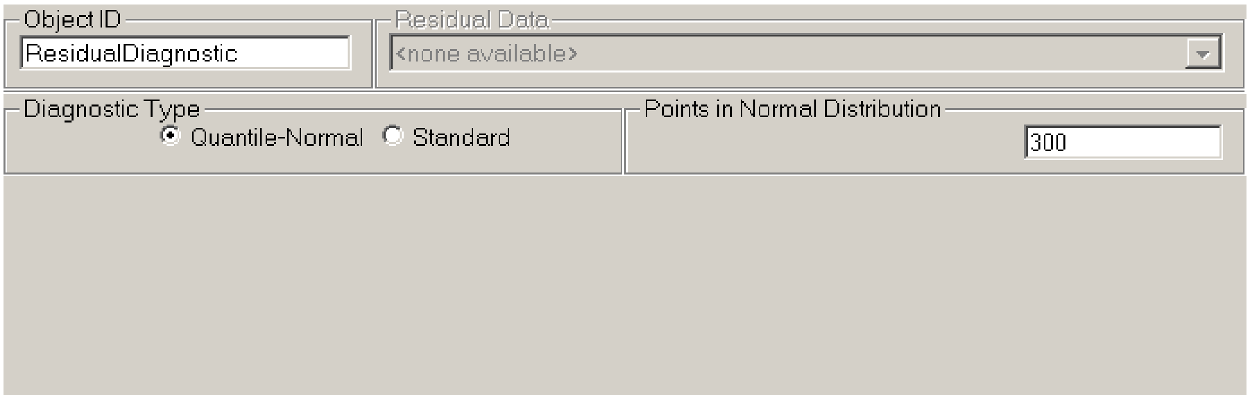


Figure 13.11 Calculate Residual Diagnostic Property Window

Application: nPost

Input Data: Extract Residuals

Output Data: Two XY data sets, one containing the manipulated data, the second a diagnostic line (*Quantile Line* or *CumNormDist*)

Properties:

Residual Data The residual data set manipulated is selected.

Diagnostic Type

- Quantile-Normal: Residual data are manipulated for a quantile-normal plot.
- Standard: Residual data are manipulated for a standard-normal plot.

Points in Normal Distribution The number of points for the resulting normal distribution is entered.

13.12 Calculate Residual Histogram

What: A special case of the **Histogram** object, this object creates the input data for a histogram plot based on residual data. The bin limits determined from the input residual data, and a linear histogram is always created. The actual histogram is plotted using an **XY Series** plot object on a plot page, with this object as the input.

Why: Manipulates data in order to plot a histogram.

Used By: **XY Series** plot object.

Appearance:

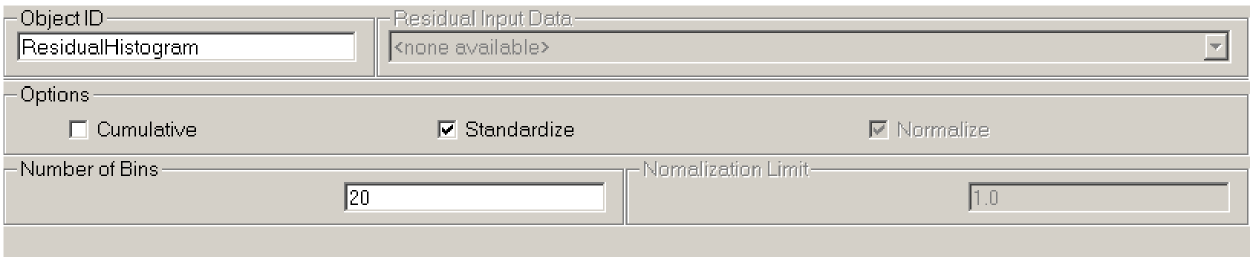


Figure 13.12 Calculate Residual Histogram Property Window

Application: nPost

Input Data: Extract Residuals

Output Data: Two XY data sets, one containing the histogram data, the second the standard normal distribution of the data. The second data set is only output if the Standardize option is selected; otherwise, the data set is null.

Properties:

Residual Input Data The residual data used to create the histogram is selected.

Options

Cumulative — Cumulative frequencies are calculated.

Standardize — Frequencies are calculated for a standardized residual (residuals are subtracted by the mean, and divided by the standard deviation).

Normalize — Frequencies are calculated for residuals normalized within the specified **Normalization Limit**.

Number of Bins The number of bins for the histogram are entered in the text box.

Normalization Limit The normalization range if normalized frequencies are calculated. For example, a normalization limit of 5 will result in bin limits between -5 and 5.

13.13 Composite Fit

What: Combines fit specification objects. A fit specification object contains a pair of field and simulated data to be selected as a constraint. Typically used in the **Fit** tab of the **Plots & Data Processing** nPre input window.

Why: The model will fit all fits specified in this object simultaneously.

Used By: **Fit Selection** tab of the **Fit Selection** nPre input window.

Appearance:

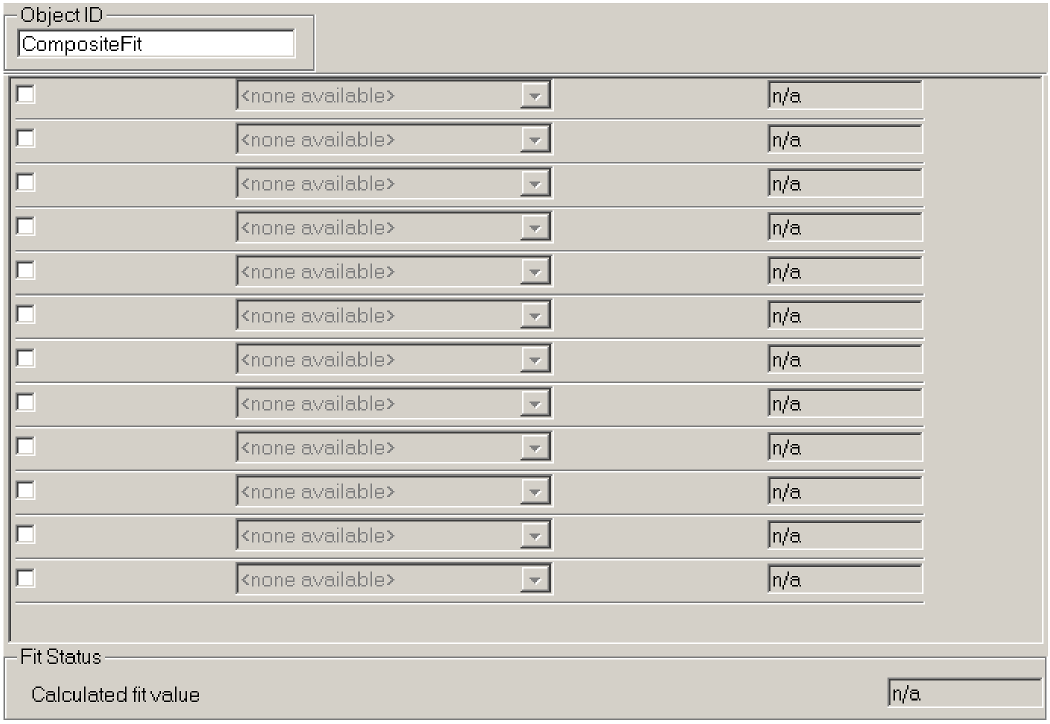


Figure 13.13 Composite Fit Property Window

Input Data: Single Fit, Sequence Fit or Composite Fit

Output Data: fit specification

Properties:

For each checkbox selected, a fit object is selected. The additional box provides the calculated fit value for each selected fit object, once simulation results have been generated.

Fit Status

Calculated Fit Value — Once simulation results have been generated, the calculated fit value for the composite fit will be provided.

13.14 Concatenate Tables

What: Joins multiple tables into one table. Tables may be joined to the base table by adding columns or rows to the base table. Each table must have the same number of rows, if adding columns, or the same number of columns, if adding rows.

Why: To join mulitple tables.

Used By: Any object using table data.

Appearance:

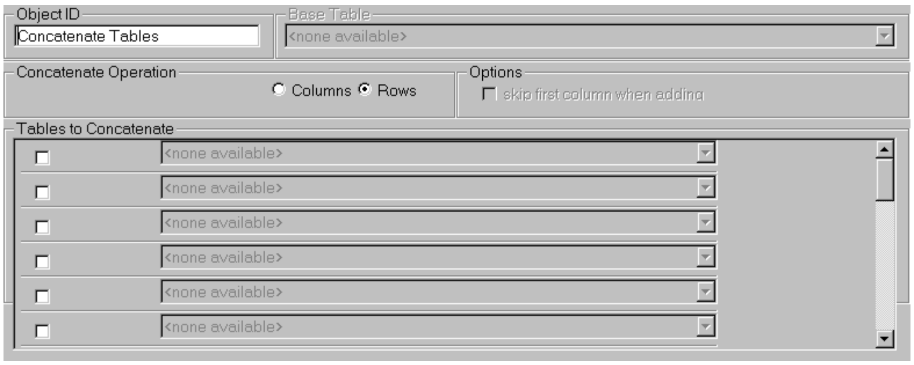


Figure 13.14 Concatenate Tables Property Window

Application: nPost

Input Data: table data

Output Data: table data

Properties:

Base Table The table data to which tables will be joined.

Concatenate Operation

Columns Tables are concatenated by columns, that is the columns of the selected tables to concatenate are added to the base table. Each selected table must have the same number of rows as the base table.

Rows Tables are concatenated by rows, that is the rows of the selected tables to concatenate are added to the base table. Each selected table must have the same number of columns as the base table.

Options

skip first column when adding When concatenating by columns, the first column of each selected table is not added to the new table.

Tables to Concatenate Selects the tables to add to the base table.

13.15 Convert Table To Grid

What: Converts a table with at least 3 rows and 3 columns into a grid. The column headers or the first row and the first column contains the grid coordinate data.

Why: To create grid data.

Used By: Any object using grid data.

Appearance:

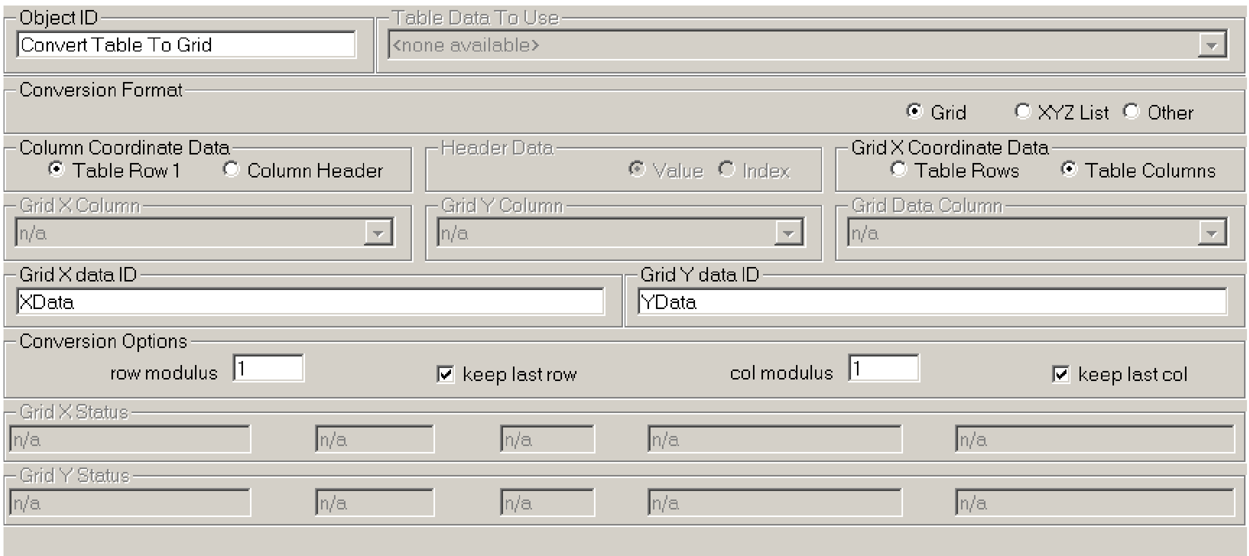


Figure 13.15 Convert Table To Grid Property Window

Application: nPost

Input Data: grid data

Output Data: grid data

Properties:

Table Data To Use The table data to be converted to a grid is selected. The table must have at least 3 rows and 3 columns.

Conversion Format

Grid The first column or column headers and the first row must contain the coordinate data for the grid.

XYZ The grid is defined by an X column, Y column and Z column.

Column Coordinate Data If Grid **Conversion Format** only.

Table Row 1 Coordinate data is provided in the first row of the table. Note that the value in column 1, row 1 is ignored in this case.

Column Header Coordinate data is provided in the column headers, instead of the first row of the table.

Header Data If Coordinate data is provided in the column headers, the coordinate value can be the column header value or the column header index.

Grid X Coordinate Data If Grid **Conversion Format** only.

Table Rows The first row or column header contains the X coordinate data. Correspondingly, the first column contains the Y coordinate data.

Table Columns The first column contains the X coordinate data. Correspondingly, the first row or column headers contains the Y coordinate data.

Grid X Column The X column for XYZ **Conversion Format**.

Grid Y Column The Y column for XYZ **Conversion Format**.

Grid Z Column The Z column for XYZ **Conversion Format**.

Grid X data ID The ID provided for grid X data.

Grid Y data ID The ID provided for grid Y data.

Conversion Options

row modulus Allows reduction in the number of table rows converted to the grid. For example, a row modulus of 2 causes every other row to be added to the grid.

keep last row For a row modulus greater than 1, the last row in the table is kept.

col modulus Allows reduction in the number of table columns converted to the grid.

keep last col For a column modulus greater than 1, the last column in the table is kept.

Grid X Status Provides the final dimensions of the grid in the X dimension: linear or log increments, the number of X coordinates, the minimum X coordinate value and the maximum X coordinate value.

Grid Y Status Provides the final dimensions of the grid in the Y dimension: linear or log increments, the number of Y coordinates, the minimum Y coordinate value and the maximum Y coordinate value.

13.16 Create BE/ET Response Function

What: Creates a response function based on baseline pressure measurement data, and barometric pressure and/or earth tide data.

Why: The response function can be used to correct pressure data for barometric and earth tide effects.

Used By: **P(t) BE/ET Compensation**

Appearance:

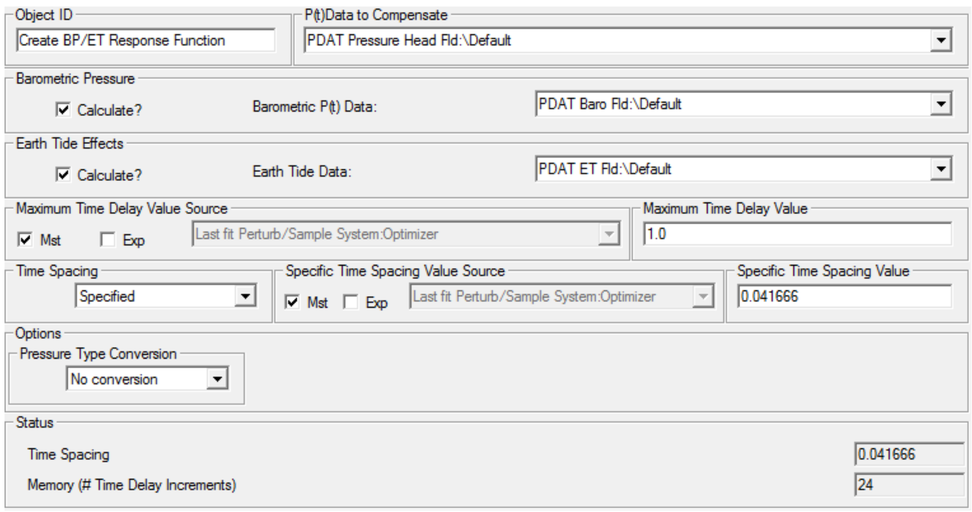


Figure 13.16 Create BE/ET Response Function

Input Data: XY data

Output Data: response function (XY data plus additional relevant data)

Properties:

P(t) Data to Compensate

Baseline pressure data for the response function in XY format. This data does not have to be the same as the data to be corrected using the **P(t) BE/ET Compensation** object.

Barometric Efficiency

If the Calculate toggle is selected, the data selected as Barometric P(t) data will be included in the response function. The barometric data must start before or at the same time and end after or at the same time as the **P(t) Data to Compensate**.

Earth Tide Effects

If the Calculate toggle is selected, the data selected as Earth Tide data will be included in the response function. The earth tide data must start before or at the same time and end after or at the same time as the **P(t) Data to Compensate**.

Maximum Time Delay Value Source Master/Slave and expose controls for the **Maximum Time Delay Value**. See Section 6.3 for more information on these controls.

Maximum Time Delay Value Describes the time lag or memory. Memory is an integer value calculated by dividing the maximum time delay by the time spacing.

Time Spacing Pressure, barometric and earth tide data must be interpolated to the same time spacing before the response function is calculated. This time spacing can be specified, or based on the average time spacing of the pressure, barometric or earth tide data.

Specific Time Spacing Value Source Master/Slave and expose controls for the **Specific Time Spacing Value**. See Section 6.3 for more information on these controls.

Specific Time Spacing Value Determines the time spacing for interpolated data.

Options

Pressure Type Conversion **P(t) Data to Compensate** may be either absolute or relative pressure data, PSIA or PSIG, respectively. If the data is PSIA and PSIG is required for the compensated data, then select "Convert PSIA to PSIG." If data is PSIA is desired and data is PSIG, then select "Convert PSIG to PSIA." Default option is no conversion (compensated data remains the same type as the data to compensate).

Status Provides the time spacing and memory used to calculate the response function. If the time spacing was specified, it should equal the **Specific Time Spacing Value**.

13.17 Create Curve from XY Data

What: Creates functional approximations of XY data sets. The functions available include: Linear, Cubic Spline, Polynomial, Step Mid and Step Full. Each curve type is described in Section 7.1.5.

Why: Used to represent well-bore boundary conditions as a function of time, and parameters as a function of radius or pressure.

Used By: The **Sequence** and **Parameter** input windows.

Appearance:

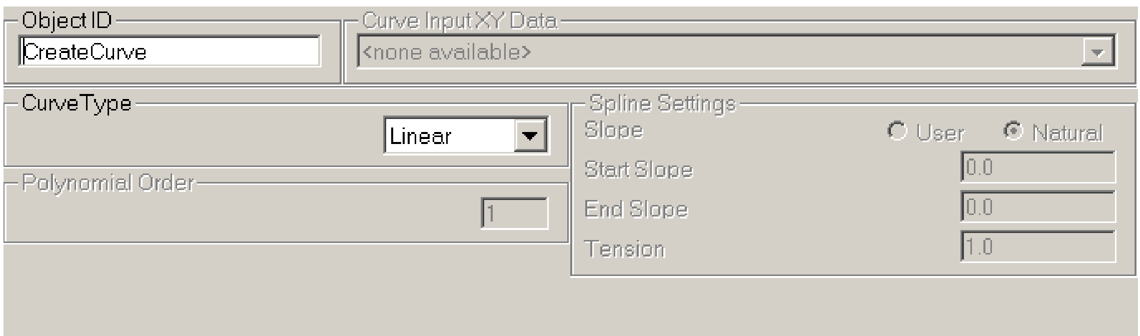


Figure 13.17 Create Curve from XY Data Property Window

Input Data: XY data

Output Data: curve data

Properties:

Curve Input XY Data The XY data set to be used as input data for the curve is selected.

Curve Type The curve type is selected: *Cubic Spline*, *Polynomial*, *Linear*, *StepMid* and *StepFull*. Each curve type is described in Section 7.1.5.

Polynomial Order For polynomial curve types, the order of the polynomial, between 1 to 10, is entered.

Spline Settings For cubic spline curve types, the shape of the curve may be modified by specifying the function slope at the extremes of the function or the spline tension.

Slope: Function slopes at the extremes of the function are specified by the user (User is selected), or are not forced to any specific slope (Natural is selected).

Start Slope: For user set slopes, the slope at the start of the function is specified.

End Slope For user set slopes, the slope at the end of the function is specified.

Tension Used to modify the shape of the function, increasing the tension factor has an effect similar to pulling on either ends of a piece of string, whereas decreasing the tension factor has the effect of providing slack to the piece of string.

13.18 Create Discrete & Step-wise Uniform CDFs

What: Converts XY data representing step-wise uniform or discrete data probability distribution functions to cumulative distribution functions.

Why: Creates a CDF of step-wise or discrete data.

Used By: Any object using CDF or XY data.

Appearance:

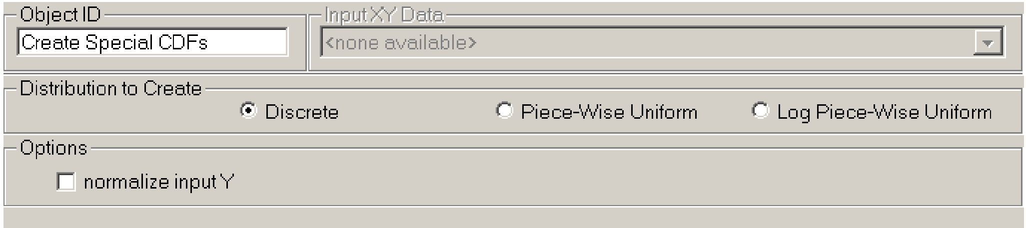


Figure 13.18 Create Real Value Property Window

Input Data: XY data

Output Data: CDF

Properties:

Input XY Data The input step-wise uniform or discrete data to be converted to a CDF. Data in the Y column must be less than 1, unless the Y data is to be normalized.

Distribution to Create A Discrete, Piece-Wise Uniform or Log Piece-Wise Uniform distribution can be created.

Options The input Y data can be normalized before the CDF is calculated. This option allows you to have data greater than 1 in the Y column.

13.19 Create Real Value

What: Outputs a single user-specified value.

Why: Used as input for many other objects.

Used By: Many other objects.

Appearance:

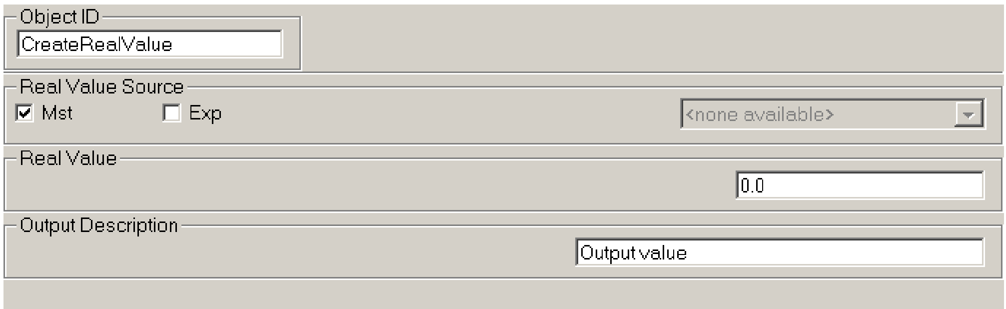


Figure 13.19 Create Real Value Property Window

Input Data: none

Output Data: real value

Properties:

Real Value Source Specifies Master/Slave and expose properties. See Section 6.3 for more information on these properties.

Real Value A real value is entered.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

13.20 Create Sampled Table Data

What: Creates a table column containing values sampled according to a specified probability distribution.

Why: To create sample data conforming to a specified distribution.

Used By: Any object using table data.

Appearance:

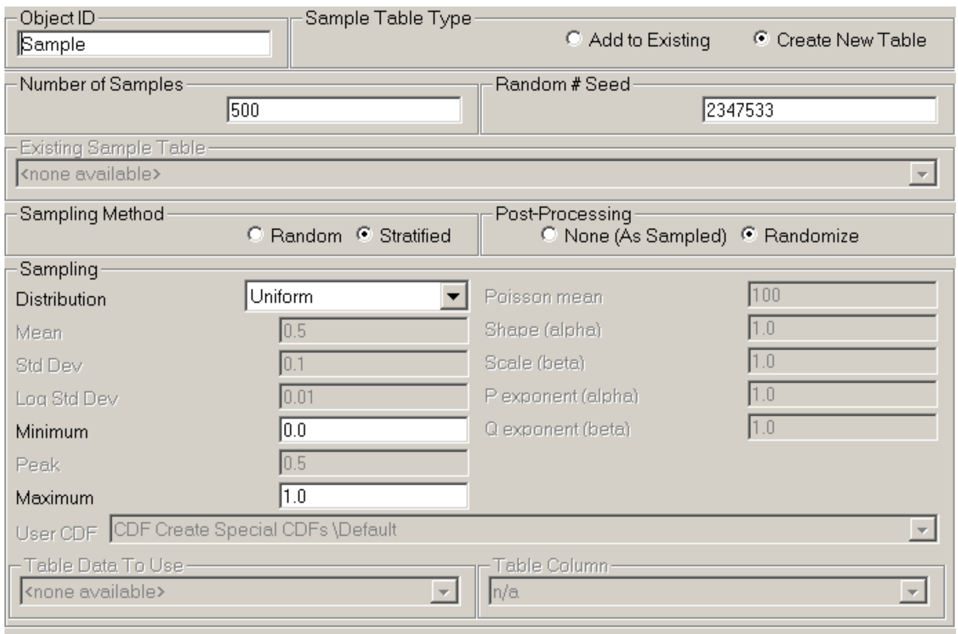


Figure 13.20 Create Sampled Table Data Property Window

Input Data: table data (optional existing table to append new column), CDF (if User CDF is selected distribution), table data (if Tabulated discrete is selected distribution)

Output Data: table data

Properties:

Sample Table Type The table column created can be created in a new table, or appended to an existing table.

Number of Samples Number of rows for the table column.

Random # Seed Random number seed used to generate the probability distribution.

Existing Sample Table If the table column is to be appended to an existing table, the table to append to is selected.

Sampling Method The sampling method can be Random or Stratified.

Post-Processing The resulting samples can be randomized before they are output to the table column.

Sampling The distribution is selected and the distribution parameters are input. The following distributions can be selected:

Normal	The mean and standard deviation are required inputs.
Truncated Normal	The mean, standard deviation, minimum and maximum are required inputs.
Log-Normal	The mean and log standard deviation are required inputs.
Truncated Log-Normal	The mean, log standard deviation, minimum and maximum are required inputs.
Uniform	The minimum and maximum are required inputs.
Log-Uniform	The minimum and maximum are required inputs.
Triangular	The minimum, peak and maximum are required inputs.
Log-Triangular	The minimum, peak and maximum are required inputs.
Exponential	The mean is the only required input.
Poisson	The Poisson mean is the only required input.
Weibull	The shape (alpha) and scale (beta) factors are required inputs.
Beta	The minimum, maximum, P exponent and Q exponent are required inputs.
Student t	The mean and standard deviation are required inputs.
User CDF	A CDF object is selected.
Tabulated	A table data object, and a column from the selected table, are selected.

13.21 Create XY Array

What: Creates a collection of XY data.

Why: Used to create custom XY output from nPre. For example, data processing in nPre can be output so that the same processing does not need to be repeated in nPost.

Used By: **XY Data** tab of the **Output Files** input window.

Appearance:

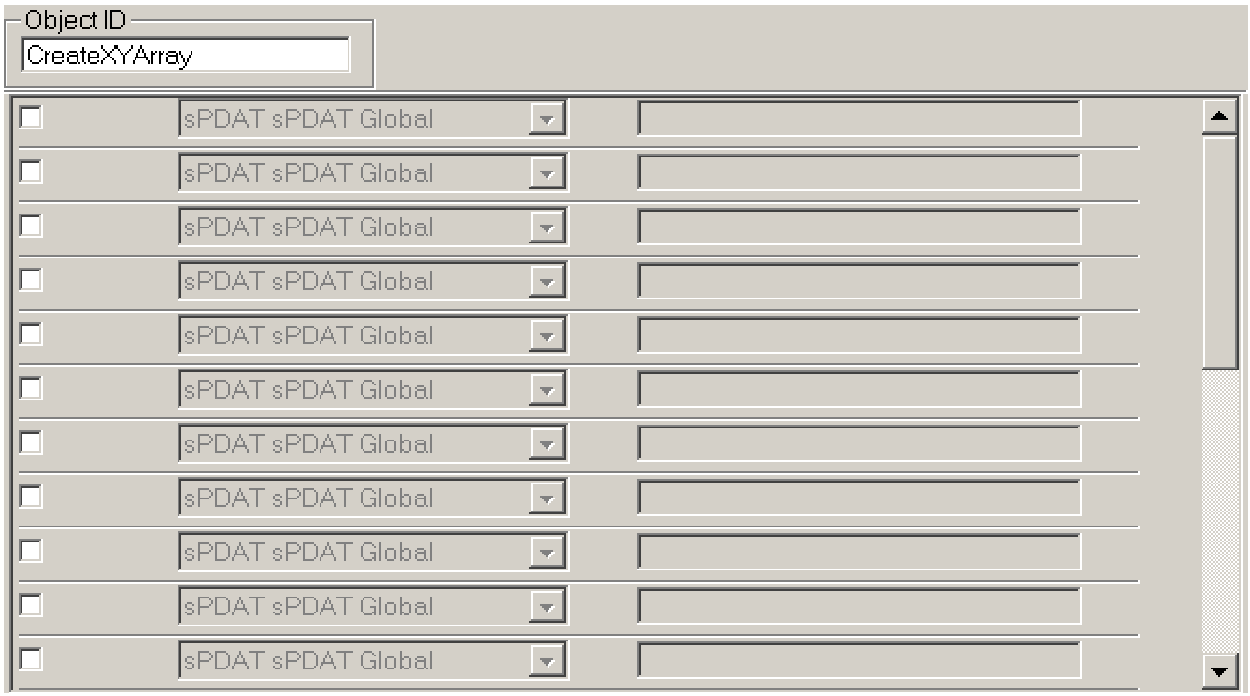


Figure 13.21 Create XY Array Property Window

Application: nPre

Input Data: XY data

Output Data: XY array

Properties:

XY data sets are added to the array by selecting a checkbox, and selecting an XY data object from the corresponding drop-down list. A text box is also provided where a short description of the XY data set may be entered.

13.22 Data Page Description

What: Contains documentation information. This object does not appear on any object selection menu. It is automatically created when a data page is created, and is always the first object on a data page.

Why: To document data processing and visualizations. The object ID for these objects is also used as the page identifier on the associated page button.

Used By: Nothing (no object output).

Appearance:

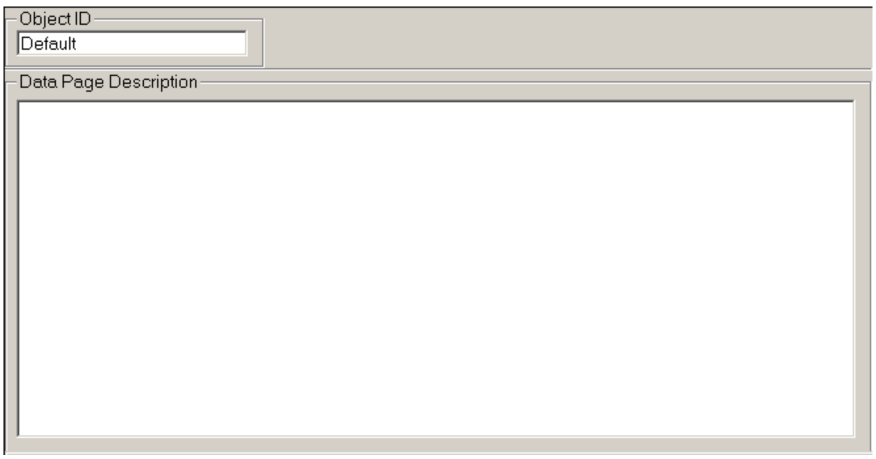


Figure 13.22 Data Page Description Property Window

Input Data: none

Output Data: none

Properties:

Data Page Description A large text box where up to 20 lines of text can be entered.

13.23 Dual Scale/Transform

What: Performs mathematical operations on both the X and the Y of XY data.

Why: Unit conversions or other data manipulations.

Used By: Any object using XY data.

Appearance:

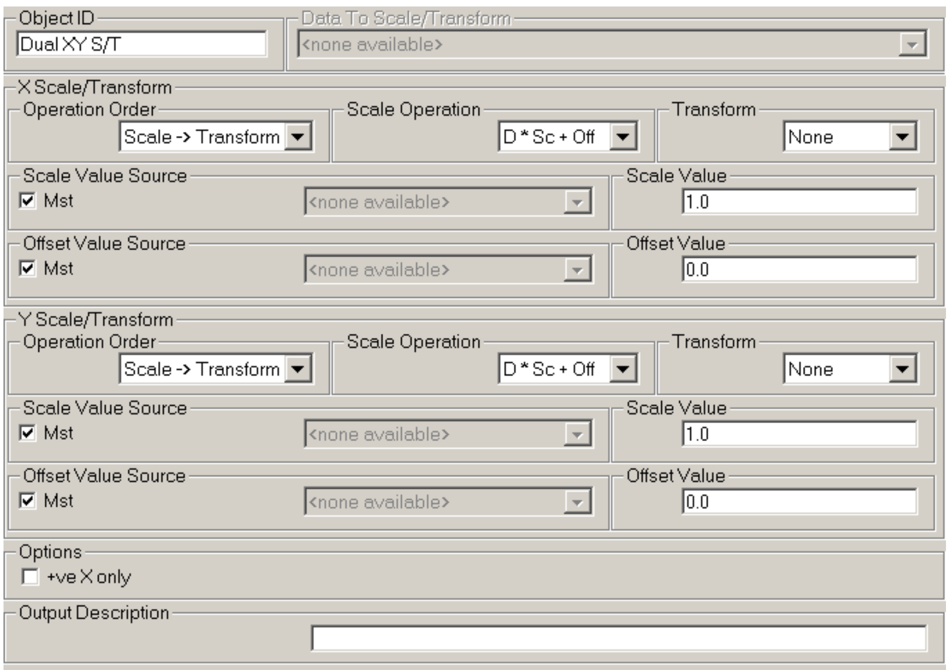


Figure 13.23 Dual Scale/Transform Property Window

Input Data: XY data

Output Data: XY data

Properties:

Options

+ve X only — If selected, the scale/transform options are only performed on positive X values, and their corresponding Y values.

The remaining scale/transform options are described in Section 7.1.3.

13.24 Enter Table Data

What: Allows the user to input or modify table data. Table data can be input or modified by hand, pasted from the clipboard, or updated from another table data-type object.

Why: Used to input or modify table data.

Used By: Any object using table data.

Appearance:

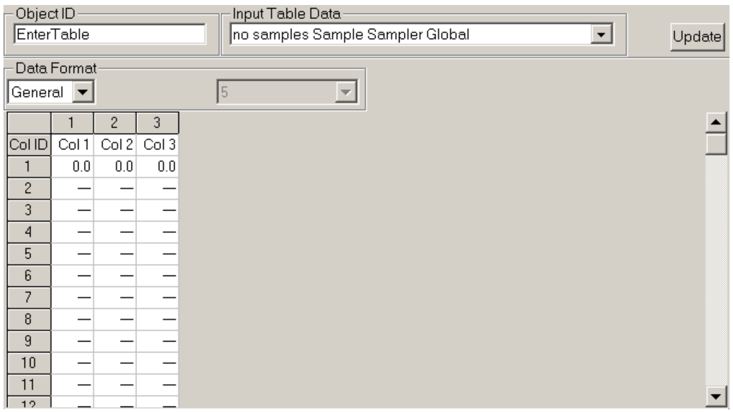


Figure 13.24 Enter Table Data Property Window

Input Data: none or table data

Output Data: table data

Properties:

Input Table Data Table data from an object selected in this drop-down list may be entered into the table by selection of the **Update** button.

Update Upon selection of this button, the table will be replaced by the table values of the object selected as the **Input Table Data**.

Data Format Specifies the numeric format of the data. Number formatting options are described in Section 6.3.3

.

Entering data into the table, and the object specific pop-up window are described in detail in Section 7.1.2.

13.25 Enter XY Data

What: Allows the user to input or modify XY data. XY data can be input or modified by hand, pasted from the clipboard, or updated from another XY data-type object.

Why: Used to input or modify XY data.

Used By: Any object using XY data.

Appearance:

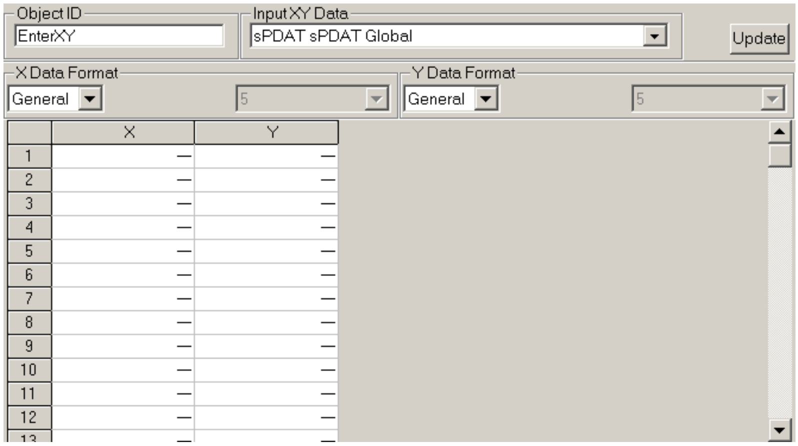


Figure 13.25 Enter XY Data Property Window

Input Data: none or XY data

Output Data: XY data

Properties:

Input XY Data XY data from an object selected in this drop-down list may be entered into the table by selection of the **Update** button.

Update Upon selection of this button, the table will be replaced by the XY values of the object selected as the **Input XY** Data.

Data Format Specifies the numeric format of the data. Number formatting options are described in Section 6.3.3.

Entering data into the table, and the object specific pop-up window are described in detail in Section 7.1.2.

13.26 Extract Covariance Matrices

What: Extracts covariance matrices from one or multiple simulations of an **nSIGHTS Optimizer Results** object. The confidence limits of the covariance matrix can be plotted using the **Confidence Limits** plot object.

Why: For the plotting of confidence limits or the viewing of the covariance matrix in a list page.

Used By: **Confidence Limits** plot object, or **Covariance List** list object.

Appearance:

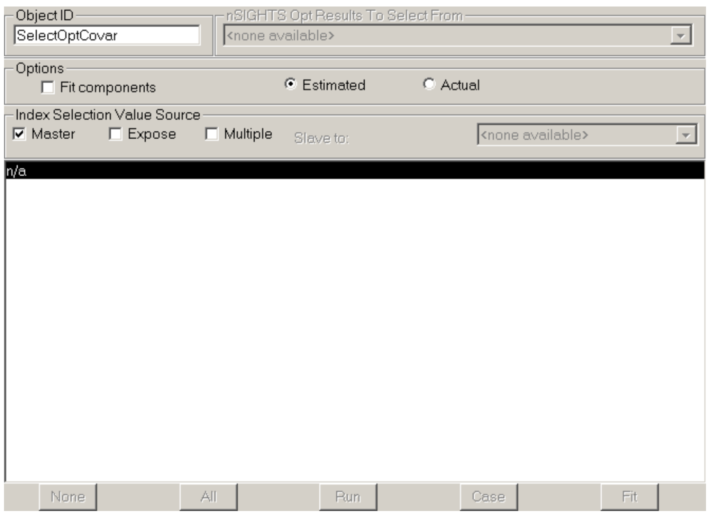


Figure 13.26 Extract Covariance Matrices Property Window

Application: nPost

Input Data: nSIGHTS Optimizer Results

Output Data: covariance data

Properties:

nSIGHTS Opt Results To Select From	The optimizer results from which the covariance matrices are to be extracted is selected.
Options	
Fit components	Allows the covariance matrix of sub-fits to be extracted. A sub-fit is a single fit of a composite fit.
Estimated	Covariance matrices use the estimated standard deviation specified by the user for each parameter.

Actual	Covariance matrices use the actual standard deviation calculated during the simulation.
Index Selection Value Source	A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the covariance matrix. One or multiple selections may be made.
Master	Selection of the simulations may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.
Expose	Selection of the simulations may be exposed. See Section 6.3.2 for more information on exposed controls.
Multiple	Multiple simulations may be selected if this checkbox is selected.
None	Only for multiple selections, no simulations will be selected.
All	Only for multiple selections, all simulations will be selected.
Run	Only for multiple selections, all simulations with the same run identifier as the currently selected simulation will be selected.
Case	Only for multiple selections, all simulations with the same case identifier as the currently selected simulation will be selected.
Fit	Only for multiple selections, all simulations with the same fit as the currently selected simulation will be selected.

13.27 Extract Cube Indexes

What: Extracts cube indices from cube data within set limits.

Why: Cube indices are used to define the cube data to be plotted in a 3D plot.

Used By: 3D plot objects for cube data, Cube Color Block and Cube Color Point.

Appearance:

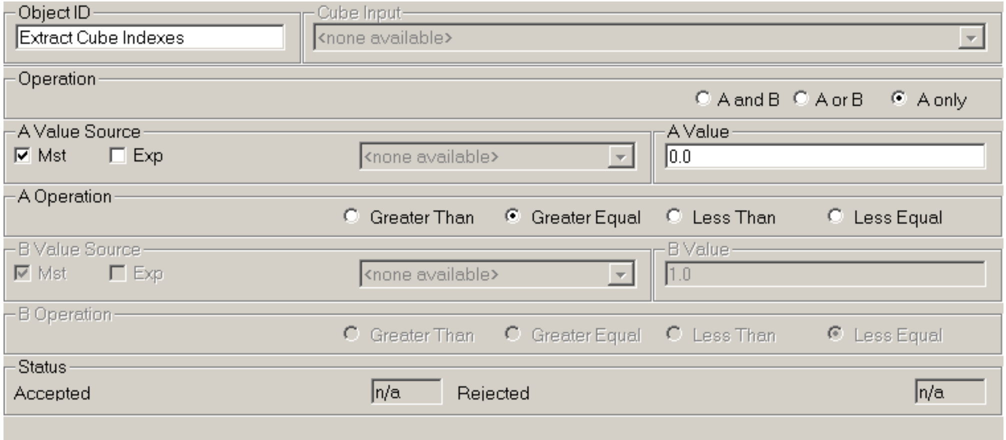


Figure 13.27 Extract Cube Indexes Property Window

Input Data: cube data

Output Data: cube indices

Properties:

Cube Input The cube data set from which indices will be extracted is selected.

Operation The cube data can be limited by two variables, A and B, representing the values at each point in the cube. If no data limitations are desired, select A only, and ensure the **A Operation** and **A value** will include all data.

A and B — Values are extracted if the value complies with both A restrictions and B restrictions.

A or B — Values are extracted if the value complies with either A restrictions or B restrictions.

A only — Data are only limited by the **A Value**.

A Value Source Master/Slave and expose controls for the **A Value**. See Section 6.3 for more information on these controls.

A Value A value for the A variable is entered.

A Operation Cube data are limited to values “greater than”, “greater than or equal to”, “less than”, or “less than or equal to” the **A Value**.

B Value Source Master/Slave and expose controls for the **B Value**. See Section 6.3 for more information on these controls.

B Value A value for the B variable is entered.

B Operation Cube data are limited to values “greater than”, “greater than or equal to”, “less than”, or “less than or equal to” to the **B Value**.

Status Indicates the number of cube indexes extracted (Accepted), and the number of cube indexes that did not meet the specified criteria (Rejected).

13.28 Extract Extended Profile from Case

What: Extracts an extended profile from a case (i.e. select the time step to extract the extended profile). The extended profile will have radius and vertical formation height for axes, with a pressure value at each point of the grid.

Why: To examine pressure results as a function of radius and vertical formation height.

Used By: Any object using extended profiles.

Appearance:

Figure 13.28 Extract Extended Profile from Case Property Window

Application: nPost

Input Data: Extract Profile Grid/Case

Output Data: extended profile, XY data containing water table height with radius, real value of extracted time

Properties:

nSIGHTS Profile Results To Select From The profile case results from which the extended profile to be extracted is selected.

Index Selection Value Source A selection box containing a list of the available time steps allows the user to select the time step from which to extract the profile grid.

Master — Selection of the time step may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.

Expose — Selection of the time step may be exposed. See Section 6.3.2 for more information on exposed controls.

13.29 Extract Grid

What: Extracts a grid from cube data such that every point of the grid represents a specified constant grid axes value.

Why: To view a slice of the cube data.

Used By: Any object using grid data.

Appearance:

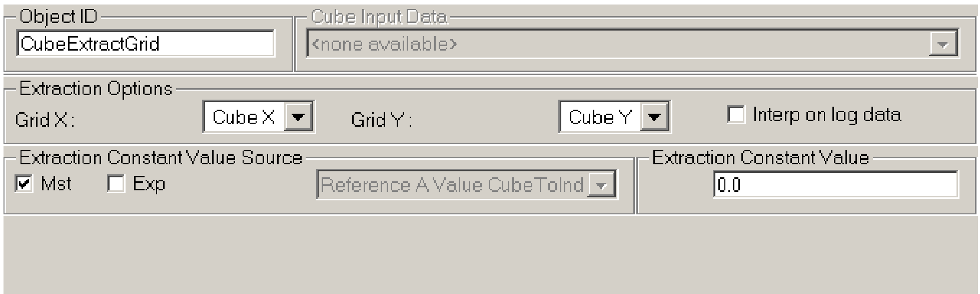


Figure 13.29 Extract Grid Property Window

Input Data: cube data

Output Data: grid data

Properties:

Cube Input Data — The cube data set from which a grid is extracted is selected.

Extraction Options

- Grid X — The cube variable used as the grid X is selected.
- Grid Y — The cube variable used as the grid Y is selected.
- Interp on log data — Linear interpolation between cube points is based on the log of the cube point values.

Extraction Constant Value Source — Master/Slave and expose controls. See Section 6.3 for more information on these controls.

Extraction Constant Value — The grid is extracted for cube variable values at this entered value (the cube variable is assumed to be the cube variable not specified as the grid X or grid Y). If the cube variable value occurs between cube points, the resulting grid point is linearly interpolated.

13.30 Extract Jacobian

What: Extracts Jacobian data from one or multiple simulations of an **nSIGHTS Optimizer Results** object.

Why: Jacobian data can be viewed in a list page, or converted to a table for plotting.

Used By: **Jacobian to Table** data object and **Jacobian List** list object.

Appearance:

Figure 13.30 Extract Jacobian Property Window

Application: nPost

Input Data: nSIGHTS Optimizer Results

Output Data: Jacobian data

Properties:

nSIGHTS Opt Results To Select From	The optimizer results from which the Jacobian matrix is to be extracted is selected.
Index Selection Value Source	A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the Jacobian matrix.
Master	Selection of the simulation may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.
Expose	Selection of the simulation may be exposed. See Section 6.3.2 for more information on exposed controls.

13.31 Extract Optimizer Results Table

What: Extracts a table containing optimized values, case parameters and/or optimization status from one or multiple simulations of an **nSIGHTS Optimizer Results** object.

Why: To examine optimization results.

Used By: Any object using table data, and the **Optimization Results** list object.

Appearance:

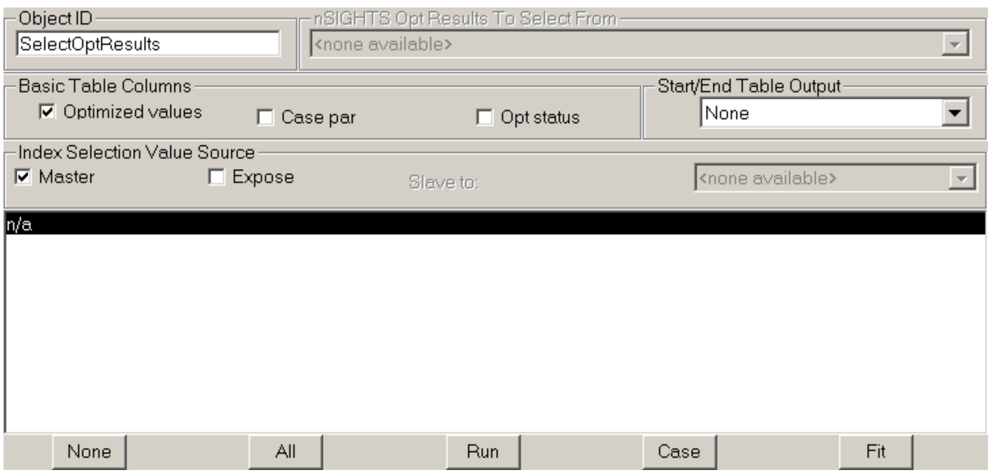


Figure 13.31 Extract Optimizer Results Table Property Window

Application: nPost

Input Data: nSIGHTS Optimizer Results

Output Data: 2 tables, one containing the basic table results, the second containing the initial and final fitting parameter values for each optimization (start/end output).

Properties:

nSIGHTS Opt Results To Select From The optimizer results from which the optimization results are to be extracted is selected.

Basic Table Columns

Optimized values — If selected, includes optimized values in the extraction.

Case par — If selected, includes the values of case parameters (e.g. suite, range or sampled values for the simulation) in the extraction.

Opt status	If selected, includes optimization status in the extraction.
Start/End Table Output	The start/end output table contains the initial and final fitting parameter values for each optimization.
None	No start/end table is output.
Regular - Segment Table	The start/end table is output. There is one column per fitting parameter, and three rows for each simulation (start value in row 1, end value in row 2, and null delimiter in row 3).
Normalized - Segment Table	The start/end table is output, with normalized initial and final optimization values. There is one column per fitting parameter, and three rows for each simulation (start value in row 1, end value in row 2, and null delimiter in row 3).
Regular - Points Table	The start/end table is output. There is a Start and End column for each fitting parameter, and a row for each selected simulation.
Normalized - Points Table	The start/end table is output, with normalized initial and final optimization values. There is a Start and End column for each fitting parameter, and a row for each selected simulation.
Index Selection Value Source	A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the optimization results. One or multiple selections may be made.
Master	Selection of the simulations may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.
Expose	Selection of the simulations may be exposed. See Section 6.3.2 for more information on exposed controls.
None	All simulations are unselected.
All	All simulations are selected.

Run	All simulations with the same run identifier as the currently selected simulation are selected.
Case	All simulations with the same case identifier as the currently selected simulation are selected.
Fit	All simulations with the same fit as the currently selected simulation are selected.

13.32 Extract Profile Grid/Case

What: Extracts a grid or a case of extended profiles from one or multiple simulations of an **nSIGHTS Profile Results** object. The grid will have time and radius for axes, with a pressure value at each point of the grid. The case of extended profiles will have a series of extended profiles at different time steps.

Why: To examine pressure results as a function of time and radius, and in the case of extended profiles, vertical formation height.

Used By: Any object using grid data, or the **Extract Extended Profile from Case** object.

Appearance:

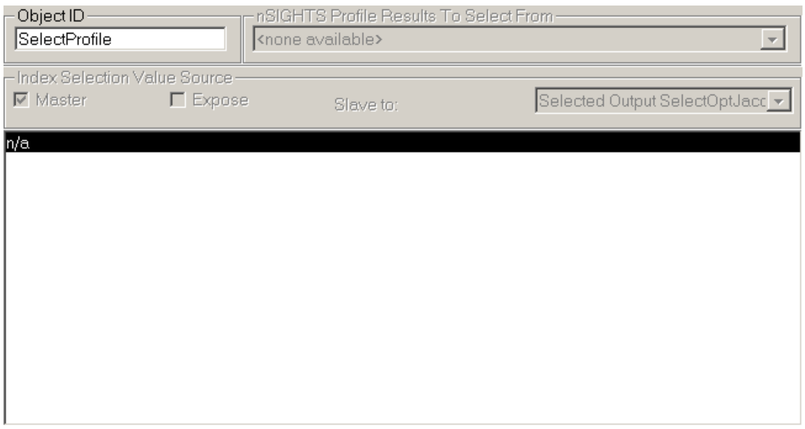


Figure 13.32 Extract Profile Grid/Case Property Window

Application: nPost

Input Data: nSIGHTS Profile Results

Output Data: grid data or case of extended profiles

Properties:

nSIGHTS Profile Results To Select From The profile results from which the profile grid or case of extended profiles is to be extracted is selected.

