Paradigm™
VISION FOR ENERGY

Sysdrill 3.0
Release Notes

Contents

Overview

Sysdrill 3.0 is a single-executable drilling engineering application that not only includes the functionality associated with previous Sysdrill products, Director, DirectorGeo, and Drill-IT, but also incorporates significant new and improved features and functions.

This document describes the functional enhancements, additions and changes for Sysdrill 3.0 and associated components.

Infrastructure Changes

Installer

The Sysdrill installer has been updated to deliver more efficient set-up of installation options and faster deployment of software components. This includes the option of installing the Sysdrill DBMS Server as a service and automatic installation of JRE components, if required.

Refer to the *Sysdrill 3.0 Installation Guide* for details of the installation procedure.

Installation Paths

The Sysdrill installer now writes common installation components (executables, resource files, help files, etc.) to the following default locations on the local network.

- **`C:\Program Files\Sysdrill 3`**
- User data files (database file, report and plot templates, preference files, etc.):
- **`C:\Documents and Settings\All Users\Application Data\Sysdrill 3`**

The folder that contains these user data files can be accessed in Windows Explorer or via the following shortcut available on the Windows **Start** menu.

`Start/All Programs/Sysdrill 3/User Data Folder`

Server Compatibility

Sysdrill 3.0 is compatible with version 3.0.12 of the Sysdrill Server. Both components are delivered as standard with the Sysdrill 3.0 installation.

Database Upgrade Requirements

Any existing Sysdrill database must be upgraded to be compatible with the new Sysdrill Server. Update of the database is achieved by running the following script from the Windows **Start** menu.

`Start/Programs/Sysdrill 3/Upgrade Scripts/v2.5.0 to v3.0.12.exe`

See Sysdrill 3.0 Installation Guide for details of the upgrade procedure.

> **Note:** The upgrade script requires the existing Sysdrill installation to be version 2.5. If you have an earlier version of Sysdrill, please contact Sysdrill support.

Upgrade Implications

The way in which certain groups of data are defined, manipulated and presented has changed in Sysdrill 3.0. Database upgrade will result in the automatic translation of existing data into this new framework while retaining data integrity. The major implications of database upgrade are as follows:

Targets

Existing 3D targets, i.e. targets with a defined thickness, will be automatically attributed with a correct thickness offset value so that the original definition is retained under the new model. For details, see “Target Functions” on page 10.

Projects

Projects are no longer split into **Planned** and **Actual** types. Existing Projects are retained beneath each well but will be listed under a single **Projects** node.

Assembly Analyses

Assembly Analyses no longer exist as objects within the database. Data previously defined for a particular Assembly Analysis will be correctly translated to all associated engineering calculations.

Calculations

- T. H. Hill DS-1™ Calculations will be incorporated into corresponding Torque and Drag calculations.
- Range Calculations will be translated into Torque and Drag Calculations.
- Existing Casing Analysis Calculations will correctly translate previously defined load profiles but will require specification of an appropriate casing interval as defined on the wellbore.

Drilling Assemblies Catalogue

A new default equipment catalogue called **`drilling assemblies`** is created by the upgrade script. This globally available catalogue contains fully-defined generic drilling assemblies for a variety of common hole sizes. This catalogue is listed in the Data Selector by selecting **Catalogues** in the new Data Selector **Display** menu.

Application Launch

- If connecting to a database in which only the default **`admin`** User ID is defined, no login is required.
- If connecting to a database where more than one user is defined, or if a password has been associated with the default **`admin`** User ID, the login screen will appear as in previous Sysdrill versions. Enter the relevant user details and click the **Login** button.
- If the Sysdrill application cannot find the specified database server, a new Server Selector window will open automatically. This feature allows connection to any active Sysdrill database servers on the network or the addition of a new server.

General Enhancements

Single Application

Sysdrill 3.0 is a single-executable drilling engineering application that not only includes the functionality associated with previous Sysdrill products, Director, DirectorGeo, and Drill-IT, but also incorporates significant new and improved features and functions.

Access to the major functional areas within the application is controlled through licensing.

Data Selector

Changes have been made to the Data Selector to improve efficiency of data presentation and navigation.

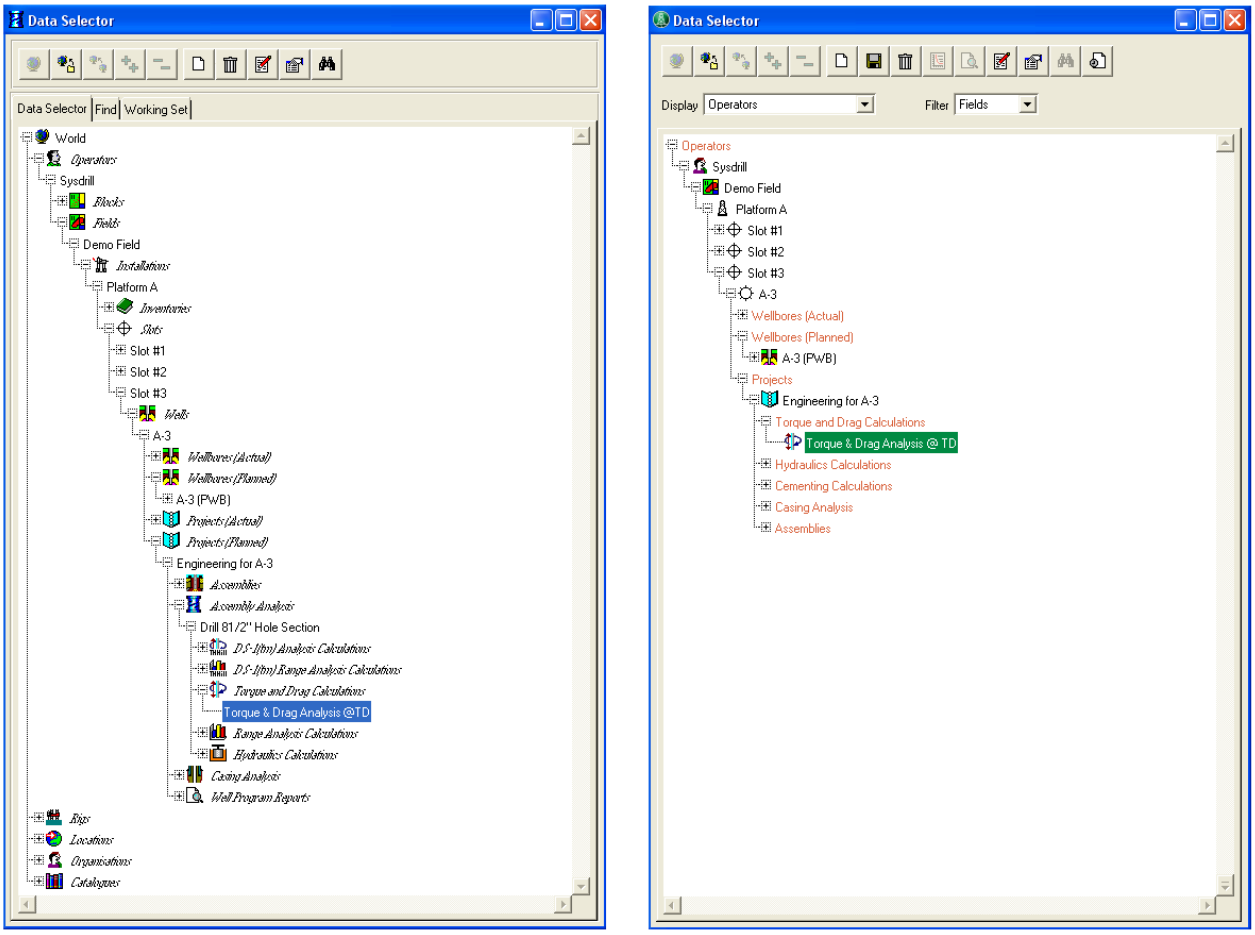

Fig. 1: Common data set displayed in v2.5 Data Selector (left) and v3.0 Data Selector (right)

Display and Filter Options

To minimize the number of objects shown within the Data Selector at any given time, two new drop-down fields **Display** and **Filter**, control which data is displayed.