Index Selection Value Source A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the profile grid or case of extended profiles.

Master	Selection of the simulation may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.
Expose	Selection of the simulation may be exposed. See Section 6.3.2 for more information on exposed controls.

13.33 Extract Range

What: Extracts XY data within a specified range.

Why: To examine a specified interval within XY data.

Used By: Any object using XY data.

Appearance:

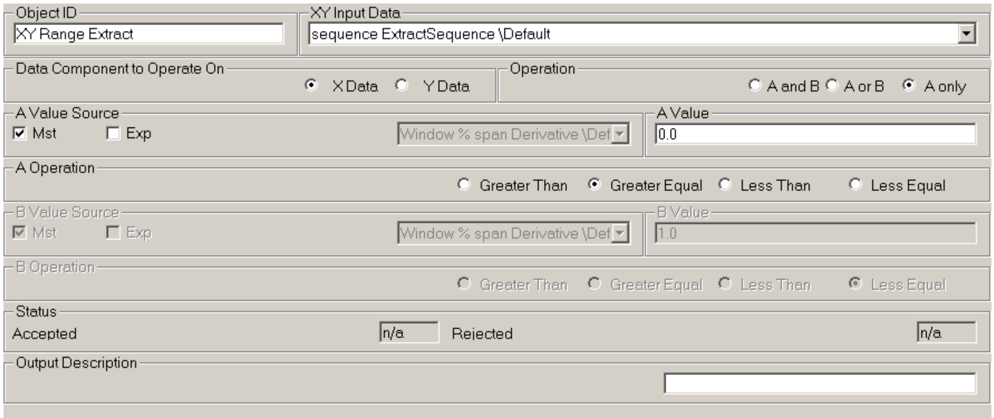


Figure 13.33 Extract Range Property Window

Application: nPost

Input Data: XY data

Output Data: XY data

Properties:

XY Data Input The input XY data is selected.

Data Component to Operate On The XY range is extracted based on a range for either X data or Y data. The limits of the range are described by two variables, A and B.

Operation The data are limited by two variables, A and B.

A and B — Values are extracted if the value complies with both A restrictions and B restrictions.

A or B — Values are extracted if the value complies with either A restrictions or B restrictions.

A only — Data are only limited by the **A Value**.

A Value Source	Master/Slave and expose controls for the **A Value**. See Section 6.3 for more information on these controls.
A Value	A value for the A variable is entered.
A Operation	XY data are limited to values "greater than", "greater than or equal to", "less than", or "less than or equal to" to the **A Value**.
B Value Source	Master/Slave and expose controls for the **B Value**. See Section 6.3 for more information on these controls.
B Value	A value for the B variable is entered.
B Operation	XY data are limited to values "greater than", "greater than or equal to", "less than", or "less than or equal to" the **B Value**.
Status	Indicates the number of XY points extracted (Accepted), and the number of XY points that did not meet the specified criteria (Rejected).
Output Description	Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

13.34 Extract Range Cube

What: Extracts cube data from one or multiple simulations of an **nSIGHTS Range Results** object.

Why: To examine the results of a range simulation with three range variables.

Used By: Any object using cube data.

Appearance:

Figure 13.34 Extract Range Cube Property Window

Application: nPost

Input Data: nSIGHTS Range Results

Output Data: cube data

Properties:

nSIGHTS Range Results To Select From The range results from which the range cube is to be extracted is selected.

Index Selection Value Source A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the range cube.

Master — Selection of the simulation may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.

Expose — Selection of the simulation may be exposed. See Section 6.3.2 for more information on exposed controls.

13.35 Extract Range Grid

What: Extracts a grid from one or multiple simulations of an **nSIGHTS Range Results** object.

Why: To examine the results of a range simulation with two range variables.

Used By: Any object using grid data.

Appearance:

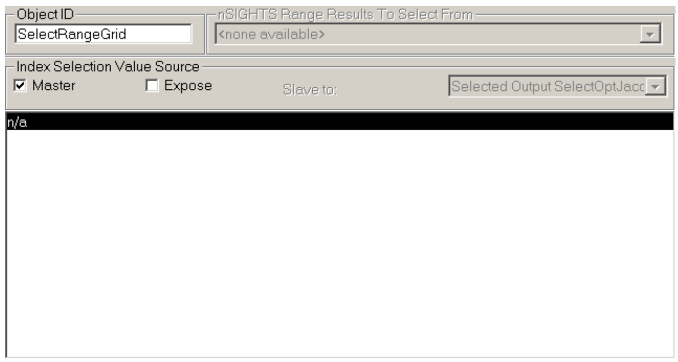


Figure 13.35 Extract Range Grid Property Window

Application: nPost

Input Data: **nSIGHTS Range Results**

Output Data: grid data

Properties:

nSIGHTS Range Results To Select From	The range results from which the range grid is to be extracted is selected.
Index Selection Value Source	A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the range grid.
Master	Selection of the simulation may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.
Expose	Selection of the simulation may be exposed. See Section 6.3.2 for more information on exposed controls.

13.36 Extract Real from Table

What: Extracts a table column real value (number of rows, minimum value, maximum value, last row value, or specified row value) and converts it to a real data type. The real value is displayed in the object property window, in the **Current Value** frame.

Why: To examine table column properties.

Used By: Any object using real values.

Appearance:

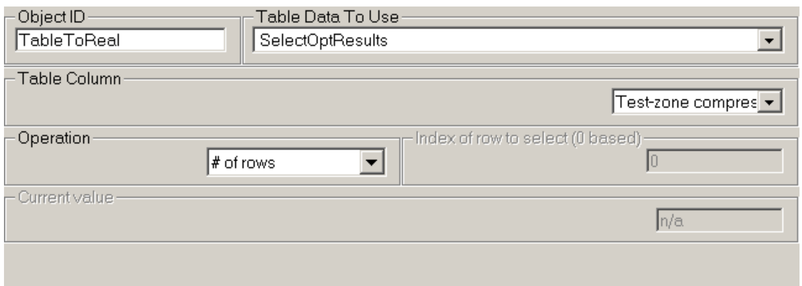


Figure 13.36 Extract Real From Table Property Window

Input Data: table data

Output Data: real value

Properties:

Table Data To Use The table real value is extracted from the selected table.

Table Column The table real value is extracted from the selected table column.

Operation The table real value extracted is selected: number of rows, minimum column value, maximum column value, last row value or specified row value.

Index of row to select (0 based) If *Specified row value* is the table real value extracted, the row is specified according to the entered row index.

Current Value Displays the extracted table real value.

13.37 Extract Residuals

What: Extracts residuals (XY data) from one or multiple simulations of an **nSIGHTS Optimizer Results** object.

Why: To examine optimization residuals.

Used By: Any object using residuals, such as **Basic Residual** or **Calculate Residual Diagnostic**, as well as any object using XY data.

Appearance:

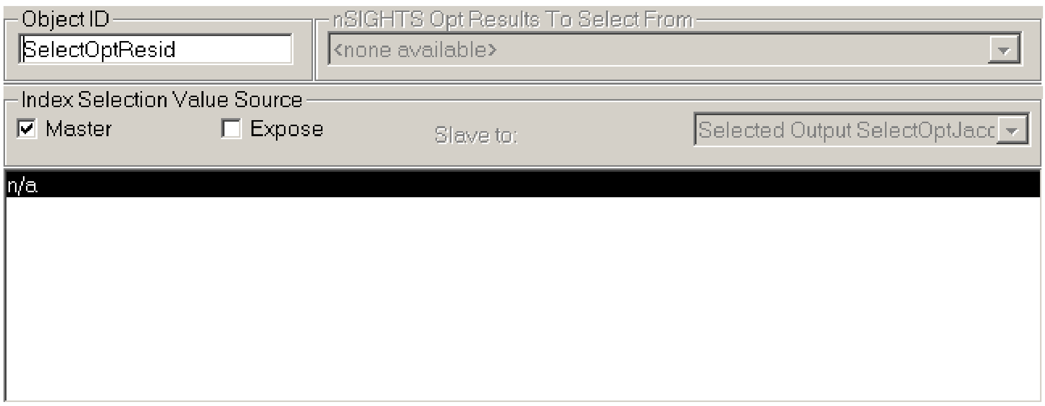


Figure 13.37 Extract Residuals Property Window

Application: nPost

Input Data: **nSIGHTS Optimizer Results**

Output Data: XY data

Properties:

nSIGHTS Opt Results To Select From	The optimizer results from which the residuals are to be extracted is selected.
Index Selection Value Source	A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the residuals.
Master	Selection of the simulation may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.
Expose	Selection of the simulation may be exposed. See Section 6.3.2 for more information on exposed controls.

13.38 Extract Sequence(s)

What: Extracts XY data for one or multiple sequences, based on the sequences defined by sequence time data.

Why: To examine simulation results within one or a set of defined sequences.

Used By: Any object using XY data.

Appearance:

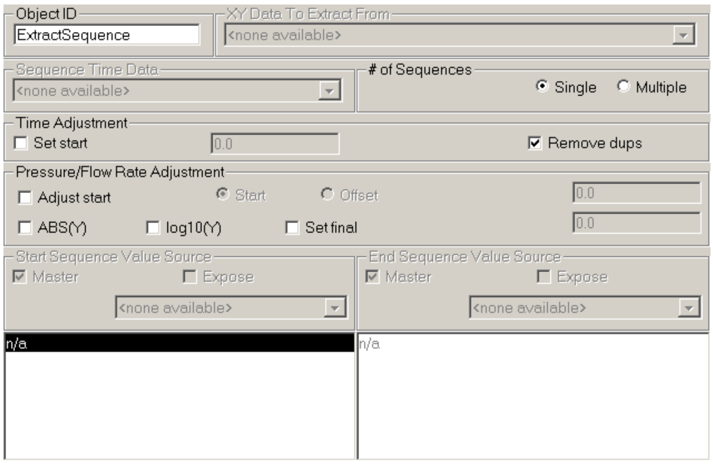


Figure 13.38 Extract Sequence(s) Property Window

Input Data: XY data and sequence time interval data

Output Data: XY data

Properties:

XY Data To Extract From The XY data set from which data are extracted is selected.

Sequence Time Data The sequence time data set is selected. In nPre, the sequence time data set is by default a system object defined in the **Sequence** input window. In nPost, the sequence time data must be read in with a **Sequence Time Interval Data** object, or with XY or profile simulation results.

# of Sequences Single or Multiple sequences may be selected.

Time Adjustment The extracted X values, or time, may be adjusted by resetting the start time, or by removing duplicate times.

Pressure/Flow Rate Adjustment The extracted Y values, or pressure or flow rate, may be adjusted.

Adjust Start	If selected, all pressure or flow rate values are decreased by the starting pressure/flow rate value, or offset by the entered value.
Start	Pressure/flow rates are decreased by the starting pressure/flow rate value
Offset	Pressure/flow rates are offset by the value entered in the adjacent text box.
ABS(Y)	If selected, the extracted Y values are the absolute value of the adjusted pressure/flow rates.
log10(Y)	If selected, the log of the adjusted pressure/flow rates is extracted.
Set final	If selected, the final pressure/flow rate is specified in the adjacent text box.
Start Sequence Value Source	The sequences available in the specified **Sequence Time Data** are listed, and the starting sequence is selected. XY data will be extracted starting at this sequence.
End Sequence Value Source	The sequences available in the specified **Sequence Time Data** are listed, and if multiple sequences were specified, the end sequence is selected.

13.39 Extract Table Range

What: Extracts a range of rows from a table column based on specified limits.

Why: To examine a subset of the data.

Used By: Any object using table data.

Appearance:

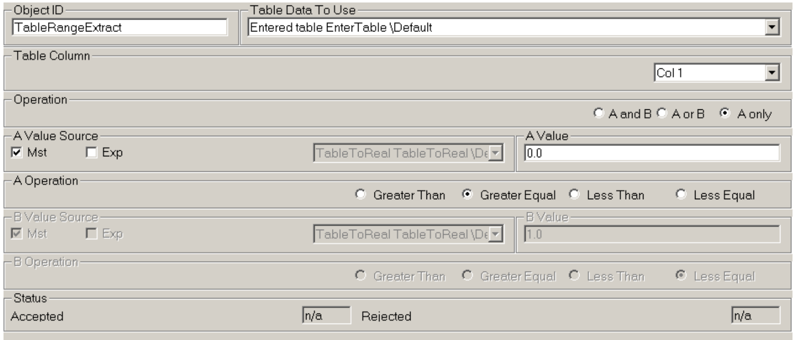


Figure 13.39 Extract Table Range Property Window

Input Data: table data

Output Data: table data

Properties:

Table Data To Use Table rows are extracted from the selected table.

Table Column Table rows are extracted from the selected table column.

Operation The table rows are extracted according to a range of values, specified by two limit variables, A and B.

A and B — Rows are extracted if the value complies with both A restrictions and B restrictions.

A or B — Rows are extracted if the value complies with either A restrictions or B restrictions.

A only — Rows are extracted if the value complies with the A restriction.

A Value Source Master/Slave and expose controls for the **A Value**. See Section 6.3 for more information on these controls.

A Value A value for the A variable is entered.

A Operation	Values are limited to values "greater than", "greater than or equal to", "less than", or "less than or equal to" to the **A Value**.
B Value Source	Master/Slave and expose controls for the **B Value**. See Section 6.3 for more information on these controls.
B Value	A value for the B variable is entered.
B Operation	Values are limited to values "greater than", "greater than or equal to", "less than", or "less than or equal to" the **B Value**.
Status	Indicates the number of rows extracted from the table (Accepted), and the number of rows in the table that did not meet the specified criteria (Rejected).

13.40 Extract Values from CDF

What: Extracts an interpolated data value or probability from a CDF, given the corresponding probability or data value.

Why: Interpolates values from the CDF.

Used By: Any object using XY data or CDFs.

Appearance:

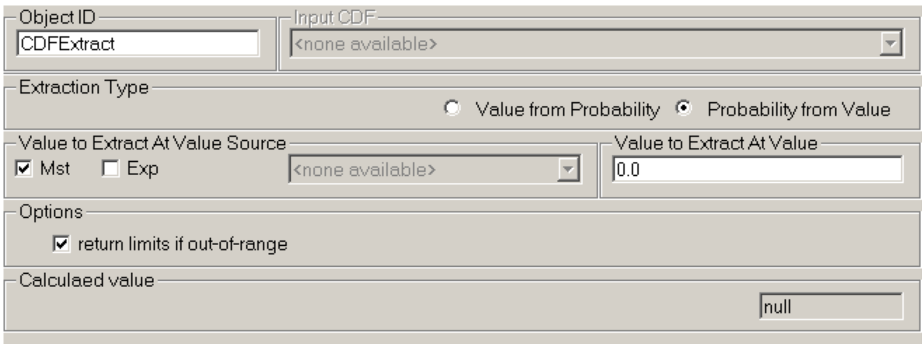


Figure 13.40 Extract Values from CDF Property Window

Input Data: CDF

Output Data: Two real values: the input value or probability, and the output value or probability.

Properties:

Input CDF	Values are interpolated from the CDF selected in the drop-down list.
Extraction Type	
Value from Probability	The object will interpolate a value given a probability.
Probability from Value	The object will interpolate a probability given a value.
Value to Extract at Value Source	Master/Slave and expose controls for the **Value to Extract at Value**. See Section 6.3 for more information on these controls.
Value to Extract at Value	If Value from Probability, a probability value used to interpolate the resulting data value. If Probability from Value, a data value used to interpolate the resulting probability value.

Options

return limits if out-of-range	If checked, and the specified data value or probability is out of range, the closest limit of probabilities or data values is provided. For example, if the maximum data value is 1.0, and the specified data value for extraction is 2.0, the resulting probability will be the probability associated with the data value of 1.0. If not checked, the resulting value is null.

Calculated value The resulting data value or probability value.

13.41 Extract XY from Grid

What: Extracts data from a grid corresponding to a specified constant grid axes X or Y value. The resulting X value will be based on one of the grid axes, and the resulting Y value is based on the value at each grid point.

Why: To view a slice of grid data.

Used By: Any object using XY data.

Appearance:

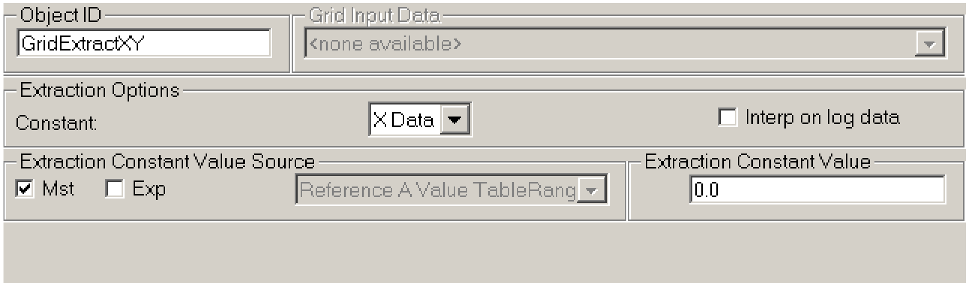


Figure 13.41 Extract XY from Grid Property Window

Input Data: grid data

Output Data: XY data

Properties:

Grid Input Data The grid data set from which the XY data are extracted is selected.

Extraction Options

Constant: The grid axes to be used as the extraction constant is selected.

Interp on log data Linear interpolation between two grid points is based on the log of the grid point values.

Extraction Constant Value Source Master/Slave and expose controls. See Section 6.3 for more information on these controls.

Extraction Constant Value X and Y values are extracted for constant values of the grid axes specified as Constant: at this entered value. If the constant value occurs between two grid points, the resulting XY point is linearly interpolated.

13.42 Extract XY from XY Results

What: Extracts one set of XY data from one or multiple simulations of an **nSIGHTS XY Results** object.

Why: To examine simulation results (e.g. pressure as a function of time).

Used By: Any object using XY data.

Appearance:

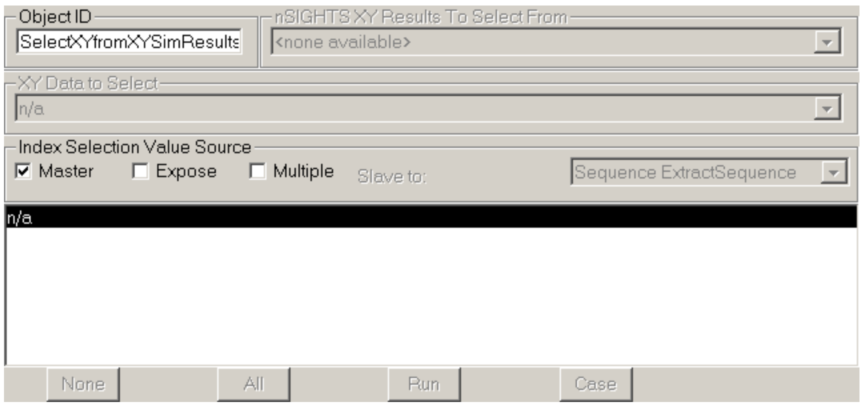


Figure 13.42 Extract XY from XY Results Property Window

Application: nPost

Input Data: **nSIGHTS XY Results**

Output Data: XY data

Properties:

nSIGHTS XY Results To Select From	The XY simulation results from which the XY data are extracted is selected.
XY Data to Select	Select the XY data from the XY data sets available in the simulation file.
Index Selection Value Source	A selection box containing a list of the available simulations allows the user to select the simulation from which to extract the XY data. One or multiple selections may be made.
Master	Selection of the simulations may be slaved to another extraction object. See Section 6.3.1 for more information on Master/Slave controls.

Expose	Selection of the simulations may be exposed. See Section 6.3.2 for more information on exposed controls.
Multiple	Multiple simulations may be selected if this checkbox is selected.
None	Only for multiple selections, no simulations will be selected.
All	Only for multiple selections, all simulations will be selected.
Run	Only for multiple selections, all simulations with the same run identifier as the currently selected simulation will be selected.
Case	Only for multiple selections, all simulations with the same case identifier as the currently selected simulation will be selected.
Fit	Only for multiple selections, all simulations with the same fit as the currently selected simulation will be selected.

13.43 Fourier Transform on Y

What: Conducts a forward or inverse Fourier transform on Y data.

Why: To observe frequency components of a test response.

Used By: Any object using XY data.

Appearance:

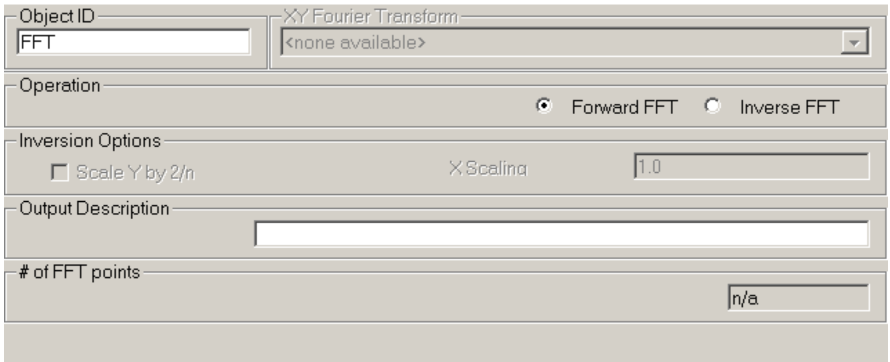


Figure 13.43 Fourier Transform on Y Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Fourier Transform The XY data set to apply the Fourier transform is selected.

Operation Either a forward or inverse Fourier transform is calculated.

Inverse Options For inverse Fourier transforms only, Y may be scaled by 2/n, and X may be scaled by the entered value.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

# of FFT points The number of calculated Fourier transform points is displayed.

13.44 Full Table Correlations

What: Calculates the Pearson R or Spearman R correlation coefficients between all column pairs within a table. For example, for a table with three columns, the correlation coefficient is calculated between column 1 and column 2, column 1 and column 3, and column 2 and column 3.

Why: Determines the correlation between table columns.

Used By: Any object using table data. The resulting coefficients can be viewed with the **View Table Data** object.

Appearance:

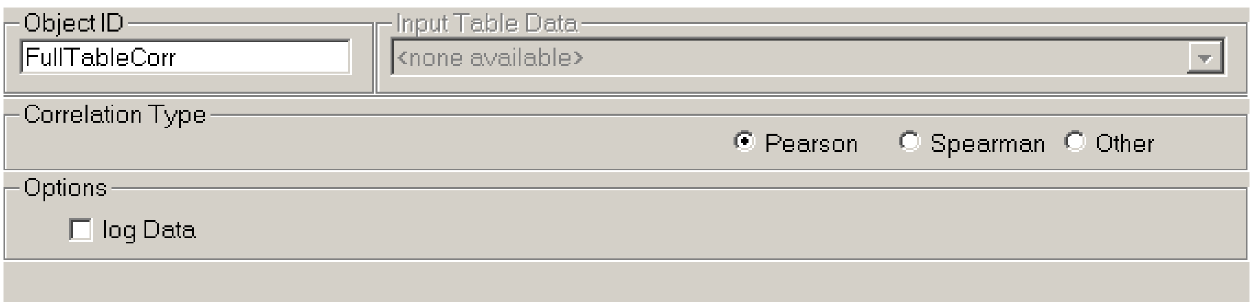


Figure 13.44 Full Table Correlations Property Window

Input Data: table data

Output Data: table data: the correlation coefficients using column 1 are within column 1 or row 1, the correlation coefficients using column 2 are within column 2 or row 2, etc., such that the correlation coefficient between column 1 and column 3 can be found in row 1, column 3 or row 3, column 1.

Properties:

Table Data To Use The input table data set is selected.

Correlation Type The correlation coefficient to be calculated is selected: Pearson R or Spearman R. Other is for future use and is not currently supported.

Options

log Data Take the log (base 10) of the data before calculating the correlation coefficient.

13.45 Histogram

What: Creates the input data for a histogram plot based on cube, grid or XY data. The actual histogram is plotted using an XY Series plot object on a plot page, with this object as the input. Note there are separate objects for each data type.

Why: Manipulates data in order to plot a histogram.

Used By: Any object using XY data. In particular, the XY Histogram plot object is used to plot the histogram.

Appearance: The appearance is identical for each data type, except for the name of the input data frame, and an extra frame for XY data. The appearance is shown for XY data:

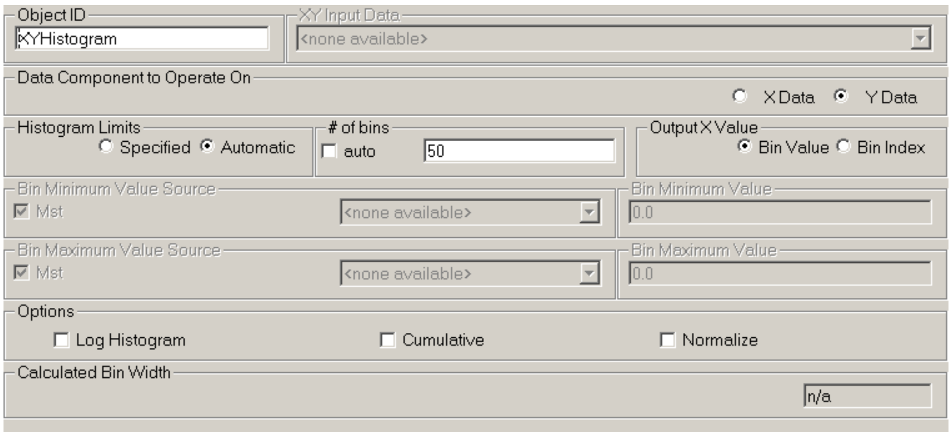


Figure 13.45 Histogram Property Window for XY Data

Input Data: cube, grid or XY data

Output Data: XY data

Properties:

Cube/Grid/XY Input Data The input data set to be converted to a histogram is selected.

Data Component to Operate On XY data only. The value frequency of X data or Y data may be calculated for the histogram.

Histogram Limits Bin minimum and maximums are Specified or Automatic.

# of bins If not auto, the number of bins for the histogram are entered in the text box.

auto The number of bins for the histogram are determined automatically.

Output X Value	The X value of the histogram is the Bin Value or the Bin Index.
Bin Minimum Value Source	Master/Slave Controls for the bin minimum, if specified. See Section 6.3.1 for more information on Master/Slave controls.
Bin Minimum Value	If specified, the bin minimum is entered in the text box.
Bin Maximum Value Source	Master/Slave Controls for the bin maximum, if specified. See Section 6.3.1 for more information on Master/Slave controls.
Bin Maximum Value	If specified, the bin maximum is entered in the text box.
Options	
Log Histogram	The log of the X or Y data is calculated before the frequency is calculated.
Cumulative	Cumulative frequencies are calculated.
Normalize	Frequencies are calculated for normalized values.
Calculated Bin Width	Displays the calculated bin width.

13.46 Integrate

What: Calculates the integral of XY data.

Why: To find the area under an XY curve.

Used By: Any object using XY data.

Appearance:

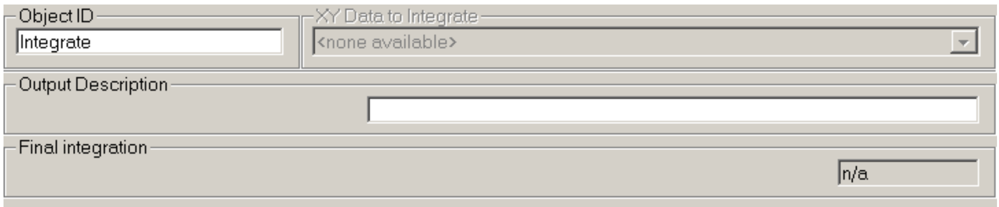


Figure 13.46 Integrate Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Data to Integrate The XY data set to be integrated is selected.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

Final Integration The resulting integration value is shown in the text box.

13.47 Interpolate Grid

What: Interpolates the data from one grid onto the grid coordinates of another grid.

Why: To create grid data with new dimensions.

Used By: Any object using grid data.

Appearance:

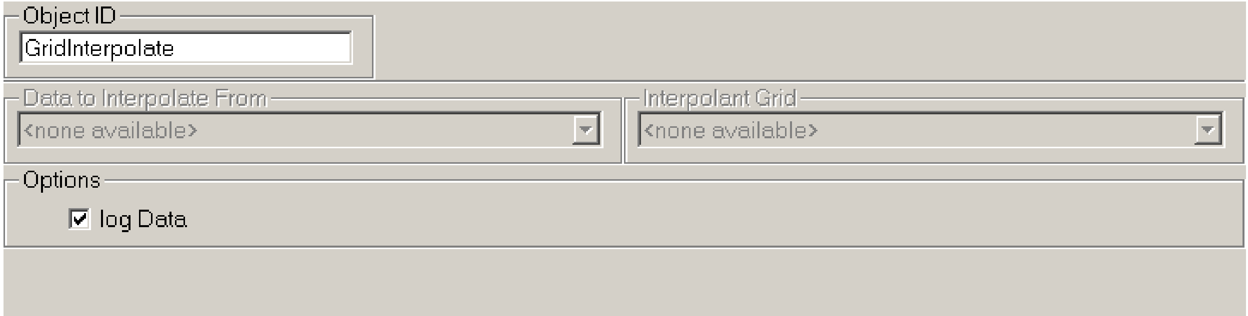


Figure 13.47 Interpolate Grid Property Window

Application: nPost

Input Data: grid data

Output Data: grid data

Properties:

Data to Interpolate From The grid data to interpolate onto the new grid is selected.

Interpolant Grid The new grid onto which the data is to be interpolated is selected. This grid provides the new coordinates for the grid.

Options

log Data — Data is log transformed for interpolation. The final output value is not log transformed.

13.48 Interpolate Table Columns

What: Interpolates Y values based on a given value for X. Values in the X table column must be in ascending order.

Why: To determine a Y value based on any given X value.

Used By: Any object using real values.

Appearance:

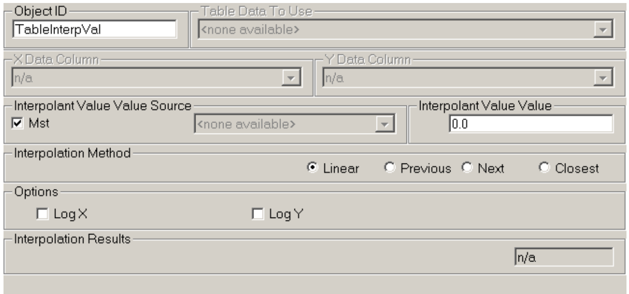


Figure 13.48 Interpolate Table Columns Property Window

Input Data: table data

Output Data: 2 real values, one X value (interpolant value) and one Y value (interpolated value).

Properties:

Table Data To Use	Table columns are interpolated from the selected table.
X Data Column	Table column to be used as the X value.
Y Data Column	Table column to be used as the Y value.
Interpolant Value Value Source	Master/Slave controls for the interpolant value. See Section 6.3 for more information on these controls.
Interpolant Value Value	The X value used to interpolate the Y value is entered.
Interpolation Method	Interpolation method is selected, described in detail in Section 7.1.4.
Options	The log of the X or Y data is taken before interpolation. The resulting interpolated value is not log transformed.
Interpolation Results	Displays the resulting interpolated Y value.

13.49 Interpolate XY Data from Curve

What: Interpolates XY values based on curve data, for a specified number of points and specified limits.

Why: This object allows curve data to be plotted.

Used By: Any object using XY data.

Appearance:

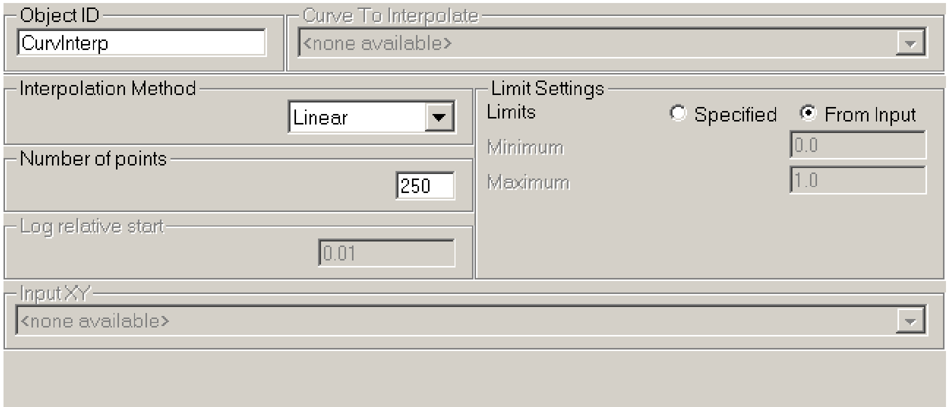


Figure 13.49 Interpolate XY Data from Curve Property Window

Input Data: curve data and if input X interpolation method, XY data

Output Data: XY data

Properties:

Curve to Interpolate The curve to interpolate is selected.

Interpolation Method Interpolation method is selected, described in detail in Section 7.1.4.

Number of points For all interpolation methods except *Input X*, determines the number of equally spaced X values and corresponding interpolated Y values.

Log relative start For *Log (Relative)* interpolation method only, determines the value of the first log X value.

Limit Settings For all interpolation methods except *Input X*.

Specified The minimum and maximum X values are specified in the Minimum and Maximum text boxes.

From Input Determines the minimum and maximum X values automatically from the input data.

Input X For the *Input X* interpolation method, XY data are selected from which the X values are used to calculate an interpolated Y value.

13.50 Jacobian to Table

What: Converts Jacobian data to table data.

Why: To examine Jacobian data.

Used By: Any object using table data.

Appearance:

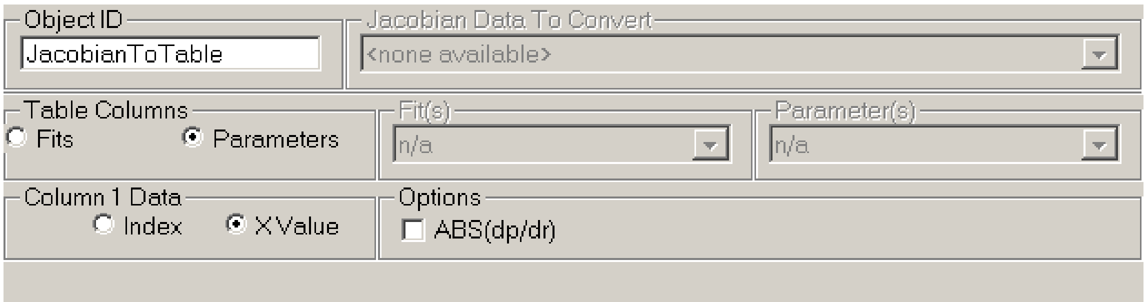


Figure 13.50 Jacobian to Table Property Window

Application: nPost

Input Data: Jacobian data

Output Data: table data

Properties:

Jacobian Data To Convert The Jacobian data set to convert is selected.

Table Columns The resulting table columns will contain Fits or Parameters.

Fit(s) For parameter table columns, the fit for which parameters will be extracted is selected. All fits or any individual fit may be selected.

Parameter(s) For fits table columns, the parameter for which fits will be extracted is selected. All parameters or any individual parameter may be selected.

Column 1 Data

Index The first column of the table will contain the fit or parameter index.

X value The first column of the table will contain the fit or parameter value.

Options Calculates the absolute value of sensitivity (sensitivity is calculated as the derivative of the parameter value with respect to the residual).

13.51 Linear Color Map

What: Creates a color map with a linear variation between starting and ending RBG or HSV values.

Why: Used to support mapping of values to colors.

Used By: Any object using color maps such as **Merge Color Maps** or color plot objects.

Appearance:

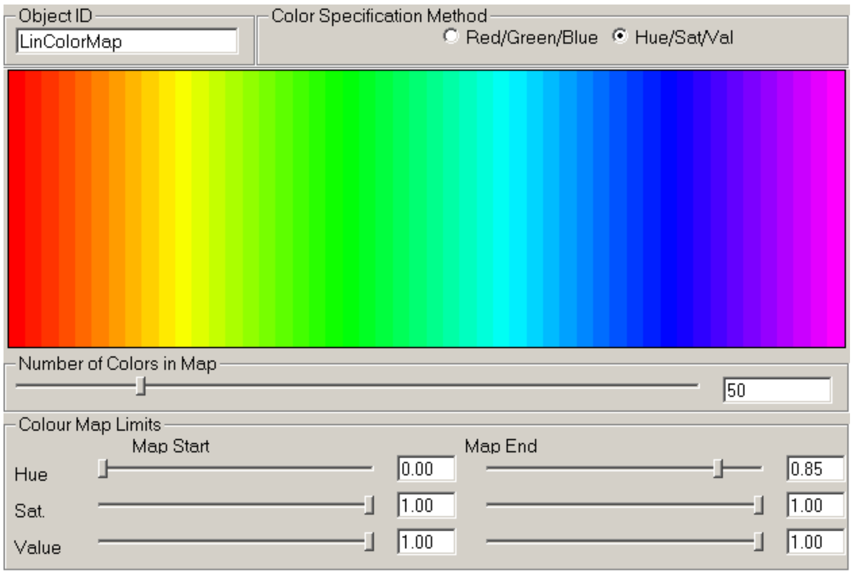


Figure 13.51 Linear Color Map Property Window

Input Data: no input

Output Data: color map

Properties:

Color Specification Method How end-point colors are defined.

Red/Green/Blue Use RGB method of primary color components.

Hue/Saturation/Value Use HSV method.

Number Of Colors In Map Color maps may consist of 5 to 256 separate colors.

Color Map Limits

Map Start The RGB or HSV components of the color at the start of the map.

Map End The RGB or HSV components of the color at the end of the map.

13.52 Matrix Math

What: Basic array mathematics (+,-,*,/, max, min) can be applied to two sets of cube data or grid data. Note there are separate objects for each data type.

Why: Data manipulations.

Used By: Any object using cube or grid data.

Appearance: The appearance is identical for each data type. The appearance is shown for grid data:

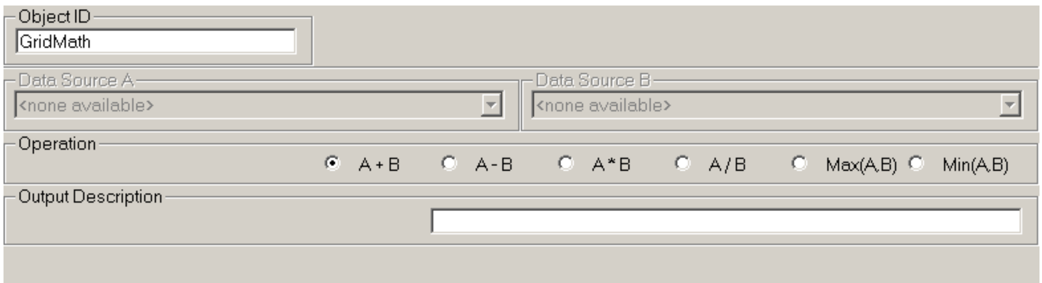


Figure 13.52 Matrix Math Property Window for Grid Data

Input Data: cube or grid data

Output Data: cube or grid data

Properties:

Data Source A The first cube/grid data set is selected.

Data Source B The second cube/grid data set is selected. Data source A and B must be of the same size (i.e. same number of nodes in the grid or cube data).

Operation The math operation between data source A and B is selected. The two data sources can be added, subtracted, multiplied, or divided. As well, the maximum or minimum of A or B at each cube/grid node can be calculated.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

13.53 Merge Color Maps

What: Combines two color maps. The two colors maps are joined together, such that the beginning of map B is placed after the end of map A.

Why: Provides flexibility in color map specification.

Used By: Any object using color maps, including itself (a **Merge Color Map** may be input for another **Merge Color Map** object).

Appearance:

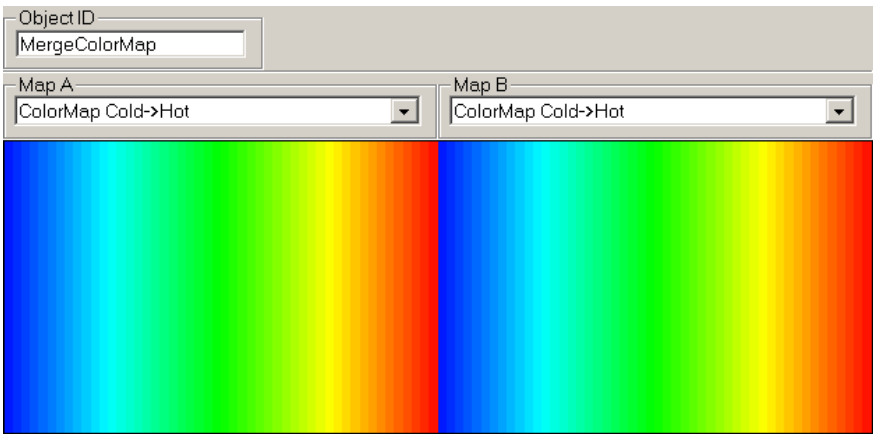


Figure 13.53 Merge Color Maps Property Window

Input Data: two color maps

Output Data: color map

Properties:

The color maps are selected in the **Map A** and **Map B** drop-down lists. The total number of colors in the input maps must be less than 256.

13.54 Normalize

What: Normalizes cube and grid data within specified data limits, based on a power value or both. Note there are separate objects for each data type.

Why: For manipulating data, in particular for normalized plots.

Used By: Any object using cube or grid data.

Appearance: The appearance is identical for each data type, except for the name of the input data frame. The appearance is shown for cube data:

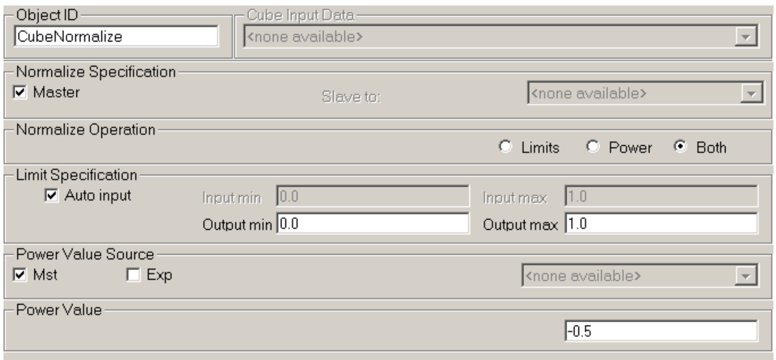


Figure 13.54 Normalize Property Window for Cube Data

Input Data: cube or grid data

Output Data: cube or grid data

Properties:

Cube/Grid Input Data The input data set to be normalized is selected.

Normalize Specification Master/Slave controls for the normalize specifications. For more information on Master/Slave controls, refer to Section 6.3.1.

Normalize Operation

Limits — Data are normalized within specified data limits.

Power — Data are normalized based on a power value.

Both — Data are normalized based on a power value within specified data limits.

Limit Specification For limit specified normalization, the input minimum and maximum limits are automatically determined or specified, and the output minimum and maximum limits are specified.

Power Value Source Master/Slave and expose controls for the power value. For more information on these controls, refer to Section 6.3.

Power Value For power value normalization, the power value is entered in the text box.

13.55 P(t) Barometric Compensation

What: Subtracts barometric fluctuations from well pressures. An efficiency or Rasmussen Deconvolution method may be used.

Why: To remove the influence of barometric fluctuations on field data.

Used By: Any object using XY data.

Appearance:

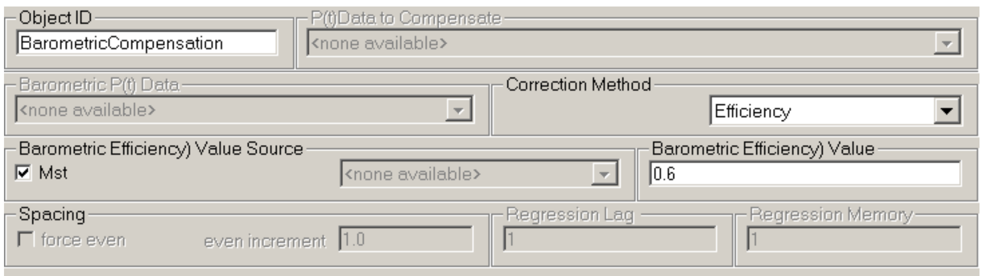


Figure 13.55 P(t) Barometric Compensation Property Window

Input Data: XY data

Output Data: XY data

Properties:

P(t) Data to Compensate Barometric fluctuations are removed from the selected input pressure time series data.

Barometric P(t) Data XY time series containing barometric pressures.

Correction Method

Efficiency — The barometric pressure change (from the initial barometric pressure) at each time in the pressure input series is calculated, and multiplied by an efficiency factor before it is subtracted from the input pressure.

Rasmussen Deconvolution — A multiple-regression deconvolution formula designed to remove barometric pressures from water level data.

Barometric Efficiency Value Source Master/Slave controls for the **Barometric Efficiency Value**. For more information on Master/Slave controls, refer to Section 6.3.1.

Barometric Efficiency Value Factor applied to the change in barometric pressure.

Spacing

For the Rasmussen Deconvolution to calculate correctly, the input pressure data points must be evenly spaced. Note that the barometric pressure data is interpolated to the data point spacing of the input pressure data.

force even

The force even toggle will cause input pressure data to be interpolated to an evently spaced set of times.

even increment

The evenly spaces set of times the pressure data is interpolated to is calculated by beginning at the start time of the input pressure data, and incrementing by the specified even time increment until the time value is greater than the end time of the input pressure data.

Regression Lag

Number of data points used to lag the input pressure data.

Regression Memory

Number of data points used for system memory.

13.56 P(t) BE/ET Compensation

What: Removes fluctuations in pressure data caused by barometric data and earth tide data. Requires a unit response function.

Why: To remove the influence of barometric and earth tide fluctuations on field data.

Used By: Any object using XY data.

Appearance:

Figure 13.56 P(t) BE/ET Compensation Property Window

Input Data: XY data and response function (**Create BE/ET Response Function**)

Output Data: XY data

Properties:

P(t) Data to Compensate	Barometric and earth tide fluctuations are removed from the selected input pressure time series data.
Response Function	Response function calculated using baseline pressure data in a **Create BE/ET Response Function** object.
Barometric P(t) Data	XY time series containing barometric pressures.
Earth Tide Data	XY time series containing earth tide data.
Status	Displays the time spacing and memory associated with the response function.

13.57 P(t) Derivative Calculation

What: Calculates the derivative of a pressure function (P(t)).

Why: In particular, used to create constraints based on the derivative of pressure.

Used By: Any object using XY data.

Appearance:

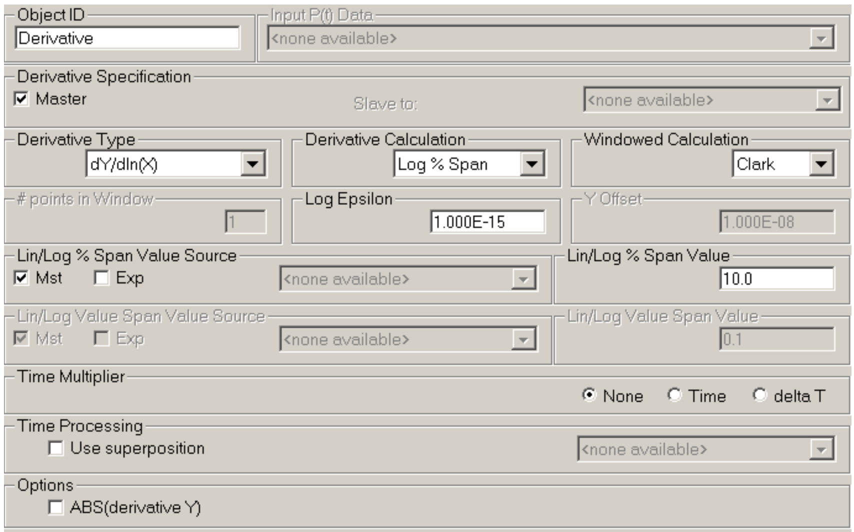


Figure 13.57 P(t) Derivative Calculation Property Window

Input Data: XY data, and if superposition of time is used, the output of a **P(t) Time Processing** object

Output Data: XY data

Properties:

Input P(t) Data The derivative is calculated for the selected input pressure time series data.

Derivative Specification Master/Slave controls for the derivative specifications. For more information on Master/Slave controls, refer to Section 6.3.1.

Derivative Type One of four derivative types is selected: *dY/dX*, *dY/dlog10(X)*, *dlog10(Y)/dlog10(X)*, or *dY/dln(X)*.

Derivative Calculation All derivative calculation procedures calculate the derivative at each data point based on a subset of data points on either side of the data point. The derivative calculation will smooth noisy input data before the derivative calculation in order to produce a useful derivative.

Between The derivative is calculated based on the slope between two adjacent data points. The X value for the derivative is the linear average of the X value of the two data points. Only useful for very smooth data.

2 Point The derivative is calculated based on the average slope between the data point and two data points on either side of the data point. The **# points in Window** parameter determines which point on either side of the data point to use. For example, if the **# of points in Window** is 1, the points adjacent to the data point are used. If the **# of points in Window** is 2, the second point from the data point will be used. Only useful for very smooth data.

Window The data points within a window surrounding the data point are used in the derivative calculation.

Log % Span All points within a specified log X distance of the data point are used in the derivative calculation. The distance is specified by a percentage of the log range of the entire data set (log(Xmax)-log(Xmin)).

Lin % Span All points within a specified X distance of the data point are used in the derivative calculation. The distance is specified by a percentage of the linear range of the entire data set (Xmax-Xmin).

Log Value Span All points within a specified X distance of the data point are used in the derivative calculation. The distance is specified as an absolute log range of the entire data set (log(Xmax)-log(Xmin)).

Lin Value Span All points within a specified X distance of the data point are used in the derivative calculation. The distance is specified as an absolute linear range of the entire data set (Xmax-Xmin).

Windowed Calculation For *Window*, *Lin/Log % Span* and *Lin/Log Value Span* methods, determines the derivative calculation algorithm used. Linear, Clark and Simmons algorithms are available.

 # points in Window For *2 Point* and *Window* calculations only, determines which points to use for a 2 Point calculation or the number of data points in the window for a Window calculation.

Log Epsilon Minimum Y value allowed for a log transform. If a Y value is less than log epsilon, the derivative is not calculated for that point.

Y Offset Adjusts Y values above the log epsilon (e.g. increases values above zero to allow log calculations).

Lin/Log % Span Value Source Master/Slave and expose controls for the lin/log % span value. For more information on these controls, refer to Section 6.3.

Lin/Log % Span Value For *Lin/Log % Span* methods, the percentage of the linear/log range of the entire data set is entered.

Lin/Log Span Value Source Master/Slave and expose controls for lin/log span value. For more information on these controls, refer to Section 6.3.

Lin/Log Span Value For *Lin/Log Value Span* methods, the absolute linear/log range of the entire data set is entered.

Time Multiplier

None The resulting Y value of the object is the calculated derivative.

T After the derivative has been calculated, the derivative is multiplied by time for the Y output.

delta T After the derivative has been calculated, the derivative is multiplied by delta time for the Y output.

Time Processing

Use Superposition Superposition may be conducted on time. The output of a **P(t) Time Processing** object is selected in the adjacent drop-down-box.

Options

ABS(derivative Y) If selected, the absolute value of the calculated derivative Y value is output.

13.58 P(t) Time Processing

What: Applies one of four time functions to X data (Horner, Agarwal, Horner Super or Bourdet Super).

Why: Used to create plots that require a time function for the X axis such as a Horner plot.

Used By: Any object using XY data.

Appearance:

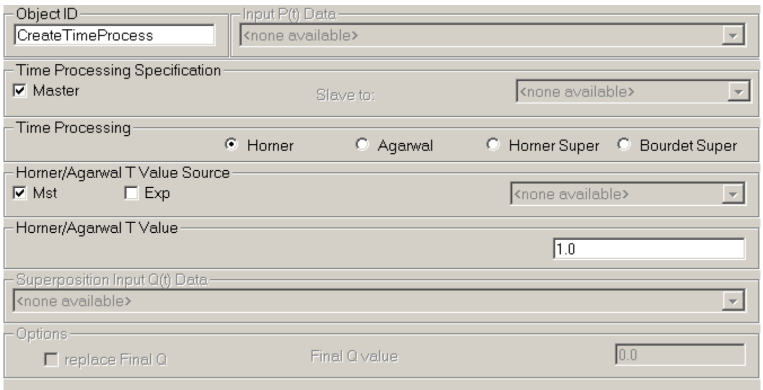


Figure 13.58 P(t) Time Processing Property Window

Input Data: XY data

Output Data: XY data

Properties:

Input P(t) Data Time processing is calculated for the X value of the selected input pressure time series data.

Time Processing Specification Master/Slave controls for the time processing specifications. For more information on Master/Slave controls, refer to Section 6.3.1.

Time Processing One of four time-processing functions is selected: Horner, Agarwal, Horner Super and Bourdet Super.

Horner/Agarwal T Value Source Master/Slave and expose controls for the **Horner/Agarwal T Value**. For more information on these controls, refer to Section 6.3.

Horner/Agarwal T Value For Horner or Agarwal time processing, the Horner time or Agarwal time is entered in the text box.

Superposition Input Q(t) Data For Horner Super or Bourdet Super time processing, the flow data to use in the time calculation is specified in the drop-down list.

Options For Horner Super or Bourdet Super time processing, the final value can be replaced.

13.59 Pen Set

What: Defines a set of pens to be used in plotting. Each pen set consists of 24 pens, each of which may be defined to be different colors. Normally, the default Standard Pen Set is all that is required.

Why: Establishes the color of plot objects.

Used By: All plot definitions.

Appearance:

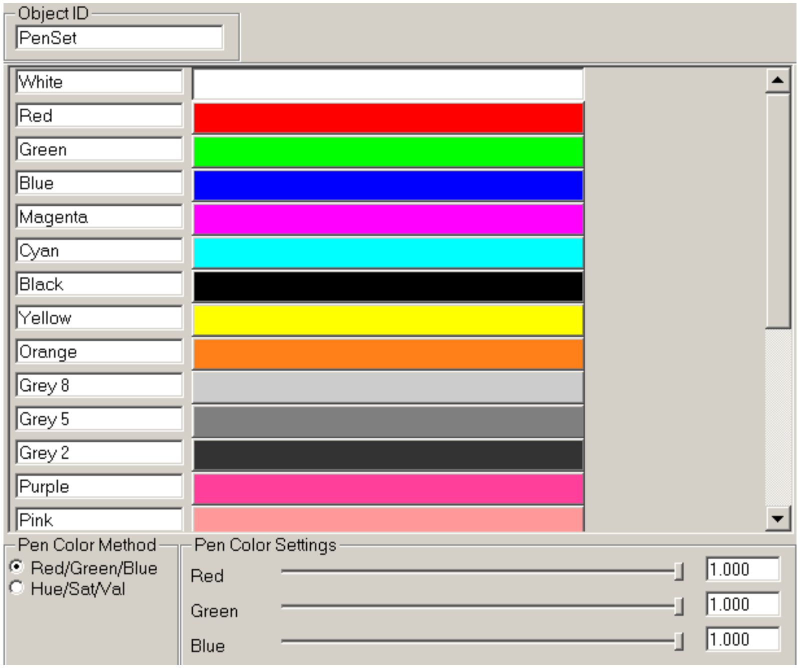


Figure 13.59 Pen Set Property Window

Input Data: no input

Output Data: pen set

Properties:

Each pen is defined by an ID and a color. Selecting a color causes the color's current settings to be shown on the sliders in the **Pen Color Settings** frame. Subsequent slider adjustments update the selected color.

Pen Color Method RGB or HSV

Pen Color Settings The RGB or HSV values for the currently selected pen.

13.60 Pulse Normalization

What: Normalizes pressure XY data based on one of two equations: (Pi-P(t)) / (Pi-Po) and 1-(Pi-P(t)) / (Pi-Po), where Pi is the static pressure and Po is the initial pulse pressure. Both Pi and Po are to be specified in the object property window.

Why: Standard well test analysis normalization.

Used By: Any object using XY data.

Appearance:

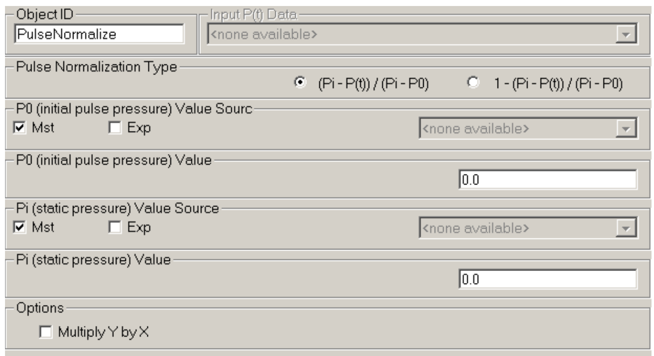


Figure 13.60 Pulse Normalization Property Window

Input Data: XY data

Output Data: XY data

Properties:

Input P(t) Data — The pressure Y values are normalized for the selected input pressure time series data.

Pulse Normalization Type — Pressure is normalized based on one of two equations: (Pi-P(t)) / (Pi-Po) or 1-(Pi-P(t)) / (Pi-Po).

P0(initial pulse pressure) Value Source — Master/Slave and expose controls for the initial pulse pressure. For more information on these controls, refer to Section 6.3.

P0(initial pulse pressure) Value — The initial pulse pressure is entered in the text box.

Pi(static pressure) Value Source — Master/Slave and expose controls for the static pressure. For more information on these controls, refer to Section 6.3.

Pi(static pressure) Value — The static pressure is entered in the text box.

Options Y can be multiplied by X.

13.61 Read Color Map

What: Reads a color map from a specially formatted text file (default file extension: *.cmap).

Why: Allows creation of color maps outside nSIGHTS (for example, in an Excel spreadsheet) to meet special requirements.

Used By: Any object using a color map.

Appearance:

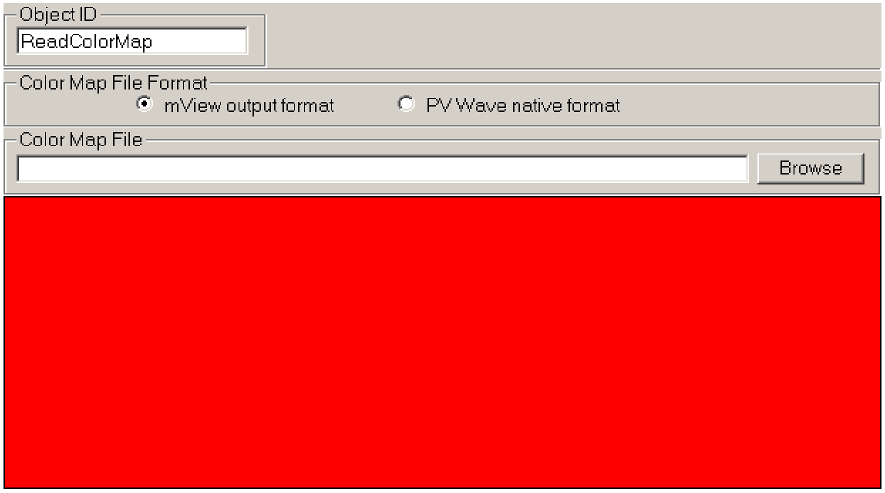


Figure 13.61 Read Color Map Property Window

Input Data: external file containing a color map definition

Output Data: color map

Properties:

Color Map File Format The format of the data in the input file (see **File Formats** below).

mView output format The format produced by the object Write Color Map.

PV Wave native format PV Wave format.

Color Map File The name of the file (including the file path) containing the color map data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

Once the color map is read, the color map defined in the file will display in the color window.

File Formats:

mView Output

The mView color map file format is as follows:

Line 1:	ncolor	# of RGB data in file (max 256)
Line 2:	Red(1) Green(1) Blue(1)	RGB values (reals 0.0 to 1.0)
	.	
	.	
	.	
Line n+1:	Red(n) Green(n) Blue (n)	n maximum 256

PV Wave

The PV Wave color map file format is as follows:

Line 1:	Red(1) Green(1) Blue(1)	RGB values (integers 0 to 255)
	.	
	.	
	.	
Line n:	Red(n) Green(n) Blue (n)	n maximum 256

13.62 Read Cube Data

What: Reads cube data from an input file (default file extension: *.cube).

Why: Allows use of cube data created or manipulated outside the current nSIGHTS application (for example, in another nSIGHTS application).

Used By: Any object using cube data.

Appearance:

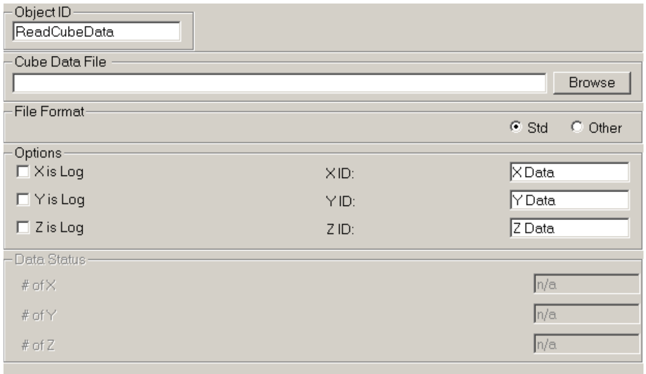


Figure 13.62 Read Cube Data Property Window

Application: nPost

Input Data: external file containing cube data

Output Data: cube data

Properties:

Cube Data File The name of the file (including the file path) containing the cube data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Format The format of the data in the input file.

Standard — Standard format output from nSIGHTS.

Other — For future use, not currently supported.

Options If X, Y or Z is a log value in the cube data file, it should be specified in the appropriate checkbox. X ID, Y ID and Z ID are used as the respective object types in drop-down lists, and labels in a **Series Legend**.

Cube X/Y/Z Status Once the cube data file is loaded, the status of the cube data is displayed: the data type (e.g. X Data), whether the data is linear or log, the number of

X/Y/Z points in the grid, the interval distance between X/Y/Z points and the total X/Y/Z length of the grid.

13.63 Read Curve File

What: Reads a curve data file (default file extension: *.nCRV). A curve file may contain several curve data sets.

Why: Allows use of curve data created or manipulated outside the current nSIGHTS application (for example, in another nSIGHTS application).

Used By: **Select Curve File**

Appearance:

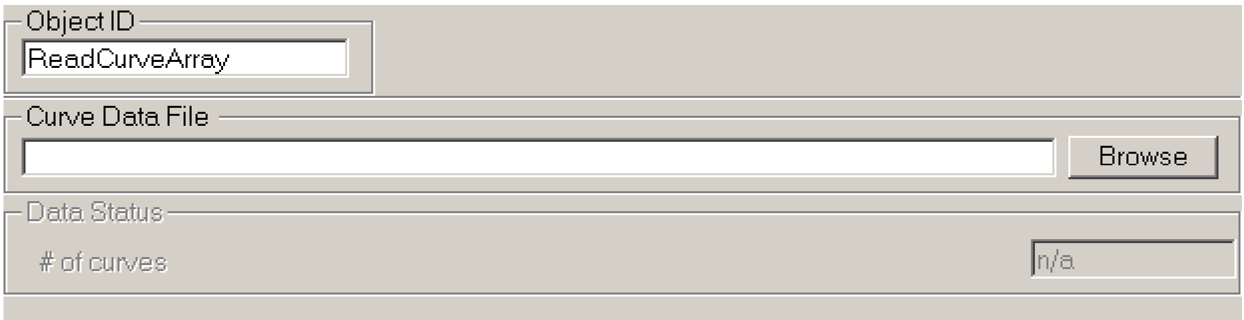


Figure 13.63 Read Curve File Property Window

Application: nPost

Input Data: external file containing curve data

Output Data: curve data file for **Select Curve File**

Properties:

Curve Data File The name of the file (including the file path) containing the curve data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog. The curve file format is based on the file format written by the **Write Curve File** object.

Data Status Once the curve data file is loaded, the number of curves in the curve file is displayed.

13.64 Read Grid Data

What: Reads grid data from an input file (default file extension: *.grd).

Why: Allows use of grid data created or manipulated outside the current nSIGHTS application (for example, in another nSIGHTS application).

Used By: Any object using grid data.

Appearance:

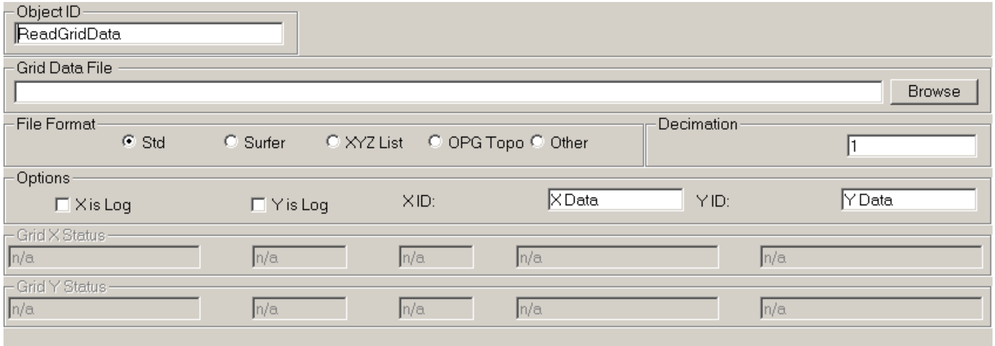


Figure 13.64 Read Grid Data Property Window

Application: nPost

Input Data: external file containing grid data

Output Data: grid data

Properties:

Grid Data File The name of the file (including the file path) containing the grid data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Format One of four file formats can be selected. See the **File Formats** section below for standard and XYZ list file formats.

Std The standard format produced by the object Write Grid File.

Surfer The grid format produced by Surfer Version 7 software. Within Surfer, select *GS ASCII (*.grd)* as the file format.

XYZ List List of XYZ points.

OPG Topo Format specific to the OPG project.

Other For future use, not currently supported.

Decimation The grid file is reduced based on the decimation factor entered in the text box: every n grid points in both X and Y are kept, where n is the decimation factor.

Options If X or Y is a log value in the grid data file, it should be specified in the appropriate checkbox. X ID and Y ID are used as the respective object types in drop-down lists, and labels in a **Series Legend**.

Grid X/Y Status Once the grid data file is loaded, the status of the grid is displayed: the data type (e.g. X Data), whether the data is linear or log, the number of X/Y points in the grid, the interval distance between X/Y points and the total X/Y length of the grid.

File Formats:

For all grids, X1 and Y1 is at the bottom left hand corner (e.g. X1=0,Y1=0).

Standard

The format produced by the object **Write Grid File**. The standard grid file format is as follows:

Line 1: file heading

Line 2: nX nY nX=number of X points, nY=number of Y points

Line 3: Grid Value at X1,Y1 … Grid Value at X1,Y20

Line a: Grid Value at X1,(nY-19) … Grid Value at X1,nY

Line a+1: Grid Value at X2,Y1 … Grid Value at X2,Y20

Last Line: Grid Value at nX,(nY-19) … Grid Value at nX,nY

XYZ list

The XYZ list grid file format is as follows:

Line 1: X1, Y1, Grid Value at X1,Y1

Line 2: X1, Y2, Grid Value at X1,Y2

Line nY: X1, nY, Grid Value at X1,nY

Line nY+1: X2, Y1, Grid Value at X2,Y1 nY= number of Y points

Line nX*nY: nX, nY, Grid Value at nX,nY nX=number of X points

13.65 Read Mini-Troll Text File

What: Reads a Mini-Troll text file and converts it to a table file.

Why: Allows use of Mini-Troll data without manipulation.

Used By: Any object using table data.

Appearance:

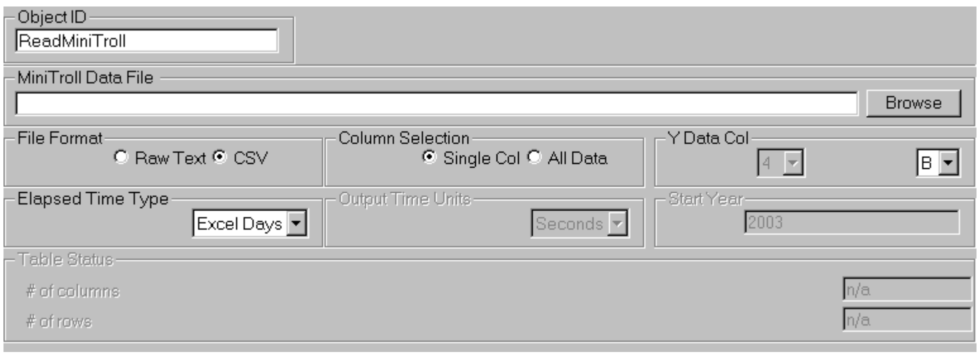


Figure 13.65 Read Mini-Troll Text File Property Window

Input Data: external file created by Mini-Troll

Output Data: table data

Properties:

Mini Troll Data File — The name of the file (including the file path) containing the Mini-Troll data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Format — Text file is in raw or CSV (comma separated variable) format.

Column Selection

- Single Col — Only a single column, specified by **Y Data Col**, is processed after the first date/time column.
- All Data — All columns are processed.

Y Data Col — The single column to be processed, based on Excel column headers for cvs data and column number for raw data.

Elapsed Time Type

- Data Start — Time starts at zero.

Year Start	Time starts at the day, month and time specified in the Mini Troll text file, and the year specified in **Start Year**.
Excel Days	Time starts at the year, day, month and time specified in the Mini Troll text file, output in Excel days (where time 1 day is the first of January, 1900).
Output Time Units	Time units for the output table data, if **Elapsed Time Type** is Data start **or** Year start**.**
Start Year	For Year Start **Elapsed Time Type**, specifies the year at time zero. Allows for files with different time scales to be placed on the same time scale.
Table Status	Once the Mini-Troll file is processed, the number of columns and rows in the table are displayed.

13.66 Read nSIGHTS Optimizer Results

What: Reads an nSIGHTS optimizer simulation results file (default file extension: *.nOpt), specified in the **Output Files** nPre input window.

Why: To examine optimization results created in nPre within nPost.

Used By: **Extract Covariance Matrices**, **Extract Jacobian**, **Extract Optimizer Results Table** and **Extract Residuals**.

Appearance:

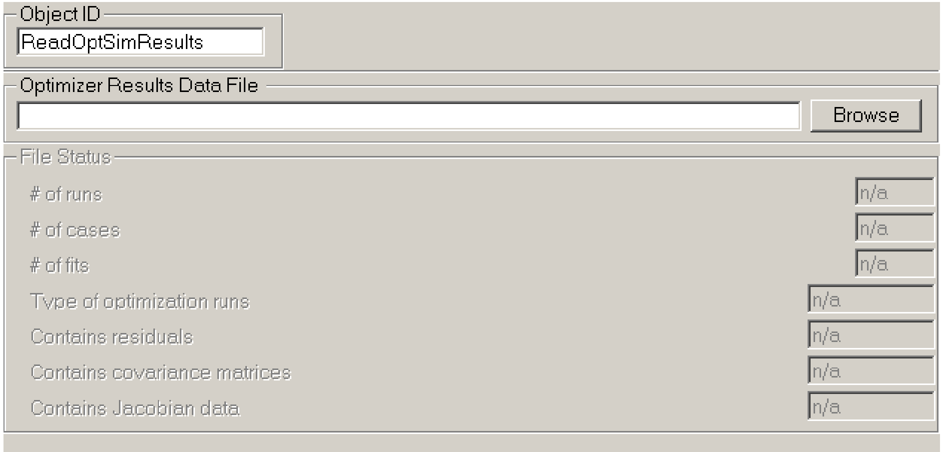


Figure 13.66 Read nSIGHTS Optimizer Results Property Window

Application: nPost

Input Data: optimizer simulation results file

Output Data: optimizer results file

Properties:

Optimizer Results Data File The name of the file (including the file path) containing the optimizer results is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Status Once the optimizer results file is loaded, the number of runs, cases and fits in the file, as well as the type of optimization runs (e.g. Sampled) and the contents of the file (e.g. Contains Residuals yes) are displayed.

13.67 Read nSIGHTS Profile Results

What: Reads an nSIGHTS profile simulation results file (default file extension: *.nPro), specified in the **Output Files** nPre input window.

Why: To examine simulation results created in nPre within nPost.

Used By: **Extract Profile Grid/Case**

Appearance:

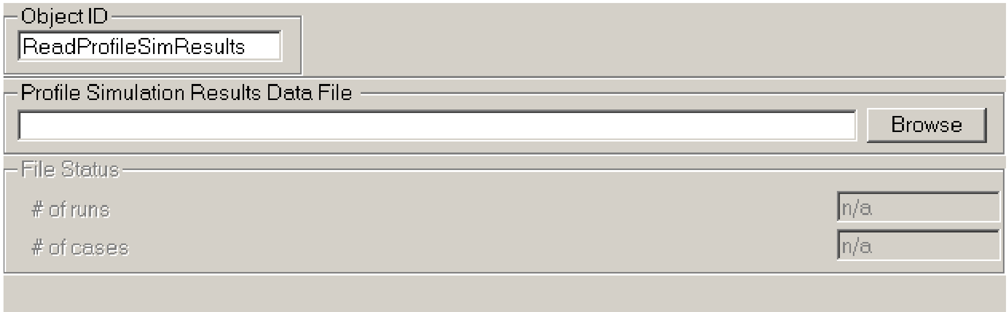


Figure 13.67 Read nSIGHTS Profile Results Property Window

Application: nPost

Input Data: profile simulation results file

Output Data: profile results file

Properties:

Profile Simulation Results Data File The name of the file (including the file path) containing the profile results is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Status Once the profile results file is loaded, the number of runs and cases in the file are displayed.

13.68 Read nSIGHTS Range Results

What: Reads an nSIGHTS range simulation results file (default file extension: *.nRng), specified in the **Output Files** nPre input window.

Why: To examine range results created in nPre within nPost.

Used By: **Extract Range Cube** and **Extract Range Grid**

Appearance:

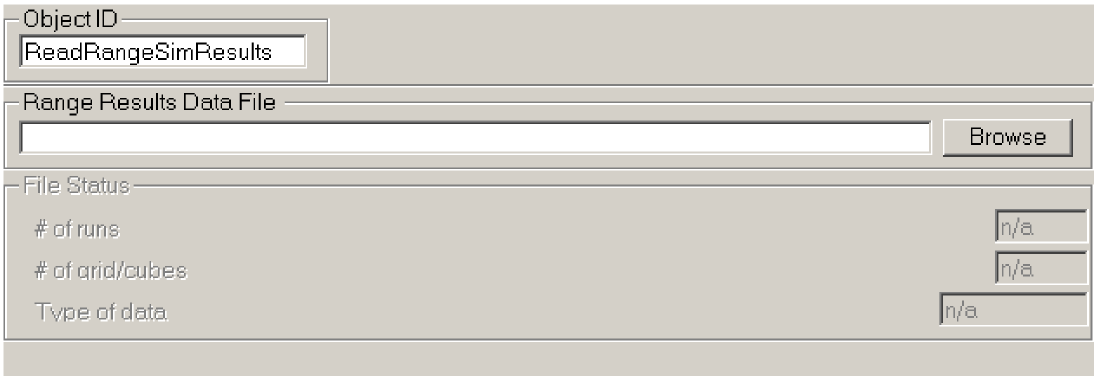


Figure 13.68 Read nSIGHTS Range Results Property Window

Application: nPost

Input Data: range simulation results file

Output Data: range results file

Properties:

Range Results Data File The name of the file (including the file path) containing the range results is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Status Once the range results file is loaded, the number of runs, the number of grids or cubes in the file, and the type of data (i.e. grid or cube data) are displayed.

13.69 Read nSIGHTS XY Results

What: Reads an nSIGHTS XY simulation results file (default file extension: *.nXYSim), specified in the **Output Files** nPre input window.

Why: To examine XY simulation results created in nPre within nPost.

Used By: **Extract XY from XY Results**

Appearance:

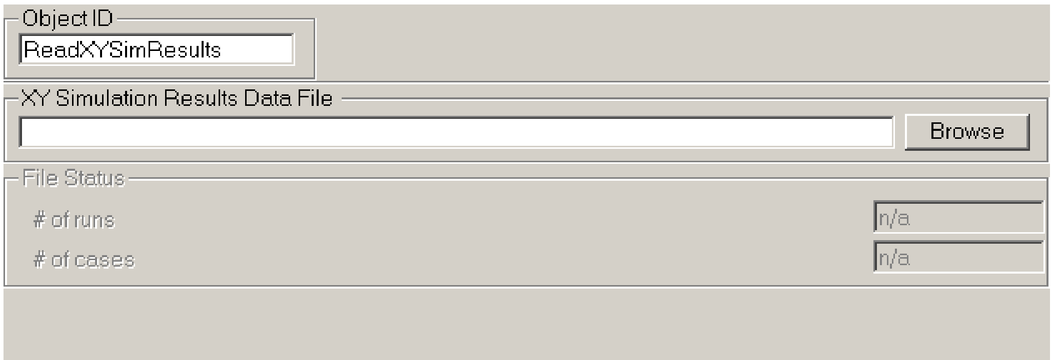


Figure 13.69 Read nSIGHTS XY Results Property Window

Application: nPost

Input Data: XY simulation results file

Output Data: XY results file

Properties:

XY Simulation Results Data File The name of the file (including the file path) containing the XY results is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Status Once the XY results file is loaded, the number of runs and cases in the file are displayed.

13.70 Read Sequence Time Interval Data

What: Reads a sequence time data file (default file extension: *.seqt).

Why: Contains time information for sequences defined in nPre, which are required for nPost objects.

Used By: **Extract Sequence(s)** and **Time Limits Extraction/Interpolation**

Appearance:

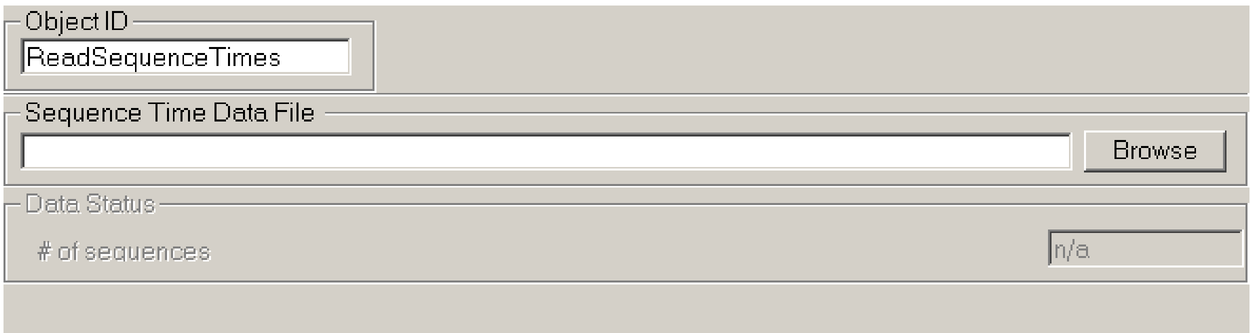


Figure 13.70 Read Sequence Time Interval Data Property Window

Application: nPost

Input Data: external file containing sequence time data

Output Data: sequence time data

Properties:

Sequence Time Data File The name of the file (including the file path) containing the sequence time data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

Data Status Once the sequence time file is loaded, the number of sequences in the file is displayed.

File Format:

The sequence time data file format is as follows:

Line 1: SeqID StartingTime

Line 2: SeqID StartingTime

.

.

Line n: SeqID StartingTime EndTime n=number of sequences

Note: The sequence ID cannot contain embedded spaces.

13.71 Read Table File

What: Reads tabular data from a file.

Why: Allows use of table data created or manipulated outside the current nSIGHTS application (for example, in another nSIGHTS application or a spreadsheet).

Used By: Any object using table data.

Appearance:

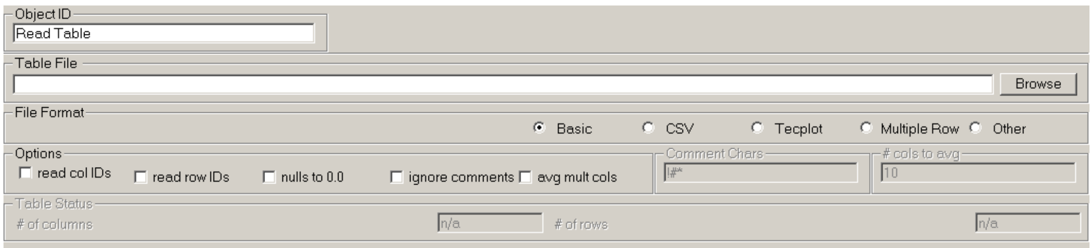


Figure 13.71 Read Table File Property Window

Input Data: external file containing tabular data

Output Data: table data

Properties:

Table File The name of the file (including the file path) containing the table data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Format One of four file formats can be selected.

Basic: Table values are separated by spaces, each line representing one row. If Read Column IDs is selected, the first row is assumed to have column IDs separated by spaces or commas, with no embedded spaces. If Read Row IDs is selected, the first value in each row is considered the row ID.

CSV: Same as Basic file format, except that commas separate table values.

Tecplot: Standard Tecplot output table.

Other: For future use, not currently supported.

Options

Read Column IDs Select if the input table contains column IDs (Basic and CSV file formats).

Read Row IDs Select if the input table contains row IDs (Basic and CSV file formats).

nulls to 0.0 All null values in the table will be set to 0.0.

ignore comments Lines beginning with a specified character will be ignored.

avg mult cols Results in a two column table, where the first column is read, and the remaining columns read are averaged. Only **# cols to avg** + 1 columns are read.

Comment Chars Characters that define a comment. The character must be the first character in a line, and the entire line is ignored.

 # cols to avg Number of columns to average if avg mult cols selected.

Table Status Once the table file is loaded, the number of columns and rows in the table are displayed.

13.72 Read XY Data

What: Reads a list of XY points from a file (default file extension: *.dat).

Why: Allows use of XY data created or manipulated outside the current nSIGHTS application (for example, in another nSIGHTS application or a spreadsheet).

Used By: Any object using XY data.

Appearance:

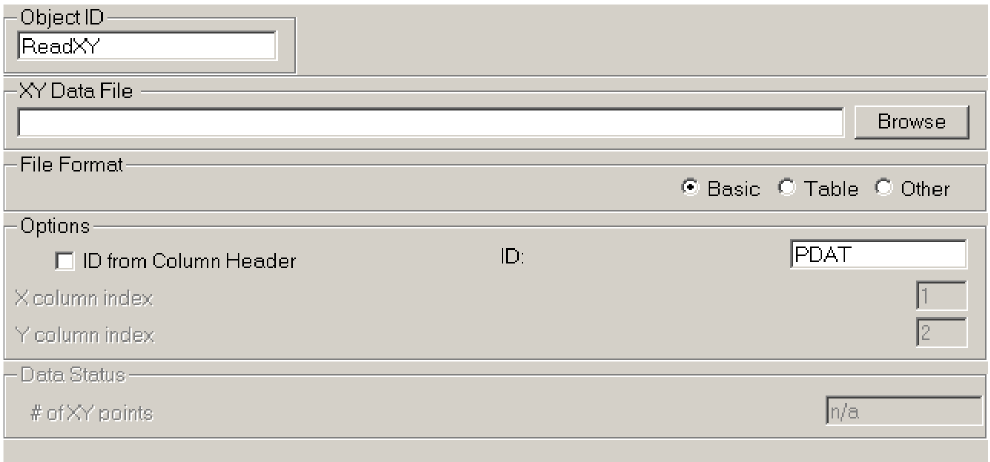


Figure 13.72 Read XY Data Property Window

Input Data: external file containing XY data

Output Data: XY data

Properties:

XY Data File The name of the file (including the file path) containing the XY data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Format One of three file formats can be selected.

Basic XY values are separated by commas or spaces, one row per line. All data after the first two values of each line are ignored. If ID from Column Header is selected, the first line of file contains column header names, without embedded spaces.

Table XY values are separated by commas or spaces, one row per line. Columns selected as the X data and the Y data are specified in the X column index and Y column index fields. If ID from Column Header is selected, the first line of file contains column header names, without embedded spaces.

Other — For future use, not currently supported.

Options

ID from Column Header — If selected, the ID is obtained from the Y column header.

ID — If not obtained from the column header, the ID is specified in the text box. The ID is used as the object type in drop-down lists, and the label in a **Series Legend**.

X column index — For table file formats, the table column to use for X data is specified.

Y column index — For table file formats, the table column to use for Y data is specified.

Data Status — Once the XY data file is loaded, the number of XY points is displayed.

13.73 Read XY Data Array

What: Reads XY array data from a file (default file extension: *.nXYA).

Why: Allows use of XY array data created or manipulated outside the current nSIGHTS application (for example, in another nSIGHTS application or a spreadsheet).

Used By: Any object using XY array data.

Appearance:

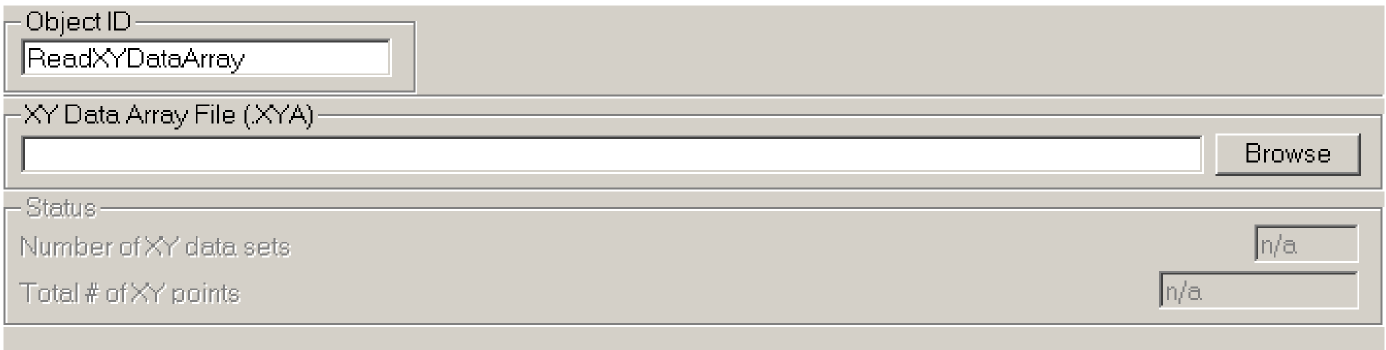


Figure 13.73 Read XY Data Array Property Window

Application: nPost

Input Data: external file containing XY array data in nSights format

Output Data: XY array

Properties:

XY Data Array File The name of the file (including the file path) containing the XY array data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

Status Once the XY array data file is loaded, the number of XY sets within the array, and the total number of XY points is displayed.

File Format:

The mView format is as follows:

Line 1:	Header	For example: 'Text XY Data Array File'
Line 2:	V1 V2	V1 and V2 are the major and minor version numbers

Line 3:	n	Number of XY data sets in array
Line 4:	XY data set ID 1	ID of the first XY data set
Line 5:	n1	Number of XY points in the first data set.
Line 6:	x11 y11	First data points of the first XY data set
	.	
	.	
Line a:	x1n y1n	Last data points of the first XY data set
Line a+1:	XY data set ID 2	ID of the second XY data set
Line a+2:	n2	Number of XY points in the second data set.

13.74 Read XYZ Label Data

What: Reads a list of XYZ co-ordinates and associated text labels from a file.

Why: Used to specify 3D labels for plotting.

Used By: 3D plot object **XYZ Labels**.

Appearance:

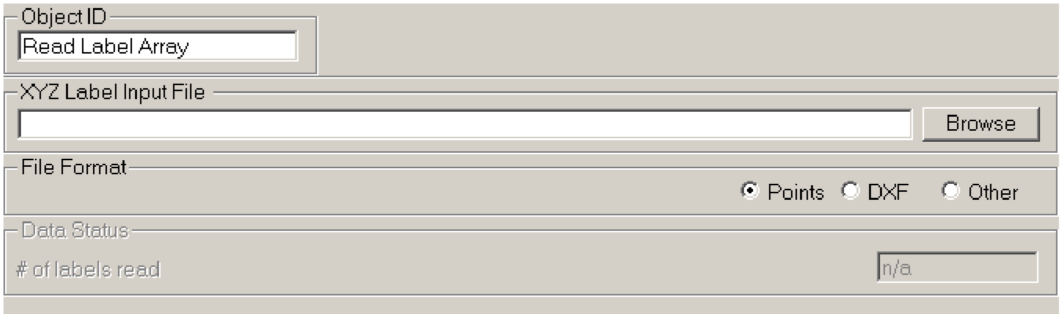


Figure 13.74 Read XYZ Label Data Property Window

Input Data: external file containing XYZ co-ordinates and associated text labels

Output Data: XYZ label

Properties:

XYZ Label Input File The name of the file (including the file path) containing the XYZ label data is entered in the text box or the **Browse** button is used to find the file using the standard Windows open file dialog.

File Format One of two file formats can be selected.

Points List of XYZ points and text separated by spaces. See the **File Formats** section below for details on the file format.

DXF AutoCad dxf format. Finds any polylines and uses the first vertex as the xyz point and the layer ID as the label.

Other For future use, not currently supported.

Data Status Once the XYZ label file is loaded, the number of labels in the file is displayed.

File Formats:

Points

The Points file format is as follows:

Line 1	X1_1 Y1_1 Z1_1 FirstLabelText
Line 2	X1_2 Y1_2 Z1_2 SecondLabelText
	.
	.
	.
Line n	X1_n Y1_n Z1_n nthLabelText
Line n+1	[blank]
Line n+2	X2_1 Y2_1 Z2_1 Group2Label1Text

13.75 Real Value(s) To Table

What: Converts real values into table data.

Why: Collects real values from an object with changing input and configures the real values in table format. For example, the statistics of an XY slice of a grid can be stored in a table for several different grid slices.

Used By: Any object using table data. In particular, the table may be viewed using the **View Table Data** object.

Appearance:

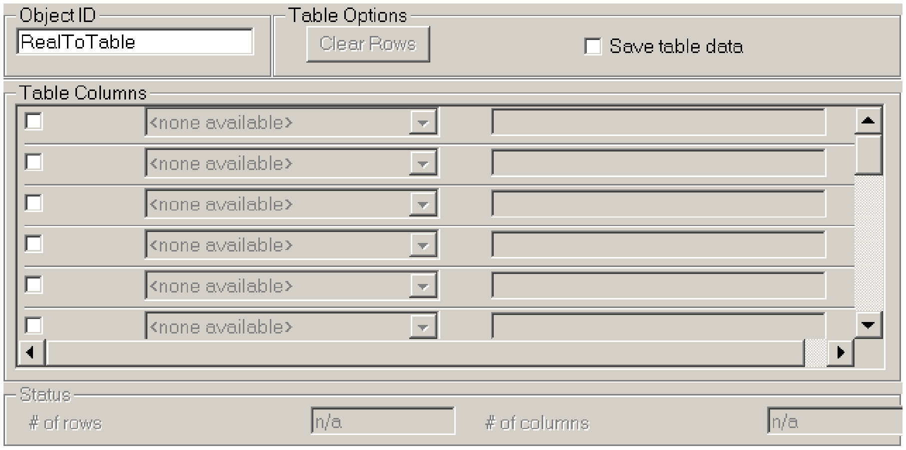


Figure 13.75 Convert Real Value(s) to Table Property Window

Input Data: real value

Output Data: table data

Properties:

Table Options

Clear Rows — Clears the table. A subsequent change in the real values defined in the **Table Columns** frame will add a new row to the table.

Save table data — Saves the current table values in the nSIGHTS configuration file.

Table Columns — In each line, a real value object can be selected from the drop-down list. The column header is input into the adjacent text box. The line is activated/deactivated with the checkbox at the beginning of the line.

Status

\# of rows — The number of rows represents the number of table rows created.

# of columns The number of columns will reflect the number of table columns defined in the **Table Columns** frame.

Apply Will add one row to the table, containing the current values of the real values in each table column.

13.76 Reduction

What: Reduces the number of XY points by skipping points or by keeping points such that the change in value between consecutive points is maximized below a specified maximum.

Why: Reduces very large XY data sets into a data set of a more manageable size.

Used By: Any object using XY data.

Appearance:

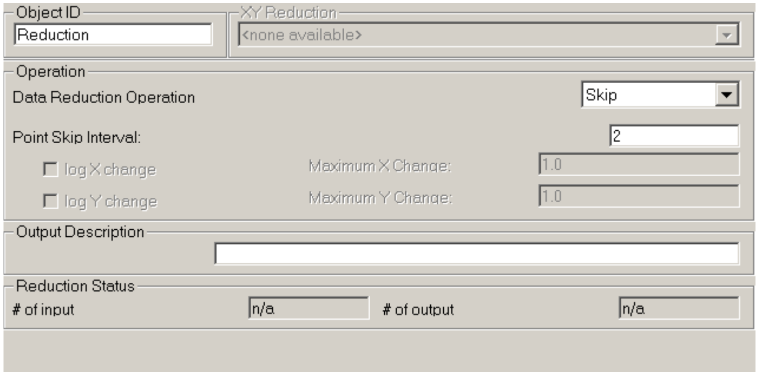


Figure 13.76 Reduction Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Data Reduction The XY data set to be reduced is selected in the drop-downlist.

Operation

Data Reduction Operation The method of reducing the XY data is selected.

Skip Values in the XY data set are skipped, according to the specified interval.

Maximum Change Points are removed such that the difference between consecutive point values is maximized below a specified maximum, for both X and Y data.

Both Values are skipped, unless the difference between consecutive point values is greater than the specified maximum.

Point Skip Interval	For skip data reduction, the interval at which points are skipped are entered. For example, with a point skip interval of 2, every other point remains within the data set.
log X change	For maximum change data reduction, the maximum change in X values is based on log X if this checkbox is selected.
Maximum X Change	For maximum change data reduction, the maximum difference in values between two consecutive X points is entered.
log Y change	For maximum change data reduction, the maximum change in Y values is based on log Y if this checkbox is selected.
Maximum Y Change	For maximum change data reduction, the maximum difference in values between two consecutive Y points is entered.
Output Description	Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.
Reduction Status	The number of input points and output points are displayed, indicating the extent of the data reduction.

13.77 Remove Duplicates

What: Removes duplicate values from X data, Y data or both. Duplicates are considered values that have differences less than a specified value.

Why: Reduces the size of the data set, or improves its appearance in plotting.

Used By: Any object using XY data.

Appearance:

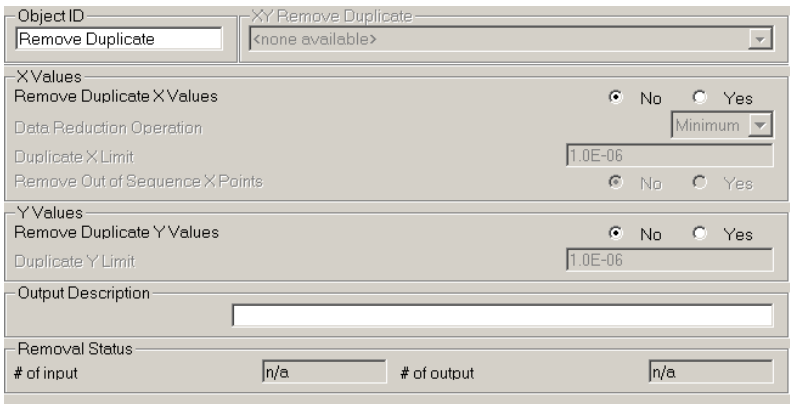


Figure 13.77 Remove Duplicates Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Remove Duplicate Duplicates will be removed from the XY data selected in the drop-down list.

X Values

Remove Duplicate X Values X duplicates are only removed if Yes is selected.

Data Reduction Operation Determines which duplicate X value to keep: the *Minimum*, *Maximum*, *Average*, *First* or *Last Y* value.

Duplicate X Limit Duplicates are considered values that have differences less than this specified value.

Remove Out of Sequence X Points X points are assumed to be ordered in ascending order. Points that do not fit within this ascending order will be removed if *Yes* is selected.

Y Values

Remove Duplicate Y Values	Y duplicates are only removed if *Yes* is selected.
Duplicate Y Limit	Duplicates are considered values that have differences less than this specified value.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

Reduction Status The number of input points and output points are displayed, indicating the number of duplicates removed.

13.78 Scale/Transform

What: Performs mathematical operations on a single real input value, cube data or grid data. Note there are separate objects for each data type.

Why: Unit conversions, other data manipulations.

Used By: Any object using real values, cube data or grid data.

Appearance: The appearance is identical for each data type, except for the name of the input data frame. The appearance is shown for cube data:

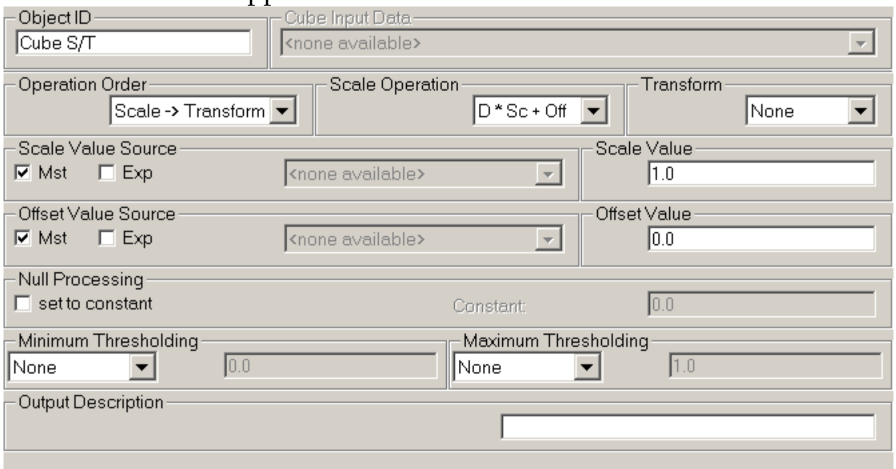


Figure 13.78 Scale/Transform Property Window for Cube Data

Input Data: real value, cube data or grid data

Output Data: real value, cube data or grid data

Properties:

Real To Scale/Transform or Cube/Grid Input Data The input data set to be scaled and/or transformed is selected.

Average/Smoothing Grid data can be averaged/smoothed. The degree of smoothing is adjusted with the Kernel Size.

Status For real value scale/transforms, the input and output values are displayed.

The remaining scale/transform options are described in Section 7.1.3.

13.79 Scale/Transform Extended Profile

What: Performs mathematical operations on an extended profile.

Why: Unit conversions, other data manipulations.

Used By: Any object using extended profiles.

Appearance:

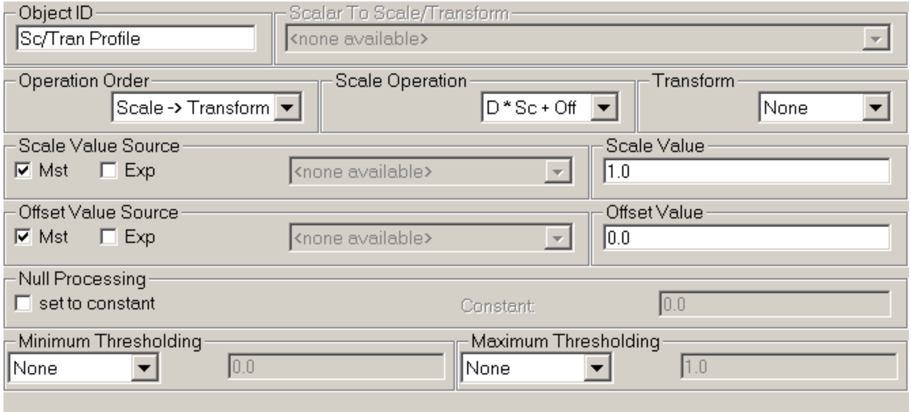


Figure 13.79 Scale/Transform Extended Profile Property Window

Input Data: extended profile

Output Data: extended profile

Properties:

Scalar To Scale/Transform The input data set to be scaled and/or transformed is selected.

The remaining scale/transform options are described in Section 7.1.3.

13.80 Select Curve from File

What: Selects a curve from a curve file. A curve file may contain several sets of curve data.

Why: Allows manipulation or plotting of one curve stored within a curve file.

Used By: Any object using curve data.

Appearance:

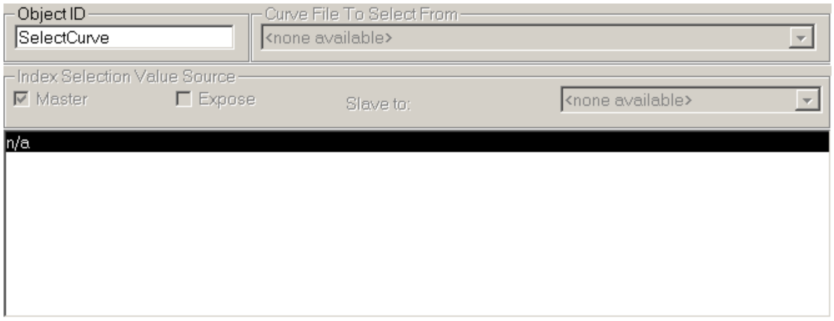


Figure 13.80 Select Curve from File Property Window

Application: nPre

Input Data: Read Curve File

Output Data: curve data

Properties:

Curve File To Select From The curve file from which the curve data are extracted is selected.

Index Selection Value Source A selection box containing a list of the available curve data sets allows the user to select the curve data to extract.

Master — Selection of the curve data may be slaved to another object. See Section 6.3.1 for more information on Master/Slave controls.

Expose — Selection of the curve data may be exposed. See Section 6.3.2 for more information on exposed controls.

13.81 Select Range Cube

What: Used in real-time processing, allows the selection of a range cube data set available during a run. Only for range mode simulations with three variables specified as range variables.

Why: Used to plot simulation range cube data during the simulation.

Used By: Any object using cube data.

Appearance:

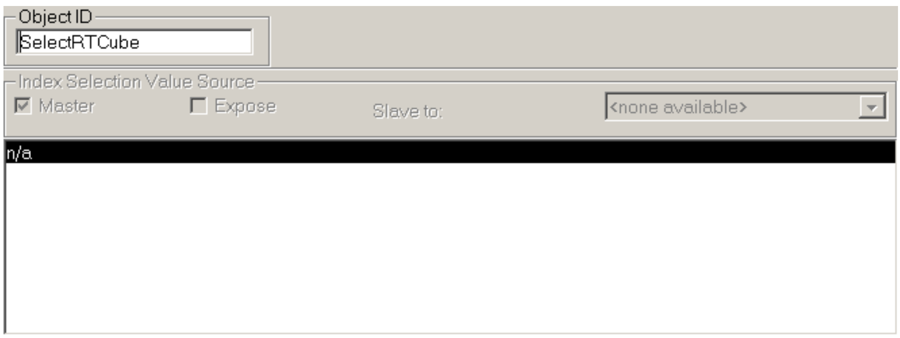


Figure 13.81 Select Range Cube Property Window

Application: nPre

Input Data: cube data

Output Data: cube data

Properties:

Index Selection Value Source A selection box containing a list of the available range cube data sets allows the user to select the range cube data to extract.

Master: Selection of the range cube data may be slaved to another object. See Section 6.3.1 for more information on Master/Slave controls.

Expose: Selection of the range cube data may be exposed. See Section 6.3.2 for more information on exposed controls.

13.82 Select Range Grid

What: Used in real-time processing, allows the selection of a range grid data set available during a run. Only for range mode simulations with two variables specified as range variables.