- The **Display** field allows the user to specify which of the major data categories (Locations, Operators, Organizations, Rigs, Catalogues, Directional Survey Tools) to display within the Data Selector. The selected category can be expanded to reveal and edit associated data objects.
- The **Filter** field becomes enabled when either Operators or Locations are selected in the **Display** field. This allows selective display of associated data objects (wellbores, engineering calculations, etc.) on the basis of their Field or Block association.

Removal of Header Nodes

The previous approach of listing specific objects under un-editable header nodes has been abandoned in favor of listing objects directly under the parent object. This provides a more efficient way of representing data. Icons denoting object type are now displayed next to each object for easy identification.

Removal of Assembly Analyses

The Assembly Analysis object has been completely removed from the Data Selector. The data that was previously entered to this object is now defined in the engineering calculations themselves.

Project Types

Projects are no longer split into **Planned** and **Actual** types. A single Project object can now be used to contain all engineering analyses in relation to a wellbore. The ability to create multiple Projects beneath a particular well remains.

Removal of Inventories

The **Inventory** object has been completely removed from the Data Selector. All storage of string components is now handled within Equipment Catalogues.

Additional Catalogue Types

- Globally-available Fluid and Fluid Material catalogues have been implemented alongside Equipment catalogues. These can be accessed in the Data Selector by selecting **Display** > **Catalogues**.
- Organization-specific Fluid and Fluid Material catalogues have been implemented alongside Equipment and Load Case catalogues. These can be accessed in the Data Selector by selecting **Display** > **Organization**.

Find and History Functions

The **Find** and **Working Set** pages have been removed as tabs within the Data Selector and are now implemented as **Find** and **History** dialog boxes launched via new buttons in the Data Selector toolbar.

‘Scratch’ Wellbores

Sysdrill 3.0 supports fast-launch ‘scratch’ wellbores that require no data setup. This allows instant creation of a Planned or Actual Wellbore. It is then possible to define engineering data beneath this wellbore object and perform analysis in the usual way.

- The Scratch Wellbore feature is intended to provide a means of conducting *preliminary* work without having to define the usual data hierarchy (Location, Field, Installation, etc.).
- Two new buttons on the main Sysdrill application window allow the user to instantly define a Planned or Actual Scratch Wellbore as required. The default data hierarchy down to Wellbore level is non-editable.
- Scratch Wellbore objects are displayed and accessed beneath default **Scratch Operator** or **Scratch Location** entries in the Data Selector. These entries can be revealed or hidden as required using a new **Show/Hide Scratch Wellbores** button, also located in the main Sysdrill application window.

‘Create New’ Option

Drop-down menus where critical object associations are made, for example, specification of a string for use in an engineering calculation, now contain a **Create New** option. This functionality allows creation of new objects without having to return to the Data Selector.

Rig Datum Default

The default **Rig Datum** now matches that of the Installation unless specifically updated by the user. Previously, the default **Rig Datum** matched that of **Slot**, if specified.

Report Updates

The appearance of the standard report templates within Sysdrill has been enhanced and new options have been made available for customization of reports.

Inclusion of Graphs and Images

Reports can now be customized to include graphs and images. Depending on the report type, standard graphs from the relevant editor will be available for inclusion. Also, the ability to display any **`.bmp`** file allows other types of images to be included in reports.

Other Customization Options

Additional Customization options include:

- Ability to add, edit, or remove report objects such as tables, breaks and comment boxes.
- Ability to control the orientation (portrait or landscape) of report sections.
- An automatic column spacing optimizer for customized tables.