Why: Used to plot simulation range grid data during the simulation.

Used By: Any object using grid data.

Appearance:

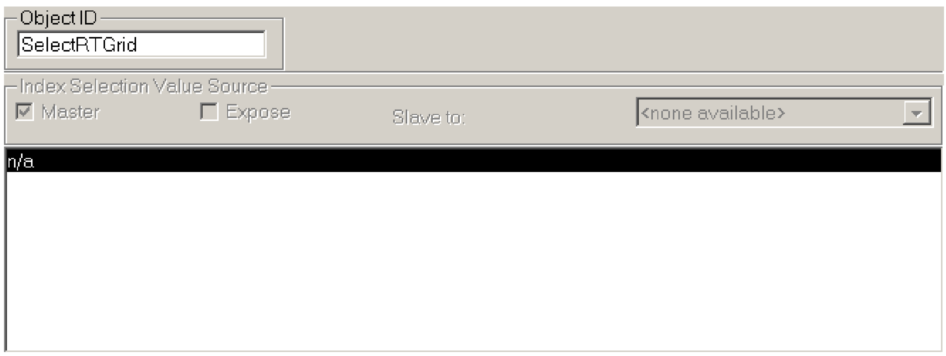


Figure 13.82 Select Range Grid Property Window

Application: nPre

Input Data: grid data

Output Data: grid data

Properties:

Index Selection Value Source A selection box containing a list of the available range grid data sets allows the user to select the range grid data to extract.

Master — Selection of the range grid data may be slaved to another object. See Section 6.3.1 for more information on Master/Slave controls.

Expose — Selection of the range grid data may be exposed. See Section 6.3.2 for more information on exposed controls.

13.83 Select XY from XY Array

What: Select an XY data set from an XY array. An XY array is a collection of XY data sets.

Why: To examine, manipulate or plot one XY data set within an XY array.

Used By: Any object using XY data.

Appearance:

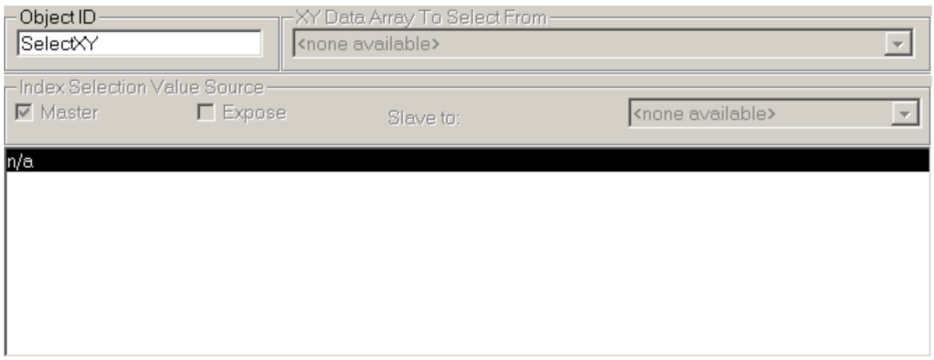


Figure 13.83 Select XY from XY Array Property Window

Input Data: XY array

Output Data: XY data

Properties:

XY Data Array To Select From The XY array from which the XY data are extracted is selected.

Index Selection Value Source A selection box containing a list of the available XY data sets in the array allows the user to select the XY data to extract.

Master: Selection of the XY data may be slaved to another object. See Section 6.3.1 for more information on Master/Slave controls.

Expose: Selection of the XY data may be exposed. See Section 6.3.2 for more information on exposed controls.

13.84 Sequence Fit

What: Similar to **(Basic) Single Fit**, except the fit can be limited to a range of time or sequences. The Y data of both field and simulated data may also be interpolated based on synthetic X data (see Section 7.1.4 for details). No interpolation occurs if *Input X* is selected as the Interpolation Method. Typically used in the **Fit** tab of the **Plots & Data Processing** nPre input window.

Why: Used to determine the field data that simulated data should be compared to during an optimization or range simulation, limited within defined sequences.

Used By: **Fit Selection** tab of the **Fit Selection** nPre input window.

Appearance:

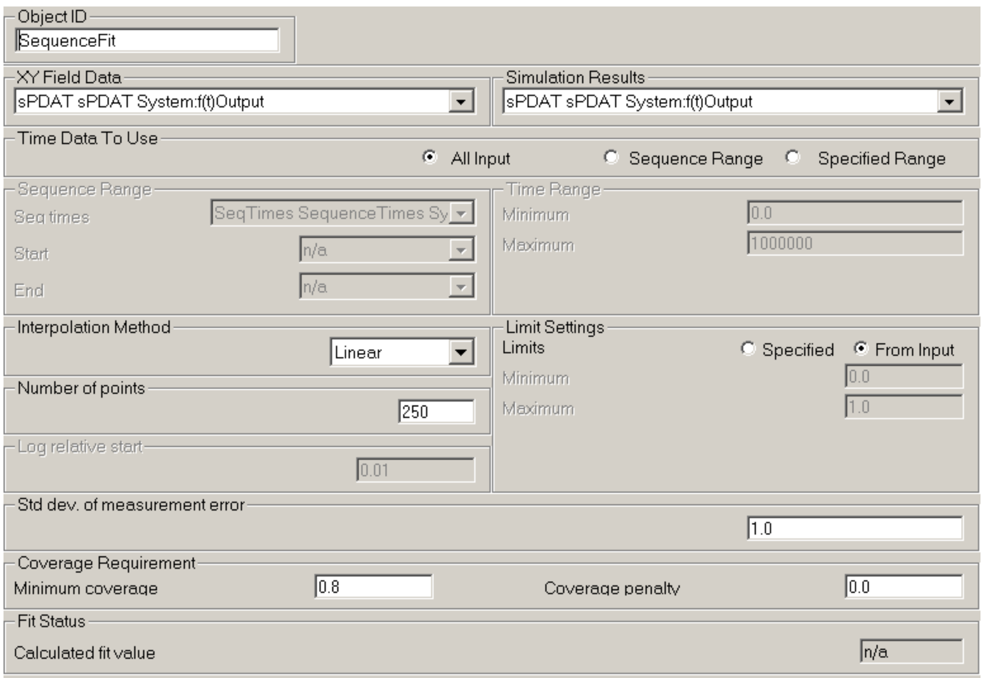


Figure 13.84 Sequence Fit Property Window

Application: nPre

Input Data: XY data

Output Data: fit specification

Properties:

XY Field Data Select XY data representing field data.

Simulation Results Select XY or table data representing simulation data.

Time Data To Use

All Input — Field and simulation data are not limited by time or sequences, i.e. all data are used for interpolation.

Sequence Range — Field and simulation data are limited by one or more sequences, as defined in the **Sequence Range** frame.

Time Range — Field and simulation data are limited by a time range defined by a minimum and maximum time in the **Time Range** frame.

Sequence Range

Seq times — The sequence time data set to be used is selected. By default, the sequence time data are a system object defined in the **Sequence** input window.

Start — The sequences available in the specified **Sequence Time Data** will be listed in the drop-down-box, and the starting sequence is selected. Field and simulation data starting at this sequence are included in the fit.

End — The sequences available in the specified **Sequence Time Data** will be listed in the drop-down-box, and the ending sequence is selected. Field and simulation data up to the end of this sequence are included in the fit.

Time Range

Minimum — Minimum time of the time range included in the fit.

Maximum — Maximum time of the time range included in the fit.

Interpolation Method — Interpolation method is selected, described in detail in Section 7.1.4. If no interpolation is desired, select the *Input X* method. Interpolation and related options apply to both field and simulated data.

Number of points — For all interpolation methods except *Input X*, determines the number of equally spaced X values and corresponding interpolated Y values.

Log relative start — For *Log (Relative)* interpolation method only, determines the value of the first log X value.

Limit Settings — For all interpolation methods except *Input X*.

Specified — The minimum and maximum X values are specified in the Minimum and Maximum text boxes.

From Input — Determines the minimum and maximum X values automatically from the input data.

Std dev of measurement error — The standard deviation is used in the calculation of the Chi-squared minimization function.

Coverage Requirement

Minimum Coverage — After data processing, the number of simulated data points may be less than the number of field data points. If the number of simulated data points multiplied by the minimum coverage value is less than the number of field data points, an error will result for the fit.

Coverage penalty — The fit value is adjusted by multipling the fit value by: 1.0 + coverage penalty / actual coverage value.

Fit Status

Calculated Fit Value — Once simulation results are generated, the calculated fit value for the specified field and simulated data will be displayed.

13.85 Single Fit

See (Basic) Single Fit

13.86 Single Scale/Transform

What: Performs mathematical operations on either the X or the Y of XY data.

Why: Unit conversions or other data manipulations.

Used By: Any object using XY data.

Appearance:

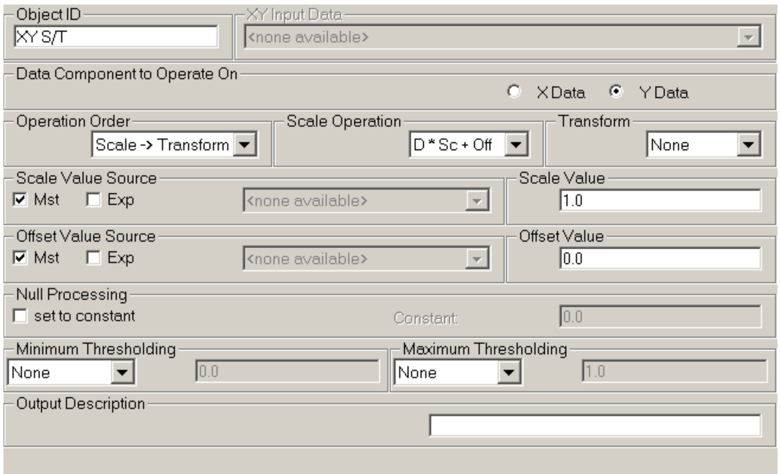


Figure 13.85 Single Scale/Transform Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Input Data The input XY data set that is scaled and/or transformed is selected.

Data Components to Operate On

X Data If selected, the X data are scaled and/or transformed.

Y Data If selected, the Y data are scaled and/or transformed.

The remaining scale/transform options are described in Section 7.1.3.

13.87 Smooth/Filter

What: Filters and smoothes XY data using one of the following methods: *FFT smooth*, *Median smooth*, *low pass* and *high pass*.

Why: Smoothes and filters anomalies within data for improved data approximations or plotting.

Used By: Any object using XY data.

Appearance:

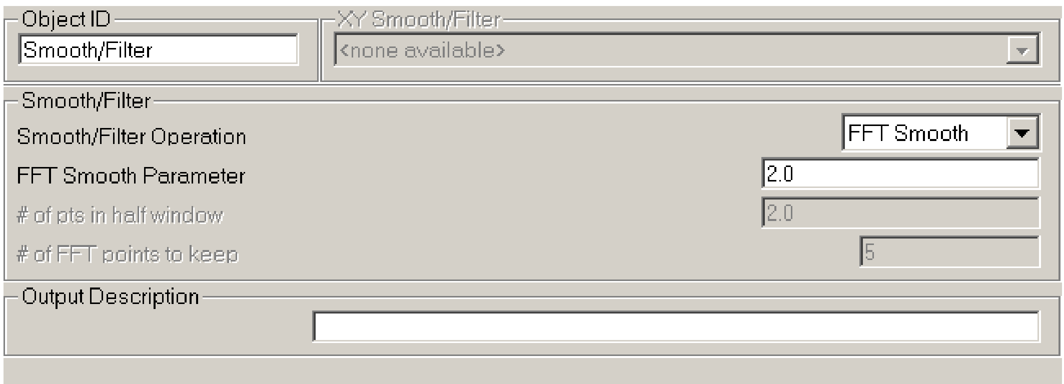


Figure 13.86 Smooth/Filter Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Smooth/Filter The input data set that is smoothed and filtered is selected in the drop-down-box.

Smooth/Filter

Smooth/Filter Operation The method of smoothing and filtering is selected in the drop-down-box.

FFT Smooth A fast Fourier transform is applied to the data, removing high frequency values.

Median Smooth Takes the average value within a window. The larger the window, the greater the smoothing.

Low Pass Removes high frequency components.

High Pass Removes low frequency components.

FFT Smooth Parameter — For *FFT Smooth*, indicates the strength of the smoothing: the greater the magnitude of the parameter, the greater the smoothing.

# of points in half window — For *Median Smooth*, determines the number of points in half a window.

# of FFT points to keep — For *Low Pass* or *High Pass*, determines the number of points to keep: the greater the number of points kept, the less smoothing of the data.

Output Description — Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

13.88 Statistics

What: Calculates basic statistics (e.g. sum, mean, minimum, maximum, etc.) for XY, cube or grid data. Four basic statistics are selected for output as real values, typically used as data labels on a plot.

Why: For examination of data. Can also be included as labels for plots.

Used By: Any object using real values.

Appearance: The appearance is identical for each data type, except for the name of the input data frame, an extra input frame for XY data, and status frames for cube and grid data. The appearance is shown for XY data:

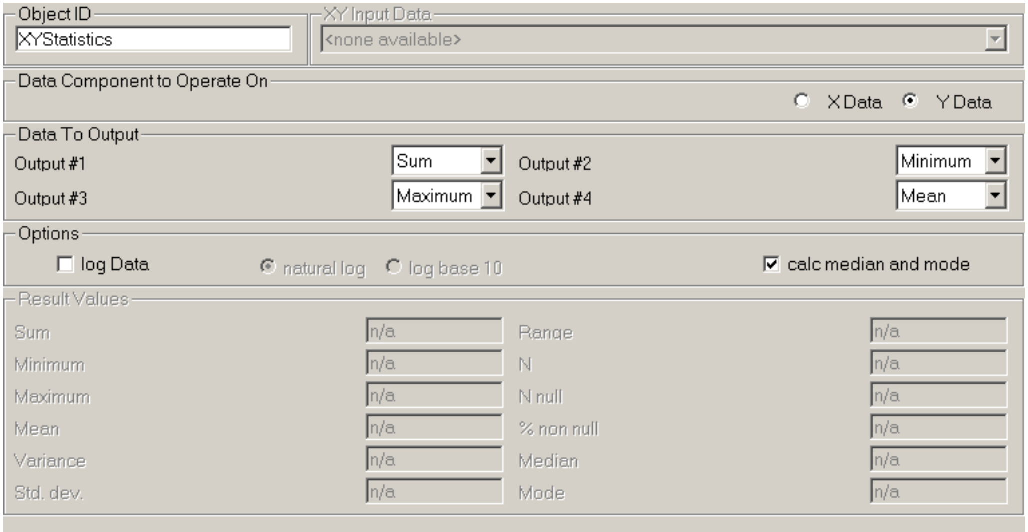


Figure 13.87 Statistics Property Window for XY Data

Input Data: XY, cube or grid data

Output Data: 4 real values

Properties:

Cube/Grid/XY Input Data Statistics are computed for the input data selected.

Data Component to Operate On XY data only. Statistics are calculated for X data or Y data.

Data to Output The statistics to output as real values are selected from four drop-down-boxes (four real values are output).

Options

log Data If selected, statistics are calculated on the log (natural or base 10) of the input data.

natural log — If log Data is selected, the natural logarithm of the input is calculated.

log base 10 — If log Data is selected, the base 10 logarithm of the input is calculated.

calc median and mode — If selected, the median and mode are calculated. The calculation of the median and mode is an option due to the large computational requirements for large data sets.

Result Values

Sum	The total of all non-null values.
Minimum	Minimum non-null value.
Maximum	Maximum non-null value.
Mean	Sum / N
Variance	$Sum((y_i - Mean)^2) /N$, where y_i = ith non-null value.
Std. dev.	$Sqrt(Sum((y_i - Mean)^2) /(N -1))$
Range	Maximum - Minimum
N	Number of non-null data.
N null	Number of null data.
% non-null	N/(N + N_null) * 100.
Median	Value in the middle of sorted data. Only calculated if specified in the **Options** frame.
Mode	Most frequently occurring value in a set of data. Only calculated if specified in the **Options** frame.

Note that only N, N Null and % non-null will be calculated if N = 0. Variance and Std. dev. are only calculated if N > 1.

Grid/Cube X/Y/Z Status — Displays the grid/cube status, see **Read Cube Data** and **Read Grid Data** objects.

13.89 Sum Tables

What: Sums the values between multiple tables. For example, the value in column 2, row 1 of Table A will be added to column 2, row 1 of Table B. A specified X column will not be summed. A maximum of 24 tables may be summed, including the base table.

Why: To combine data within a table.

Used By: Any object using table data.

Appearance:

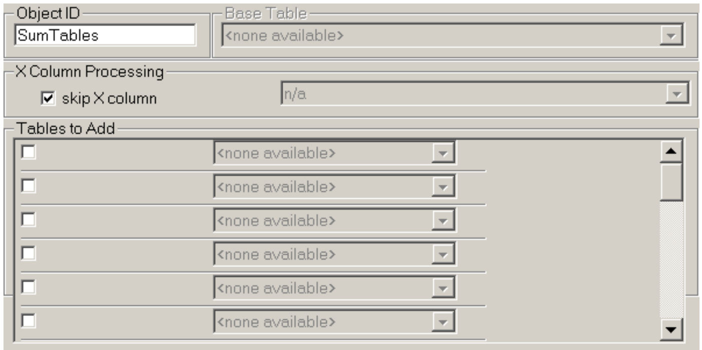


Figure 13.88 Sum Tables Property Window

Input Data: table data

Output Data: table data

Properties:

Base Table Selects the table to which the tables specified in the **Tables to Add** frame are added. The X column and table size are obtained from this base table.

X Column Processing

skip X column — If selected, the specified column in the drop-down-box will be excluded from table addition. The column will appear in the output table as it appears in the base table.

Tables to Add A checkbox and associated drop-down-box indicates the tables to sum with the base table. Each table selected must be the same size as the base table (i.e. equal number of rows and columns).

13.90 Table Column Correlations

What: Calculates the Pearson R and Spearman R correlation coefficients between two specified columns of a table.

Why: Determines the correlation between table columns.

Used By: Any object using real values.

Appearance:

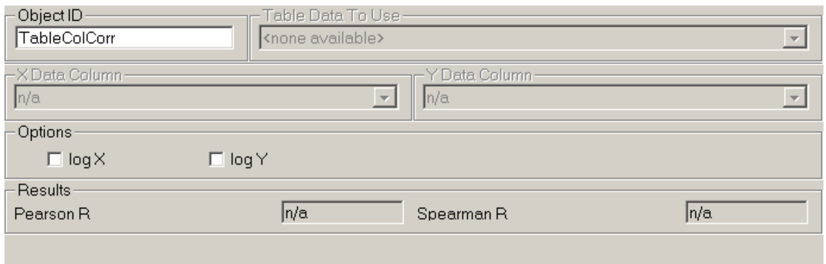


Figure 13.89 Table Column Correlations Property Window

Input Data: table data

Output Data:

XY data sets: one containing the two columns used as input (Correlation data), the second containing the correlation line.

4 real values: the resulting Pearson R, the resulting Spearman R, the X column ID and the Y column ID

Properties:

Table Data To Use The input table data set is selected.

X Data Column The table column to be used as the X value is selected.

Y Data Column The table column to be used as the Y value is selected.

Options

log X Take the log (base 10) of the X data before calculating the correlation coefficient.

log Y Take the log (base 10) of the Y data before calculating the correlation coefficient.

Results Once the **Apply** button is selected, the calculated Pearson R and Spearman R correlation coefficients are displayed.

13.91 Table Column Math

What: Basic mathematics (+,-,*,/) are applied to two table columns.

Why: Data manipulations.

Used By: Any object using XY data.

Appearance:

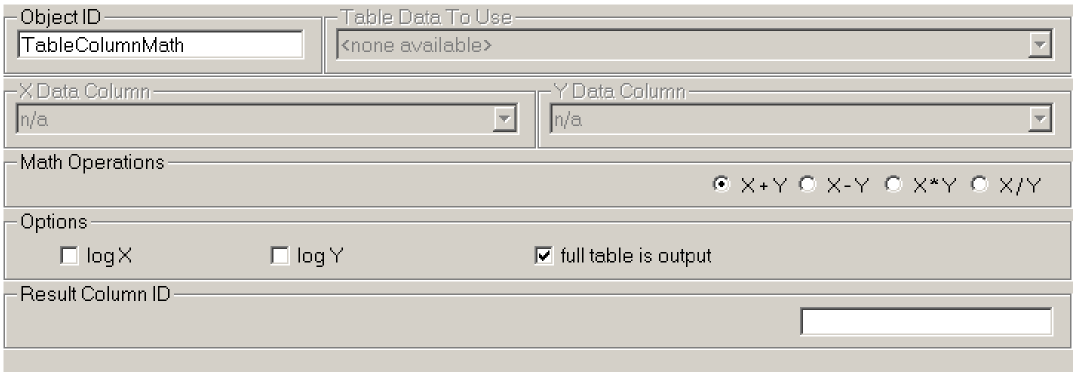


Figure 13.90 Table Column Math Property Window

Input Data: table data

Output Data: table data

Properties:

Table Data To Use The input table is selected.

X Data Column The column to be used as X data is selected.

Y Data Column The column to be used as Y data is selected.

Math Operations The math operation between column X and Y is selected. The two columns can be added, subtracted, multiplied or divided.

Options

log X The X data can be log transformed before the math operation is conducted.

log Y The Y data can be log transformed before the math operation is conducted.

full table is output If selected, the output table will contain all the columns of the input table, with an additional column containing the math results. If not checked, the output table will contain three columns, one X column, one Y column and one math results column.

Result Column ID The column containing the math results will have a column ID as specified in the text box.

13.92 Table Column Scale/Transform

What: Performs mathematical operations on a specified column of a table.

Why: Unit conversions, other data manipulations.

Used By: Any object using table data.

Appearance:

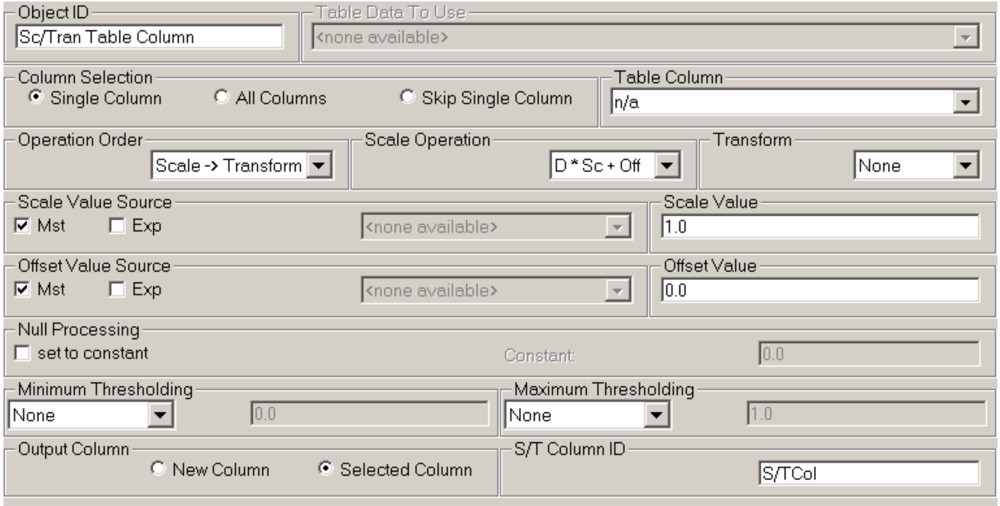


Figure 13.91 Table Column Scale/Transform Property Window

Application: nPost

Input Data: table data

Output Data: table data

Properties:

Table Data To Use The input table data set containing the column to be scaled and/or transformed is selected.

Column Selection Scale/Transform can be performed on a single selected table column, all columns or all columns except the selected table column.

Table Column The table column that is scaled and/or transformed.

Output Column The resulting scale/transform can be output into a new column, or replace the column selected as the table column to scale/transform.

S/T Column ID Column ID of the new/replaced column.

The remaining scale/transform options are described in Section 7.1.3.

13.93 Table Column Statistics

What: Calculates basic statistics (e.g. sum, mean, minimum, maximum, etc.) for a specified column of a table. Four basic statistics are selected for output as real values, typically used as data labels on a plot.

Why: For examination of table column data. Can also be included as labels for plots.

Used By: Any object using real values.

Appearance:

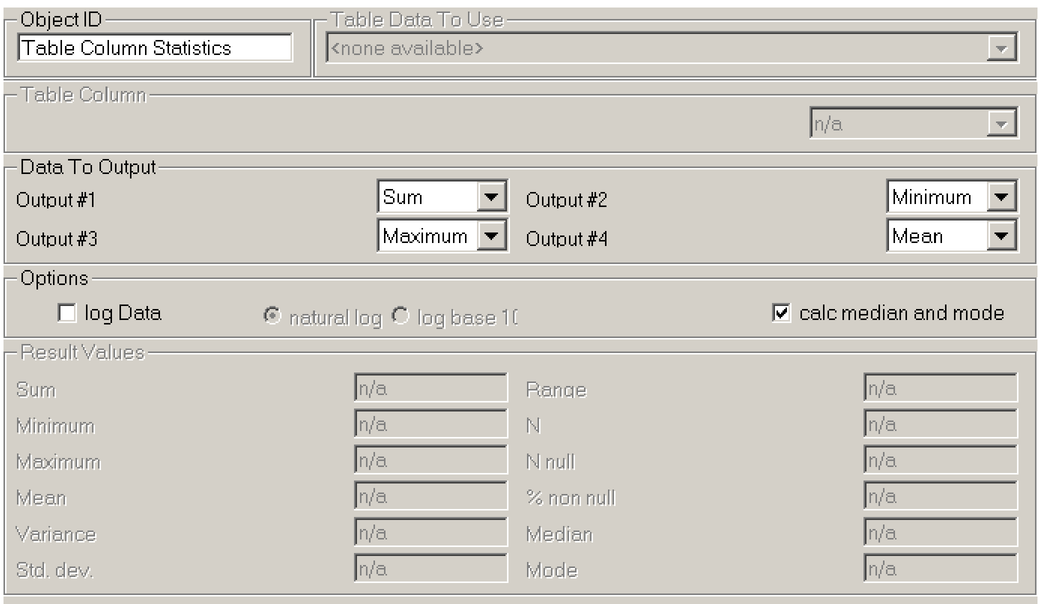


Figure 13.92 Table Column Statistics Property Window

Input Data: table data

Output Data: 4 real values

Properties:

Table Data To Use Statistics are calculated on a column of the table data selected.

Table Column Statistics are calculated on the specified table column.

The remaining options are described in the **Statistics** object, Section 13.88.

13.94 Table Column To Histogram

What: Creates the input data for a histogram plot based on a specified column of a table. The actual histogram is plotted using an **XY Series** plot object on a plot page, with this object as the input.

Why: Manipulates data in order to plot a histogram.

Used By: Any object using XY data. In particular, the **XY Series** plot object is used to plot the histogram.

Appearance:

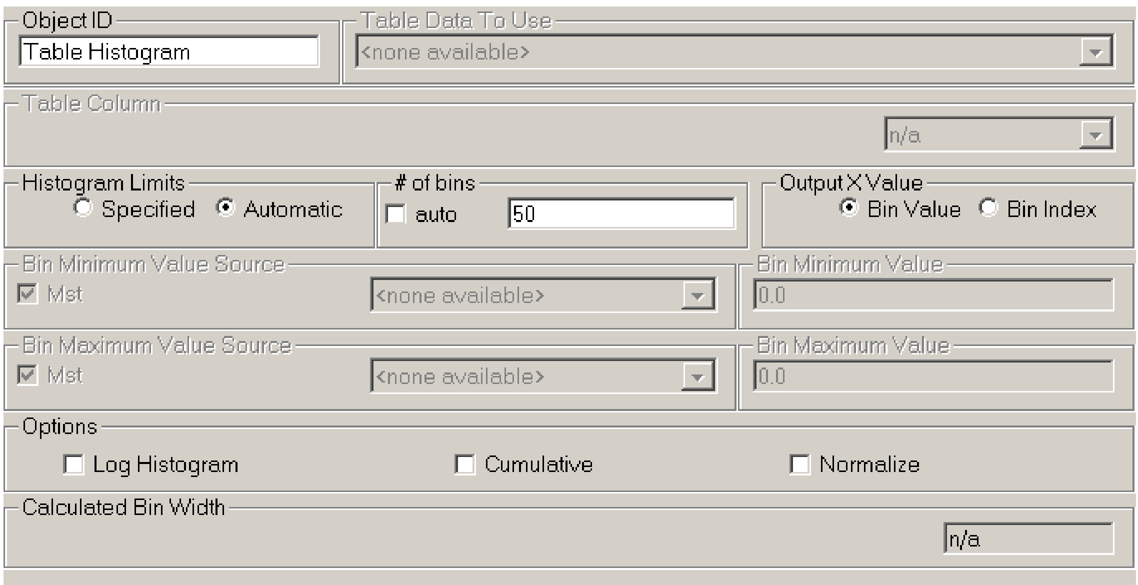


Figure 13.93 Table Column to Histogram Property Window

Input Data: table data

Output Data: XY data

Properties:

Table Data To Use Selects the input table data from which a column is converted to a histogram.

Table Column The value frequency of the table column selected is calculated for the histogram.

The remaining options are described in the **Histogram** object, Section 13.413.45 Histogram5.

13.95 Table Columns To XY

What: Extracts two specified columns from a table to create XY data.

Why: To convert table data to XY data.

Used By: Any object using XY data.

Appearance:

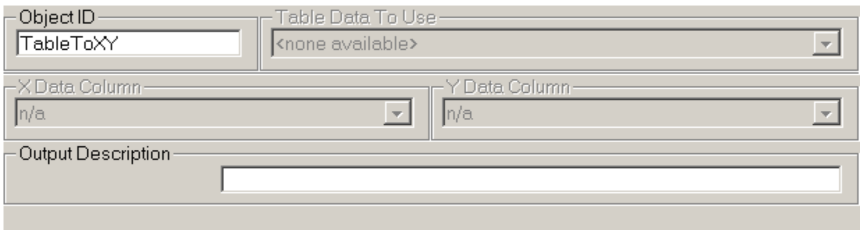


Figure 13.94 Table Columns to XY Property Window

Input Data: table data

Output Data: XY data

Properties:

Table Data To Use XY data are extracted from columns of the table data selected.

X Data Column The specified table column is used as the X data.

Y Data Column The specified table column is used as the Y data.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists and the label of the object in a **Series Legend**.

13.96 Table Row Index Logic

What: Conducts Boolean Logic (AND, OR, XOR) between two sets of table rows.

Why: Used to select specified rows from a table. For example, table rows can be can be limited to rows with a hydraulic conductivity and a flow dimension greater than specified values. An application of this object would be a to limit the selection of simulations according to several parameter values, using the Master/Slave facility (the object's **Index Selection Value Source** will be a slave to this **Table Row Index Logic** object).

Used By: Any object using table data.

Appearance:

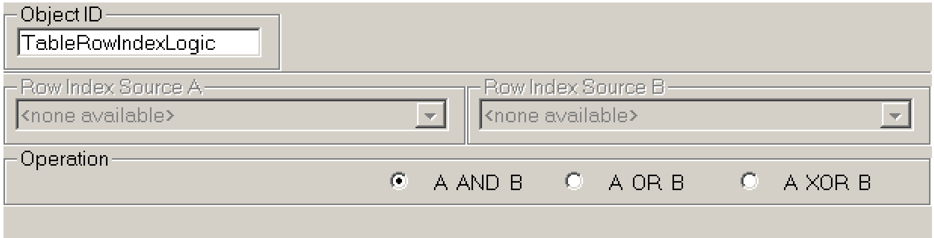


Figure 13.95 Table Row Index Logic Property Window

Application: nPost

Input Data: output from Extract Table Rows

Output Data: table data

Properties:

Row Index Source A Select table rows, extracted from an **Extract Table Rows** object, to be compared with the table rows specified as Source B.

Row Index Source B Select table rows, extracted from an **Extract Table Rows** object, to be compared with the table rows specified as Source A.

Operation One of three Boolean logic operators may be selected:

A AND B Row Indexes that occur in both A and B are output (i.e. only indexes common to A and B).

A OR B Row Indexes that occur in either A or B are output (i.e. all A indexes and all B indexes).

A XOR B Row Indexes that occur in either A or B, but not both, are output (i.e. all indexes in A and B except those indexes common to A and B).

13.97 Table Row Statistics

What: Calculates basic statistics (e.g. sum, mean, minimum, maximum, etc.), as well as confidence limits and the median, for all rows of a table. The statistics are output in table format, and may be viewed as a table with the **View Table Data** object.

Why: For examination of table row data. Can also be included as labels for plots.

Used By: Any object using table data.

Appearance:

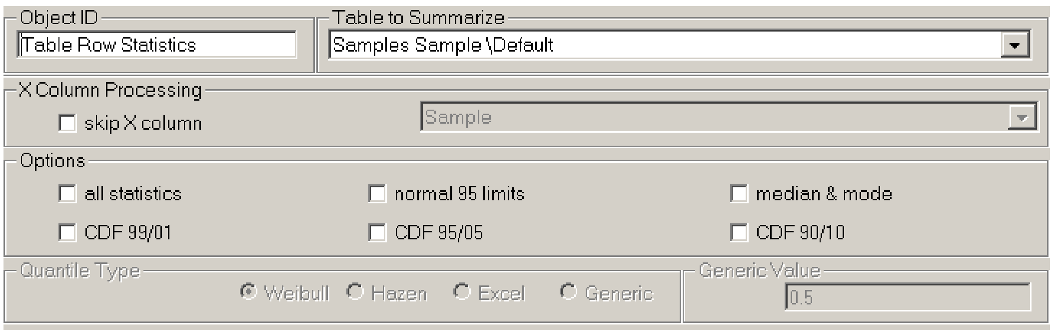


Figure 13.96 Table Row Statistics Property Window

Input Data: table data

Output Data: table data

Properties:

Table to Summarize A table data object is selected, from which statistics will be calculated for each row of the table.

X Column Processing

skip X column If selected, the specified column in the drop-down-box will be excluded from the row statistics.

Options Each option determines the statistics calculated. The statistics calculated are viewed by viewing the resulting table data with a **View Table Data** object. At a minimum, even if none of the options are selected, the mean, min and max are output. Each option adds additional statistics to the table.

All statistics If selected, outputs the statistics outlined for the **Statistics** object for each table row.

normal 95 limits If selected, outputs the following statistics for each table row:

Upper95 Upper 95% confidence limit.

Lower95 Lower 95% confidence limit.

median & mode If selected, outputs the following statistics for each table row:

Median The middle number of non-null data, i.e. half the non-null data have values greater than the median, and half have values less than the median. If the number of non-null data is even, the median is the average of the two middle numbers.

Mode Most frequently occurring value in a set of data.

CDF 99/01 If selected, outputs the following statistics for each table row:

CDF99 The interpolated value of the CDF for a 99% probability.

CDF01 The interpolated value of the CDF for a 1% probability.

CDF 95/05 If selected, outputs the following statistics for each table row:

CDF95 The interpolated value of the CDF for a 95% probability.

CDF05 The interpolated value of the CDF for a 5% probability.

CDF90/10 If selected, outputs the following statistics for each table row:

CDF90 The interpolated value of the CDF for a 90% probability.

CDF10 The interpolated value of the CDF for a 10% probability.

Quantile Type If a CDF is required to calculate a row statistic, determines the quantile type used to calculate the CDF, as described in Section 13.6.

Generic Value As described in Section 13.6.

13.98 Time Limits Extraction/Interpolation

What: Extracts XY data for a range of sequences or time and within specified data limits, and interpolates the extracted data.

Why: Allows the examination of XY within a specified time frame.

Used By: Any object using XY data.

Appearance:

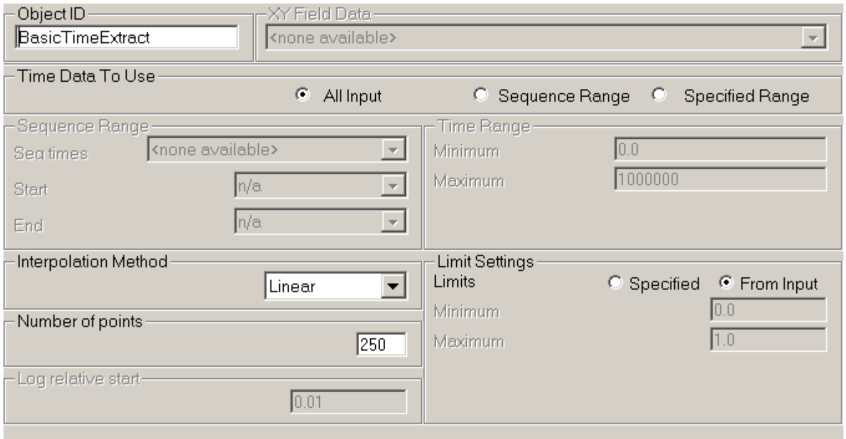


Figure 13.97 Time Limits Extraction/Interpolation Property Window

Input Data: XY data and sequence time interval data if Sequence Range time data selected.

Output Data: XY data

Properties:

XY Input Data Select XY data to extract and/or interpolate.

Time Data To Use

All Input XY data are not limited by time or sequences, i.e. all data are used for interpolation.

Sequence Range XY data are limited by one or more sequences, as defined in the **Sequence Range** frame.

Time Range XY data are limited by a time range defined by a minimum and maximum time in the **Time Range** frame.

Sequence Range

Seq times The sequence time data set to be used is selected. In nPre, the sequence time data are by default a system object defined in the

Sequence input window. In nPost, the sequence time data must be read in with a **Sequence Time Interval Data** object, or with XY or profile simulation results.

Start	The sequences available in the specified **Sequence Time Data** will be listed in the drop-down-box, and the starting sequence is selected. XY data starting at this sequence is extracted.
End	The sequences available in the specified **Sequence Time Data** will be listed in the drop-down-box, and the ending sequence is selected. XY data up to the end of this sequence is extracted.
Time Range	
Minimum	Minimum time of the time range extracted.
Maximum	Maximum time of the time range extracted.
Interpolation Method	Interpolation method is selected, described in detail in Section 7.1.4. If no interpolation is desired, select the *Input X* method.
Number of points	For all interpolation methods except *Input X*, determines the number of equally spaced X values and corresponding interpolated Y values.
Log relative start	For *Log (Relative)* interpolation method only, determines the value of the first log X value.
Limit Settings	For all interpolation methods except *Input X*.
Specified	The minimum and maximum X values are specified in the Minimum and Maximum text boxes.
From Input	Determines the minimum and maximum X values automatically from the input data.

13.99 Transpose

What: Switches the X and Y data (i.e. output X = input Y and output Y = input X).

Why: To manipulate data.

Used By: Any object using XY data.

Appearance:

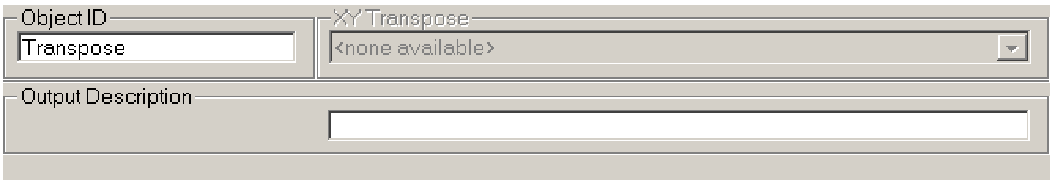


Figure 13.98 Transpose Property Window

Input Data: XY data

Output Data: XY data

Properties:

XY Transpose Selects the XY input data for which the X and Y will be transposed.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists and the label of the object in a **Series Legend**.

13.100 Transpose Table Columns and Rows

What: Switches the column and row data (i.e. output rows = input columns and output columns = input rows).

Why: To manipulate data.

Used By: Any object using table data.

Appearance:

Figure 13.99 Transpose Table Columns and Rows Property Window

Input Data: table data

Output Data: table data

Properties:

Input Table Data Selects the table data for which the columns and rows will be transposed.

X Column Processing If skip X column is selected, a specified column is removed from the table before it is transposed.

13.101 Validate XY Data as CDF

What: Checks XY data to see if it fulfils the criteria of a CDF, and outputs that CDF.

Why: CDFs may be modified using XY data objects. This object ensures that the XY data is still a CDF, and converts it back to the CDF data type.

Used By: Any object using XY data or CDFs.

Appearance:

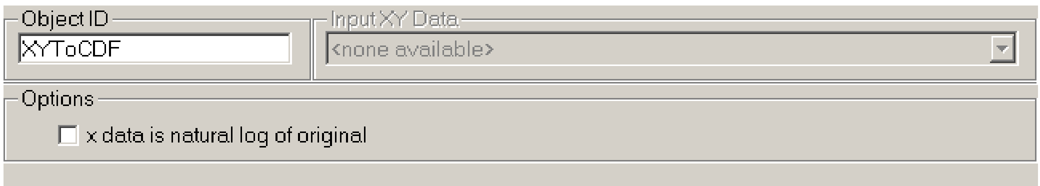


Figure 13.100 Evaluate XY Data as CDF Property Window

Input Data: XY data

Output Data: CDF

Properties:

Input XY Data The XY data set to be evaluated is selected in the drop-down box.

Options

x data is natural log of original The X data (the values) are the log of the original data used to create the CDF.

13.102 Vector Math

What: Basic array mathematics (+,-,*,/, max, min) can be applied to two sets of XY data.

Why: Data manipulations.

Used By: Any object using XY data.

Appearance:

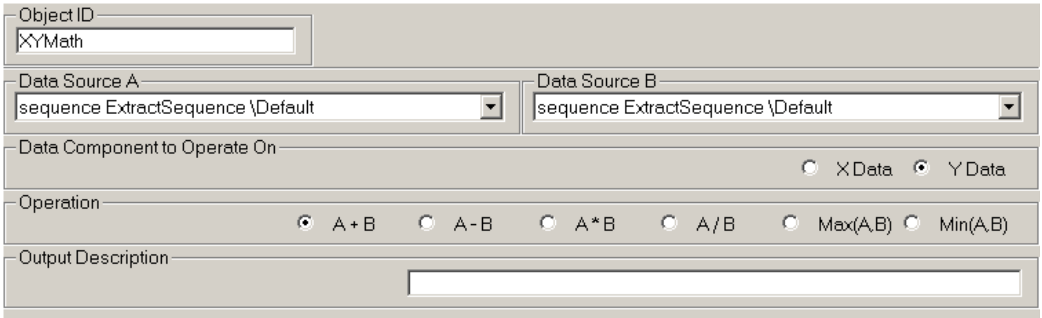


Figure 13.101 Vector Math Property Window

Input Data: XY data

Output Data: XY data

Properties:

Data Source A The first XY data set is selected.

Data Source B The second XY data set is selected. Data source A and B must be of the same size (i.e. same number of XY points).

Data Component to Operate On Math can be applied to the X data or the Y data.

Operation The math operation between data source A and B is selected. The two data sources can be added, subtracted, multiplied or divided. As well, the maximum or minimum of A or B at each XY point can be calculated.

Output Description Provides a description of the object, which will be used as the object type in drop-down lists, and the label of the object in a **Series Legend**.

13.103 View Grid Data

What: Allows the user to view grid data.

Why: Used to view grid data created in another object.

Used By: Any object using grid data.

Appearance:

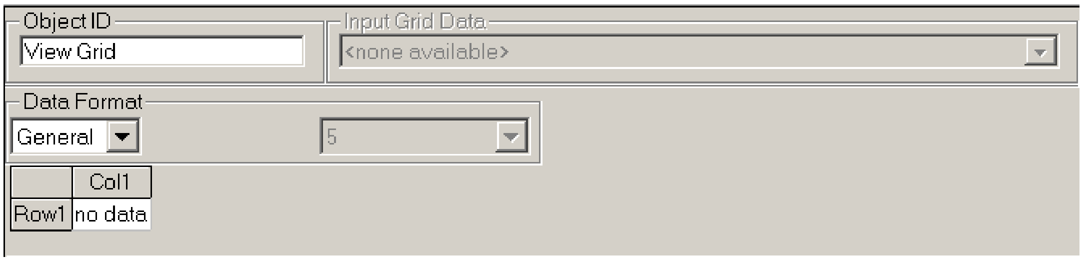


Figure 13.102 View Grid Data Property Window

Input Data: grid data

Output Data: grid data

Properties:

Input Grid Data Grid data from the object selected are viewed in this property window.

Data Format Specifies the numeric format of the data. Number formatting described in Section 6.3.3.

Data are viewed in the table once the **Apply** button has been selected.

13.104 View Table Data

What: Allows the user to view table data.

Why: Used to view table data created in another object, such as **Real Values(s) to Table** or **Table Row Statistics**.

Used By: Any object using table data.

Appearance:

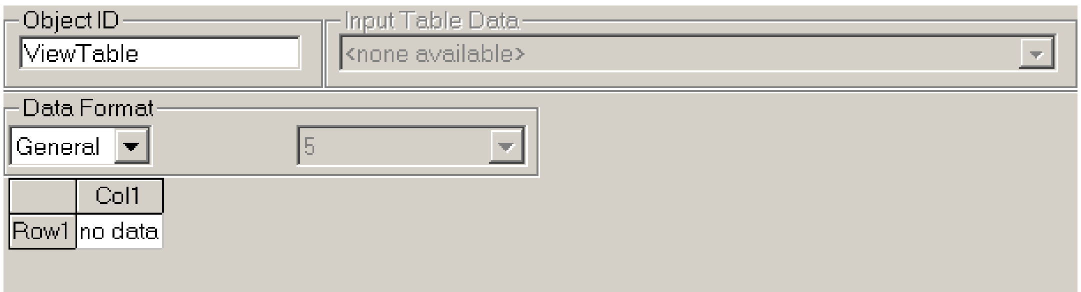


Figure 13.103 View Table Data Property Window

Input Data: table data

Output Data: table data

Properties:

Input Table Data Table data from the object selected are viewed in this property window.

Data Format Specifies the numeric format of the data. Number formatting described in Section 6.3.3.

Data are viewed in the table once the **Apply** button has been selected. To modify table data, use the **Enter Table Data** object.

13.105 View XY Data

What: Allows the user to view XY data.

Why: Used to view XY data created in another object, such as **Read XY Data** or **Dual Scale Transform**.

Used By: Any object using XY data.

Appearance:

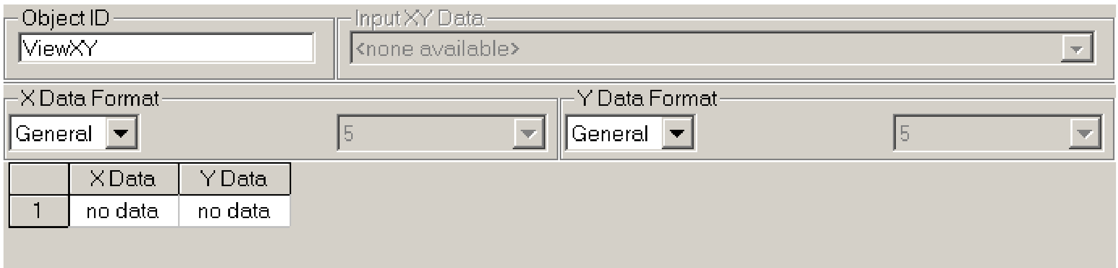


Figure 13.104 View XY Data Property Window

Input Data: XY data

Output Data: XY data

Properties:

Input XY Data XY data from the object selected are viewed in this property window.

X/YData Format Specifies the numeric format of the X and Y data. Number formatting options are described in Section 6.3.3.

Data are viewed in the table once the **Apply** button has been selected. To modify XY data, use the **Enter XY Data** object.

13.106 Write Color Map

What: Writes a color map to a text file.

Why: Allows a color map to be used or manipulated outside the current nSIGHTS application.

Appearance:

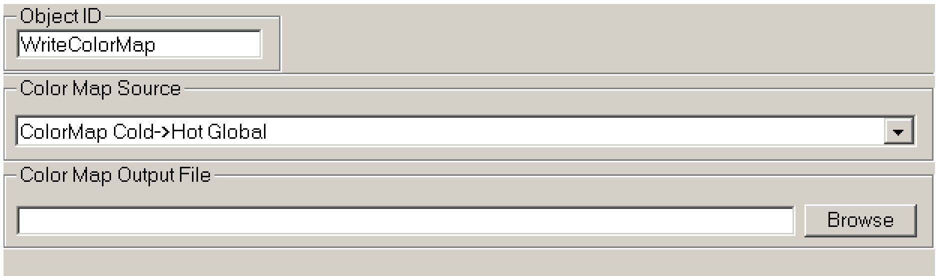


Figure 13.105 Write Color Map Property Window

Application: nPre, nPost as an output object

Input Data: color map

Output Data: text output file containing color map information compatible with **Read Color Map**, default file extension *.cmap

Properties:

Color Map Source Selects the color map data to be output.

Color Map Output File The path and name of the output file is entered in the text box or the **Browse** button is used to find the file path using the standard Windows open file dialog.

The output file is only written once the **Apply** button is selected.

13.107 Write Curve

What: Writes single or multiple curve data to a text file. Up to 24 curves may be included in one file.

Why: Allows curve data to be used or manipulated outside the nSIGHTS application (for example, in another nSIGHTS application).

Appearance:

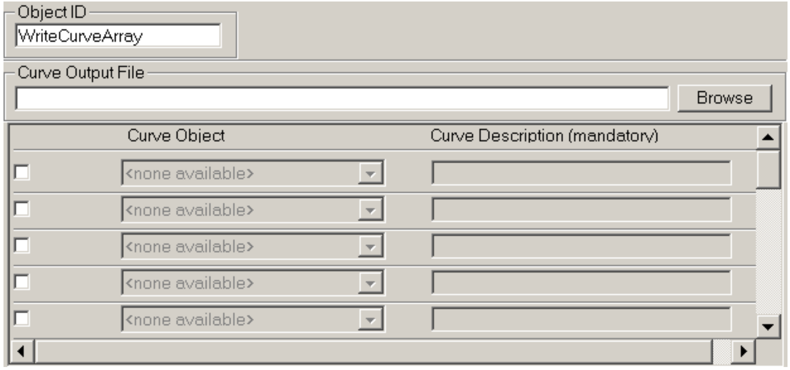


Figure 13.106 Write Curve Property Window

Application: nPre, nPost as an output object

Input Data: curve data

Output Data: text output file containing curve file information compatible with **Read Curve File**, default file extension *.nCRV

Properties:

Curve Output File The path and name of the output file is entered in the text box or the **Browse** button is used to find the file path using the standard Windows open file dialog.

Curve Object Curve data to be included in the output file is selected with the checkbox and adjacent drop-down list. Up to 24 curve data objects can be written to the output file.

Curve Description (mandatory) A description of the curve is required. This description is used as the curve ID once the file is loaded into another nSIGHTS application.

The output file is only written once the **Apply** button is selected.

13.108 Write Table

What: Writes a table to a text file.

Why: Allows table data to be used or manipulated outside the nSIGHTS application (for example, in another nSIGHTS application).

Appearance:

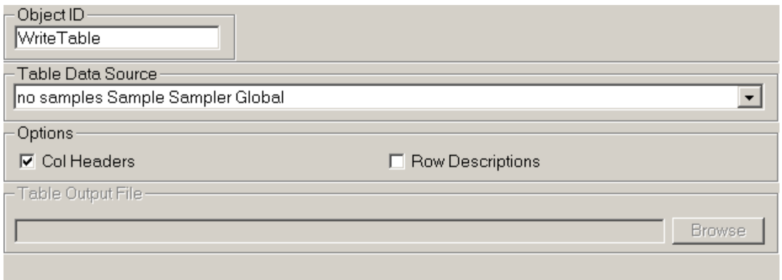


Figure 13.107 Write Table Property Window

Application: nPre, nPost as an output object

Input Data: table data

Output Data: text output file containing table data compatible with **Read Table File**

Properties:

Table Data Source Selects the table data to be output.

Options

Col Headers If selected, the first line of file contains column header names, right justified.

Row Descriptions If selected, each row is prefaced by a row identifier.

Table Output File The path and name of the output file is entered in the text box or the **Browse** button is used to find the file path using the standard Windows open file dialog.

The output file is only written once the **Apply** button is selected.

File Format:

The table is written as a text file with each column right justified in a field 16 characters wide, each column separated by a space (Basic file format for the **Read Table File** object). Numeric values are written in scientific notation with 9 digit precision.

13.109 Write XY File

What: Writes an XY data set to a text file.

Why: Allows XY data to be used or manipulated outside the nSIGHTS application (for example, in another nSIGHTS application).

Appearance:

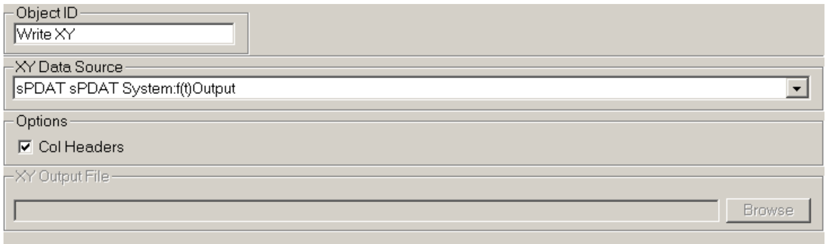


Figure 13.108 Write XY Data Property Window

Application: nPre, nPost as an output object

Input Data: XY data

Output Data: text output file containing XY data compatible with **Read XY Data**, default file extension *.dat

Properties:

XY Data Source Selects the XY data to be output.

Options

Col Headers If selected, the first line of file contains column header names, right justified.

XY Output File The path and name of the output file is entered in the text box or the **Browse** button is used to find the file path using the standard Windows open file dialog.

The output file is only written once the **Apply** button is selected.

File Format:

The XY data are written as a text file with each column right justified in a field 16 characters wide, each column separated by a space. Numeric values are written in scientific notation with 9 digit precision.

13.110 Write XY Data Array

What: Writes XY array data to a text file.

Why: Allows XY array data to be used or manipulated outside the nSIGHTS application (for example, in another nSIGHTS application).

Appearance:

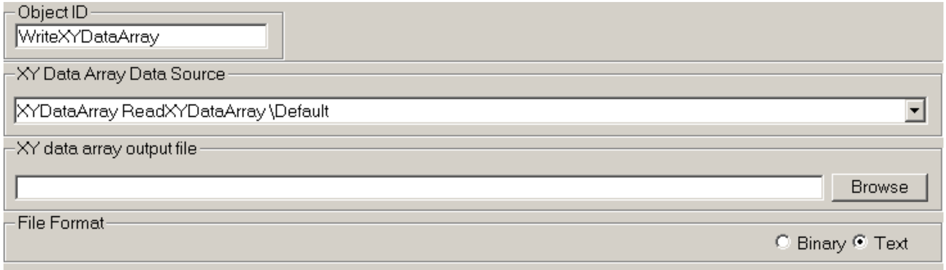


Figure 13.109 Write XY Data Array Property Window

Application: nPost

Input Data: XY array data

Output Data: text output file containing XY array data compatible with **Read XY Data Array**, default file extension *.nXYA

Properties:

XY Data Array Data Source Selects the XY array data to be output.

XY data array output file The path and name of the output file is entered in the text box or the **Browse** button is used to find the file path using the standard Windows open file dialog.

File Format The output file can be written in text or binary format.

The output file is only written once the **Apply** button is selected.

14 APPENDIX B – PLOT OBJECT DESCRIPTIONS

This Appendix is divided into four sections:

(1) Default Plot Objects

(2) Data Display Plot Objects

(3) Annotation Plot Objects

(4) Active Plot Objects

Default plot objects are automatically created upon creation of a plot page, whereas data display, annotation and active plot objects are created using the **Object→New** command. Within the selection menu of the **Object→New** command, data display object names are prefixed by **Data:**, annotation object names are prefixed by **Anno:**, and active objects have prefixes specific to the object.

14.1 Default Plot Objects

14.1.1 2D XY Main Menu

What: Controls the general layout and characteristics of 2D XY plots.

Appearance:

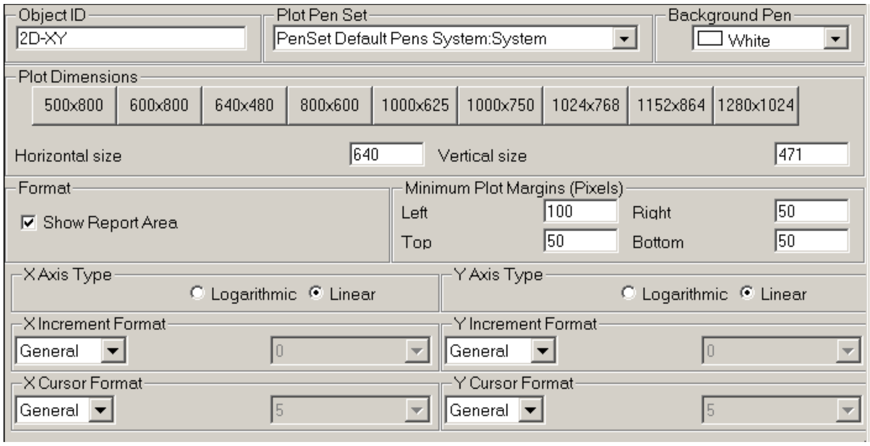


Figure 14.1 2D XY Main Menu Property Window

Properties:

ObjectID — For plot pages the object ID of the main menu is used as the title of the plot window itself, and as the identifier for the page in the object tree.

Plot pen set — The pen set to be used for all objects on the plot. This restricts all objects on the plot to the same palette of 24 colors (except for objects which use color maps to display data).

Background Pen — The pen color used for the background in the plotting area.

Plot Dimensions — Size of the window area. Pressing any of the buttons sets the X and Y of the window accordingly. Custom window sizes can be set manually with the following commands:

- Horizontal size — X dimension in pixels.
- Vertical size — Y dimension in pixels.

Format

- Show report area — If selected, the bottom of the plot window will contain an area for displaying cursor related data.

Minimum Plot Margins (Pixels) The distance between the plot axes/frame and the edge of the plotting area.

The following dialog prompts are also available on the **2D XY Axes** objects. Changes made here will be automatically updated in the **2D XY Axes** objects.

X/YAxis Type Linear or logarithmic axes can be defined.

X/Y Increment Label Format Numeric format for labels at each major increment. Numeric format is discussed further in Section 6.3.3.

X/Y Cursor Reporting Format Numeric format for the X or Y value of the current cursor location in the cursor reporting area. This format is also used for all reporting plot objects that do not have a specific reporting format. Numeric format is discussed further in Section 6.3.3.

14.1.2 2D XY Axes

What: There are two default plot objects to define the plot axes, one for the X axis and one for the Y axis, each with identical object property windows.

Appearance:

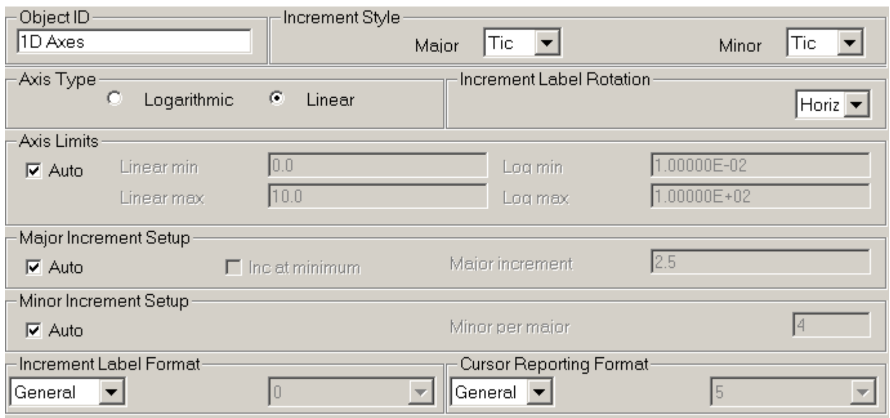


Figure 14.2 2D XY Axes Property Window

Properties:

Increment Style — Axes increments are represented by grid lines (*Grid*), tic marks (*Tic*), or not plotted (*None*).

Major — Style for labelled increments.

Minor — Style of unlabelled increments between major increments.

Axis Type — Linear or logarithmic axes can be defined. This dialog prompt is also available on the **2D XY Main Menu** object. Changes made here will be automatically updated in the **2D XY Main Menu** object.

Increment Label Rotation — Increment labels can be horizontal or vertical (left or right).

Axes Limits — Defines the domain of the plot.

Auto — Axes are adjusted to enclose all defined plot objects.

Linear min — The minimum co-ordinate value if a linear axis is used.

Linear max — The maximum co-ordinate value if a linear axis is used.

Log min — The minimum co-ordinate if a log axis is used.

Log max — The maximum co-ordinate if a log axis is used.

Major Increment Setup Distance between labelled increments for linear axes.

Auto Increments are set automatically based on data range.

Major increment Value to use if not Auto.

Minor Increment Setup Number of minor increments between each major increment for linear axes.

Auto Increments are set automatically based on major increment size.

Minor per major Value to use if not Auto.

The following dialog prompts are also available on the **2D XY Main Menu** object. Changes made here will be automatically updated in the **2D XY Main Menu** object.

Increment Label Format Numeric format for labels at each major increment. Numeric format is discussed further in Section 6.3.3.

Cursor Reporting Format Numeric format for the X or Y value of the current cursor location in the cursor reporting area. This format is also used for all reporting plot objects that do not have a specific reporting format. Numeric format is discussed further in Section 6.3.3.

14.1.3 2D Plot Annotation

What: Provides control over axes labelling and the general appearance of all 2D plots. Note that labelling the X axis with time and date labels is conducted by not showing the X axis (Control□*Y axis Only*, or Control□*None*), and using the annotation object **Time Axes** in conjunction with the settings in the default **X axis** object.

Appearance:

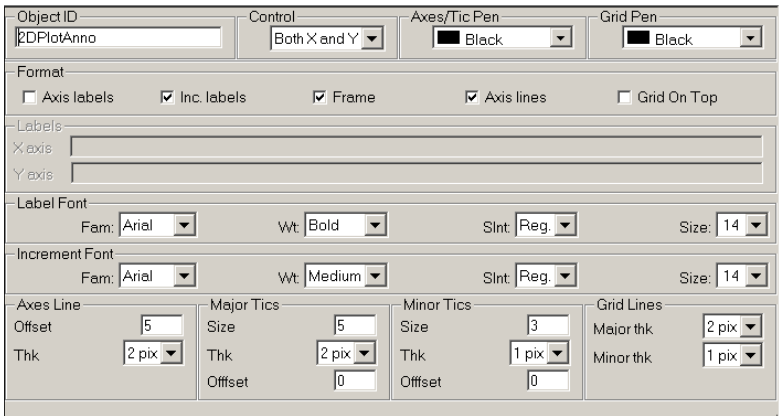


Figure 14.3 2D Plot Annotation Property Window

Properties:

Control

Both X and Y	Both the X axis and Y axis are displayed.
X Axis Only	Only the X axis is displayed.
Y Axis Only	Only the Y axis is displayed.
None	Neither the X or Y axes are displayed.

Axes/Tic Pen The pen color used for the axes lines, tics, and labels.

Grid Pen The pen color used for any increment grid lines.

Format Toggle control over components of annotation

Axis labels — If selected, labels will be drawn to the left of the left Y axis and underneath the bottom X axis.

Frame	If selected, the axes (including tics) are drawn on the top and right as well as the bottom and left. Increment labels will not be drawn on these mirror axes.
Axis lines	Axes lines will only be drawn if this is selected.
Grid On Top	If major or minor grid lines are used, this controls the order in which the grid is drawn – before the plot data objects (toggle not set) or after the plot data objects (toggle selected).
Labels	If toggle Axis labels is set, the text entered here will be displayed at the appropriate axis.
X axis	Label displayed under bottom X axis.
Y axis	Label displayed to left of left Y axis.
Label Font	The font used for axis labels. Font dialogs are discussed in Section 6.3.4.
Increment Font	The font used for axes increment labels.
Axes Line	The offset of the axes line in pixels away from the data plotting area, and the thickness of the lines used to draw the axes.
Major Tics	The length of the major tics in pixels and their thickness.
Minor Tics	The length of the minor tics in pixels and their thickness.
Grid Lines	The thickness of major and minor grid lines in pixels.

14.1.4 3D XYZ Main Menu

What: Controls the general layout and characteristics of 3D XYZ plots.

Appearance:

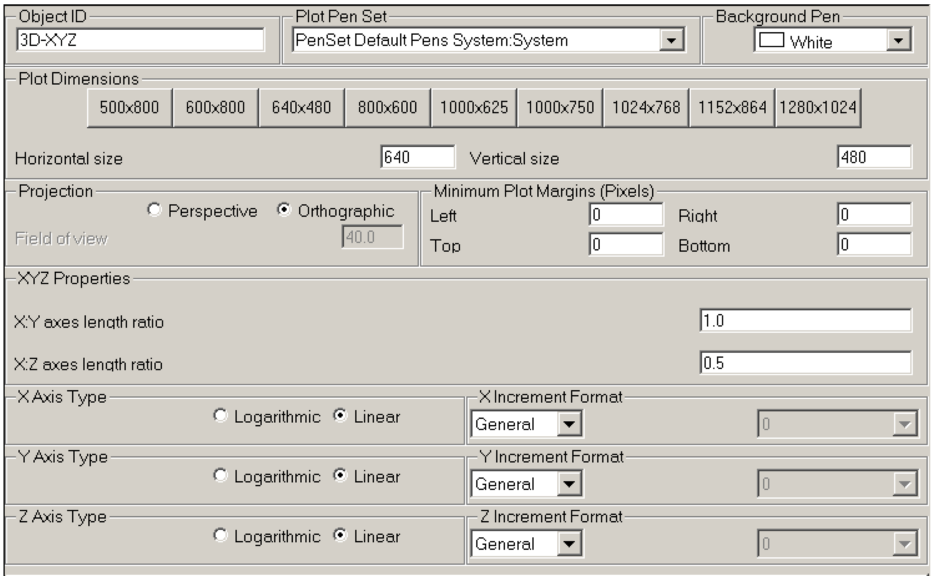


Figure 14.4 3D XYZ Main Menu Property Window

Properties:

ObjectID, **Plot Pen Set**, **Background Pen**, **Plot Dimensions**, **Minimum Plot Margins**, **X/Y/Z Axis Type** and **X/Y/Z Increment Format** are as described for the **2D XY Main Menu**.

Projection How 3D space is converted to a 2D representation.

Perspective Lines diminish with distance from the view co-ordinate.

Orthographic Relative sizes remain the same at all distances from the view co-ordinate.

Field of View For Perspective, the angle of the *viewing lens*. Smaller values reduce perspective distortion.

XYZ Properties Used to set the relative lengths of the plotted axes. The X axes has a relative length of 1.

X:Y axes length ratio Controls length of Y (horizontal axes).

X:Z axes length ratio Controls length of Z (vertical axes).

14.1.5 3D XYZ Axes

What: There are three default plot objects to define the plot axes, one for the X axis, one for the Y axis and one for the Z axis, each with identical object property windows.

Appearance and Properties:

Appearance and all dialog items in the object property windows were previously described for the **2D XY Axes** object property window.

14.1.6 3D Axes Labels

What: Provides control over axes labelling for 3D plots.

Appearance:

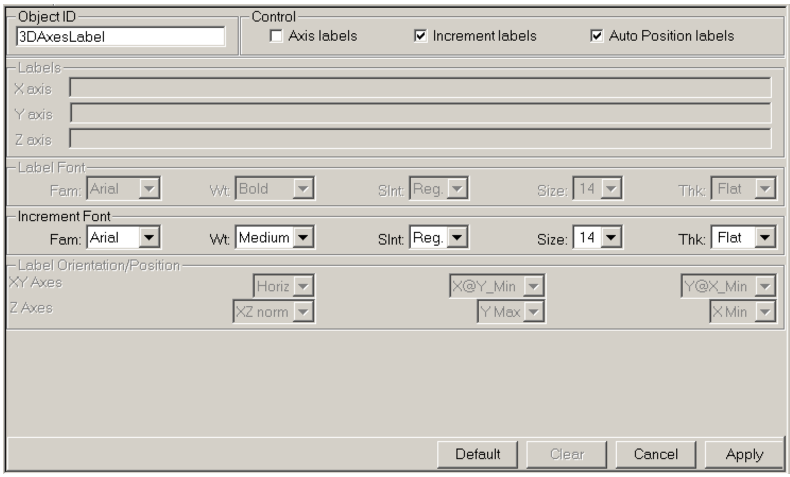


Figure 14.5 3D Axes Labels Property Window

Properties:

Control

Axis labels	Labels are plotted at each axis if turned on.
Increment labels	Numeric values of major increments are plotted at each axis if turned on.
Auto Position labels	The orientation and location of labels are adjusted as the view azimuth and elevation are changed.

Labels	If toggle Axis labels is selected, the text entered here will be displayed at the appropriate axis
X axis	Label displayed under X axis.
Y axis	Label displayed under Y axis.
Z axis	Label displayed adjacent to Z axis.
Label Font	The font used for axes labels. The font dialog is described in Section 6.3.4.
Increment Font	The font used for axes increment labels.

Label Orientation/Position	Controls text plane, orientation and position of X, Y, and Z labels if Auto Position Labels is not selected.
XYaxes	
plane	Vertical or horizontal.
X pos	X axis labelling is at X axis associated with Y min or Y max.
Y pos	Y axis labelling is at Y axis associated with X min or X max.
Z Axes	
plane	XZ or YZ, normal or reversed.
Y pos	Z axis labelling is at Z axis associated with Y min or Y max.
X pos	Z axis labelling is at Z axis associated with X min or X max.

14.1.7 3D Axes Format

What: This rather complex menu provides control over general formatting of 3D plot axes.

Appearance:

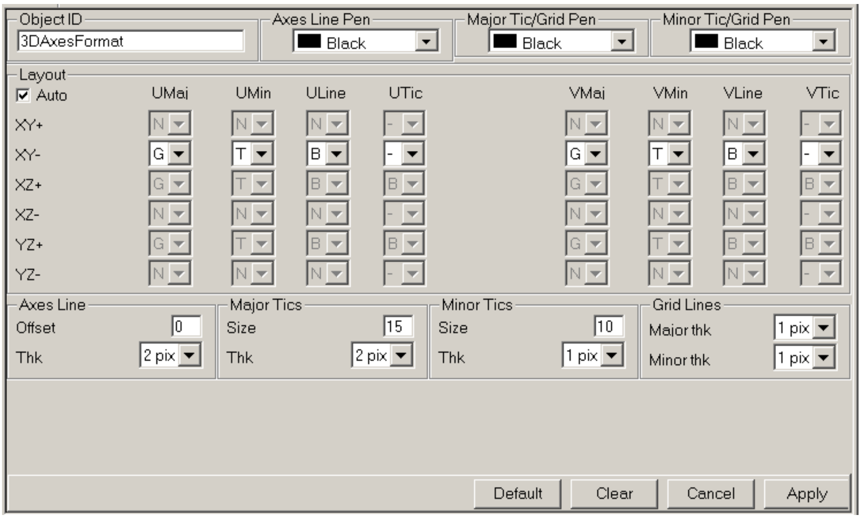


Figure 14.6 3D Axes Format Property Window

Properties:

Axes Line Pen The pen color used for the axes lines.

Major Tic/Grid Pen The pen color used for major tics and grid lines (and the increment labels and axes labels).

Minor Tic/Grid Pen The pen color used for minor tics and grid lines.

Layout A 3D plot is a cube which has 6 sides available for axes tics and grid lines. The controls in the **Layout** frame provide complete control over the appearance of each side. There are four controls for each axes direction on each plane. The "U" controls affect the horizontal axes on vertical planes and the X axes on the horizontal planes. The "V" controls affect the vertical axes (Z axes) on vertical planes and the Y axes on the horizontal planes.

Auto If set, the bottom XY plane (XY-) is used as a template for the XZ and YZ planes which are on the far side of the data view from the viewer.

Maj Controls presence of major tics/grid lines:

N No tic marks/grid lines.

	T	Tic marks at major increments.
	G	Grid lines at major increments.
Min		Controls presence of minor tics/grid lines:
	N	No minor tic marks/grid lines.
	T	Tic marks at minor increments.
	G	Grid lines at minor increments.
Line		Controls presence of axes lines:
	N	No axes lines drawn.
	-	Axes line drawn at other axes minimum.
	+	Axes line drawn at other axes maximum.
	B	Axes line drawn at both ends of other axes.
Tics		Controls presence of tics (if major or minor tics are specified):
	-	Tics drawn at other axes minimum.
	+	Tics drawn at other axes maximum.
	B	Tics drawn at both ends of other axes.

Axes Line The offset of the axes line in pixels away from the data plotting area, and the thickness of the lines used to draw the axes.

Major Tics The length of the major tics in pixels and their thickness.

Minor Tics The length of the minor tics in pixels and their thickness.

Grid Lines The thickness of major and minor grid lines in pixels.

Note: All axes lines and tic marks can be disabled by pressing the Clear button for the menu.

14.1.8 3D Lighting

What: Provides control over Open GL lighting used on all 3D plots.

Appearance:

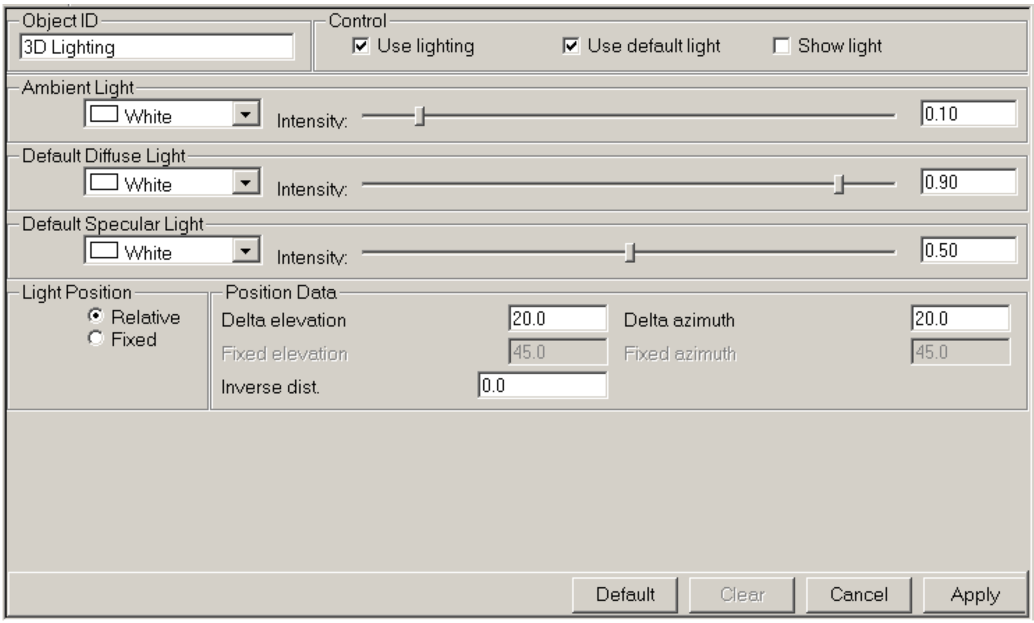


Figure 14.7 3D Lighting Property Window

Properties:

Control Overall determination of lighting

Use lighting — If set, OpenGL lighting is used. If not set there is no lighting and object edges will need to be displayed to gain perspective information.

Use default light — If set, a point source diffuse light and ambient (background) lighting are used. If not set, only ambient lighting is used.

Show light — Shows the location of the diffuse light as a black cube. The vector from the center of the view to the light is shown as a straight red line.

Ambient Light A combination control that sets the color and relative intensity of the ambient light.

Default Diffuse Light A combination control that sets the color and relative intensity of the directional light.

Default Specular Light Not used at this time.

Light position	How the position of the diffuse light is specified.
Relative	Light position is relative to the current view elevation and azimuth.
Fixed	Light is at a fixed XYZ, independent of the view.
Position data	The actual location of the light source.
Delta elevation	For relative position, added to view elevation.
Delta azimuth	For relative position, added to view azimuth.
Fixed elevation	For fixed position.
Fixed azimuth	For fixed position.
Inverse Dist.	1 / distance to light. A value 0.0 means light is infinite.

14.1.9 Composite Main Menu

What: Controls the general layout and characteristics of composite plots.

Appearance:

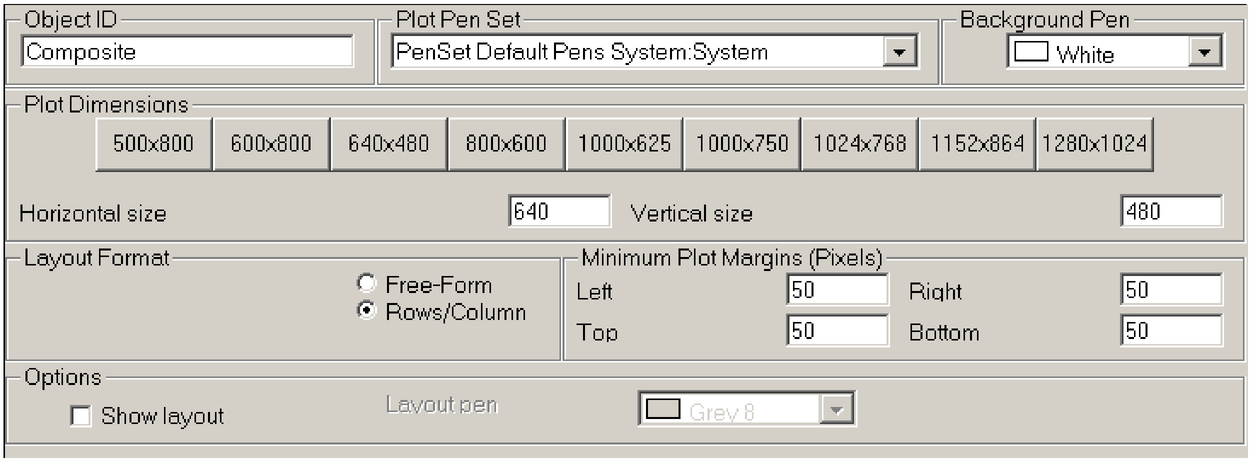


Figure 14.8 Composite Main Menu Property Window

Properties:

ObjectID, **Plot Pen Set**, **Background Pen**, **Plot Dimensions**, and **Minimum Plot Margins** are as described for the **2D XY Main Menu**.

Layout Format

Free-Form — Individual plots are placed in a layout rectangle specified by an X/Y origin and width within the **CompositeLayout** object.

Row/Columns — Individual plots are placed in a grid layout, with the number and spacing of the grid rows and columns specified in the **CompositeLayout** object.

Options

Show layout — Layout rectangles are displayed.

Layout pen — The pen color used for the layout lines.

14.1.10 Composite Layout

What: Controls the layout of the nested plots. Layout can be rows/columns or free-form, as specified in the **Composite Main Menu** default object.

Appearance:

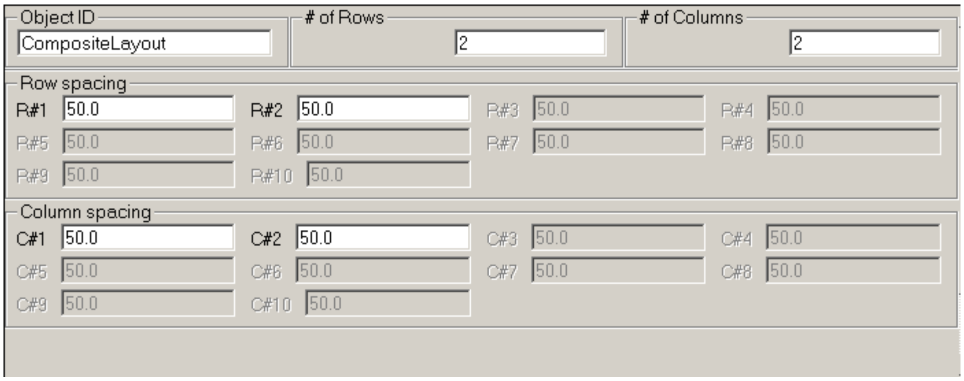


Figure 14.9 Rows/Columns Composite Layout Property Window

Figure 14.10 Free-Form Composite Layout Property Window

Properties for Rows/Columns Layout:

# of Rows Number of rows in the grid layout, up to a maximum of ten rows. A plot can be placed in each row of the grid layout, such that up to ten plots can be placed vertically within the layout.

# of Columns Number of columns in the grid layout, up to a maximum of ten columns. A plot can be placed in each column of the grid layout, such that up to ten plots can be placed horizontally within the layout.

Row Spacing

R#1-R#10 The spacing or width of each row, based on a 0-100 co-ordinate system.

Column Spacing

C#1-C#10 The spacing or width of each column, based on a 0-100 co-ordinate system.

Properties for Free-Form Layout:

Each line represents one layout rectangle. To activate the layout rectangle, toggle on the check mark at the beginning of the line.

XOff The X co-ordinate of the bottom left-hand corner of the layout rectangle, in a 0-100 co-ordinate system.

YOff The Y co-ordinate of the bottom left-hand corner of the layout rectangle, in a 0-100 co-ordinate system.

XWid The width of the layout rectangle in the X direction, in a 0-100 co-ordinate system.

YWid The width of the layout rectangle in the Y direction, in a 0-100 co-ordinate system.

14.2 Data Display Plot Objects

14.2.1 Confidence Limits - Two Parameter

What: Plots single, dual or triple confidence limits of a covariance matrix.

Why: To plot confidence limits of data.

Used By: **Series Legend**

Appearance: This object appears different in 2D and 3D.

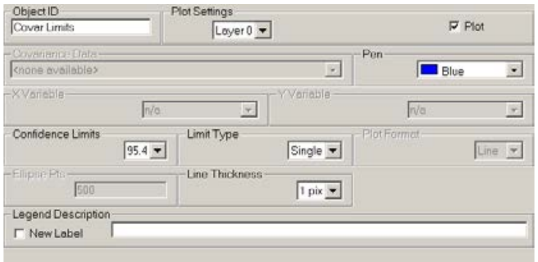


Figure 14.11 2D Two Parameter Confidence Limits Property Window

Figure 14.12 3D Confidence Limits Property Window

Input Data: **Extract Covariance Matrices**

Output Data: series legend specifications

Properties:

Covariance Data Confidence limits are plotted for the covariance data selected.

Pen The color of the confidence limits is selected from the plot window's plot pen set.

X Variable A parameter is selected for the X axis from a list of available parameters based on the covariance data selected.

Y Variable	A parameter is selected for the Y axis from a list of available parameters based on the covariance data selected.
Z Variable	For 3D plot object, a parameter is selected for the Z axis from a list of available parameters based on the covariance data selected.
Confidence Limits	A probability is selected (99.0, 95.4, 90.0, 68.3) for the confidence limits. The probability indicates the likelihood the true parameter values are within the plotted confidence error bar or region.
Limit Type	
Single	An error bar for each axes will define the confidence limits.
Dual	An ellipse will be used to define the confidence region. In 3D, an ellipse is plotted in all three planes (XY,YZ and XZ).
Triple	For 3D plot object, an ellipsoid will be used to define the confidence region.
Plot Format	
Line	The only plot format for *Single* limit type. For *Dual* limit type, the confidence region is plotted as a Line surrounding the region. For *Triple* limit type, the lines of the slices and meridians of the ellipsoid are drawn.
Solid	For *Dual* or *Triple* limit type, the ellipse/ellipsoid defining the confidence region is solid, filled with the color defined in **Pen**.
Tube	For 3D plot objects, plots the same information as for *Line* plot format, but the lines are plotted as three-dimensional tubes.
Ellipse Pts	For *Dual* limit type, the number of points defining the ellipse of the confidence region can be defined.
Ellipsoid Slices	For 3D plot object and *Triple* limit type, defines the resolution of the ellipsoid. For example, if the ellipsoid was a globe, the slices would represent the globe's latitude.
Ellipsoid Meridians	For 3D plot object and *Triple* limit type, defines the resolution of the ellipsoid. For example, if the ellipsoid was a globe, the meridians would represent the globe's longitude.
Line Thickness	The thickness of the error bars, ellipse line or slices and meridians is defined in pixels.

Tube Extrusion For 3D plot object and *Tube* plot format.

Cap Ends — The ends of the tube are filled with a polygon, such that the viewer cannot see inside the tube.

Polygon type — The tube can be several shapes: *Triangle*, *Square*, *Octagon* or *Round*.

Polygon size — Point size of each polygon of the tube in pixels.

Legend Description

New Label — A label used for the **Series Legend** object can be entered in the text box. If the New Label checkbox is not selected, the **Object ID** is used as the legend label.

Offset For 3D plot object, XYZ offset is used to improve visibility of objects (see discussion of 3D plot object visibility in Section 8.1.2.1).

14.2.2 Confidence Limits - Multiple Single Parameter

What: Plots a symbol representing the best estimate and/or a single vertical line repesenting the confidence limits of a single parameter for each parameter and for each selected covariance matrix. Each parameter is plotted at its associated index along the x axis, and results on the y axis are normalized.

Why: To plot confidence limits of data.

Used By: **Series Legend**

Appearance:

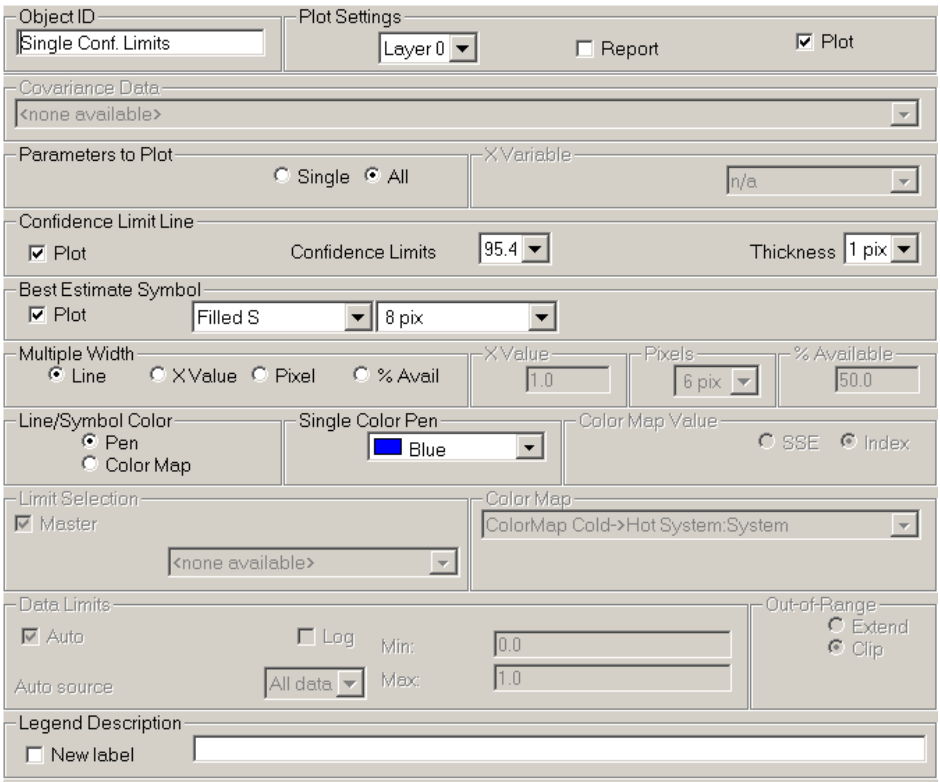


Figure 14.13 Multiple Single Parameter Confidence Limits Property Window

Input Data: **Extract Covariance Matrices**

Output Data: series legend specifications

Properties:

Covariance Data	Best estimates and/or confidence limits are plotted for the covariance data selected.
Parameters to Plot	A single parameter or all the parameters can be plotted.

X Variable If only a single parameter is plotted, the parameter to plot is selected here.

Confidence Limit Line

Plot If toggled on, confidence limit lines are plotted.

Confidence Limits A probability is selected (99.0, 95.4, 90.0, 68.3) for the confidence limits. The probability indicates the likelihood the true parameter values are within the limits of the confidence limit line.

Thickness The thickness of the confidence limit line is defined in pixels.

Best Estimate Symbol If the Plot toggle is selected, best estimate symbols are plotted according to the specified symbol type and size.

Multiple Width For covariance data containing more than one covariance matrix, confidence limit lines and best estimate symbols can be plotted in a single line (i.e. one on top of the other) or spread out. The spread of lines and symbols is limited to a span along the X axis of 1, centered on the parameter index.

X Value The spread of lines/symbols is over the specified X value. The X value must be less than 1, the maximum span along the X axis.

Pixel The spread of lines/symbols in pixels.

% Available The spread of lines/symbols expressed as a percentage of the maximum span along the X axis.

Line/Symbol Color Confidence limit lines and best estimate symbols may be plotted in a single color, or using a color map.

Single Color Pen The single color of the confidence limit lines and best estimate symbols.

Color Map Value The color of the confidence limit lines and best estimate symbols can correspond to the SSE value of the covariance matrix, or the index of the covariance matrix.

Limit Selection A master/slave control to connect the data limits to those specified in another object. Master/Slave controls are described in Section 6.3.1.

Color Map The color map used to associate colors with data values is selected.

Data Limits	Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.
Auto	If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.
Log	If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.
Auto Source	The method for determining the data limits automatically. *All Data* is the only option.
Min	Minimum data value for color mapping.
Max	Maximum data value for color mapping.
Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Legend Description	
New Label	A label used for the **Series Legend** object can be entered in the text box. If the New Label checkbox is not selected, the **Object ID** is used as the legend label.

14.2.3 Confidence Limits - Multiple Dual Parameter

What: Plots a symbol representing the best estimate and/or an ellipse repesenting dual confidence limits of each combination of two parameters for each selected covariance matrix. Results are normalized, and plotted in a grid according to parameter index, such that each grid square contains the symbols and ellipses for only two parameters.

Why: To plot confidence limits of data.

Used By: **Series Legend**

Appearance:

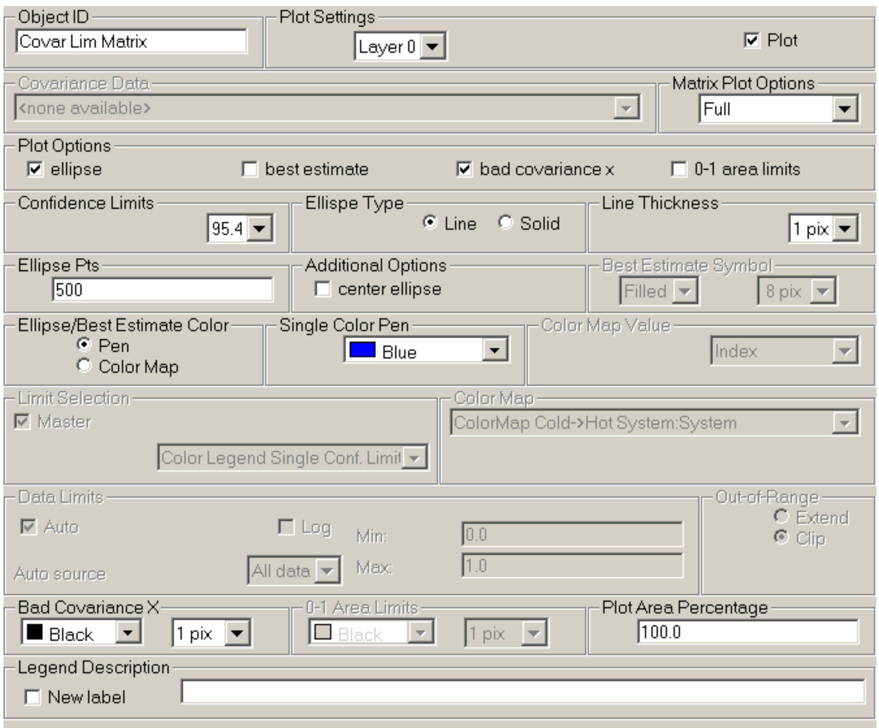


Figure 14.14 Multiple Dual Parameter Confidence Limits Property Window

Input Data: **Extract Covariance Matrices**

Output Data: series legend specifications

Properties:

Covariance Data Best estimates and/or confidence limits are plotted for the covariance data selected.

Matrix Plot Options	The full resulting grid of ellipses and/or symbols can be plotted, or can be limited to the upper diagonal, lower diagonal, diagonal only, upper only or lower only.
Plot Options	Selects the data to be plotted: confidence limit ellipses, best estimate symbols, a large x in the grid square if the covariance of the parameters is bad, and the normalized zero to one area limits for each grid square.
Confidence Limits	A probability is selected (99.0, 95.4, 90.0, 68.3) for the confidence limits. The probability indicates the likelihood the true parameter values are within the plotted confidence ellipse.
Ellipse Type	Ellipses can be plotted as a line (outline of the ellipse), or as a solid filled ellipse.
Line Thickness	The thickness of the confidence limit ellipse line is defined in pixels. Only if Line is the ellipse type.
Ellipse Pts	The number of points used to define the ellipse.
Additional Options	The ellipse for each covariance matrix can be centered within its grid square.
Best Estimate Symbol	If plotted, best estimate symbols are plotted according to the specified symbol type and size.
Ellipse/Best Estimate Color	Confidence limit ellipses and best estimate symbols may be plotted in a single color, or using a color map.
Single Color Pen	The single color of the confidence limit ellipses and best estimate symbols.
Color Map Value	The color of the confidence limit ellispse and best estimate symbols can correspond to the SSE value of the covariance matrix, the index of the covariance matrix, the length of the main diagonal of the ellipse or the length of the off diagonal of the ellipse.
Limit Selection	A master/slave control to connect the data limits to those specified in another object. Master/Slave controls are described in Section 6.3.1.
Color Map	The color map used to associate colors with data values is selected.
Data Limits	Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit

values that correspond to the first and last color in the color map respectively.

Auto	If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.
Log	If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.
Auto Source	The method for determining the data limits automatically. *All Data* is the only option.
Min	Minimum data value for color mapping.
Max	Maximum data value for color mapping.
Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Bad Covariance X	If plotted, the color and thickness of the x lines are specified here.
0-1 Area Limits	If plotted, the color and thickness of the area limit lines are specified here.
Plot Area Percentage	Data within each grid square spans the specified percentage of the grid square. Reducing the plot area reduces confusion between data near the area limits of adjacent grid squares.
Legend Description	
New Label	A label used for the **Series Legend** object can be entered in the text box. If the New Label checkbox is not selected, the **Object ID** is used as the legend label.

14.2.4 Cube Color Block

What: Displays color blocks around each cube data value for specified cube indices within specified cube value limits. Blocks are colored according to the associated value.

Why: Displays cube data in a 3D plot window.

Used By: **Color Legend**

Appearance:

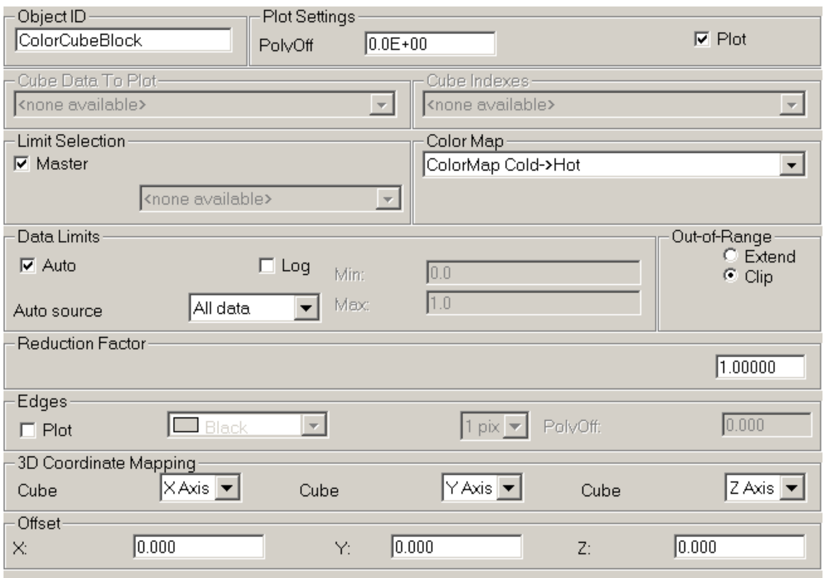


Figure 14.15 Color Cube Block Property Window

Input Data: cube data, cube indexes and color map

Output Data: color map limit specifications

Properties:

Cube Data To Plot The cube data set to be plotted is selected.

Cube Indexes The indexes of cube data to be plotted are selected. Cube indexes are defined in an **Extract Cube Indexes** object.

Limit Selection A master/slave control to connect the data limits to those specified in another object (e.g. **Cube Color Point**, **Grid Color Block**, etc.). Master/Slave controls are described in Section 6.3.1.

Color Map The color map used to associate colors with data values is selected.

Data Limits — Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.

Auto — If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.

Log — If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.

Auto Source — The method for determining the data limits automatically.

All Data — The data limits are based on all data values.

Cube in View — The data limits are based on the data values within the window view.

Min — Minimum data value for color mapping.

Max — Maximum data value for color mapping.

Out-of-Range — Colors used for data values outside the data limits.

Extend — Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.

Clip — Values outside the data limits range are not plotted.

Reduction Factor — Factor by which the plotted blocks are reduced. Reduction is performed by shrinking the block along the lines between block vertices and the enclosed node by the factor.

Edges — Controls the plotting of block edges with lines.

Plot — If selected, edges are plotted.

Pen — Color for edges selected from the plot window's plot pen set.

Thk — Edge line thickness.

PolyOff — Polygon offset of lines. Used only for OpenGL 1.1.

3D Co-ordinate Mapping	Determines which cube variable is plotted as the X, Y and Z axis. Once the input data has been selected and applied, the three Cube dialog prompts will be replaced with the name of each cube variable.
Offset	XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.5 Cube Color Isovolume

What: Displays a smooth color isovolume at the specified cube value. The volume is analogous to a 3D filled contour.

Why: Displays cube data in a 3D plot window.

Used By: **Color Legend**

Appearance:

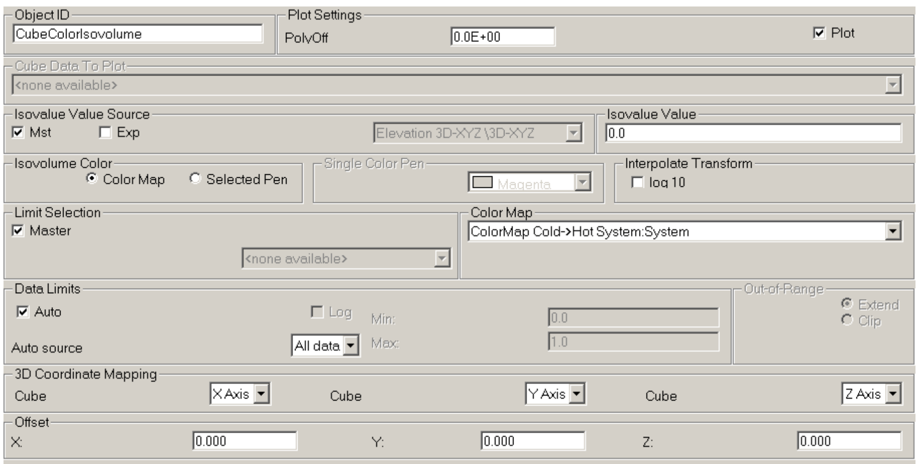


Figure 14.16 Color Cube Isovolume Property Window

Input Data: cube data and color map

Output Data: color map limit specifications

Properties:

Cube Data To Plot The cube data set to be plotted is selected.

Isovalue Value Source A master/slave and expose controls for the **Isovalue Value**. See Section 6.3 for more information on these controls.

Isovalue Value The value at which the volume is created. The volume connects all points in the cube data at this value (points are interpolated from the cube node values where required).

Isovolume Color

Color Map The isovolume color is based on the limit specifications and the specified color map. Note that the isovolume will be a solid c dependent upon where the isovalue lays within the limit specifications.

Selected Pen	The isovolume color is the color specified as the **Single Color Pen**.
Single Color Pen	The color of the isovolume if the **Isovolume Color** is Selected Pen.
Interpolate Transform	
log 10	Interpolation of volume points is conducted on log 10 cube data.
Limit Selection	Only if the **Isovolume Color** is Color Map. A master/slave control to connect the data limits to those specified in another object (e.g. **Cube Color Point**, **Grid Color Block**, etc.). Master/Slave controls are described in Section 6.3.1.
Color Map	If the **Isovolume Color** is Color Map, the color map used to associate colors with data values is selected.
Data Limits	Only if the **Isovolume Color** is Color Map. Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.
Auto	If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.
Log	Option is handled by the **Interpolate Transform** option.
Auto Source	The method for determining the data limits automatically.
All Data	The data limits are based on all data values.
Min	Minimum data value for color mapping.
Max	Maximum data value for color mapping.
Out-of-Range	Not available for this object.
3D Co-ordinate Mapping	Determines which cube variable is plotted as the X, Y and Z axis. Once the input data has been selected and applied, the three Cube dialog prompts will be replaced with the name of each cube variable.

Offset XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.6 Cube Color Point

What: Displays points at each cube data value for specified cube indices within specified cube value limits. Points are colored according to the associated value.

Why: Displays cube data in a 3D plot window.

Used By: **Color Legend**

Appearance:

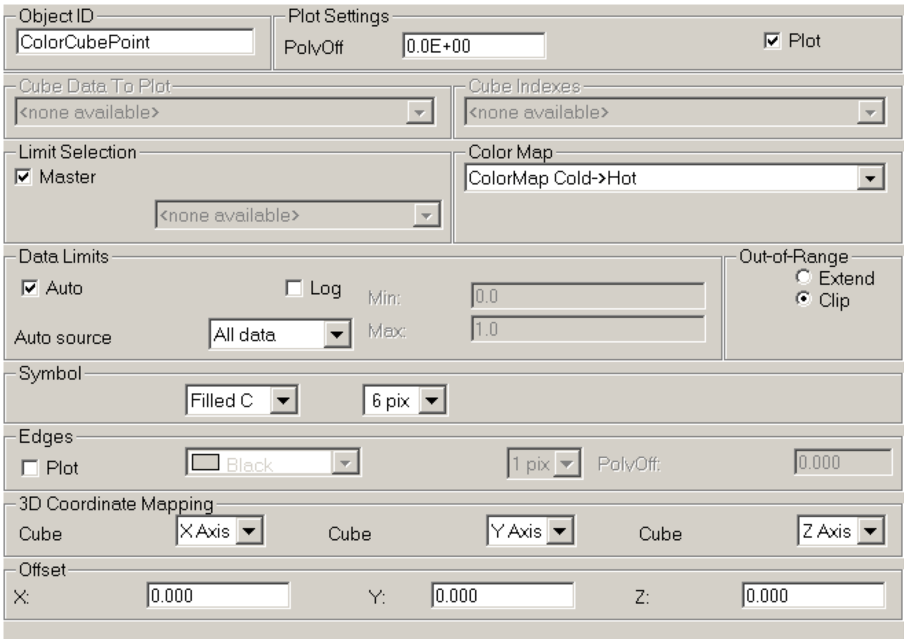


Figure 14.17 Cube Color Point Property Window

Input Data: cube data, cube indexes and color map

Output Data: color map limit specifications

Properties:

Cube Data To Plot The cube data set to be plotted is selected.

Cube Indexes The indexes of cube data to be plotted are selected. Cube indexes are defined in an **Extract Cube Indexes** object.

Limit Selection A master/slave control to connect the data limits to those specified in another object (e.g. **Cube Color Block**, **Grid Color Block**, etc.). Master/Slave controls are described in Section 6.3.1.