Trajectory Functions

Lease Line/Hard Line Support

The following enhancements allow improved definition and handling of boundary polygons.

Block Boundaries

The Block editor now allows definition of lease line, hard line, and other boundary polygons by Latitude/Longitude or Northing/Easting coordinates. Boundaries defined in the Block editor can be visualized instantly within a popup view window. Boundaries are also available for inclusion in 3D Views and Wellpath Plots for any wellbores associated with the Block. To define boundary objects on the Block, an appropriate map projection must be associated with the parent Location.

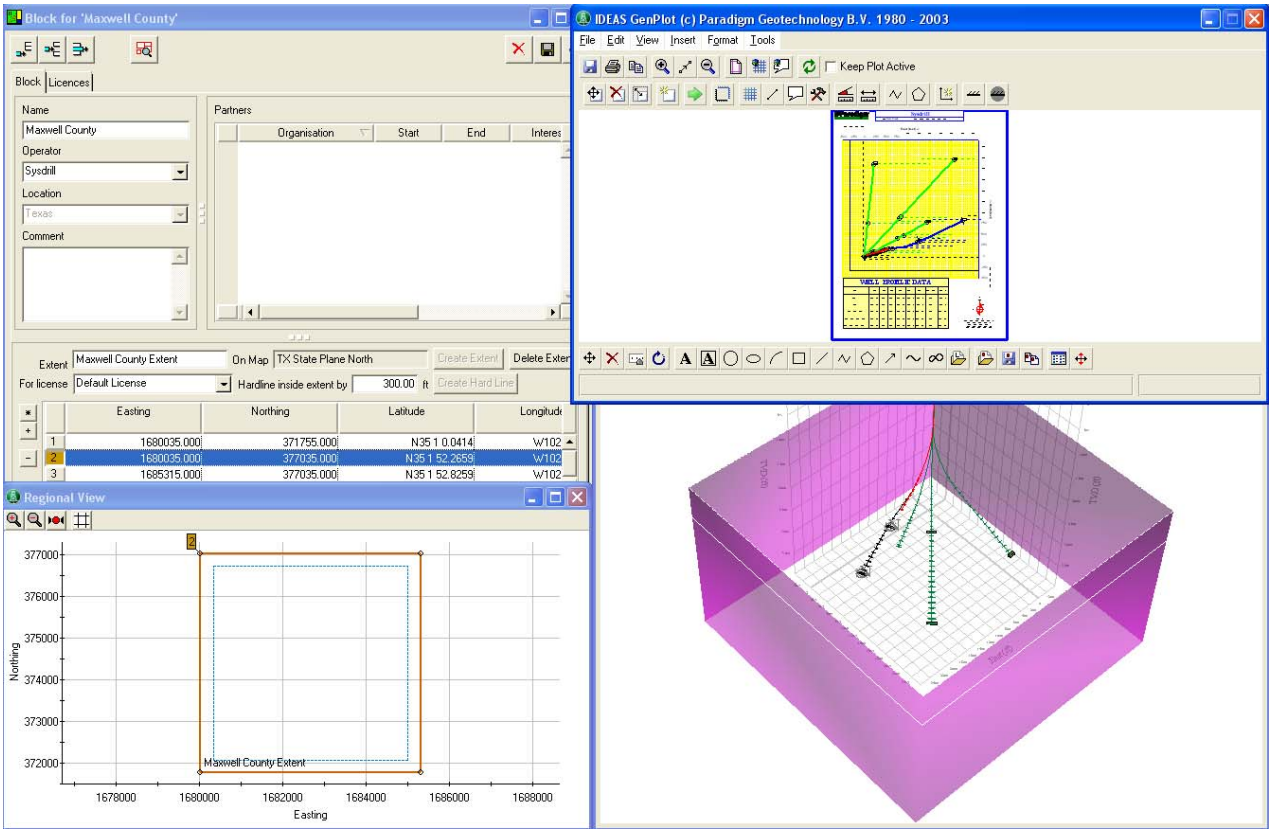

Fig. 2: New lease line/hard line functions

GenPlot Boundaries

- The previous **Edit Hardlines** function in GenPlot has been enhanced to allow more efficient definition of multiple boundary objects by local North/East coordinates. Hatching can be optionally applied to defined boundary lines.