Color Map The color map used to associate colors with data values is selected.

Data Limits	Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.
Auto	If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.
Log	If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.
Auto Source	The method for determining the data limits automatically.
All Data	The data limits are based on all data values.
Cube in View	The data limits are based on the data values within the window view.
Min	Minimum data value for color mapping.
Max	Maximum data value for color mapping.
Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Symbol	Select from available symbols: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond. The approximate relative size in pixels is also selected.
Edges	Controls the plotting of point edges with lines. Only available for filled symbols.
Plot	If selected, edges are plotted.
Pen	Color for edges selected from the plot window’s plot pen set.
Thk	Edge line thickness.
PolyOff	Polygon offset of lines. Used only for OpenGL 1.1.

3D Co-ordinate Mapping	Determines which cube variable is plotted as the X, Y and Z axis. Once the input data has been selected and applied, the three Cube dialog prompts will be replaced with the name of each cube variable.
Offset	XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.7 Grid Color Block

What: Displays color blocks around each grid data value within specified grid value limits. Blocks are colored according to the associated value.

Why: Displays grid data in a plot window.

Used By: **Color Legend**

Appearance: This object appears different in 2D and 3D.

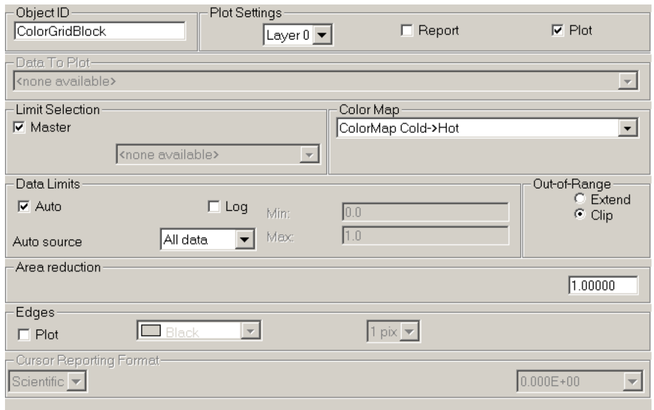


Figure 14.18 2D Color Grid Block Property Window

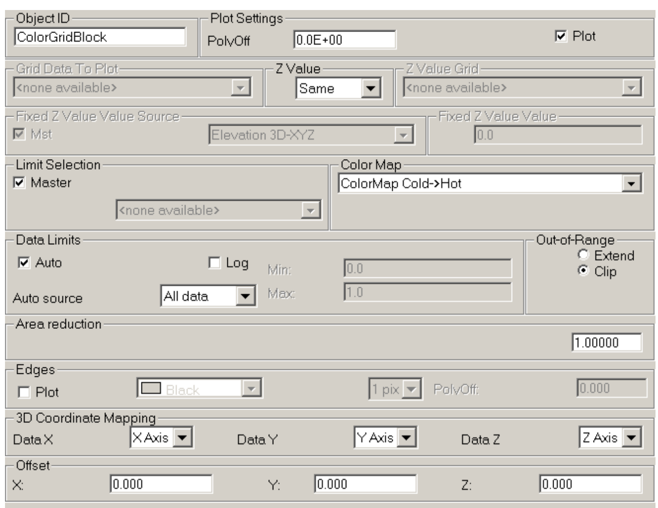


Figure 14.19 3D Color Grid Block Property Window

Input Data: grid data and color map

Output Data: color map limit specifications

Properties:

Grid Data To Plot	The grid data set to be plotted is selected.
Z value	For 3D plots, a Z value needs to be identified to plot XY data in a 3D plot.
Same	The grid value at each grid co-ordinate is used as the Z value.
Other Grid	Grid value is based on the grid value from another grid of the same size.
Constant	The grid is plotted at a constant Z value. The Z value may be specified, or based on the Z value of another object.
Z Value Grid	For 3D plots, a grid is selected of the same size as the **Grid Data To Plot**. The value from the selected grid is used as the Z value.
Fixed Z Value Value Source	For 3D plots, Master/Slave controls for a *Constant* Z value. For grids extracted from a cube, the grid extraction value may be used as the constant Z value. Master/Slave controls are described in Section 6.3.1.
Fixed Z Value Value	For 3D plots and *Constant* Z value, the constant Z value at which to plot the grid.
Limit Selection	A master/slave control to connect the data limits to those specified in another object (e.g. **Cube Color Block**, **Grid Color Point**, etc.). Master/Slave controls are described in Section 6.3.1.
Color Map	The color map used to associate colors with data values is selected.
Data Limits	Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.
Auto	If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.
Log	If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.
Auto Source	The method for determining the data limits automatically.

All Data The data limits are based on all data values.

Grid in View The data limits are based on the data values within the window view.

Min Minimum data value for color mapping.

Max Maximum data value for color mapping.

Out-of-Range Colors used for data values outside the data limits.

Extend Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.

Clip Values outside the data limits range are not plotted.

Area Reduction Factor by which the plotted blocks are reduced. Reduction is performed by shrinking the block along the lines between block vertices and the enclosed node by the area reduction factor.

Edges Controls the plotting of block edges with lines.

Plot If selected, edges are plotted.

Pen Color for edges selected from the plot window's plot pen set.

Thk Edge line thickness.

PolyOff Polygon offset of lines. Used only for OpenGL 1.1.

Cursor Reporting Format For 2D plots, the numeric format of the values associated with the cursor position in the report area of the 2D plot window. Numeric format controls are described in Section 6.3.3.

3D Co-ordinate Mapping For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.

Offset For 3D plots, XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.8 Grid Color Fill

What: Displays color filled contours of the nodes of a grid based on specified grid value limits.

Why: Displays contours of grid data in a plot window.

Used By: **Color Legend**

Appearance: This object appears different in 2D and 3D.

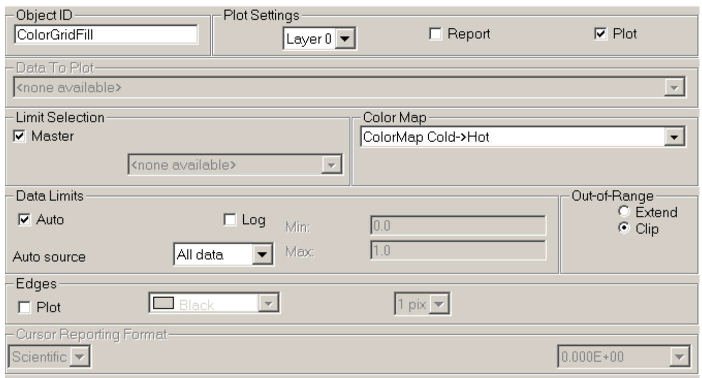


Figure 14.20 2D Grid Color Fill Property Window

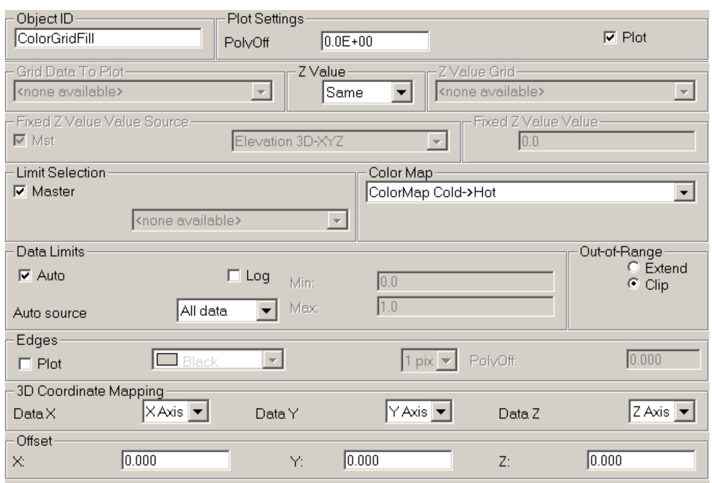


Figure 14.21 3D Color Grid Fill Window

Input Data: grid data and color map

Output Data: color map limit specifications

Properties:

Grid Data To Plot	The grid data set to be plotted is selected.
Z value	For 3D plots, a Z value needs to be identified to plot XY data in a 3D plot.

Same The grid value at each grid co-ordinate is used as the Z value.

Other Grid Grid value is based on the grid value from another grid of the same size.

Constant The grid is plotted at a constant Z value. The Z value may be specified, or based on the Z value of another object.

Z Value Grid For 3D plots, a grid is selected of the same size as the **Grid Data To Plot**. The value from the selected grid is used as the Z value.

Fixed Z Value Value Source For 3D plots, Master/Slave controls for a *Constant* Z value. For grids extracted from a cube, the grid extraction value may be used as the constant Z value. Master/Slave controls are described in Section 6.3.1.

Fixed Z Value Value For 3D plots and *Constant* Z value, the constant Z value at which to plot the grid.

Limit Selection A master/slave control to connect the data limits to those specified in another object (e.g. **Cube Color Block**, **Grid Color Point**, etc.). Master/Slave controls are described in Section 6.3.1.

Color Map The color map used to associate colors with data values is selected.

Data Limits Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.

Auto If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used

Log If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.

Auto Source The method for determining the data limits automatically.

All Data The data limits are based on all data values.

Grid in View The data limits are based on the data values within the window view.

Min	Minimum data value for color mapping.
Max	Maximum data value for color mapping.
Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Edges	Controls the plotting of triangulation edges with lines. (The grid is automatically triangulated in order to generate contours.)
Plot	If selected, triangulation edges are plotted.
Pen	Color for edges selected from the plot window's plot pen set.
Thk	Edge line thickness.
PolyOff	Polygon offset of lines. Used only for OpenGL 1.1.
Cursor Reporting Format	For 2D plots, the numeric format of the values associated with the cursor position in the report area of the 2D plot window. Numeric format controls are described in Section 6.3.3.
3D Co-ordinate Mapping	For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.
Offset	For 3D plots, XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.9 Grid Color Point

What: Displays points at each grid data value within specified grid value limits. Points are colored according to the associated value.

Why: Displays grid data in a plot window.

Used By: **Color Legend**

Appearance: This object appears different in 2D and 3D.

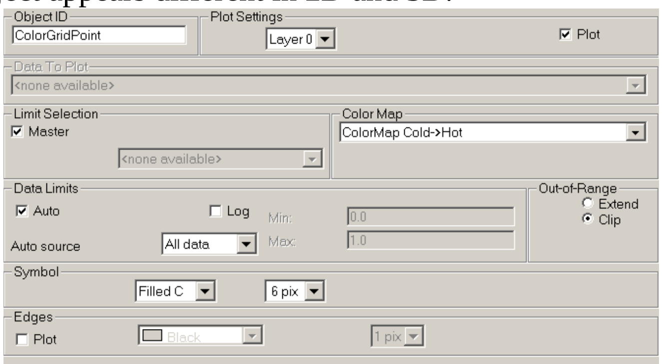


Figure 14.22 2D Grid Color Point Property Window

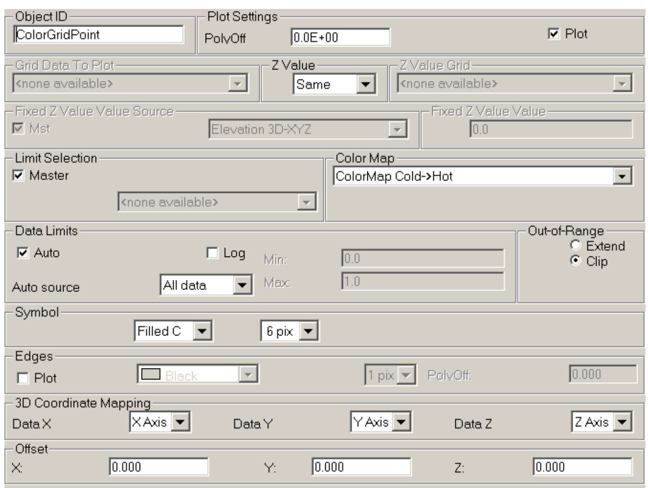


Figure 14.23 3D Color Grid Point Property Window

Input Data: grid data and color map

Output Data: color map limit specifications

Properties:

Grid Data To Plot The grid data set to be plotted is selected.

Z value	For 3D plots, a Z value needs to be identified to plot XY data in a 3D plot.
Same	The grid value at each grid co-ordinate is used as the Z value.
Other Grid	Grid value is based on the grid value from another grid of the same size.
Constant	The grid is plotted at a constant Z value. The Z value may be specified, or based on the Z value of another object.
Z Value Grid	For 3D plots, a grid is selected of the same size as the **Grid Data To Plot**. The value from the selected grid is used as the Z value.
Fixed Z Value Value Source	For 3D plots, Master/Slave controls for a *Constant* Z value. For grids extracted from a cube, the grid extraction value may be used as the constant Z value. Master/Slave controls are described in Section 6.3.1.
Fixed Z Value Value	For 3D plots and *Constant* Z value, the constant Z value at which to plot the grid.
Limit Selection	A master/slave control to connect the data limits to those specified in another object (e.g. **Cube Color Point**, **Grid Color Block**, etc.). Master/Slave controls are described in Section 6.3.1.
Color Map	The color map used to associate colors with data values is selected.
Data Limits	Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.
Auto	If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.
Log	If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.
Auto Source	The method for determining the data limits automatically.
All Data	The data limits are based on all data values.

Grid in View	The data limits are based on the data values within the window view.
Min	Minimum data value for color mapping.
Max	Maximum data value for color mapping.
Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Symbol	Select from available symbols: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond. The approximate relative size in pixels is also selected.
Edges	Controls the plotting of point edges with lines. Only available for filled symbols.
Plot	If selected, edges are plotted.
Pen	Color for edges selected from the plot window's plot pen set.
Thk	Edge line thickness.
PolyOff	Polygon offset of lines. Used only for OpenGL 1.1.
3D Co-ordinate Mapping	For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.
Offset	For 3D plots, XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.10 Grid Contour

What: Displays single contour lines of the nodes of a grid based on specified grid values.

Why: Display grid contours in a plot window.

Used By: **Series Legend**

Appearance: This object appears different in 2D and 3D.

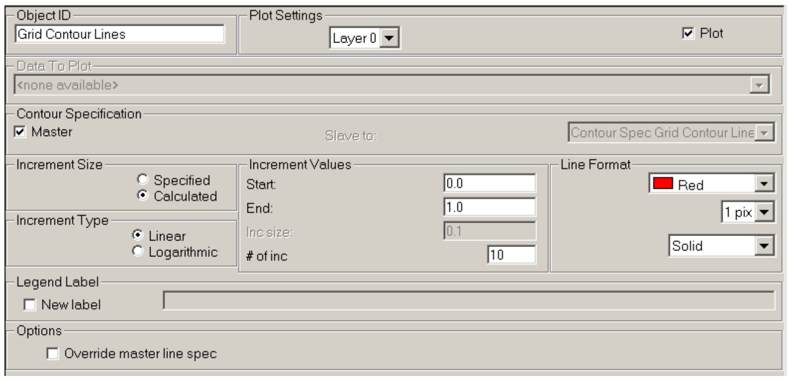


Figure 14.24 2D Grid Contour Property Window

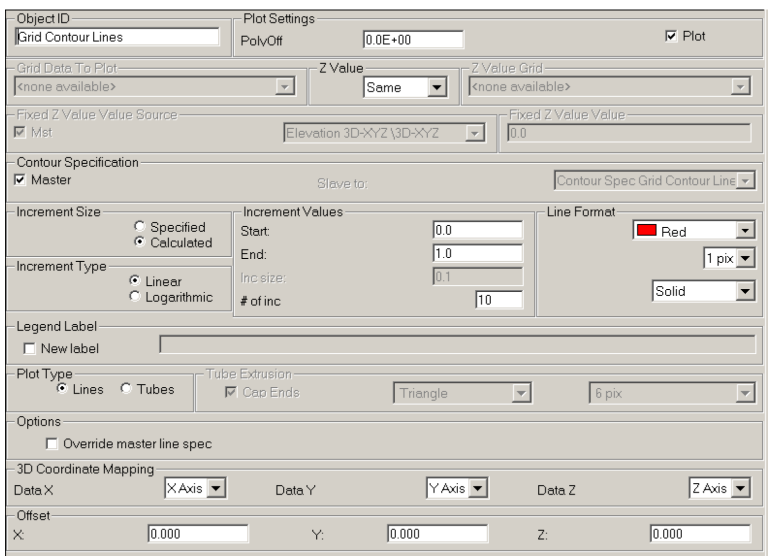


Figure 14.25 3D Grid Contour Property Window

Input Data: grid data

Output Data: series legend specifications

Properties:

Grid Data To Plot	The grid data set to be plotted is selected.
Z value	For 3D plots, a Z value needs to be identified to plot XY data in a 3D plot.

Same The grid value at each grid co-ordinate is used as the Z value.

Other Grid Grid value is based on the grid value from another grid of the same size.

Constant The grid is plotted at a constant Z value. The Z value may be specified, or based on the Z value of another object.

Z Value Grid For 3D plots, a grid is selected of the same size as the **Grid Data To Plot**. The value from the selected grid is used as the Z value.

Fixed Z Value Value Source For 3D plots, Master/Slave controls for a *Constant* Z value. For grids extracted from a cube, the grid extraction value may be used as the constant Z value. Master/Slave controls are described in Section 6.3.1.

Fixed Z Value Value For 3D plots and *Constant* Z value, the constant Z value at which to plot the grid.

Contour Specification A master/slave control to connect the contour specifications to those specified in another object (e.g. another **Grid Contour** object). Master/Slave controls are described in Section 6.3.1.

Increment Size How the contour increment is specified.

Specified Enter minimum and increment, calculate maximum.

Calculated Enter minimum and maximum, calculate increment.

Increment Type Increments are equally spaced in linear or logarithmic data space.

Increment Values The contour lines to plot.

Start Data value of first contour to plot (minimum contour value).

End Data value of last contour to plot (maximum contour value) if **Increment Size** is Calculated.

Inc Size Delta between lines if **Increment Size** is Specified. For log increments the value is in terms of log cycles.

# of Inc Number of contour increments to plot. Contour lines will be drawn for number + 1 values. Enter 0 to plot a single line at the start value.

Line Format The appearance of each contour line. Color, line width, and line pattern can be specified.

Legend Label If the New Label is toggled, up to 40 characters of user-entered text in the text box is used in legend label data output by the object. If the New Label checkbox is toggled off, the default legend label data will be the object ID.

Options Override master line spec allows the object limits to be slaved to another object, but to have a unique line format.

Plot Type For 3D plot objects.

Lines Contours are plotted as lines.

Tubes Plots the same information as for Line plot type, but the contours are plotted as three-dimensional tubes.

Tube Extrusion For 3D plot objects and Tube plot format.

Cap Ends The ends of the tube are filled with a polygon, such that the viewer cannot see inside the tube.

Polygon type The tube can be several shapes: *Triangle*, *Square*, *Octagon* or *Round*.

Polygon size Point size of each polygon of the tube in pixels.

3D Co-ordinate Mapping For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.

Offset XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.11 Grid Fishnet

What: Plots grid lines of the grid, connecting all nodes of the grid. The number of grid lines can be reduced, based on an X and Y modulus.

Why: To view the grid in a plot window.

Used By: **Series Legend**

Appearance: This object appears different in 2D and 3D.

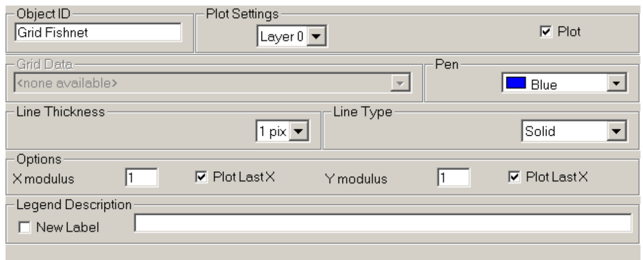


Figure 14.26 2D Grid Fishnet Property Window

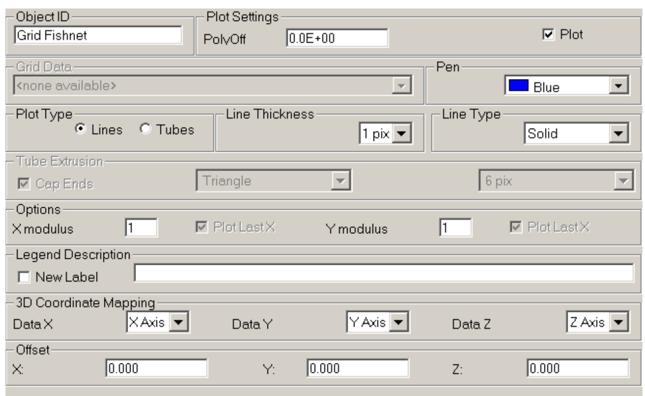


Figure 14.27 3D Grid Fishnet Property Window

Input Data: grid data

Output Data: series legend specifications

Properties:

Grid Data The grid data set to be plotted is selected.

Pen The color of the grid fishnet is selected from the plot window's plot pen set.

Plot Type For 3D plots, the grid fishnet can be plotted as 2D Lines, or 3D Tubes.

Line Thickness The thickness of the grid fishnet lines is selected.

Line Type The line pattern of the grid fishnet lines is selected.

Tube Extrusion For 3D plot object and Tubes plot type.

Cap Ends The ends of the tube are filled with a polygon, such that the viewer cannot see inside the tube.

Polygon type The tube can be several shapes: *Triangle*, *Square*, *Octagon* or *Round*.

Polygon size Point size of each polygon of the tube in pixels.

Options

X modulus Reduces the number of X grid points included in the fishnet by the user-specified factor.

Plot Last X Ensures that the last X grid line (grid line at maximum X value) is plotted.

Y modulus Reduces the number of Y grid points included in the fishnet by the user-specified factor.

Plot Last Y Ensures that the last Y grid line (grid line at maximum Y value) is plotted.

Legend Label If New Label is toggled, up to 40 characters of user-entered text in the text box is used in legend label data output by the object. If the New Label checkbox is toggled off, the default legend label data will be the object ID.

3D Co-ordinate Mapping For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.

Offset XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.12 Multiple Table Series

What: In a 2D plot, displays columns of up to 8 multiple tables as XY data using symbols and/or lines. X and Y data columns are specified for each table.

Why: Standard XY data display.

Used By: **Series Legend**

Appearance:

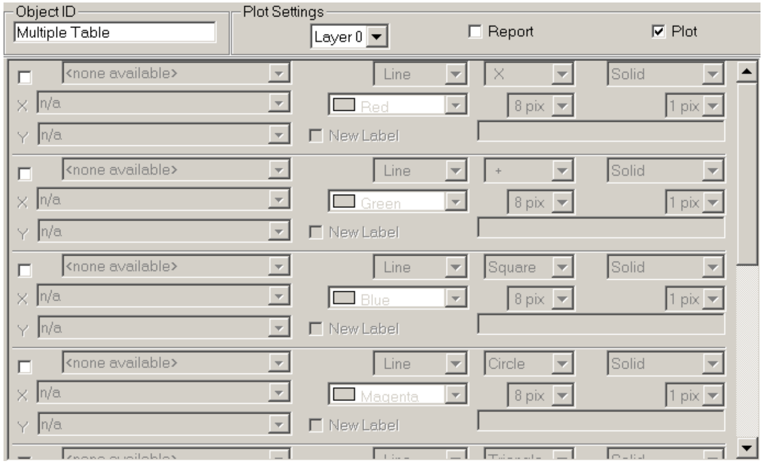


Figure 14.28 Multiple Table Series Window

Input Data: table data

Output Data: series legend specifications

Properties:

Each **Multiple Table Series** object can plot up to 8 XY series. The scroll box contains 8 input areas, separated by horizontal lines. Each input area is used to describe one XY series. A different format can be used to plot each XY series selected.

Select The toggle box in the upper left corner of input area must be selected to plot the selected XY series. The table data object from which to extract the XY series is selected from the adjacent drop-down-box.

X The table column from the selected table to be used as the X data of the series.

Y The table column from the selected table to be used as the Y data of the series.

Type The XY series is plotted as lines and/or symbols.

Pen	Select the color of the lines and/or symbols from the plot window's plot pen set.
Symbol type	Available if Type is not *Line*, one of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
Symbol size	The approximate relative size of the symbol in pixels is selected.
Line type	Available if Type is not *Symbol*, the line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.
Line thk	Thickness of the line in pixels.
New label	When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object output ID of each table input.

14.2.13 Profile Color Fill

What: Displays color filled contours of the nodes of an extended profile based on specified data value limits.

Why: Displays contours of an extended profile in a plot window.

Used By: **Color Legend**

Appearance: This object appears different in 2D and 3D.

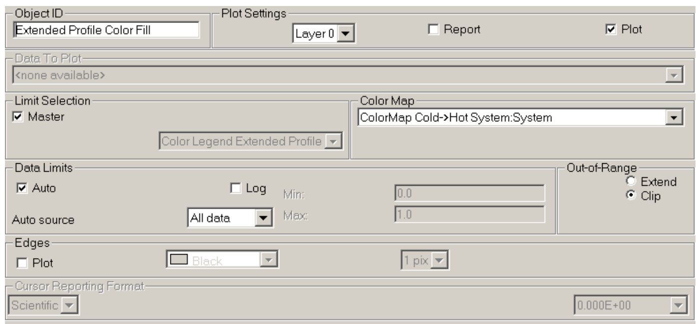


Figure 14.29 2D Profile Color Fill Window

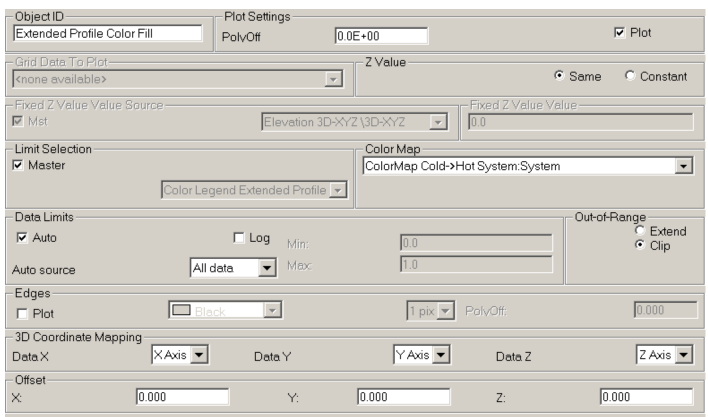


Figure 14.30 3D Profile Color Fill Window

Input Data: extended profile and color map

Output Data: color map limit specifications

Properties:

Data To Plot The extended profile to be plotted is selected.

Z value For 3D plots, a Z value needs to be identified to plot XY data in a 3D plot.

Same The value at each profile co-ordinate is used as the Z value.

Other Grid Z value is based on the profile value from another profile of the same size.

Constant The profile is plotted at a constant Z value. The Z value may be specified, or based on the Z value of another object

.

Z Value Grid For 3D plots, a profile is selected of the same size as the **Data To Plot**. The value from the selected profile is used as the Z value.

Fixed Z Value Value Source For 3D plots, Master/Slave controls for a *Constant* Z value. Master/Slave controls are described in Section 6.3.1.

Fixed Z Value Value For 3D plots and *Constant* Z value, the constant Z value at which to plot the profile.

Limit Selection A master/slave control to connect the data limits to those specified in another object. Master/Slave controls are described in Section 6.3.1.

Color Map The color map used to associate colors with data values is selected.

Data Limits Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.

Auto If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.

Log If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.

Auto Source The method for determining the data limits automatically.

All Data The data limits are based on all data values.

Grid in View The data limits are based on the data values within the window view.

Min Minimum data value for color mapping.

Max Maximum data value for color mapping.

Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Edges	Controls the plotting of triangulation edges with lines. (The extended profile is automatically triangulated in order to generate contours.)
Plot	If selected, triangulation edges are plotted.
Pen	Color for edges selected from the plot window's plot pen set.
Thk	Edge line thickness.
Cursor Reporting Format	The numeric format of the values associated with the cursor position in the report area of the 2D plot window. Numeric format controls are described in Section 6.3.3.
3D Co-ordinate Mapping	For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.
Offset	For 3D plots, XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.14 Profile Contour

What: Displays single contour lines of the nodes of an extended profile grid based on specified data values.

Why: Display extended profile contours in a plot window.

Used By: **Series Legend**

Appearance: This object appears different in 2D and 3D.

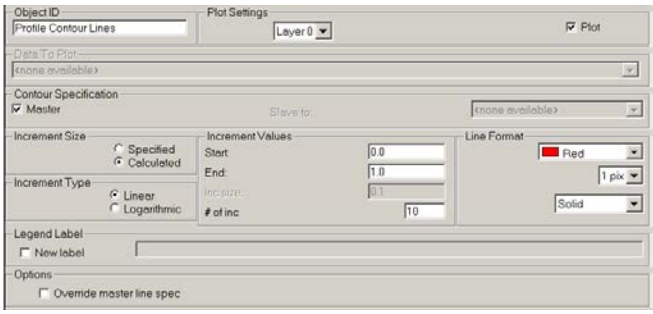


Figure 14.31 2D Profile Contour Property Window

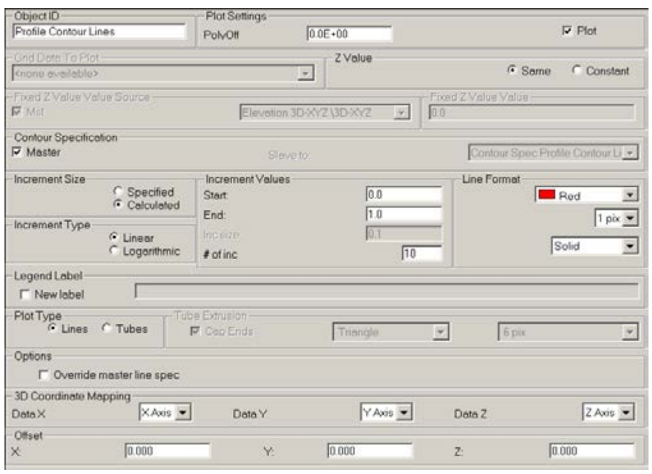


Figure 14.32 3D Profile Contour Property Window

Input Data: extended profile

Output Data: series legend specifications

Properties:

Data To Plot The profile data to be plotted is selected.

Z value For 3D plots, a Z value needs to be identified to plot XY data in a 3D plot.

Same	The value at each profile co-ordinate is used as the Z value.
Other Grid	Z value is based on the profile value from another profile of the same size.
Constant	The profile is plotted at a constant Z value. The Z value may be specified, or based on the Z value of another object.
Z Value Grid	For 3D plots, a profile is selected of the same size as the **Data To Plot**. The value from the selected profile is used as the Z value.
Fixed Z Value Value Source	For 3D plots, Master/Slave controls for a *Constant* Z value.Master/Slave controls are described in Section 6.3.1.
Fixed Z Value Value	For 3D plots and *Constant* Z value, the constant Z value at which to plot the profile.
Contour Specification	A master/slave control to connect the contour specifications to those specified in another object (e.g. another **Profile Contour** object). Master/Slave controls are described in Section 6.3.1.
Increment Size	How the contour increment is specified.
Specified	Enter minimum and increment, calculate maximum.
Calculated	Enter minimum and maximum, calculate increment.
Increment Type	Increments are equally spaced in linear or logarithmic data space.
Increment Values	The contour lines to plot.
Start	Data value of first contour to plot (minimum contour value).
End	Data value of last contour to plot (maximum contour value) if **Increment Size** is Calculated.
Inc Size	Delta between lines if **Increment Size** is Specified. For log increments the value is in terms of log cycles.
# of Inc	Number of contour increments to plot. Contour lines will be drawn for number + 1 values. Enter 0 to plot a single line at the start value.
Line Format	The appearance of each contour line. Color, line width, and line pattern can be specified.

Legend Label	If the New Label is toggled, up to 40 characters of user-entered text in the text box is used in legend label data output by the object. If the New Label checkbox is toggled off, the default legend label data will be the object ID.
Options	Override master line spec allows the object limits to be slaved to another object, but to have a unique line format.
Plot Type	For 3D plot objects.
Lines	Contours are plotted as lines.
Tubes	Plots the same information as for Line plot type, but the contours are plotted as three-dimensional tubes.
Tube Extrusion	For 3D plot objects and Tube plot format.
Cap Ends	The ends of the tube are filled with a polygon, such that the viewer cannot see inside the tube.
Polygon type	The tube can be several shapes: *Triangle*, *Square*, *Octagon* or *Round*.
Polygon size	Point size of each polygon of the tube in pixels.
3D Co-ordinate Mapping	For 3D plots, determines which grid and Z variable is plotted as the X, Y and Z axis.
Offset	XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.15 Single Table Series

What: In a 2D plot, displays columns of single table as XY data using symbols and/or lines. Only one column is selected as the X data column. Multiple columns can be selected for the Y data.

Why: Standard XY data display.

Used By: **Series Legend**

Appearance:

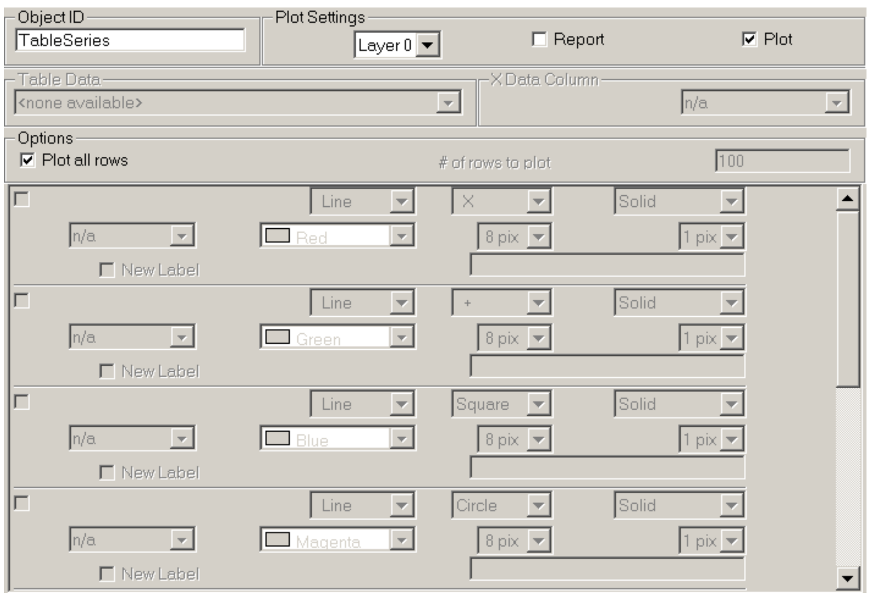


Figure 14.33 Single Table Series Property Window

Input Data: table data

Output Data: series legend specifications

Properties:

Table Data The table data set to be plotted is selected

X data column The column in the input table that will form the X co-ordinate of the series.

Options

Plot all rows If toggled off, only rows 1 to the specified # of rows will be plotted.

# of rows to plot If Plot all rows is toggled off, the maximum number of rows to be plotted is specified.

Each **Single Table Series** object can plot up to 8 XY series from one table, all using the same X values specified in the **X data column**. A different format can be used to plot each XY series selected. The scroll box contains 8 input areas, separated by horizontal lines. Each input area is used to describe one XY series.

Select	The toggle box in the upper left corner of input area must be selected to plot the selected XY series.
Y	The table column from the selected table to be used as the Y data of the series.
Type	The XY series is plotted as lines and/or symbols.
Pen	Select the color of the lines and/or symbols from the plot window's plot pen set.
Symbol type	Available if Type is not *Line*, one of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
Symbol size	The approximate relative size of the symbol in pixels is selected.
Line type	Available if Type is not *Symbol*, the line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.
Line thk	Thickness of the line in pixels.
New label	When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the column ID of the Y data in the input table.

14.2.16 Table Color Series

What: Plots selected columns from a table using colored symbols. The color of the symbols varies according to the value in the Color Data column.

Why: Standard display of table data.

Used By: **Color Legend**

Appearance: This object appears different in 2D and 3D.

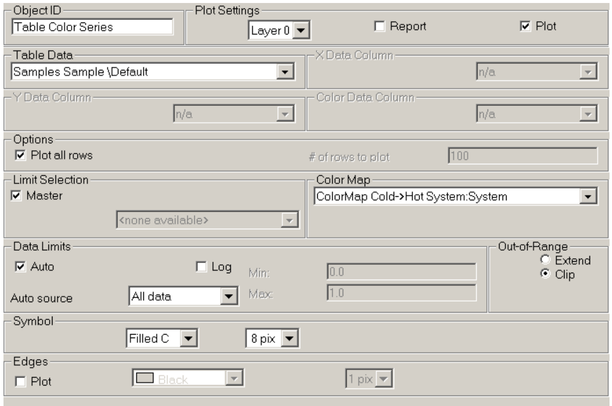


Figure 14.34 2D Table Color Series Property Window

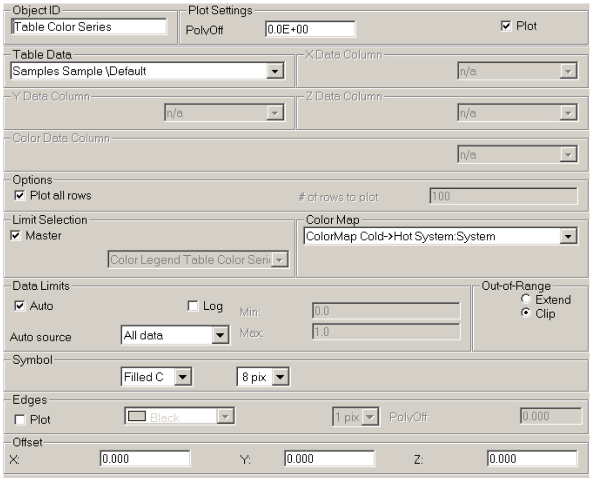


Figure 14.35 3D Table Color Series Property Window

Input Data: table data and color map

Output Data: color map limit specifications

Properties:

Table Data The table data set to be plotted is selected

X data column The column in the input table that will form the X co-ordinate of the series.

Y data column The column in the input table that will form the Y co-ordinate of the series.

Z data column For 3D plots, the column in the input table that will form the Z co-ordinate of the series.

Color Data column The column in the input table that will determine the color of the symbols.

Options

Plot all rows If toggled off, only rows 1 to the specified # of rows will be plotted.

# of rows to plot If Plot all rows is toggled off, the maximum number of rows to be plotted is specified.

Limit Selection Master and slave controls for the **Color Map**, **Data Limits** and **Out-of-Range** controls. For more on masters and slaves, see Section 6.3.1.

Color Map Specify the color map to be used.

Data Limits Controls how data values in the input data are mapped to colors in the input color map. This involves minimum and maximum data limit values that correspond to the first and last color in the color map respectively.

Auto If set, then the data limits are extracted from the data, based on the Auto Source. If not set, then the data limits specified by the Min and Max properties are used.

Log If set, the log range is mapped to the colors, and the log of the data values are used in calculating the mapped color. Otherwise, linear mapping is used.

Auto Source The method for determining the data limits automatically.

All Data The data limits are based on all data values.

Symbols in View The data limits are based on the data values within the window view.

Min Minimum data value for color mapping.

Max	Maximum data value for color mapping.
Out-of-Range	Colors used for data values outside the data limits.
Extend	Values below the minimum data limit are given the first color in the color map, values above the maximum data limit are given the last color in the color map.
Clip	Values outside the data limits range are not plotted.
Symbol	Determine the symbol type, and the size of the symbol.
Symbol type	One of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
Symbol size	The relative size of the symbol in pixels is selected.
Edges	To plot symbol edges, turn on the Plot toggle. Specify the symbol plot edge color and thickness.

14.2.17 Table Histogram

What: Plots two columns of table data as bars in a standard histogram format.

Why: Standard histogram data display.

Used By: **Series Legend**

Appearance:

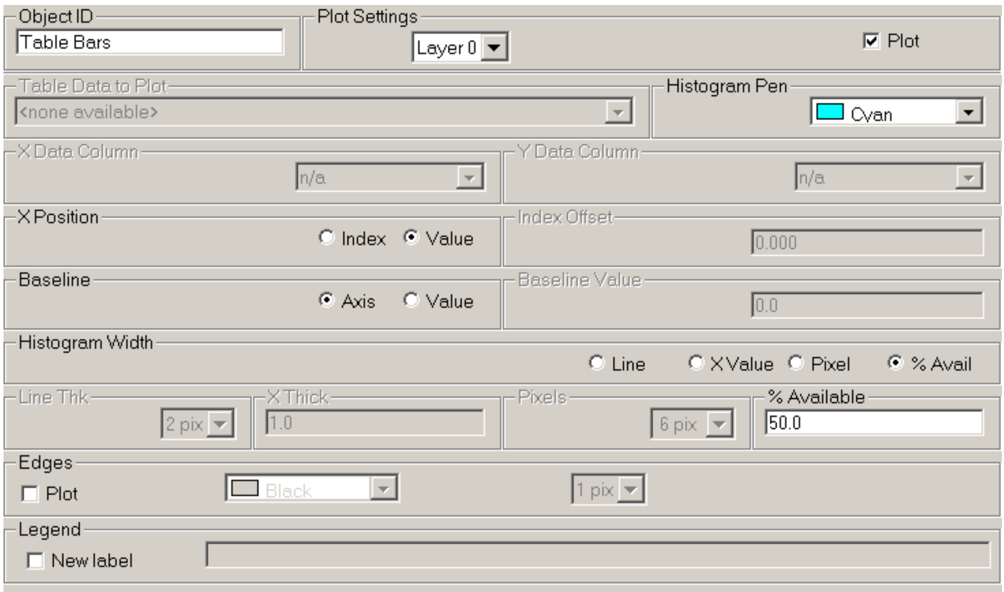


Figure 14.36 Table Histogram Property Window

Input Data: table data

Output Data: series legend specifications

Properties:

Table Data to Plot The table data set to be plotted is selected.

Histogram Pen All histogram bars are plotted in the specified color.

X Data Column The table column to be used as the X data is selected.

Y Data Column The table column to be used as the Y data is selected.

X Position

Index — The X value of histogram bars is based on the index value (e.g. the first Y value is plotted at an index of 1, the second at an index of 2, etc.)

Value — The X value of histogram bars is based on the X value in the data set.

Index Offset — If an Index **X Position** is used, an offset can be applied to the X data column indexes.

Baseline

Axis — Histogram bars will extend down to the X axis, regardless of the Y value at the X axis.

Value — Histogram bars will extend down (or up) to the Y value specified in the **Baseline Value** box.

Baseline Value — If Value is specified as the **Baseline**, the minimum Y value of the histogram bars is specified.

Histogram Width

Line — Histogram bars are plotted as lines.

X Value — Histogram bars are plotted as bars, with a thickness specified as an X increment.

Pixels — Histogram bars are plotted as bars, with a thickness specified as a pixel width. Similar to lines, however a rectangle is created which can be surrounded by an edge.

% Avail — Histogram bars are plotted as bars, with a thickness specified as percentage of the minimum distance between bars.

Line Thk — For histogram bars plotted as lines, the line thickness is specified.

X Thick — For histogram bar thickness specified as an X value, the thickness as an X increment is specified.

Pixels — For histogram bar thickness specified as a pixel width, the thickness in pixels is specified.

% Available — For histogram bar thickness specified as the percentage of space between X values, the thickness as a percentage is specified.

Edges — For all histogram width types except line.

Plot — If toggled, edges of the bars will be plotted using the pen color and pixel thickness specified within this dialog frame.

Legend

New label — When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object ID of the input object.

14.2.18 Table Horsetail

What: Displays all columns of a table, using one selected column as the X data.

Why: Standard display of many data sets.

Used By: **Series Legend**, **Color Legend**

Appearance:

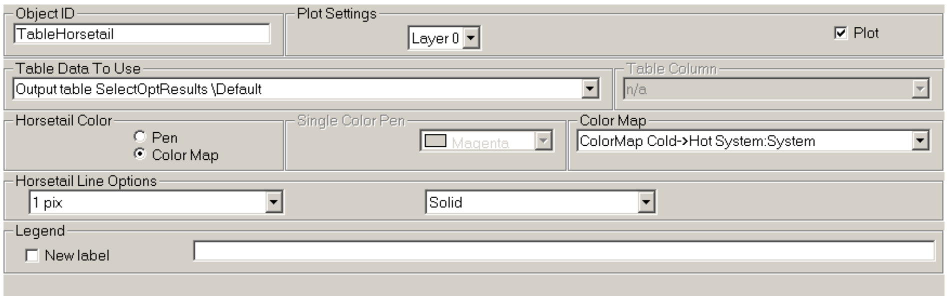


Figure 14.37 Table Horsetail Property Window

Input Data: table data

Output Data: series and color legend specifications

Properties:

Table Data To Use The table data to be plotted is selected.

Table Column The table column to be used as the X data is selected.

Horsetail Color

Pen — All data set lines are plotted in the same color.

Color Map — Each data set line is plotted in a different color.

Single Color Pen If Pen is selected as the **Horsetail Color**, select the color of the lines from the plot window's plot pen set.

Color Map If Color Map is selected as the **Horsetail Color**, select a color map from the drop-down list.

Horsetail Line Options

Line thk — Thickness of the line in pixels.

Line type — The line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.

Legend

New label	When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object ID of the input object.

14.2.19 Table Series

What: In a 3D plot, displays columns of single table as XYZ data using symbols and/or lines.

Why: Standard XYZ data display.

Used By: **Series Legend**

Appearance:

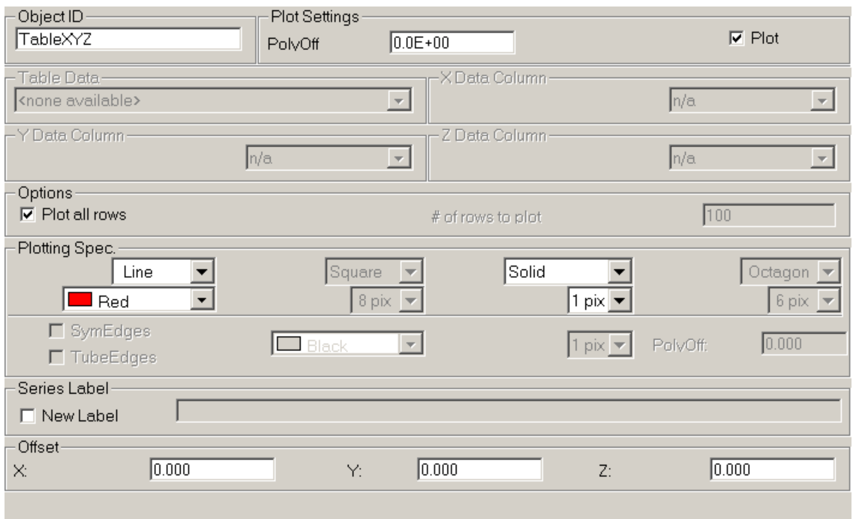


Figure 14.38 Table Series Property Window

Input Data: table data

Output Data: series legend specifications

Properties:

Table Data The table data set to be plotted is selected

X data column The column in the input table that will form the X co-ordinate of the series.

Y data column The column in the input table that will form the Y co-ordinate of the series.

Z data column The column in the input table that will form the Z co-ordinate of the series.

Options

Plot all rows If toggled off, only rows 1 to the specified # of rows will be plotted.

# of rows to plot — If Plot all rows is toggled off, the maximum number of rows to be plotted is specified.

Plotting Spec.

Type — The XY series is plotted as lines and/or symbols.

Pen — Select the color of the lines and/or symbols from the plot window's plot pen set.

Symbol type — Available if Type is not *Line*, one of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.

Symbol size — The relative size of the symbol in pixels is selected.

Line type — Available if Type is not *Symbol*, the line pattern is selected: *Solid*, *Dashed*, *Double-Dash* or *Extruded*.

Line thk — Thickness of the line in pixels.

Tube type — Available if Line type is *Extruded*, the tube pattern is selected: *Triangle*, *Square*, *Octagon* or *Round*.

Tube size — The relative size of the tube in pixels is selected.

Edges

SymEdges — If selected, plots a line around plotted symbols.

TubeEdges — If selected, plots a line around plotted tubes.

Edge Pen — Select the color of the symbol or tube edges.

Edge line thk — Thickness of edge lines in pixels.

PolyOff — Polygon offset of lines. Used only for OpenGL 1.1.

Series Label

New label — When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the column ID of the Z data.

Offset — XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.2.20 XY Array Horsetail

What: Displays all XY data sets contained within an XY array.

Why: Standard XY data display of many XY data sets.

Used By: **Series Legend**, **Color Legend**

Appearance:

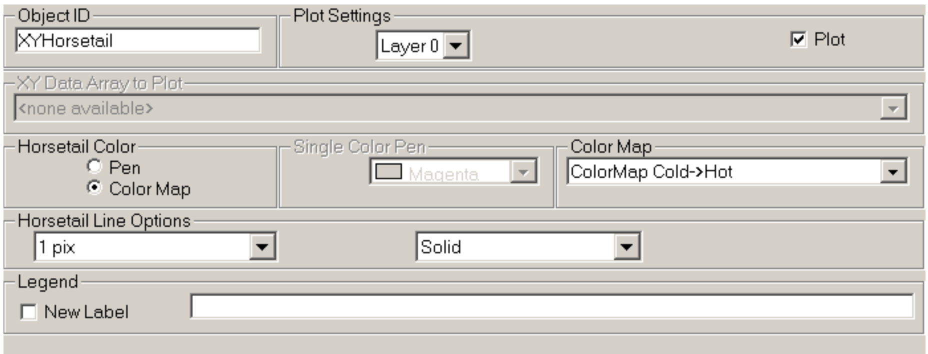


Figure 14.39 XY Array Horsetail Property Window

Input Data: XY array

Output Data: series and color legend specifications

Properties:

XY Data Array to Plot The XY array data set to be plotted is selected.

Horsetail Color

Pen — All data set lines are plotted in the same color.

Color Map — Each data set line is plotted in a different color.

Single Color Pen If Pen is selected as the **Horsetail Color**, select the color of the lines from the plot window's plot pen set.

Color Map If Color Map is selected as the **Horsetail Color**, select a color map from the drop-down list.

Horsetail Line Options

Line thk — Thickness of the line in pixels.

Line type — The line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.

Legend

New label	When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object ID of the input object.

14.2.21 XY Data Array Series

What: Displays selected XY data series within an XY data array using symbols and/or lines.

Why: Standard XY data display.

Used By: **Series Legend**

Appearance:

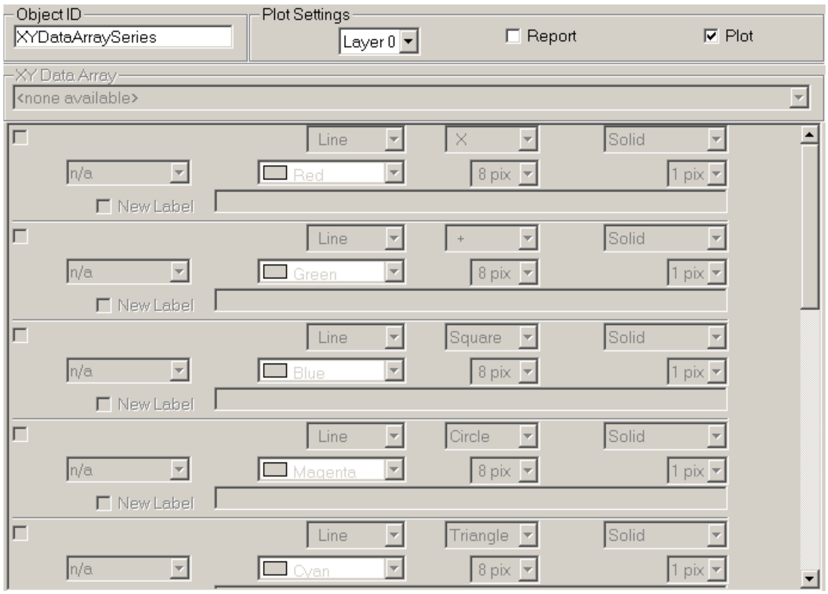


Figure 14.40 2D XY Series Property Window

Input Data: XY array

Output Data: series legend specifications

Properties:

XY Data Array The XY data array is selected. The XY series within the array to be plotted are selected in the scroll box below.

Each **XY Data Array Series** object can plot up to 12 XY series, each plotted using a different format. The scroll box contains 12 input areas, separated by horizontal lines. Each input area is used to describe one XY series within the specified XY data array.

Select The toggle box in the upper left corner of input area must be selected to plot the selected XY series. The XY series to be plotted is selected in the drop-down list; only XY series within the XY data array are available in the drop-down list.

Type	The XY series is plotted as lines and/or symbols.
Pen	Select the color of the lines and/or symbols from the plot window's plot pen set.
Symbol type	Available if Type is not *Line*, one of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
Symbol size	The approximate relative size of the symbol in pixels is selected.
Line type	Available if Type is not *Symbol*, the line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.
Line thk	Thickness of the line in pixels.
New label	When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object XY series ID within the input XY array.

14.2.22 XY Histogram

What: Plots XY data as bars in a standard histogram format.

Why: Standard histogram data display.

Used By: **Series Legend**

Appearance:

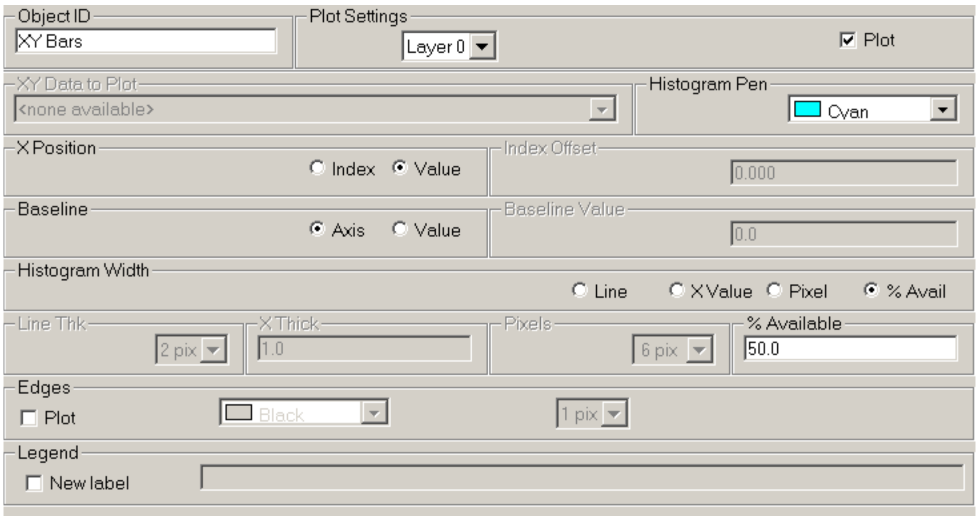


Figure 14.41 XY Histogram Property Window

Input Data: XY data

Output Data: series legend specifications

Properties:

XY Data to Plot The XY data set to be plotted is selected.

Histogram Pen All histogram bars are plotted in the specified color.

X Position

Index The X value of histogram bars is based on the index value (e.g. the first Y value is plotted at an index of 1, the second at an index of 2, etc.).

Value The X value of histogram bars is based on the X value in the data set.

Index Offset If an Index **X Position** is used, an offset can be applied to the X data indexes.

Baseline

Axis — Histogram bars will extend down to the X axis, regardless of the Y value at the X axis.

Value — Histogram bars will extend down (or up) to the Y value specified in the **Baseline Value** box.

Baseline Value — If Value is specified as the **Baseline**, the minimum Y value of the histogram bars is specified.

Histogram Width

Line — Histogram bars are plotted as lines.

X Value — Histogram bars are plotted as bars, with a thickness specified as an X increment.

Pixels — Histogram bars are plotted as bars, with a thickness specified as a pixel width. Similar to lines, however a rectangle is created which can be surrounded by an edge.

% Avail — Histogram bars are plotted as bars, with a thickness specified as percentage of the minimum distance between bars.

Line Thk — For histogram bars plotted as lines, the line thickness is specified.

X Thick — For histogram bar thickness specified as an X value, the thickness as an X increment is specified.

Pixels — For histogram bar thickness specified as a pixel width, the thickness in pixels is specified.

% Available — For histogram bar thickness specified as the percentage of space between X values, the thickness as a percentage is specified.

Edges — For all histogram width types except line.

Plot — If toggled, edges of the bars will be plotted using the pen color and pixel thickness specified within this dialog frame.

Legend

New label — When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object ID of the input object.

14.2.23 XY Series

What: Displays multiple XY data using symbols and/or lines.

Why: Standard XY data display.

Used By: **Series Legend**

Appearance: This object appears different in 2D and 3D.

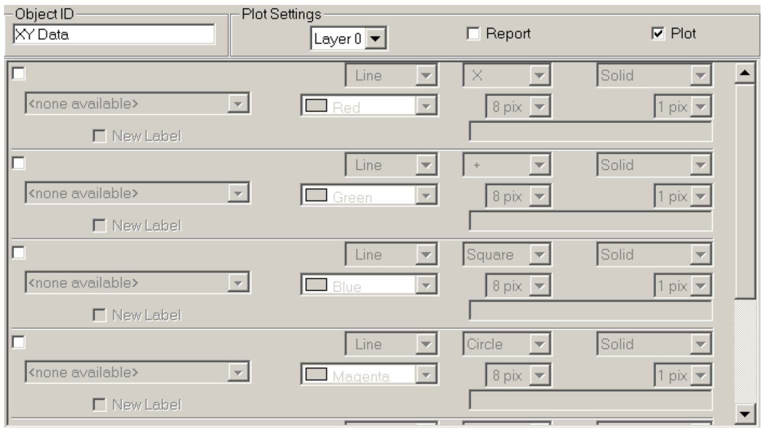


Figure 14.42 2D XY Series Property Window

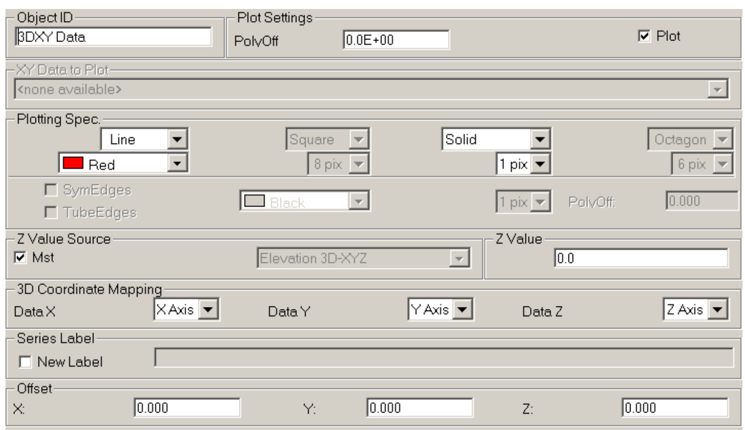


Figure 14.43 3D XY Series Property Window

Input Data: XY data

Output Data: series legend specifications

2D Plot Object Properties:

Each **XY Data Series** object can plot up to 8 XY series, each plotted using a different format. The scroll box contains 8 input areas, separated by horizontal lines. Each input area is used to describe one XY series.

Select	The toggle box in the upper left corner of input area must be selected to plot the selected XY series. The XY series to be plotted is selected in the drop-down list.
Type	The XY series is plotted as lines and/or symbols.
Pen	Select the color of the lines and/or symbols from the plot window's plot pen set.
Symbol type	Available if Type is not *Line*, one of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
Symbol size	The approximate relative size of the symbol in pixels is selected.
Line type	Available if Type is not *Symbol*, the line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.
Line thk	Thickness of the line in pixels.
New label	When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object output ID of the input XY data.

3D Plot Object Properties:

Each **XY Data Series** object can plot only one XYZ series, using X and Y from the selected XY data, and Z values specified as the Z value source.

Plotting Spec.

Type	The XY series is plotted as lines and/or symbols.
Pen	Select the color of the lines and/or symbols from the plot window's plot pen set.
Symbol type	Available if Type is not *Line*, one of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
Symbol size	The relative size of the symbol in pixels is selected.
Line type	Available if Type is not *Symbol*, the line pattern is selected: *Solid*, *Dashed*, *Double-Dash* or *Extruded*.

Line thk — Thickness of the line in pixels.

Tube type — Available if Line type is *Extruded*, the tube pattern is selected: *Triangle*, *Square*, *Octagon* or *Round*.

Tube size — The relative size of the tube in pixels is selected.

Edges

SymEdges — If selected, plots a line around plotted symbols.

TubeEdges — If selected, plots a line around plotted tubes.

Edge Pen — Select the color of the symbol or tube edges.

Edge line thk — Thickness of edge lines in pixels.

PolyOff — Polygon offset of lines. Used only for OpenGL 1.1.

Z Value Source — Master/Slave controls for the Z value. Master/Slave controls are described in Section 6.3.1.

Z Value — XY values will be plotted at the constant Z value entered.

3D Co-ordinate Mapping — Determines which X, Y and Z values are plotted as the X, Y and Z axis.

Series Label

New label — When toggled on, the label output is entered by the user in the adjacent text box. When toggled off, the label output is the object output ID of the input XY data.

Offset — XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.3 Annotation Plot Objects

14.3.1 Color Legend

What: Annotation object that displays a color bar and associated data limits.

Why: Gives numeric context to plot objects using color maps.

Used By: Nothing (no object output).

Appearance:

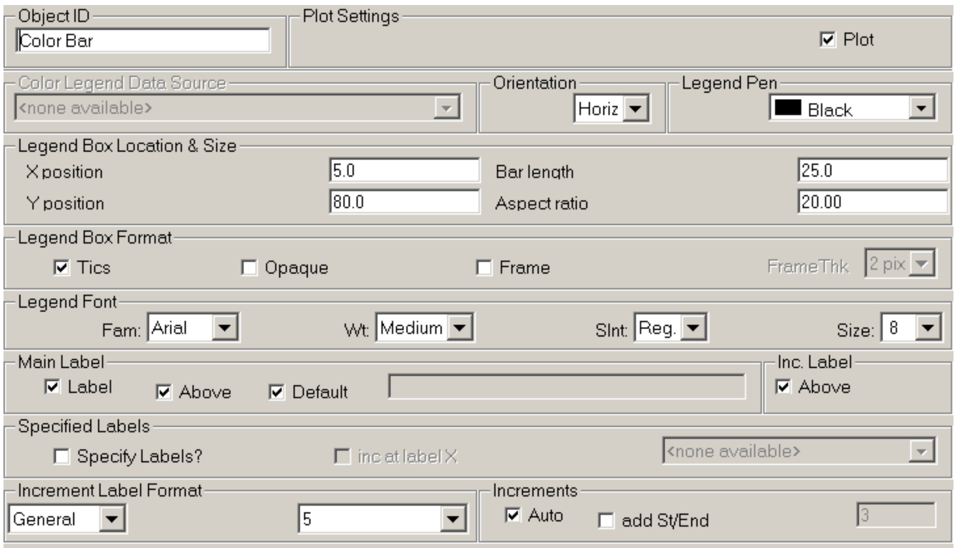


Figure 14.44 Color Legend Property Window

Input Data: **Color Cube Block**, **Color Cube Point**, **Color Grid Block**, **Color Grid Fill**, **XY Array Horsetail**

Output Data: none

Properties:

Color Legend Data Source Select the color plot object the color legend will represent.

Orientation

Horizontal Legend is horizontal.

Right Legend is vertical, main label is read from top to bottom.

Left Legend is vertical, main label is read from bottom to top.

Legend Pen Pen color used for label, tics, and frame, selected from the plot window's plot pen set.

Legend Box Location & Size

X, Y Position Location of upper left corner of bar in a 0-100 annotation co-ordinate system.

Bar length Height (if vertical) or width (if horizontal) in annotation units.

Aspect ratio Width (if vertical) = length / aspect ratio.

Legend Box Format

Tics Draws tic marks at increments.

Opaque Places the color bar and annotation on an opaque rectangle of background color (allows bar to be overlaid on data areas).

Frame Places a rectangular frame around the color bar and annotation.

Thk Thickness (in pixels) of frame.

Legend Font Specifies the font used for increments and the main label. Font formatting options are described in Section 6.3.4.

Main Label

Label Includes a data label next to the color bar.

Above/Left If selected, the data label is above the color bar (if horizontal), or to the left of the color bar (if vertical). If not selected, the data label is below the color bar (if horizontal) or to the right of the color bar (if vertical).

Default When toggled on, the main label is entered by the user in the adjacent text box. When toggled off, the main label is based on the object ID of the selected color object.

Inc. Label

Above/Left If selected, the increment labels are placed above the color bar (if horizontal), or to the left of the color bar (if vertical). If not selected, the increment labels are placed below the color bar (if horizontal) or to the right of the color bar (if vertical).

Specified Labels	If the Specified Labels toggle is selected, the labels on the legend can be specified from an XYZ label source. If inc at label X toggle is selected, the X value in the label source is used to determine the location of the label, otherwise the labels are distributed along the data increments.
Increment Label Format	Specifies the numeric format of the increment labels. Number formatting is described in Section 6.3.3.
Increments	Specifies the number of increments in the color bar.
Auto	The number of increments is based on data type (lin/log) and range. Not implemented.
# of inc	Actual number of increments, if Auto is not selected.

14.3.2 Data Labels

What: Annotation object that displays property and input settings for other objects in a legend box.

Why: Ensures annotation is updated as objects change.

Used By: Nothing (no object output).

Appearance:

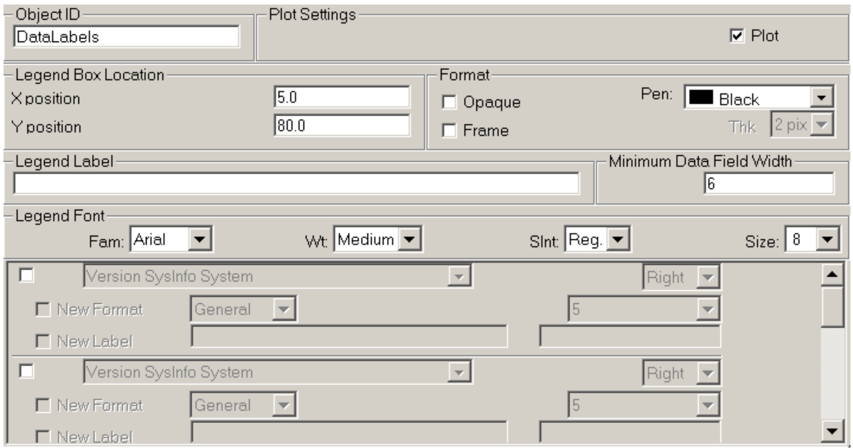


Figure 14.45 Data Labels Property Window

Input Data: many objects produce one or more label outputs

Output Data: none

Properties:

Legend Box Location

X, Y Position — Location of upper left corner of legend box in a 0-100 annotation co-ordinate system.

Format

Opaque — Places text on opaque rectangle of background color.

Frame — Places a rectangular frame around data label.

Pen — Pen color used for text and frame, selected from the plot window's plot pen set.

Thk — Thickness (in pixels) of frame.

Legend Label — User-input label placed above specified data labels.

Minimum Data Field Width Specifies minimum width of label, based on the number of characters.

Legend Font Specifies the font used for the legend label and the specified data labels. Font formatting options are described in Section 6.3.4.

Data Labels Each **Data Labels** object can plot up to 6 data labels, plotted consecutively within one legend box, one data label per line. The scroll box in the property window contains 6 input areas, separated by horizontal lines. Each input area is used to describe one data label.

Select The toggle box in the upper left corner of each input area must be selected to plot the selected data label.

Data Source The data label to be plotted is selected in the adjacent drop-down list.

Justification Each data label is justified within an enclosing sub-rectangle. This property controls the justification within the sub-rectangle.

New format If the data value is associated with a numeric value, the user can override the existing format. Numeric formatting options are described in Section 6.3.3.

New Label If selected, the existing description associated with the label is overridden. The first text box will create a label in front of the data (e.g. data descriptor), the second text box will create a label after the data (e.g. units of the data).

14.3.3 Extra Grid Lines

What: Displays a grid line at a specified X or Y value. The grid line may also be labelled.

Why: To emphasize a value in the X or Y axis.

Used By: Nothing (no object output).

Appearance:

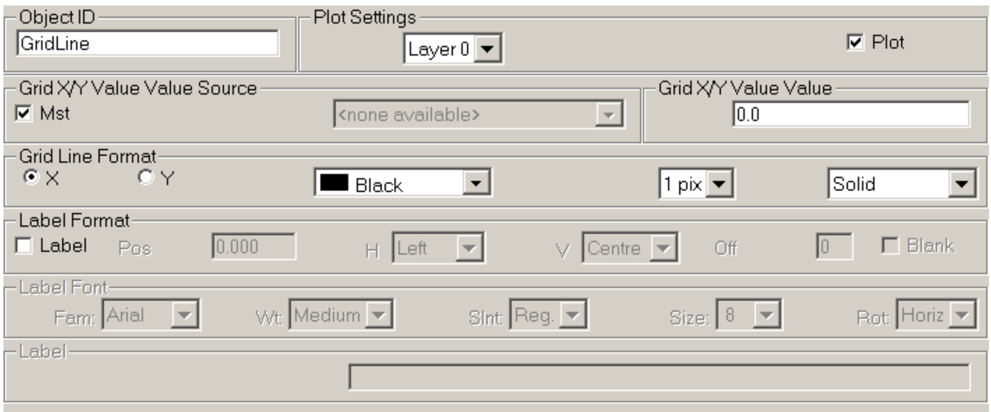


Figure 14.46 Extra Grid Lines Property Window

Input Data: none

Output Data: none

Properties:

Grid X/Y Value Value Source A master/slave control to connect the **Grid X/Y Value Value** to a value specified in another object (e.g. another **Extra Grid Lines** object). Master/Slave controls are described in Section 6.3.1.

Grid X/Y Value Value The X or Y value at which the grid line will be drawn.

Grid Line Format

X — The **Grid X/Y Value Value** will represent an X co-ordinate.

Y — The **Grid X/Y Value Value** will represent a Y co-ordinate.

Pen — Select the color of the grid line from the plot window's plot pen set.

Line thk — Thickness of the grid line in pixels.

Line type — The grid line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.

Label Format

Label	If selected, a label will be placed adjacent to the grid line.
Pos.	Position of the label, based on a 0-100 co-ordinate system from the start to the end of the grid line.
H	Horizontal justification.
V	Vertical justification.
Off	Offset space between the grid line and the label.
Blank	Creates a blank in the grid line, where the grid line and label intersect.

Label Font Specifies the font used for the label. Font formatting options are described in Section 6.3.4.

Label Label text is user-input in the text box.

14.3.4 Label Axis

What: Creates an X or Y axis with XYZ labels in place of numeric increments. The X and Y values of the labels are used to determine label location along the axis. Used when the X or Y axis is not displayed (**Control** in the **2D Plot Annotation** default object).

Why: Standard label increment annotation.

Used By: Nothing (no object output).

Appearance:

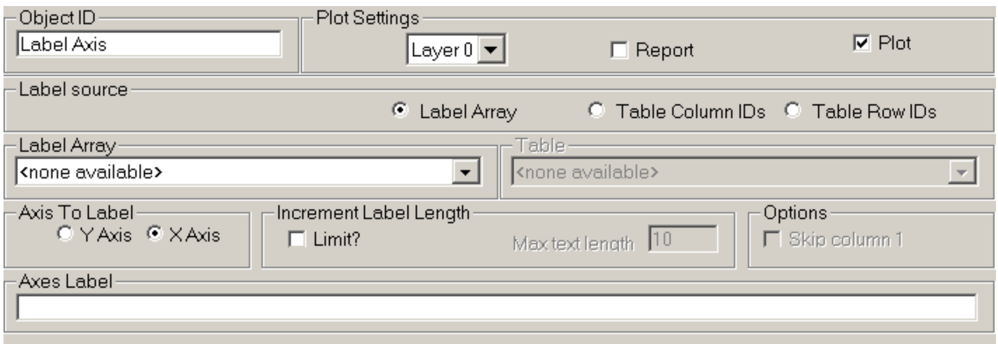


Figure 14.47 Label Axis Property Window

Input Data: XYZ labels

Output Data: none

Properties:

Label Source The labels can be specified from XYZ labels, or table column or row IDs.

Label Array XYZ labels to use as label increments. The X or Y value will be used to place the label along the respective axis.

Table The table from which table column or row IDs are obtained.

Axis To Label Specifies the axes to replace, either the X or Y axis.

Increment Label Length The increment label length can be limited, to force multi-line label increments. The Max text length value specifies the maximum number of characters per line in each increment label.

Options

Skip column 1 — If labels are provided from table column IDs, allows the first column ID to be skipped.

Axes Label — Determines the label for the label axes.

14.3.5 Sequence Grid Lines

What: Displays a grid line to define sequence intervals. Grid lines are created for the starting time of each sequence and for the end time of the last sequence. The grid lines may be labelled with the sequence identifier.

Why: To emphasize the beginning and starting points of sequences.

Used By: Nothing (no object output).

Appearance:

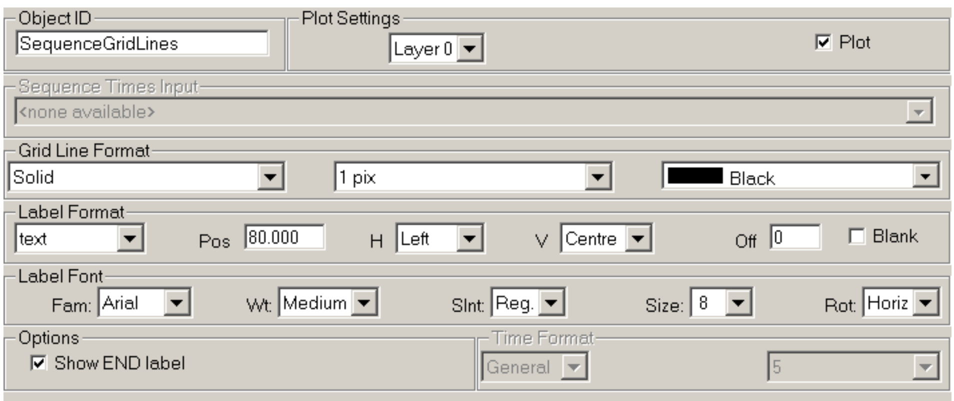


Figure 14.48 Sequence Grid Lines Property Window

Input Data: **Sequence Time Interval Data**

Output Data: none

Properties:

Sequence Times Input The sequence time data set is selected. In nPre, the sequence time data are by default a system object defined in the **Sequence** input window. In nPost, the sequence time data must be read in with a **Sequence Time Interval Data** object, or with XY or profile simulation results.

Grid Line Format

Line type The grid line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.

Line thk Thickness of the grid line in pixels.

Pen Select the color of the grid line from the plot window's plot pen set.

Label Format

none — If selected, no labels will be plotted.

text — If selected, the sequence identifier will be placed adjacent to the grid line.

value — If selected, the time of the grid line will be placed adjacent to the grid line.

Pos. — Position of the label, based on a 0-100 co-ordinate system from the start to the end of the grid line.

H — Horizontal justification.

V — Vertical justification.

Off — Offset space between the grid line and the label.

Blank — Creates a blank in the grid line, where the grid line and label intersect.

Label Font — Specifies the font used for the label. Font formatting options are described in Section 6.3.4.

Options

Show END label — A grid line is created for the starting time of each sequence, in addition to the end time of the last sequence. If this checkbox is selected, a label of "END" will be placed adjacent to the grid line representing the end time of the last sequence.

Time Format — If a value label is selected, the numeric format of the time is selected here. Numeric formatting options are described in Section 6.3.3.

14.3.6 Series Legend

What: Annotation object creates a legend box for describing symbols and/or lines used by other plot objects.

Why: Standard plot annotation.

Used By: Nothing (no object output).

Appearance:

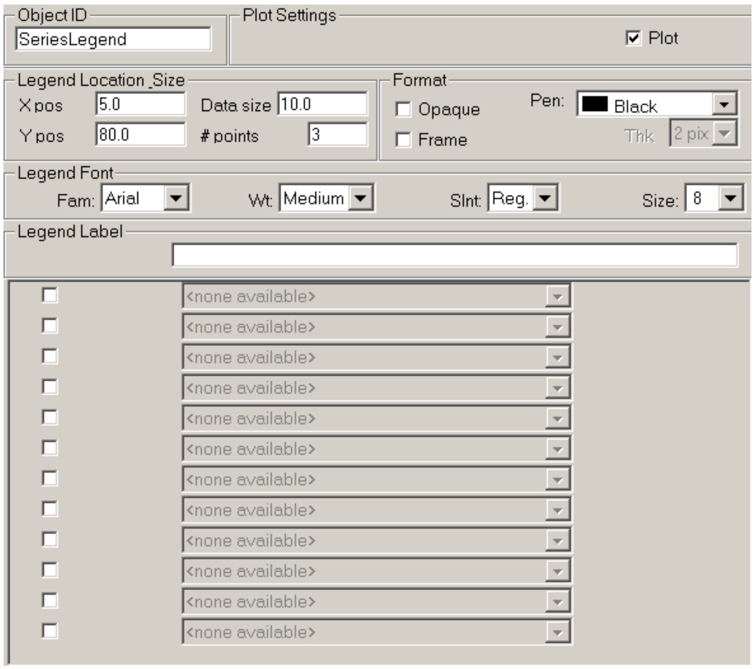


Figure 14.49 Series Legend Property Window

Input Data: **Confidence Limits**, **Grid Contour**, **Grid Fishnet**, **Multiple Table Series**, **Table Series**, **XY Array Horsetail**, **XY Series**.

Output Data: none

Properties:

Legend Box Location & Size

X, Y Position — Location of upper left corner of the legend in a 0-100 annotation co-ordinate system.

Data Size — Length in 0-100 space of symbol/line display.

points — Number of points in symbol/line display.

Legend Box Format

Opaque	Places the series legend on an opaque rectangle of background color (allows legend to be overlaid on data areas).
Frame	Places a rectangular frame around the series legend.
Legend Pen	Pen color used for labels and frame, selected from the plot window's plot pen set.
Thk	Thickness (in pixels) of frame.

Legend Font Specifies the font used for labels. Font formatting options are described in Section 6.3.4.

Legend Label Additional label placed in upper right corner of legend.

Legend Data Legend data from 12 different input objects can be displayed by each **Series Legend** object. The input objects are selected in the scroll box, one input object per line.

Selected	Checkbox must be selected for the input objects to be included in the legend.
Data Source	Series data to include in the legend are selected.

14.3.7 Table Labels

What: Plots table data in the plot window, such that each table value is plotted with an x location corresponding to the table row index, and a y location corresponding to the table column index.

Why: Plots data values directly in the plot window. For example, correlation matrix values can be plotted in the plot window.

Used By: Nothing (no object output).

Appearance:

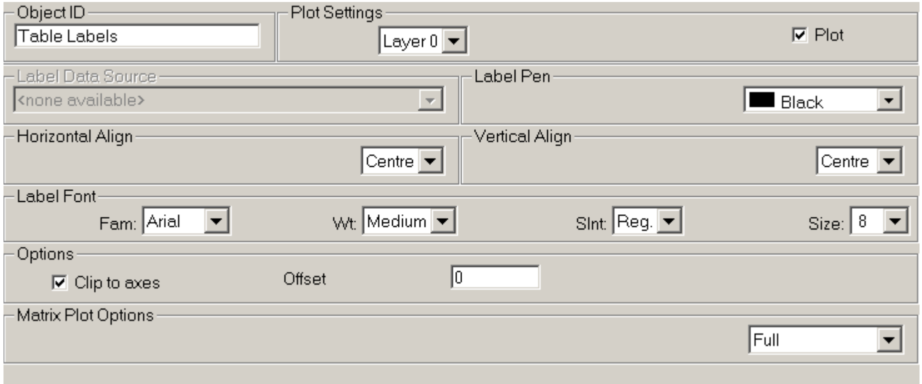


Figure 14.50 Table Labels Property Window

Input Data: Table Data

Output Data: none

Properties:

Label Source Table data values to plot.

Label Pen Color of the data label text.

Horizontal Align Horizontal alignment of the label relative to the X (column) value.

Vertical Align Vertical alignment of the label relative to the Y (row) value.

Label Font Specifies the font used for the labels. Font formatting options are described in Section 6.3.4.

Options

Clip to axes Labels outside the current axes limits are not plotted if this option is selected.

Offset — Data labels are offset by the specified value.

Matrix Plot Options — The full resulting grid of labels can be plotted, or can be limited to the upper diagonal, lower diagonal, diagonal only, upper only or lower only.

14.3.8 Time Axes

What: Annotation object that displays an X axis with date and/or time labels, in conjunction with the settings in the X axis default object. It is best displayed when the X axis is not displayed (**Control** in the **2D Plot Annotation** default object).

Why: Standard time and/or date axes annotation.

Used By: Nothing (no object output).

Appearance:

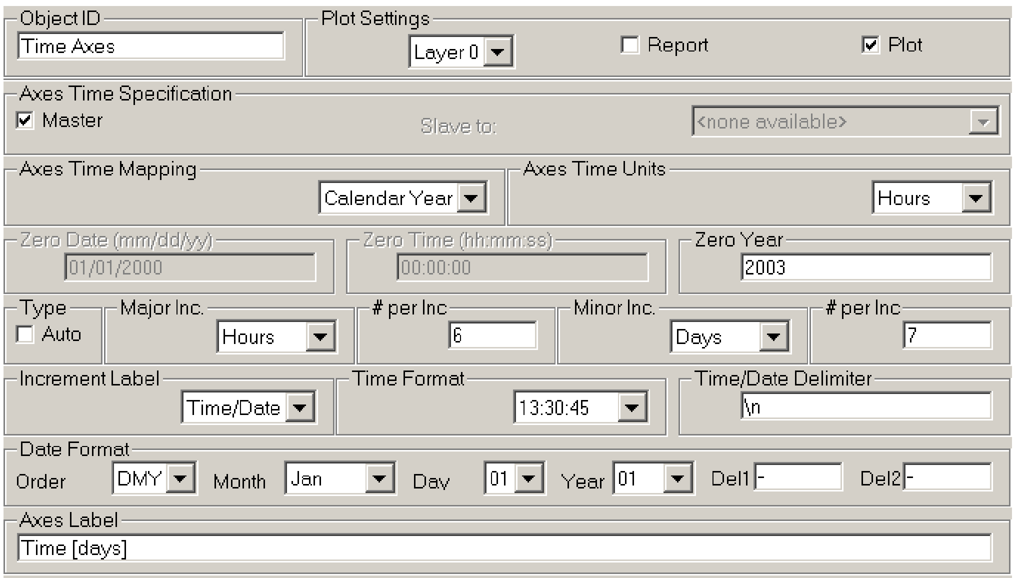


Figure 14.51 Time Axes Property Window

Input Data: none

Output Data: none

Properties:

Axes Time Specification Master/Slave control for the **Axes Time Mapping** and **Axes Time Units** controls. Master/Slave controls are described in detail in Section 6.3.1.

Axes Time Mapping Specifies the format used to specify the zero date and time.

- Arbitrary — The zero date and time is specified in the **Zero Date** and **Zero Time** controls.
- Calendar Year — Day 1 is specified as the first of January of the year specified in the **Zero Year** control.

Excel Days	Day 1 is specified as the first of January, 1900.
Axes Time Units	For Arbitrary and Calendar Year, specifies the date or time units for the minimum and maximum values specified in the **X Axis** default object. The time units are days if the **Axes Time Mapping** is Excel Days.
Zero Date	For Arbitrary time mapping, specifies the zero date in month, day, year format.
Zero Time	For Arbitrary time mapping, specifies the zero time in hours, minutes, seconds format.
Zero Year	For Calendar Year time mapping, specifies the zero year. The first of January is assumed to be the zero day and month.
Type	If Auto is selected, the major and minor increments are determined automatically.
Major Inc.	If not Auto, specifies the major increment units.
# per Inc	If not Auto, specifies the number of major increments.
Minor Inc.	If not Auto, specifies the minor increment units.
# per Inc	If not Auto, specifies the number of minor increments.
Increment Label	Determines the units for the increment labels (*Date*, *Time*, *Time/Date*, *Date/Time*).
Time Format	Determines the format for time labels.
Time/Date Delimiter	Determines the delimiter between time and date labels. \n represents a carriage return.
Date Format	Determines the format for date labels.
Axes Label	Determines the label for the time axes.

14.3.9 User Labels

What: Annotation object that displays a legend box containing user entered text.

Why: Standard annotation.

Used By: Nothing (no object output).

Appearance:

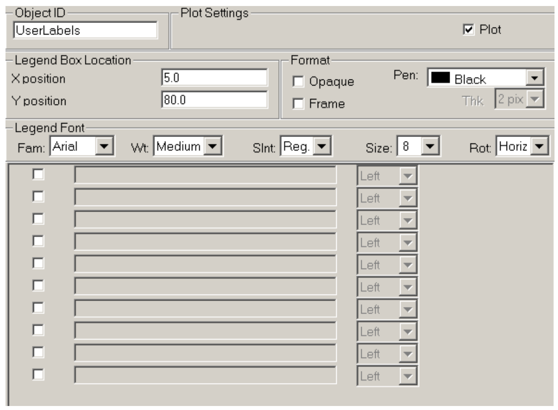


Figure 14.52 User Labels Property Window

Input Data: none

Output Data: none

Properties:

Legend Box Location & Size

X, Y Position — Location of upper left corner of the legend in a 0-100 annotation co-ordinate system.

Legend Box Format

Opaque — Places the legend box on an opaque rectangle of background color (allows labels to be overlaid on data areas).

Frame — Places a rectangular frame around the legend box.

Legend Pen — Pen color used for labels and frame, selected from the plot window's plot pen set.

Thk — Thickness (in pixels) of frame.

Legend Font Specifies the font used for labels. Font formatting options are described in Section 6.3.4.

Label Text Twelve lines of user-input label can be displayed by each **User Labels** object. The text is entered in the text boxes within the scroll box, one text box per line of resulting label text.

Selected Checkbox must be selected for the entered label to be included in the legend box.

Label Text Label text is entered in the text box.

Justification Justification of the label text within the legend box.

14.3.10 XY Labels

What: Displays 3D labels in a 2D data space.

Why: Text annotation of data values, cultural features.

Used By: Nothing (no object output).

Appearance:

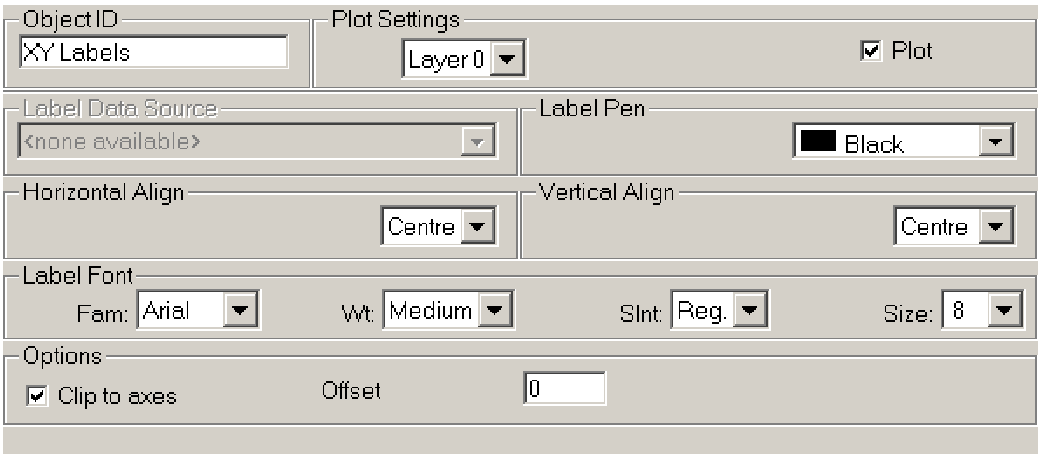


Figure 14.53 XY Labels Property Window

Input Data: **Read XYZ Labels, Create XYZ Label for Real**

Output Data: none

Properties:

Label Data Source Select the object containing the source of the XY labels.

Label Pen Pen color used for labels, selected from the plot window's plot pen set.

Horizontal Align Horizontal justification relative to the label co-ordinate.

Vertical Align Vertical justification relative to the label co-ordinate.

Legend Font Specifies the font used for labels. Font formatting options are described in Section 6.3.4.

Options

Clip to Axes XY labels outside the current axes limits will not be plotted.

Offset XY label location will be offset by the entered value (based on a 0-100 annotation co-ordinate space).

14.3.11 XYZ Labels

What: Displays 3D labels in 3D data space.

Why: Text annotation of data values, cultural features.

Used By: Nothing (no object output).

Appearance:

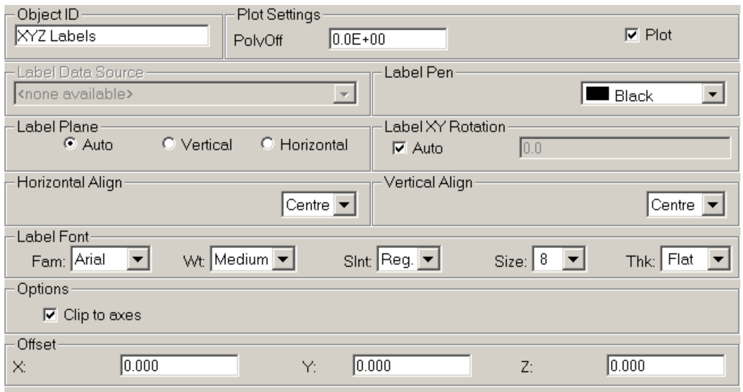


Figure 14.54 XYZ Labels Property Window

Input Data: **Read XYZ Labels, Create XYZ Label for Real**

Output Data: none

Properties:

Label Data Source Select the object containing the source of the XYZ labels.

Label Pen Pen color used for labels, selected from the plot window's plot pen set.

Label Plane

Auto The plane onto which the text will be displayed is determined by the current view elevation. The label plane is horizontal if the view elevation is greater than 45 degrees, vertical otherwise.

Vertical The text is displayed orthogonal to the XY plane.

Horizontal The text is displayed parallel to the XY plane.

Label XY Rotation

Auto	Label rotation in the XY plane is perpendicular to the current view azimuth.
Rotation	If not Auto, the rotation angle of the label in the XY plane is entered in degrees (0.0 is parallel to X axis).
Horizontal Align	Horizontal justification relative to the label co-ordinate.
Vertical Align	Vertical justification relative to the label co-ordinate.
Label Font	Specifies the font used for labels. Font formatting options are described in Section 6.3.4.
Options	
Clip to Axes	XYZ labels outside the current axes limits will not be plotted.
Offset	XYZ offset is used to improve the visibility of objects (see discussion of 3D plot object visibility, Section 8.1.2.1).

14.4 Active Plot Objects

14.4.1 Analytics: Line Data

What: Creates a line with 5 points in a 2D plot window. Each point in the line can be dragged to move, rotate, extend or shrink the line. The location of the line, in addition to its length, slope and Y intercept, are provided in the object property window, and are output as data labels.

Why: Allows the user to create a straight line on a 2D plot interactively.

Used By: **Data Labels**

Appearance:

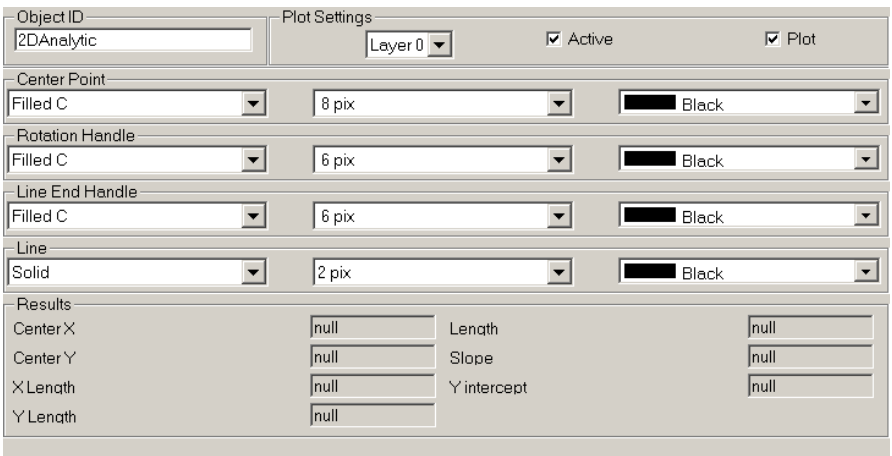


Figure 14.55 Analytics: Line Data Property Window

Input Data: none

Output Data: data labels of line properties

Properties:

Center Point The center of the analytic line is represented by the specified symbol. Dragging the center point moves the entire line.

Symbol type One of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.

Symbol size The approximate relative size of the symbol in pixels is selected.

Pen Select the color of the symbol from the plot window's plot pen set.

Rotation Handle Two points, one each between the center and the ends of the analytic line, are represented by the specified symbol. Dragging either of these points within the 2D window rotates and changes the length of the analytic line. Symbol formatting options are as described for the **Center Point**.

Line End Handle — Two points on each end of the analytic line are represented by the specified symbol. Dragging either of these points within the 2D window changes the length of the analytic line, as well as the location of the line end. Symbol formatting options are as described for the **Center Point**.

Line — The analytic line formatting options.

Line type — The line pattern is selected: *Solid*, *Dashed*, or *Double-Dash*.

Line thk — Thickness of the line in pixels.

Pen — Select the color of the symbol from the plot window's plot pen set.

Results — The resulting line properties are provided, including the center point X and Y co-ordinate, the line length, the X and Y component of the line length, the line slope and the line Y intercept.

Pop-Up Window:

Within the 2D plot window, in select mode, a new pop-up window specific to this object is available, as shown in Figure 14.56 Analytics: Line Data Pop-Up Window:

Figure 14.56 Analytics: Line Data Pop-Up Window

Apply — Equivalent to the **Apply** button on the **Analytics: Line Data** object's property window.

Reset — Returns the analytic line to the default location, length and rotation.

14.4.2 Modify: Enter/Edit XY

What: Object creates or deletes XY data points.

Why: Allows the user to create a new XY data set or add and delete points from an existing data set interactively.

Used By: Any object using XY data points.

Appearance:

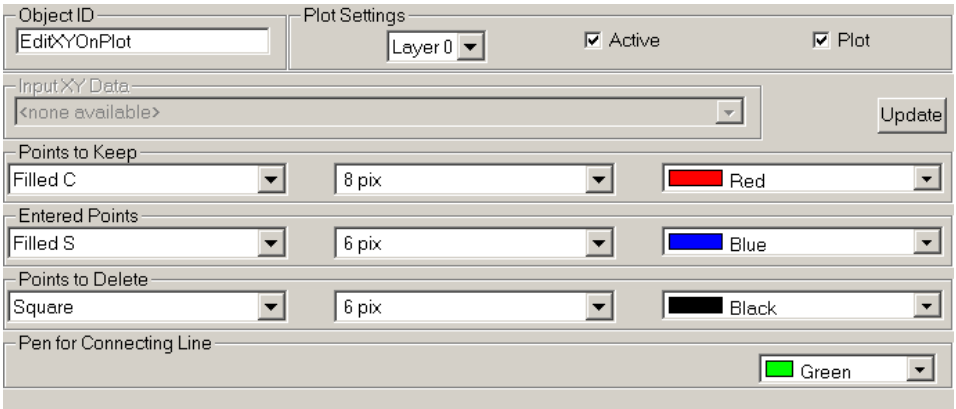


Figure 14.57 Modify: Enter/Edit XY Property Window

Input Data: none or XY data

Output Data: XY data

Properties:

Input XY Data — Select an XY data source to be edited. Will not be used as a source unless the **Update** button is selected.

Update — The **Update** button will delete all existing points, and create new points based on the XY points of the object selected as **Input XY Data**.

Points to Keep — Existing points are represented by the specified symbol.

- Symbol type — One of the available symbols is selected: X, +, square, circle, triangle, diamond, filled square, filled circle, filled triangle and filled diamond.
- Symbol size — The approximate relative size of the symbol in pixels is selected.
- Pen — Select the color of the symbol from the plot window's plot pen set.

Entered Points — Points entered with the mouse (in **Enter** mode) are represented by the specified symbol. Once the **Apply** command is selected, the entered points will be represented by the **Points to Keep** symbol. Symbol formatting options are as described for **Points to Keep**.

Points to Delete Points selected with the mouse in **Delete** mode are represented by the specified symbol. Once the **Apply** command is selected, the selected points will be deleted from the object. Symbol formatting options are as described for **Points to Keep**.

Pen for Connecting Line Existing and entered points are connected by a line of the specified color.

Pop-Up Window:

Within the 2D plot window, in select mode, a new pop-up window specific to this object is available, as shown in Figure 14.58 Modify: Enter/Edit XY Pop-Up Window:

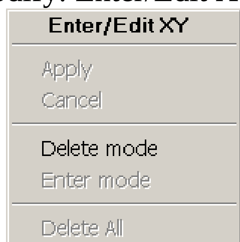


Figure 14.58 Modify: Enter/Edit XY Pop-Up Window

Apply Equivalent to the **Apply** button on the **Modify: Enter/Edit XY** object's property window.

Cancel Equivalent to the **Cancel** button on the **Modify: Enter/Edit XY** object's property window.

Delete mode Once selected, all clicks of the mouse near an existing point will change the point's symbol to the **Points to Delete** symbol. Once the **Apply** button is selected, all points with the **Points to Delete** symbol will be deleted.

Enter mode New points, represented by the **Entered Points** symbol, will be created with each click of the mouse in the 2D plot window. A line will connect the point with the previously selected, created or closest point. Once the **Apply** button is selected, all points with the **Entered Points** symbol will be entered.

Delete All All points within all active **Modify: Enter/Edit XY** objects will be deleted.

15 APPENDIX C – NPOST LIST OBJECT DESCRIPTIONS

15.1 Covariance List

What: Displays the values of the covariance matrix in a list window.

Why: Provides text values of the covariance matrix.

Used By: Nothing.

Appearance:

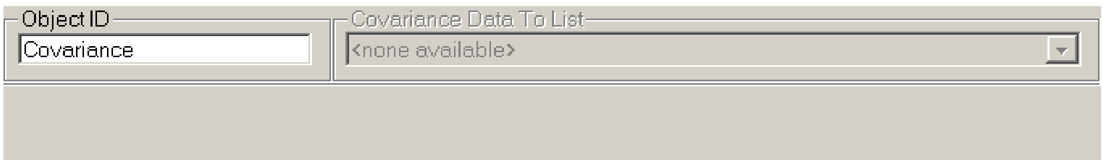


Figure 15.1 Covariance List Property Window

Input Data: **Extract Covariance Matrices**

Output Data: none

Properties:

Covariance Data To List Select the Extract Covariance Matrices object to be displayed in the list window.

15.2 Full Table Statistics

What: Displays full statistics for each table column of a table in a list window.

Why: Allows examination of the statistics of all table columns within a separate window.

Used By: Nothing.

Appearance:

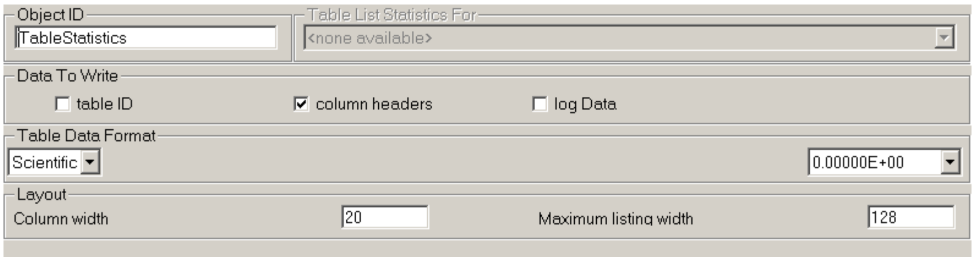


Figure 15.2 Full Table Statistics List Property Window

Input Data: table data

Output Data: none

Properties:

Table List Statistics For Select the table data to calculate and display statistics for in the list window.

Data to Write The table ID and column headers can be included in the list output. All data can be logged before statistics are calculated.

Table Data Format Determines the numeric format of the data.

Layout Column width and the maximum width of the table in the list window can be specified.

15.3 Jacobian List

What: Displays Jacobian data, as well as each parameter's and each fit's percentage of the total sensitivity in a list window.

Why: Provides text values and properties of the Jacobian matrix.

Used By: Nothing.

Appearance:

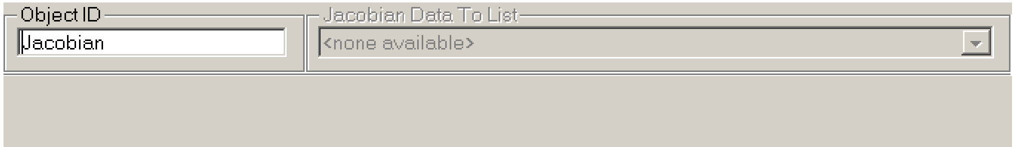


Figure 15.3 Jacobian List Property Window

Input Data: **Extract Jacobian Data**

Output Data: none

Properties:

Jacobian Data To List Select the Extract Jacobian Data object to be displayed in the list window.

15.4 Optimization Results

What: Displays optimizer results output, including a summary of the simulation, fit value data, fitted parameter values, parameter correlation values and 95% confidence intervals in a list window.

Why: Provides text values of optimization results.

Used By: Nothing.

Appearance:

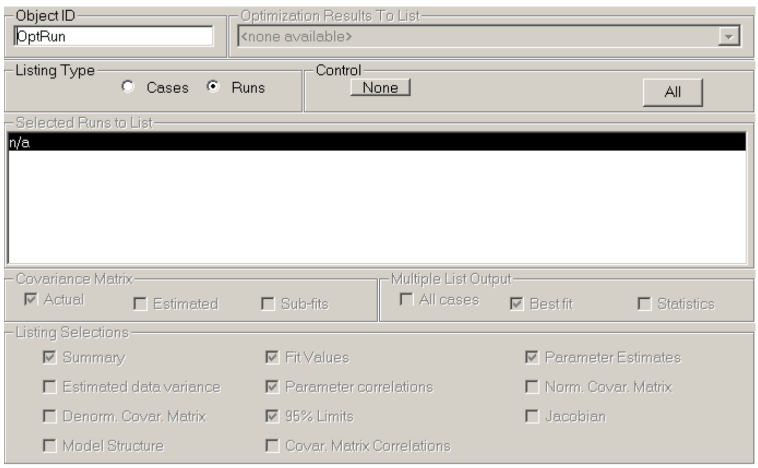


Figure 15.4 Optimization Results Property Window

Input Data: **nSIGHTS Optimizer Results**

Output Data: none

Properties:

Optimization Results To List Select the nSIGHTS Optimizer Results object to be displayed in the list window.

Listing Type

Cases All cases will be displayed in the Selected Runs to List window.

Runs Only runs will be displayed in the Selected Runs to List window.

Control

None Clears all runs or cases selected in the Selected Runs to List window.

All Selects all runs or cases in the Selected Runs to List window.

Selected Runs to List A selection box containing a list of the available runs or cases allows the user to select the runs or cases to be viewed in the list window.

Covariance Matrix

Estimated Covariance matrices use the estimated standard deviation specified by the user for each parameter.

Actual Covariance matrices use the actual standard deviation calculated during the simulation.

Sub-fits Allows the covariance matrix of sub-fits to be extracted. A sub-fit is a single fit of a composite fit.

Multiple List Output

All Cases Results for each case selected in the Selected Runs to List are displayed.