- The **Edit Annotations** dialog box within GenPlot now contains additional checkboxes to allow both Block boundary and GenPlot boundary objects to be toggled on and off.

Target Functions

Several changes have been made to the way in which targets are defined, manipulated, and represented in Sysdrill. This includes the ability to define a wellpath intersection point (or landing point) that is offset from the defined target position.

Target Definition

Targets are now defined as a target face with an associated thickness, rather than as a shape around a central point. This change has no practical implications when defining 2D target objects. For 3D target objects, the default target center is located on the target face rather than half way through the defined target thickness.

Target Offset Functions

- Specification of a target shape offset is now performed within the **Shape** tab before or after the target is incorporated in a wellpath design. This is achieved through manual entry of offset values relative to the target center point. These functions are also available in the **Targets** page of the Field Editor.
- A new **Wellpath Offsets** tab allows specification of the wellpath intersection point (landing point) within the target. The landing point can be defined before or after the target is incorporated in a wellpath design and can be achieved through both interactive drag and drop of the intersection symbol within the 2D schematic using **[Shift]/MB1**, or through manual entry of offset values relative to the target boundary.
- The Project Ahead module has been updated to make use of the same interface for specifying the intersection point on a target.

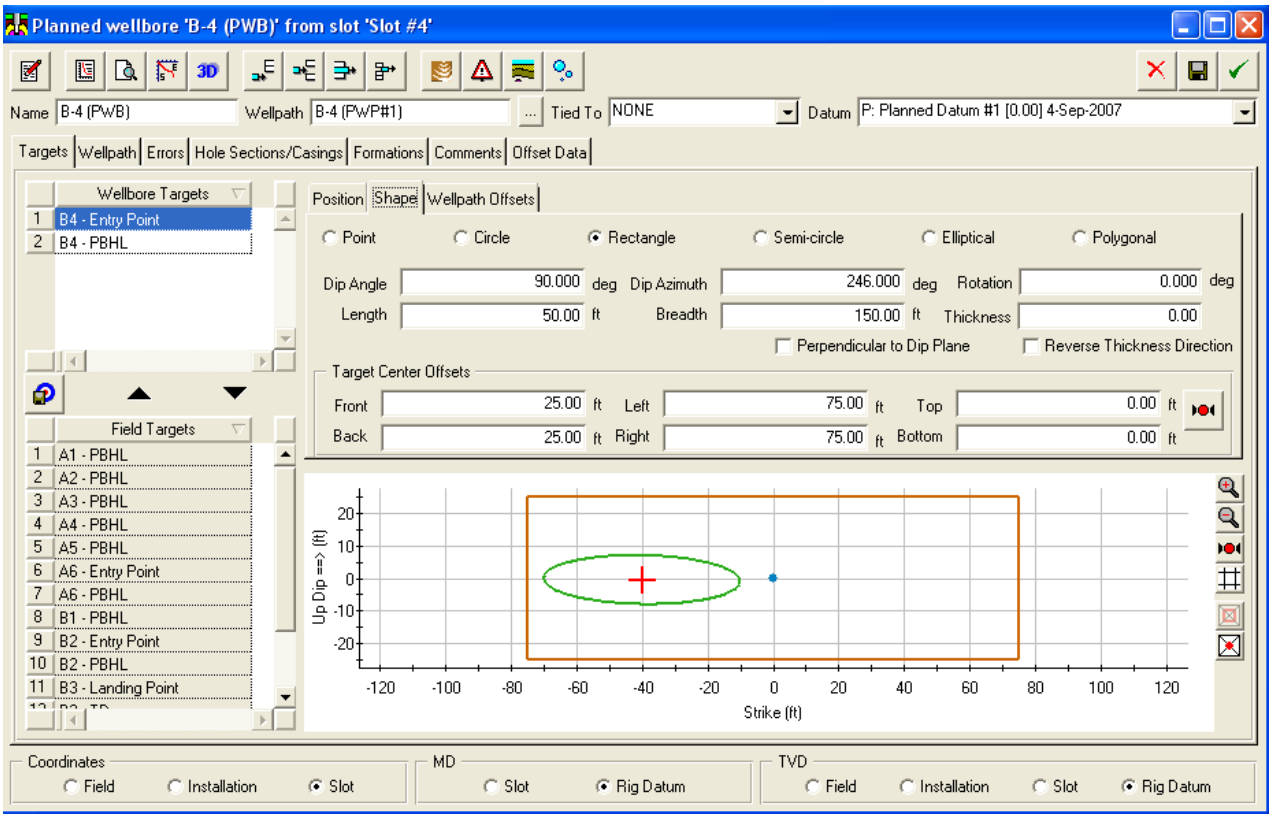

Fig. 3: New Targets Interface

Target Views

The 2D schematic target view has been updated to represent a target plane at a specified thickness offset from the target face. The default **Target View** perspective is perpendicular to the target plane with target highside (North for non-dipping targets) at the top. However, once a target is incorporated within a wellpath design, a second view perspective becomes optionally available. This **Wellpath View** represents the target plane seen from a position on the entry vector of the wellpath.

Uncertainty Ellipse Intersection

If an error model exists on the wellpath at the depth at which it intersects the target plane, the **Target View** will display the edge of the error uncertainty ellipse in that plane.

AutoPlanner

The Wellplanning Spreadsheet now includes an **AutoPlan** option that will automatically generate a reasonable first-pass wellpath trajectory through all targets associated with the wellbore. This wellpath can then be refined, if necessary, by update of appropriate constraint values. The **AutoPlan** function supports two basic approaches to wellplanning: one is an all-purpose solution, the other is configured to meet requirements often encountered in

land-based horizontal work. Each approach involves best ordering of targets, default profile combinations based on number of targets and default minimum dogleg constraints.

The **AutoPlan** functionality is implemented as both a button-triggered calculation option or as a default setting to give the user flexibility in terms of its use or non-use in any given wellplan.

Manual Well Planning Enhancements

The following enhancements have been made to the previous manual wellplanning functions:

Default Kick Off

The wellplanning spreadsheet now features a second default row representing an unspecified kick-off point vertically below the start of the wellpath. A depth (entered by MD or TVD) is required to define the initial vertical interval for the wellpath.

Automatic Target Selection

If one or more targets are associated with the wellbore, target details will be automatically populated in the target line of any profile added to the wellplanning spreadsheet. Target selection will be performed in a logical order based on target distance from surface. The selection can be manually updated if necessary.

Project Ahead Updates

The following changes have been made to the Project Ahead Editor

Target Functions

The Project Ahead Editor now shares the same updated target functions described in the previous section. This includes the **Target Views**, **Intersection Point** and **Uncertainty Ellipse Intersection** functions.

Interface Changes

Changes to the Project Ahead Editor interface include:

- The **Plan Ahead** projection mode is now the default.
- The **3D View** tab rather than the **Results Sheet** is now displayed by default.
- The **3D View**/**Results Sheet** combo box has been moved to the right.
- For projections based on a 3DS Profile, it is now possible to define separate dogleg values for the 2 build/turn sections of the profile

Planned Wellpath Import

Wellpath import functions for the Planned Wellbore Editor have been combined so that all trajectory import operations are handled through a single wizard, launched by a button on the Wellpath page of the Planned Wellbore Editor. Supported import options include, text file, clipboard, and external sources (DEX, Epos and WITSML).