Best Fit Only the best fit of all selected cases are displayed.

Statistics Provides statistics (minimum, maximum, mean and standard deviation) of the Fit Value and Fitted Parameter Value data.

Listing Selections Specifies which optimization results to display in the list window.

15.5 Table

What: Displays a table in a list window.

Why: Allows examination of a table within a separate window.

Used By: Nothing.

Appearance:

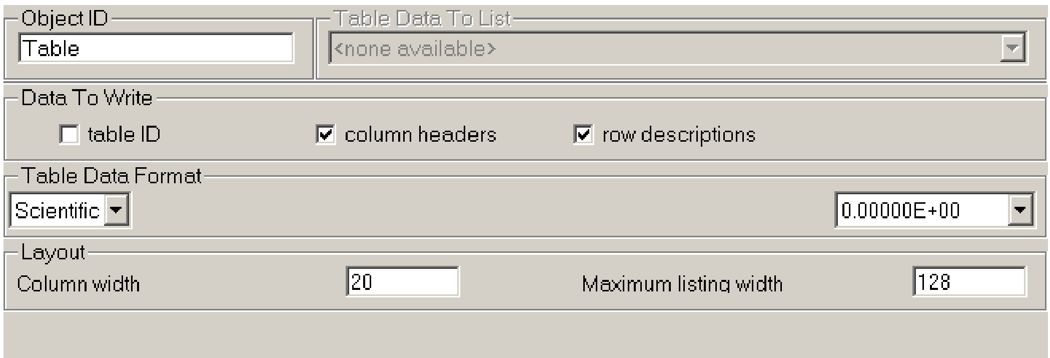


Figure 15.5 Table List Property Window

Input Data: table data

Output Data: none

Properties:

Table Data To List Select the table data to be displayed in the list window.

Data to Write The table ID, column headers and row descriptors can be included in the list output.

Table Data Format Determines the numeric format of the data.

Layout Column width and the maximum width of the table in the list window can be specified.

15.6 XY Data

What: Displays XY data in a list window.

Why: Allows examination of XY data within a separate window.

Used By: Nothing.

Appearance:

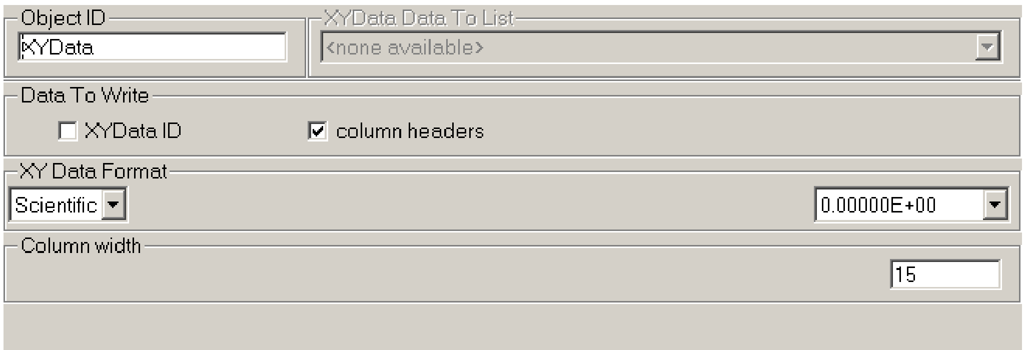


Figure 15.6 XY Data List Property Window

Input Data: XY data

Output Data: none

Properties:

XY Data To List Select the XY data to be displayed in the list window.

Data to Write The XYData ID and column headers can be included in the list output.

XY Data Format Determines the numeric format of the data.

Column width Column width in the list window can be specified.

15.7 XY Data Array

What: Displays XY array data in a list window.

Why: Allows examination of XY array data within a separate window.

Used By: Nothing.

Appearance:

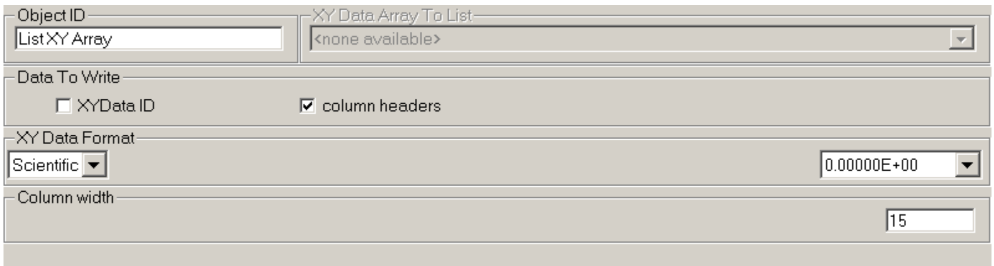


Figure 15.7 XY Array Data List Property Window

Input Data: XY array data

Output Data: none

Properties:

XY Data Array To List Select the XY array data to be displayed in the list window.

Data to Write The XYData ID and column headers can be included in the list output.

XY Data Format Determines the numeric format of the data.

Column width Column width in the list window can be specified.

16 APPENDIX D – NPOST OUTPUT OBJECT DESCRIPTIONS

As most nPost output objects are identical to nPre data objects, refer to Appendix A for a description of all output objects except **Write Grid File**.

16.1 Write Grid File

What: Writes a grid to a text file.

Why: Allows grid data to be used or manipulated outside the nSIGHTS application (for example, in another nSIGHTS application).

Appearance:

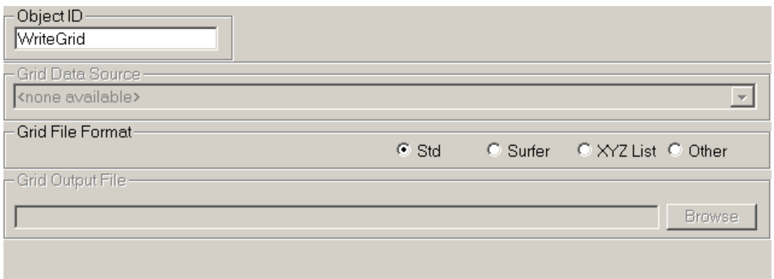


Figure 16.1 Write Grid File Property Window

Application: nPost

Input Data: table data

Output Data: text output file containing grid data compatible with Read Grid Data, default file extension *.grd

Properties:

Grid Data Source Selects the grid data to be output.

Grid File Format One of four file formats can be selected. See the Read Grid Data object description for standard and XYZ list file formats.

Std The standard grid file format.

Surfer The grid format produced by Surfer Version 7 software, based on the *GS ASCII (*.grd)* file format.

XYZ List List of XYZ points.

Other For future use, not currently supported.

Grid Output File The name of the output file is entered in the text bar or the Browse button is used to find the file path using the standard Windows open file dialog.

The output file is only written once the **Apply** button is selected.

17 APPENDIX E – OBJECT NAMES

Object names sometimes appear different in the object menu, the object tree and the object description area. The following tables provide alternate names given the object name in the object tree, sorted alphabetically. Object names used in the user manual, including object description appendices, refer to the object menu name.

17.1 Data Objects

Table 17.1 Data Object Names

Object Tree	Object Menu	Object Description
Add Noise to XY	Add Noise	Add Random Component to XY Data
Add Real To Table	Real Value(s) To Table	Add Real Value To Table
Add XY to XY Array	Add XY to Array	Add XY to XY Array
BarometricCompensation	P(t) Barometric Compensation	BarometricCompensation
BasicResidual	Calculate Basic Residual	Basic Residual Calculation
BasicTimeExtract	Time Limits Extraction/Interpolation	Extract/Interpolate XY Data by Time Limits
BE/ET Compensation	P(t) BE/ET Compensation	Barometric Efficiency and/or Earth Tide Compensation
Calc Opt Confidence	Calculate Joint Confidence for Opt Results	Calculate Joint Confidence for Opt Results
Calc Grid Confidence	Calculate Joint Confidence for Grid	Calculate Joint Confidence for Grid Data
Calc Table Confidence	Calculate Joint Confidence for Table	Calculate Joint Confidence for Table Data
CompositeFit	Composite Fit	Composite Fit
Concatenate Tables	Concatenate Tables	Concatenate Tables
Convert Table To Grid Data	Convert Table To Grid	Convert Table To Grid
Convert Table to XY	Table Columns To XY	Convert Table Columns to XY Data

Table 17.1 Data Object Names		
Object Tree	**Object Menu**	**Object Description**
Correlate All Table Columns	Full Table Correlations	Calculate Correlation Coefficients for all Table Columns
Correlate Table Columns	Table Column Correlations	Calculate Correlation Coefficient of 2 Table Columns
Create BE/ET Response Function	Create BE/ET Response Function	Create BE/ET Response Function
Create Curve	Create Curve from XY Data	Create Curve Data
Create Special CDFs	Create Discrete & Step-Wise Uniform CDFs	Create Discrete & Step-Wise Uniform CDFs
Create Real Value	Create Real Value	Create Real Value
CreateTimeProcess	P(t) Time Processing	Create Time Process Data
CreateXYArray	Create XY Array	Create XY Array
Cube Histogram	Histogram	Histogram of Cube Data
Cube Math	Matrix Math	Mathematical Operations on Cube Data
Cube Statistics	Statistics	Univariate Statistics of Cube Data
Curve Interpolate	Interpolate XY Data from Curve	Interpolate on Curve
DataPgDesc		Data Page Description
Derivative	P(t) Derivative Calculation	Create Derivative Data
Enter Table	Enter Table Data	Enter Table Data
Enter XY	Enter XY Data	Enter XY Data
Extract Cube Indexes	Extract Cube Indexes	Extract Indexes of Cube Data
ExtractSequence	Extract Sequence(s)	Extract Sequence Interval
Extract Grid from Cube	Extract Grid	Extract Grid from Cube
Extract Real from Table	Extract Real from Table	Extract Real from Table Column
Extract Table Rows	Extract Table Range	Extract Rows from Table

Table 17.1 Data Object Names		
Object Tree	**Object Menu**	**Object Description**
Extract XY from Grid	Extract XY from Grid	Extract XY from Grid Data
Extract XY	Extract Range	Extract XY Data
Fourier Transform	Fourier Transform on Y	Fourier Transform on XY Data
Grid Histogram	Histogram	Histogram of Grid Data
Grid Math	Matrix Math	Mathematical Operations on Grid Data
Grid Statistics	Statistics	Univariate Statistics of Grid Data
Integrate	Integrate	Integrate XY Data
Interpolate CDF	Extract Values from CDF	Interpolate Value or Probability from CDF
Interpolate Grid	Interpolate Grid	Interpolate Grid Data onto Different Grid Coordinates
Interpolate Table	Interpolate Table Columns	Interpolate Real Value from Table
JacobianToTable	Jacobian To Table	Jacobian To Table
Linear Color Map	Linear Color Map	Create Linear Color Map
Merge Color Maps	Merge Color Maps	Merge Color Maps
Normalize Cube	Normalize	Normalize Cube Data
Normalize Grid	Normalize	Normalize Grid Data
Pen Set	Pen Set	Create Pen Set
PulseNormalize	Pulse Normalization	Normalize Pulse Data
Read Color Map	Read Color Map	Read Color Map
Read Cube Data	Read Cube Data	Read Cube Data
Read Curve Array	Read Curve File	Read Curve Array
Read Grid	Read Grid Data	Read Grid Data
Read Label Array	Read XYZ Label Data	Read Label Array

Table 17.1 Data Object Names		
Object Tree	**Object Menu**	**Object Description**
ReadMiniTroll	Read Mini-Troll Text File	ReadMiniTroll
ReadOptSimResults	Read nSIGHTS Optimizer Results	Read Optimizer Results File
ReadProfileSimResults	Read nSIGHTS Profile Results	Read Profile Sim Results File
ReadRangeSimResults	Read nSIGHTS Range Results	Read Range Results File
ReadSequenceTimes	Read Sequence Time Interval Data	Read Sequence Times
Read Table	Read Table File	Read Table Data
Read XY	Read XY Data	Read XY Data
Read XY Array	Read XY Data Array	Read XY Array
ReadXYSimResults	Read nSIGHTS XY Results	Read XY Sim ResultsFile
Reduction	Reduction	Reduction of XY Density
Remove Duplicates	Remove Duplicates	Remove Duplicates from XY Data
ResidualDiagnostic	Calculate Residual Diagnostic	Residual Diagnostic
ResidualHistogram	Calculate Residual Histogram	ResidualHistogram
Sample	Create Samples Table Data	Create/Add To Sample Table
Sc/Tran Cube	Scale/Transform	Scale/Transform Cube Data
Sc/Tran Grid	Scale/Transform	Scale/Transform Grid Data
Sc/Tran Profile	Scale/Transform Extended Profile	Scale/Transform Profile
Sc/Ttran Real	Scale/Transform	Scale/Transform Real Data
Sc/Tran Table Column	Table Column Scale/Transform	Scale/Transform Table Column
Sc/Tran X and Y	Dual Scale/Transform	Scale/Transform of X and Y Data
Sc/Tran X or Y	Single Scale/Transform	Scale/Transform of X or Y Data
SelectCurve	Select Curve from File	Select Curve
SelectOptCovar	Extract Covariance Matrices	Select Covariance Matrices
SelectOptJacob	Extract Jacobian	Select Jacobian Data

Table 17.1 Data Object Names		
Object Tree	**Object Menu**	**Object Description**
SelectOptResid	Extract Residuals	Select Residuals
SelectOptResults	Extract Optimizer Results Table	Select Results
SelectProfile	Extract Profile Grid/Case	Select Profile from Profile Sim Results
SelectRangeCube	Extract Range Cube	Select Range Cube
SelectRangeGrid	Extract Range Grid	Select Range Grid
SelectRTCube	Select Range Cube	Select RunTime Range Cube
SelectRTGrid	Select Range Grid	Select RunTime Range Grid
Select Single Profile	Extract Extended Profile from Case	Extract Extended Profile from Profile Case
SelectXY	Select XY from XY Array	Select XY
SelectXYfromXYSimResults	Extract XY from XY Results	Select XY from Results
SequenceFit	Sequence Fit	Sequence Fit
SingleFit	(Basic) Single Fit	Single Fit
Smooth/Filter	Smooth/Filter	Smooth/Filter XY Data
Sum Tables	Sum Tables	Sum Tables
Table CDF	Calculate CDF of Table Column (Table Column CDF/Quantile)	Calculate Table Column CDF
Table Column Math	Table Column Math	Mathematical Operations on Table Columns
Table Histogram	Table Column To Histogram	Histogram of Table Column Data
Table Row Index Logic	Table Row Index Logic	Boolean Logic on Table Rows
Table Row Statistics	Table Row Statistics	Univariate Statistics of Table Rows
Table Column Statistics	Table Column Statistics	Univariate Statistics of a Table Column
Transpose	Transpose	Transpose X and Y Data

Table 17.1 Data Object Names		
Object Tree	**Object Menu**	**Object Description**
Transpose Table Columns & Rows	Transpose Table	Transpose Table Columns & Rows
Validate XY as CDF	Validate XY Data as CDF	Validate XY as CDF
View Grid	View Grid Data	View Grid Data
View Table	View Table Data	View Table Data
View XY	View XY Data	View XY Data
WriteColorMap	Write Color Map	Write Color Map
WriteCurveArray	Write Curve File	Write Curve File
WriteTable	Write Table File	Write Table
WriteXY	Write XY File	Write XY Data
WriteXYDataArray	Write XY Data Array	WriteXYDataArray
Sc/Tran XY Array	Array Scale/Transform	Scale/Transform of XY Array
XY Histogram	Histogram	Histogram of XY Data
XY Math	Vector Math	Mathematical Operations on XY Data
XY CDF	Calculate CDF of XY Data (CDF/Quantile)	XY CDF
XY Statistics	Statistics	Univariate Statistics of XY Data

17.2 Plot Objects

Table 17.2 Plot Object Names		
Object Tree	**Object Menu**	**Object Description**
2DPlotAnno	2D Plot Annotation	2DPlot Annotation
2D-XY	2D XY Main Menu	2D XY Plot
3D Lighting	3D Lighting	3D Light Setup

Table 17.2 Plot Object Names		
Object Tree	**Object Menu**	**Object Description**
3DAxesFormat	3D Axes Format	3D Axes Formatting
3DAxesLabel	3D Axes Labels	3D Axes Labelling
3DXY Data	XY Series	3D XY Data
3D-XYZ	3D XYZ Main Menu	3D XYZ Plot
Analytic Line	Analytics: Line Data	2D Line Analysis
Color Bar	Color Legend	Color Bar and Numeric Limits
Covar Limits	Confidence Limits - Two Parameter	Covariance Matrix Confidence Limits - Two Parameter
Covar Lim Matrix	Confidence Limits - Multiple Dual Parameter	Covariance Matrix Confidence Limits - Multiple Dual Parameter
Cube Color Blocks	Cube Color Block	Cube Color Blocks
Cube Color Symbols	Cube Color Point	Cube Color Symbols
Cube Isovolume	Cube Color Isovolume	Single Color Isovolume of Cube Data
Data Labels	Data Labels	Data Labels
Enter/Edit XY	Modify: Enter/Edit XY	Enter/Edit XY On Plot
Grid Color Area	Grid Color Block	Grid Color Area
Grid Color Fill	Grid Color Fill	Grid Color Fill
Grid Color Symbols	Grid Color Point	Grid Color Symbols
Grid Contour Lines	Grid Contour	Grid Contour Lines
Grid Fishnet	Grid Fishnet	Grid Fishnet
Grid Line	Extra Grid Lines	2D Grid Line
Label Axis	Label Axis	Label Axis
Line & Symbol Legend	Series Legend	Line & Symbol Legend
Multiple Table Series	Multiple Table Series	Series from Multiple Tables
Profile Color Fill	Profile Color Fill	Extended Profile Color Fill

Table 17.2 Plot Object Names		
Object Tree	**Object Menu**	**Object Description**
Profile Contour Lines	Profile Contour	Extended Profile Contour Lines
SequenceGridLines	Sequence Grid Lines	Sequence Lines
Single Conf Limits	Confidence Limits - Multiple Single Parameter	Covariance Matrix Confidence Limits - Multiple Dual Parameter
Single Table Series	Single Table Series	Series from a Single Table
Table Bars	Table Histogram	Table Bars
Table Color Series	Table Color Series	Color Symbols from Columns of a Single Table
Table Horsetail	Table Horsetail	TableHorsetail
Table Labels	Table Labels	Table Labels
Time Axis	Time Axis	Time Axis
User Labels	User Labels	User Entered Labels
X Axis	2D XY Axes	Single 1D Axis
XY Array Horsetail	XY Array Horsetail	XY Array Horsetail
XY Array Series	XY Data Array Series	Series from Single XY Array
XY Bars	XY Histogram	XY Bars
XY Data Series	XY Series	Series from Multiple XY Data
XY Labels	XY Labels	XY Labels
XYZ Labels	XYZ Labels	XYZ Labels
Y Axis	2D XY Axes	Single 1D Axis
Z Axis	3D XYZ Axes	Single 1D Axis

17.3 List Objects

Table 17.3 List Object Names		
Object Tree	**Object Menu**	**Object Description**
Covariance	Covariance List	Covariance
Jacobian	Jacobian List	Jacobian
OptRun	Optimization Results	List Optimization Run
List Table	Table	Listing of Table Data
List Table Statistics	Full Table Statistics	Listing of Statistics for All Table Columns
List XY Data	XY Data	Listing of XY Data
List XY Array	XY Data Array	Listing of XY Array

17.4 Output Objects

Table 17.4 Output Object Names		
Object Tree	**Object Menu**	**Object Description**
Write Color Map	Write Color Map File	Write Color Map
Write CurveArray	Write Curve File	Write Curve File
Write Grid	Write Grid File	Write Grid
Write Table	Write Table to File	Write Table
Write XY	Write XY Data to File	Write XY Data

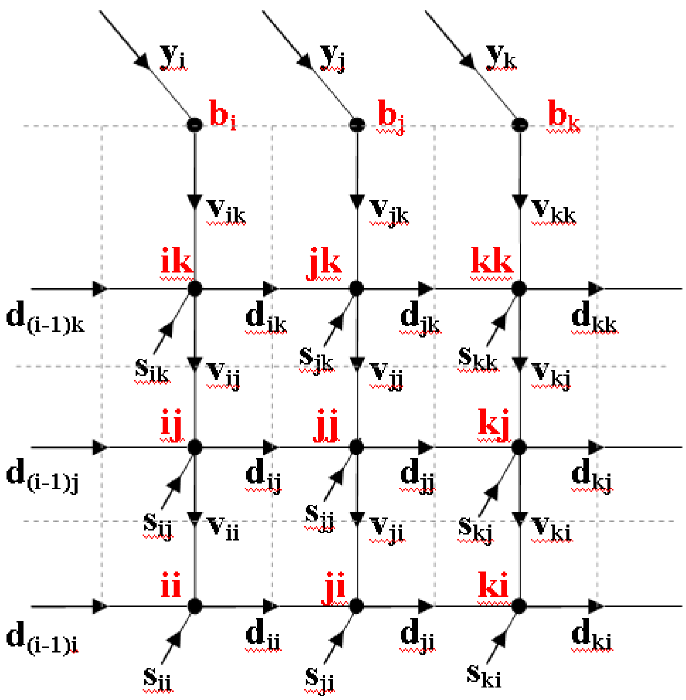
18 APPENDIX F – UNCONFINED AQUIFER IMPLEMENTATION

18.1 Introduction

The capability to conduct well test analysis in unconfined aquifers was added to the nSIGHTS code. This document provides the theoretical development of the nSIGHTS code for unconfined aquifers, as well as a verification of the code. The theoretical development of the code is complementary to the technical documentation for nSIGHTS, documented in "GTFM Functional Description, Theoretical Development, and Software Architecture" (Nuclear Waste Management Program, 1996). The equations for unconfined aquifers implemented in nSIGHTS assumes a two-dimensional, liquid, non-leaky, single porosity system.

18.2 General Approach

The following figure shows a segment of the directed graph within a flow system similar to that shown in Figure 3.2 of the nSIGHTS technical documentation (Nuclear Waste Management Program, 1996). There are three vertical nodes in this example.



where:

d_{ii} represents the flow between nodes ii and ji,

v_{ij} represents the flow between nodes ij and ii

s_{ii} represents the flow due to storage within the volume represented by node ii

y_i represents the flow caused by the changing water table level within the i node column

b_i represents the water table elevation at node column i (this node is in addition to the number of vertical nodes)

Constitutive relationships hold for each node, with an additional relationship required for the water table node. For example, at any given time t and n vertical nodes, equation (1) represents the constitutive relationship at node jj and equation (2) represents the relationship at the water table associated with node column j:

$$d_{ij} - d_{jj} + v_{jk} - v_{jj} + s_{jj} = 0 \tag{1}$$

$$- v_{jk} + y_j = 0 \tag{2}$$

When expanded with the edge equations, the constitutive relationships for each node are used to create a set of algebraic equations describing the system. Solving the equations yields nodal pressure and water table elevations at each node.

18.2.1 System Geometry

The system geometry definition is unchanged from the system geometry described in the nSIGHTS technical documentation (Nuclear Waste Management Program, 1996).

In the development of the edge equations, the thickness of the formation is a variable, and is consequently kept separate from the area term. Assuming a flow dimension of 2, the area term used in the unconfined edge equations is equal to the area term described in equation 3.1-9 of the nSIGHTS technical documentation divided by the thickness of the formation:

$$A_i = 2\pi r_i \tag{3}$$

where:

A_i is flow area between nodes i and i + 1

r_i is the average radius between nodes i and i + 1

Flow dimensions other than 2 can be used, but flow dimensions greater than 2 are theoretically suspect.

As the volume term contains the area term, it is likewise divided by the formation thickness:

$$Vi = \pi r_1^2 - \pi r_{i-1}^2 \quad (4)$$

where V_i is the volume of node i

The vertical node spacing is equal along the height of the node column, with the first node located at the bottom of the column, and a b node at the top of the column. The b node is in addition to the number of vertical nodes. As the height of the node column changes with time (as the water table lowers or raises), the node spacing is re-calculated at each time step.

The area and volume terms are the same for each node in a column, with the exception of the bottom and top node. The bottom node has only half the volume of an interior vertical node, and the top node has 1.5 times the volume of an interior node.

18.2.2 Edge Equations

Edge equations describe the volumetric flow (L3t-1) for each type of graph edge. Four edge equations are developed for the unconfined system: horizontal flow, vertical flow, storage, and water table yield. For convenience, the edge equations are defined here in terms of head, instead of pressure. The actual implementation is in terms of pressure.

Horizontal flow:

$$d_{ij} = K_H A_i b_{ij} \frac{\Delta h}{\Delta r} \quad (5)$$

where:

K_H = horizontal hydraulic conductivity, Lt^{-1}

b_{ij} = block height, L

Δh = change in head between nodes ij and (i+1)j, L

Δr = distance between nodes ij and (i+1)j, L

Vertical Flow:

$$v_{ij} = K_V V_i \frac{\Delta h}{b_{ij}} \quad (6)$$

where:

K_V = vertical hydraulic conductivity, Lt^{-1}

Δh = change in head between nodes ij and i(j+1), L

Note that for the top vertical node, $\Delta h = h – b$.

Storage:

$$s_{ij} = \mathrm{S}V_i b_{ij} \frac{\Delta h}{\Delta t} \qquad (7)$$

where:

S = formation specific storage, L^{-1}

Δh = change in head at node ij between time t and time t-□t, L

Δt = time step size, t

Water Table Yield:

$$y_i = S_y V_i \frac{\Delta b}{\Delta t} \qquad (8)$$

where:

S_y = specific yield

Δb = change in water table height between time t and time t-□t, L

18.2.3 Matrix Equations

The edge equations can be reduced to the following form:

$$d_{ij} = D_{ij}(h_{(i+1)j} - h_{ij}) \qquad (9)$$

$$v_{ij} = W_{ij}(h_{ij} - h_{i(j+1)})$$

$$s_{ij} = S_{ij}(h_{ij} - h_{ij(t-\Delta t)})$$

$$y_i = Y_i(b_i - b_{i(t-\Delta t)})$$

The b_i terms within D_{ij}, W_{ij} and S_{ij} are taken from the previous time step (i.e. $b_{i(t-□t))}$), in order to produce a linear set of equations.

Applying constitutive relationships at node i (assuming n vertical nodes) yields:

$$D_{(i-l)j}(h_{ij} - h_{(i-l)j}) - D_{ij}(h_{(i+1)j} - h_{ij}) + W_{ij}(h_{ij} - h_{i(j+1)}) - W_{i(j-1)}(h_{i(j-1)} - h_{ij}) + S_{ij}(h_{ij} - h_{ij(t-\Delta t)}) = 0 \qquad (10)$$

and

$$-W_{in}(h_{in} - b_i) + Y_i(b_i - b_{i(t-\Delta t)}) = 0 \qquad (11)$$

Rearranging equations (10) and (11) yields:

$$-D_{(i-1)j}h_{(i-1)j} - W_{ij}h_{i(j+1)} + (D_{(i-1)j} + D_{ij} + W_{ij} + W_{i(j-1)} + S_{ij})\, h_{ij} - W_{i(j-1)}h_{i(j-1)} - D_{ij}h_{(i+1)j} = S_{ij}h_{ij(t-\Delta t)} \quad (12)$$

and

$$-W_{in}h_{in} + (W_{in} + Y_i)\, b_i = Y_i b_{i(t-\Delta t)} \quad (13)$$

Using the boundary conditions described in the nSIGHTS technical documentation and applying equations (12) and (13) to the entire system graph (assuming 3 vertical nodes and m radial nodes) leads to the following matrix equation:

$$\begin{pmatrix} A11 & -W11 & & & -D11 & & & & & & & \\ -W11 & A12 & -W12 & & & -D12 & & & & & & \\ & -W12 & A13 & -W13 & & & -D13 & & & & & \\ & & -W13 & B1 & & & & & & & & \\ -D11 & & & & A21 & -W21 & & & -D21 & & & \\ & -D12 & & & -W21 & A22 & -W22 & & & & & \\ & & -D13 & & & -W22 & A23 & -W23 & & & & \\ & & & & & & -W23 & B2 & & & & \\ & & & & \dots & & \dots & \dots & \dots & & & \\ & & & & & -Dm1 & & & -Wm1 & Am2 & -Wm2 & \\ & & & & & & -Dm2 & & & -Wm2 & Am3 & -Wm3 \\ & & & & & & & & & & -Wm3 & Bm \end{pmatrix} \cdot \begin{pmatrix} h11 \\ h12 \\ h13 \\ b1 \\ h21 \\ h22 \\ h23 \\ b2 \\ \dots \\ hm2 \\ hm3 \\ bm \end{pmatrix} = \begin{pmatrix} -Q_w + (B_w + S_{11})h_{11(t-\Delta t)} \\ S_{12}h_{12(t-\Delta t)} \\ S_{13}h_{13(t-\Delta t)} \\ Y_1\, b_{1(t-\Delta t)} \\ S_{21}h_{21(t-\Delta t)} \\ S_{22}h_{22(t-\Delta t)} \\ S_{23}h_{23} \\ Y_2 b_{2(t-\Delta t)} \\ \dots \\ Q_0 + S_{m2}h_{m2(t-\Delta t)} \\ Q_0 + S_{m3}h_{m3(t-\Delta t)} \\ Y_m b_{m(t-\Delta t)} \end{pmatrix} \quad (14)$$

where:

$A_{11} = S_{11} + W_{11} + D_{11} + B_w$

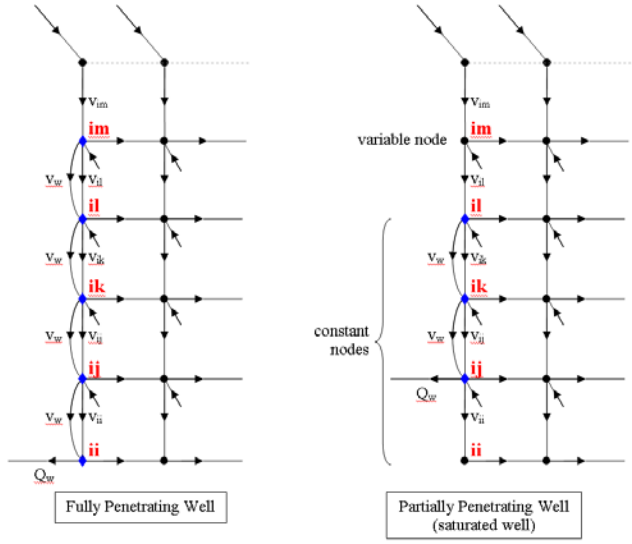
$A_{ij} = D_{(i-1)j} + D_{ij} + W_{i(j-1)} + S_{ij}$

$B_i = W_{i3} + Y_i$

The existing linear matrix solver in nSIGHTS assumes a tri-diagonal form. In order to solve equation (14), which has two additional diagonal bands, a banded matrix solver was implemented.

18.2.4 Well Boundary Condition

Both fully penetrating and partially penetrating wells are implemented for the unconfined solution in nSIGHTS. In both cases, flow is extracted from the bottom node of the well, and an additional high-conductivity flow edge is added between well nodes. The figure below shows a segment of the directed graph near the well, for a case with five vertical nodes. The location of the extraction node, and the additional vertical flow edges for both the fully penetrating and partially penetrating well cases are shown. Only edges relevant to the discussion are labeled.



where:

blue diamonds represent well nodes

v_w represents the high-conductivity vertical well flow between well nodes

Q_w represents the well flow rate

The high conductivity vertical flow term is defined as follows:

$$v_w = K_w A_w \frac{\Delta h}{b_{ij}} \tag{15}$$

where

$$K_w = \frac{r_w^2 \, pg}{8\mu} \tag{16}$$

$$A_w = \pi r_w^2 \tag{17}$$

r_w is the well radius

This high conductivity term is added the vertical flow edge equation, such that for well nodes, W_{ij} is redefined as:

$$W_{ij} = (K_V V_i + K_W A_W)\frac{1}{b_{ij}} \tag{18}$$

The matrix equations are then solved as described above in section 2.3.

In the full penetration well case, the node spacing at the well changes with time. As the location of the well nodes cannot change with time in the partial penetration case without causing numerical instabilities, two sets of vertical nodes are defined in the partial penetration case: a set of variable vertical nodes and a set of constant vertical nodes. In the case where the partially penetrating well screen extends to surface (a water table well), the variable vertical nodes are defined as well nodes, and the constant vertical nodes are defined as formation nodes below the well. If the partially penetrating well does not extend to surface (saturated well), the variable vertical nodes are defined as formation nodes, and the constant vertical nodes are split into well nodes and formation non-well nodes. The partially penetrating well shown in the above figure is a saturated well. The case of the saturated well does not allow the water table to drop below the top elevation of the well screen.

The well nodes of a partially penetrating well are defined as all nodes between two elevation values, defined by the offset from the bottom of the formation and the well screen length. For a water table well, the well screen length is assumed to be the saturated formation thickness minus the bottom offset.

18.3 Verification

The unconfined implementation was verified by comparing nSIGHTS results to those produced by the analytic code WTAQ (Barlow and Moench, 1999). A number of different configurations were analyzed:

(1) Full penetration well, no wellbore storage

(2) Full penetration well, wellbore storage

(3) Water-table partial penetration with wellbore storage

(4) Saturated partial penetration with wellbore storage

(5) Saturated partial penetration with wellbore storage, anisotropy and skin

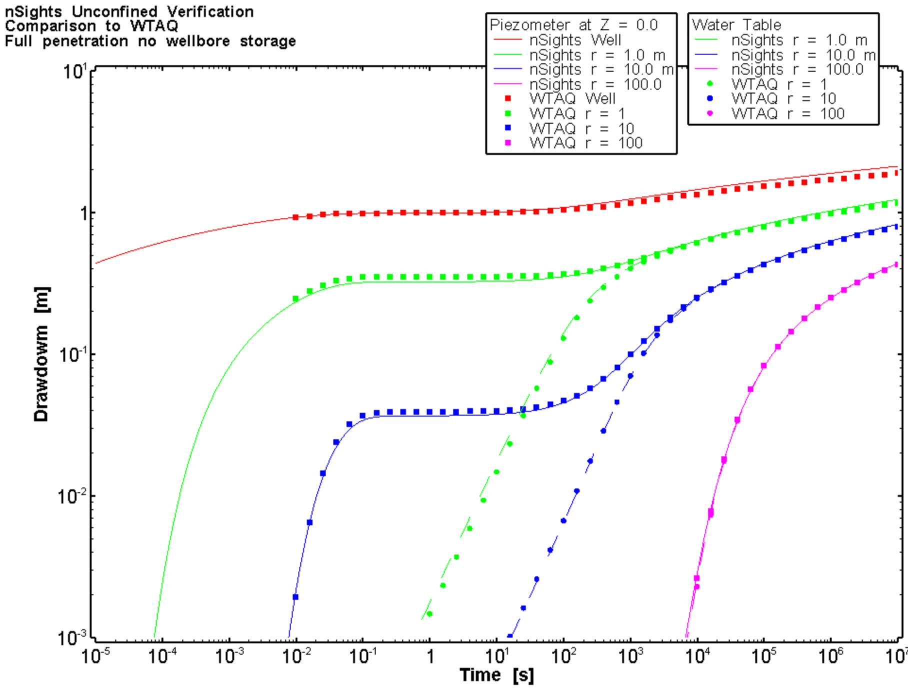
The formation and well parameters common to all cases used to generate the results were:

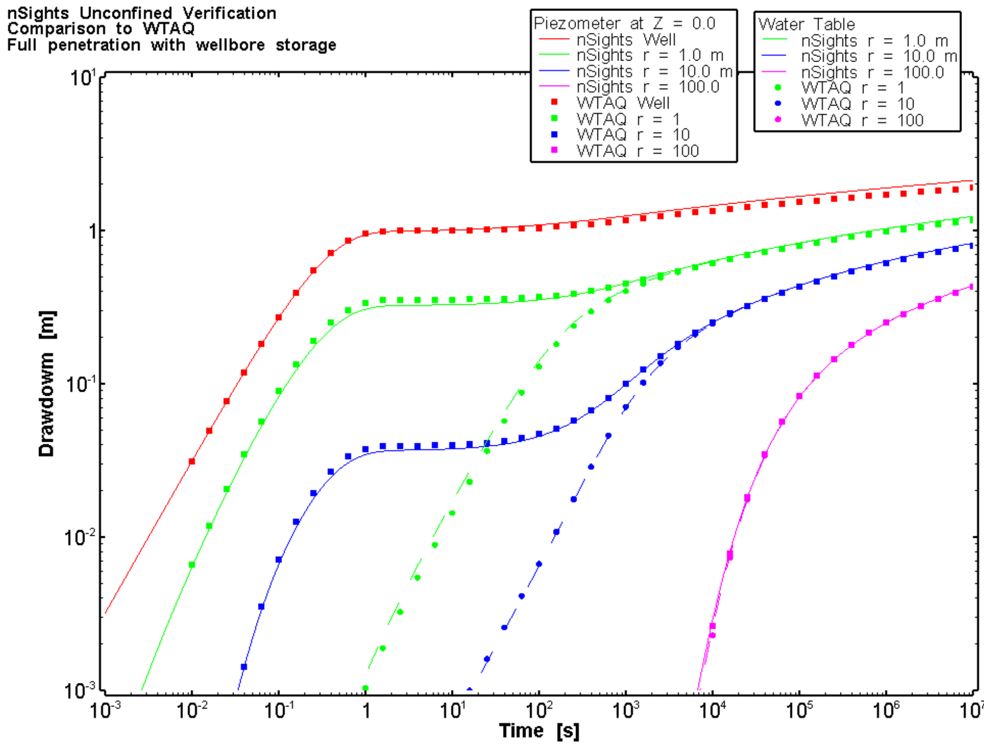
Saturated formation thickness	10.0 m
Formation conductivity (isotropic)	1.0E-4 m/s
Formation specific storage	1.0E-7 m^{-1}
Formation specific yield	0.01

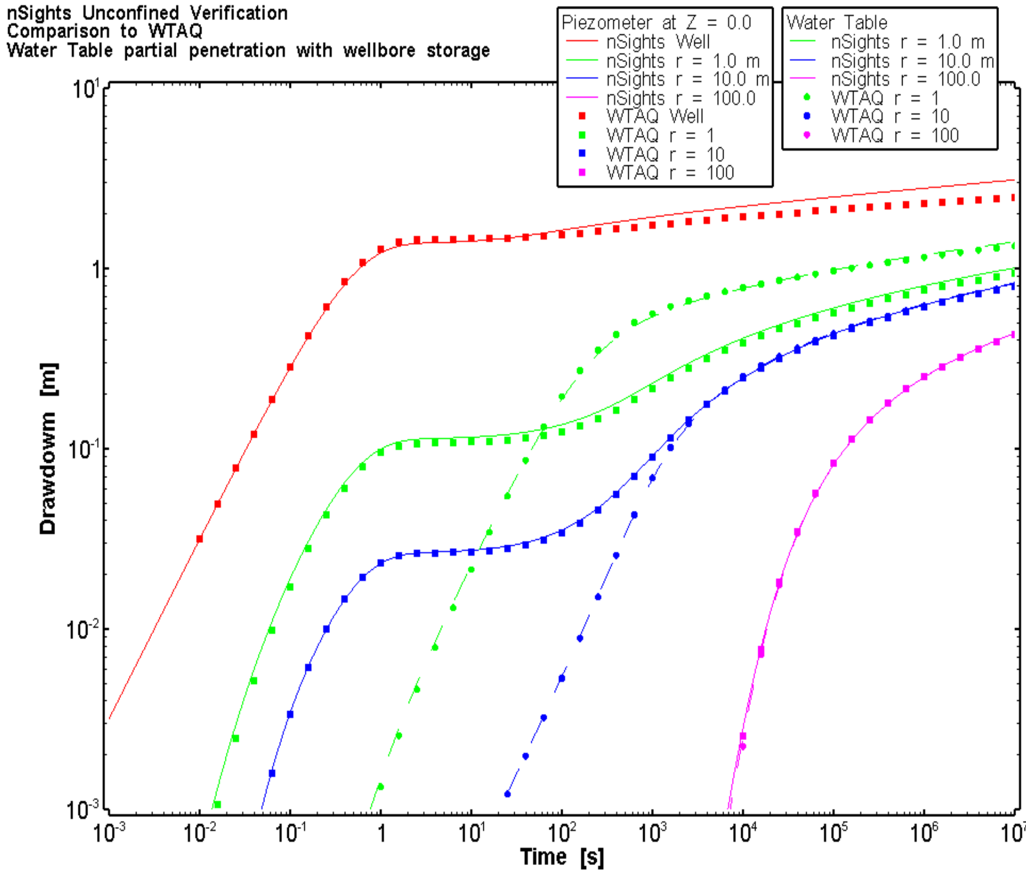
Well extraction rate	1.0E-3 m^3/s
Well radius	0.01 m
# of vertical nodes	40
# of radial nodes	150

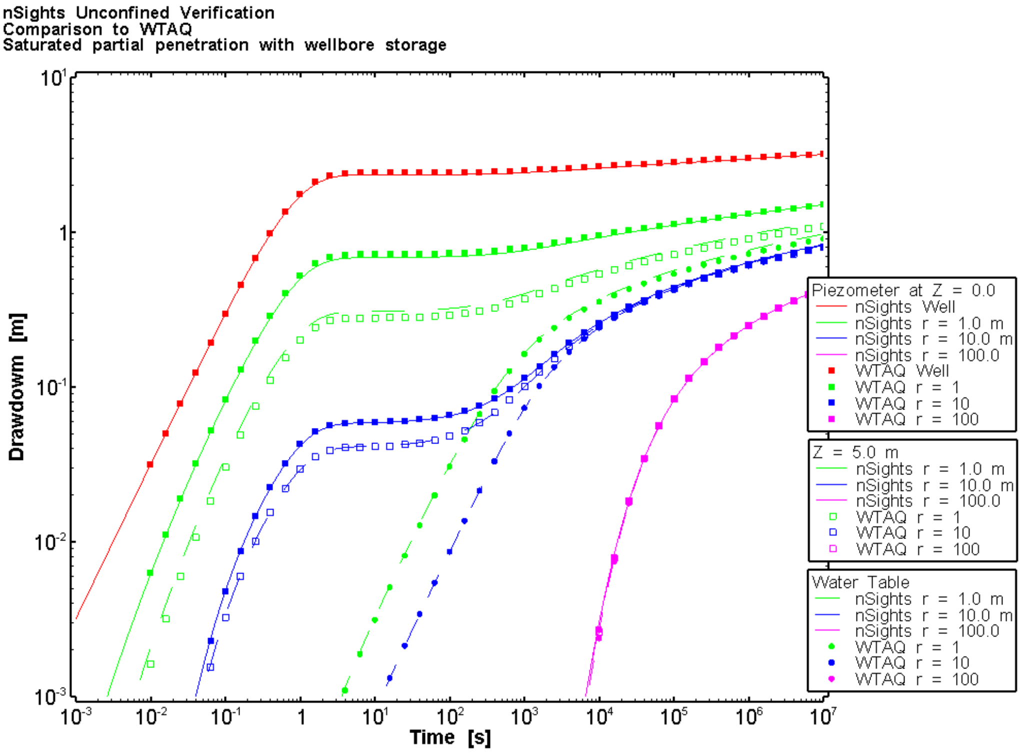
Results were extracted as drawdown at the well and at observation points located at radii of 1.0 m, 10.0 m, and 100.m. Radial data were extracted at the water table, and at the bottom of the aquifer (Z = 0.0).

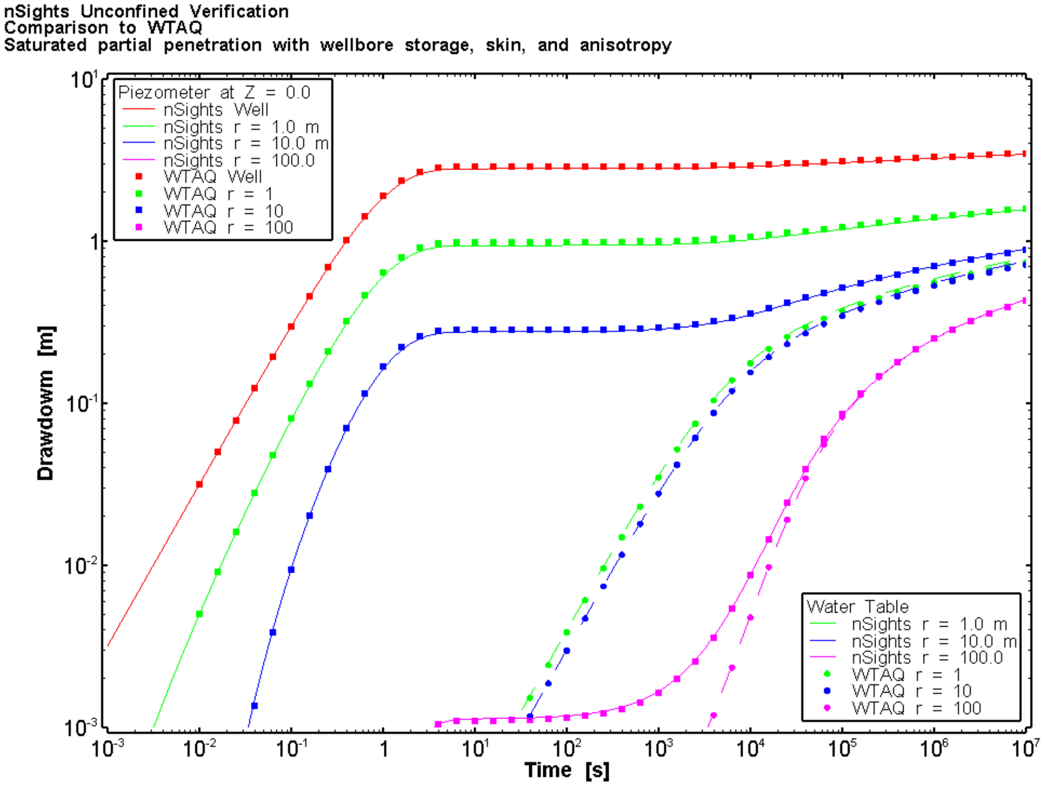
Agreement between the models was excellent:




nSights Unconfined Verification
Comparison to WTAQ
Full penetration with wellbore storage
Piezometer at Z = 0.0
nSights Well
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ Well
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Water Table
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Drawdowm [m]
Time [s]


nSights Unconfined Verification
Comparison to WTAQ
Water Table partial penetration with wellbore storage
Piezometer at Z = 0.0
nSights Well
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ Well
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Water Table
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Drawdowm [m]
Time [s]


nSights Unconfined Verification
Comparison to WTAQ
Saturated partial penetration with wellbore storage
Drawdowm [m]
Time [s]
Piezometer at Z = 0.0
nSights Well
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ Well
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Z = 5.0 m
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Water Table
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100


nSights Unconfined Verification
Comparison to WTAQ
Saturated partial penetration with wellbore storage, skin, and anisotropy
Drawdowm [m]
Time [s]
Piezometer at Z = 0.0
nSights Well
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ Well
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100
Water Table
nSights r = 1.0 m
nSights r = 10.0 m
nSights r = 100.0
WTAQ r = 1
WTAQ r = 10
WTAQ r = 100

The results for the well drawdown for the water table partial penetration case did not agree as well as other results. This is likely due to the different pumping well implementations used. WTAQ assumes that the radial flow to the pumping well is constant along the length of the screened section. For water table partial penetration (and for full penetration), nSIGHTS will vary the length of the pumping section as drawdown occurs. This results in a variable flow rate per unit length as a function of time which may explain the differences. This effect also shows up in the full penetration cases, but not at the same magnitude. The difference is not apparent in the saturated partial penetration case as the well node discretization is constant.

18.4 nSIGHTS Implementation Details

18.4.1 Parameters

The unconfined implementation uses the following parameters:

(1) Saturated formation thickness – the initial thickness of the saturated formation before pumping starts (this is the same parameter as formation thickness, renamed).

(2) Formation specific yield – characterizes gravity drainage or delayed yield from the water table.

(3) Formation vertical conductivity – Kz for anisotropic case only

(4) Number of variable vertical nodes - vertical discretization, divides distance from bottom of formation to water table into nv equally spaced intervals. The actual interval spacing depends upon the height of the water table which is a function of radius and time.

For water table partial penetration the following parameters are added:

(5) Partial penetration bottom offset – the distance from the bottom of the formation to the bottom of the pumping well. The well is assumed to be screened from this position up to the water table.

(6) # of constant vertical nodes – the distance from the bottom of the formation to the bottom of the well is divided into nc constant intervals. This interval does not vary as a function of radii or time.

For saturated partial penetration the parameters are defined slightly differently:

(7) Partial penetration bottom offset – the distance from the bottom of the formation to the bottom of the pumping well.

(8) Partial penetration screen length – the length of the screened interval.

(9) # of constant vertical nodes – the distance from the bottom of the formation to the top of the screened interval is divided into nc constant intervals. This interval does not vary as a function of radii or time.

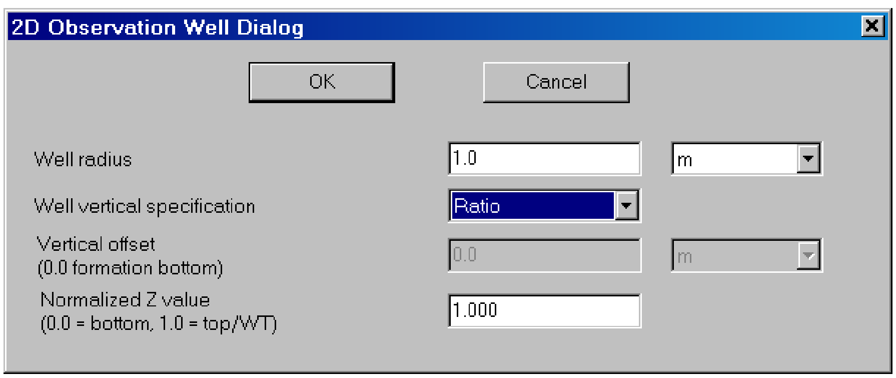
The confined parameter "Static formation pressure" is not entered in the unconfined solution. It is calculated from the Saturated thickness and fluid density. All nodes are initialized to this common value.

If a skin zone is specified, the parameter Skin specific yield is added. The skin zone is always isotropic.

18.4.2 Data Capture

Captured pressure or head at the pumping well or observation well is relative to a datum at the bottom of the formation.

Data capture specification for observation wells includes a definition of the vertical location of the observation point:



The vertical position can be specified as an actual value in metres above the bottom of the formation, or as a ratio of the formation thickness. If actual is chosen, and the simulated water table drops below the observation point, a value of 0.0 will be reported. For ratio, the actual position will vary as the water table fluctuates but will always be in the saturated zone.

A new data capture type has been added. "Water table" records the thickness of the saturated zone at a specified radius.

18.5 Numerics

As described above, the model domain is discretized at every time step based on the water table position at the end of the previous time step. Obviously, this discretization thickness must be finite and positive. However, under some conditions (e.g. excessive pumping rate) , the thickness may go negative. In this case nSights resets the thickness to a minimal value. If the Config Liquid flag "Allow –ve pressures" is set to "no", an error condition occurs and the simulation aborts. If the flag is "yes", the simulation continues with the minimal thickness but results beyond this time will be incorrect. The minimal thickness is set at 0.001 m for the fully penetrating case, and 0.001 m above the top of the constant thickness zone for the partial penetration case.

18.6 References

Barlow, P.M., and Moench, A.F., 1999, WTAQ--a computer program for calculating drawdowns and estimating hydraulic properties for confined and water-table aquifers: U.S. Geological Survey Water-Resources Investigations Report 99-4225, 74 p.

Nuclear Waste Management Program. August 15, 1996. GTFM Functional Description, Theoretical Development, and Software Architecture. ERMS #40244. Albuquerque, NM: Sandia National Laboratories.