The result of this change is that Actual and Planned Wellbore Editors now share a common trajectory import interface and import options.

Other Updates

The following section outlines changes not covered by the previous enhancement descriptions.

Location Editor

The Location editor has been expanded to include a Comments field and a table in which any map projections associated with the Location can be defined. Map projections listed in the Location editor are used exclusively for defining boundary objects within Blocks associated with the Location.

Automatic Declination Check

The Installation editor now does an automatic check for a current declination record when the editor is saved. If no current record is found, the user has the option of creating a new record based on the current date and time or to specify an existing declination record defined on the Installation as being current.

Slot Editor

The Rig Datums page of the Slot Editor now displays the Planned and Actual Rig Datum tables at the same time. This removes the need to swap the view between the two tables when editing.

New Fulfils Plan PopUp Window

When an Actual Wellbore is created, an automatic popup window allows the user to specify the Planned Wellbore that the Actual Wellbore fulfils. To set this value after an Actual Wellbore is created, use the **Fulfills Plan** field in the Details window (see Wellbore Editor Interface changes below).

Wellbore Editor Interface

The Wellbore Editor has been updated in the following ways:

- The Wellbore Editor now contains the superset of previous Director, DirectorGeo and Drill-IT wellbore functions.
- Key data fields, **Name**, **Wellpath,** and **Tied To**, are now implemented as permanently available interface elements along the top of the dialog box.
- The Details page is now implemented as a separate window, launched from a new button in the Wellbore Editor toolbar.
- The functions previously available in the Geosteering Manager page are now incorporated in the Formations page.
- Wellbore Editor pages have been reordered to better accommodate common workflows.
- Toolbar buttons for data-specific functions have been moved to the relevant pages of the Wellbore Editor. An example of this is the implementation of the wellplanning profile buttons immediately above the Wellplanning Spreadsheet.
- A new general comments field has been added to the Comments page.
- The Offset Data page now features the same display-filtering options available within the Data Selector.
- The Casing Seat Calculator is now launched from the Wellbore editor. For more details, see “Casing Seat Calculator” on page 29.
- The **Set Up External Source** button has been removed from the Wellbore Editor interface. Management of external sources is now available via the **Tools > Manage Sources** option when working in a Wellbore Editor. The **Geosteer Well** > **Create New** option in the Formations page allows fast creation of links to Geolog Wells for geosteering.

2D View

The 2D View window now includes a depth-based position calculator.

3D View

The 3D Viewer has been updated in the following ways:

- It is now a floating window that can be moved outside the main Sysdrill application window, if required. It has been implemented in such a way as to always remain ‘on top’ in terms of Sysdrill window ordering.
- A new **Decorated** display option has been implemented for target objects. This allows visualization of the target center point and target dip and strike planes. This option is available on the Detailed Settings page of the 3D View Options dialog box.
- In addition to interactive HTML output, 3D Views can now be saved as **`.bmp`** images, facilitating easy incorporation in GenPlot wellpath plots via the **Import Logo** function.
- The default display colors associated with several objects have been updated.

Improved Interoperability

Sysdrill 3.0 further extends the ability to import and export trajectory data to and from other sources, including WITSML, DEX and WDS. Available import and export options are summarized below.

Editor	Data Type	Formats	Import	Export
Planned Wellbore	Wellpath	DEX	x	x
		EPOS (WDS)	x	x
		WITSML	x	x
Actual Wellbore	Survey section	DEX	x	
		EPOS (WDS)	x	
		WITSML	x	
	Wellpath	DEX		x
		EPOS (WDS)		x
		WITSML		x
		WITSML		x

Engineering Functions

Combined Torque & Drag and Range Analyses

The previous Torque & Drag, DS-1, and Range Analysis functions have been combined and enhanced within a single calculation dialog box to deliver a more powerful, flexible, and efficient approach to detailed mechanical analysis.

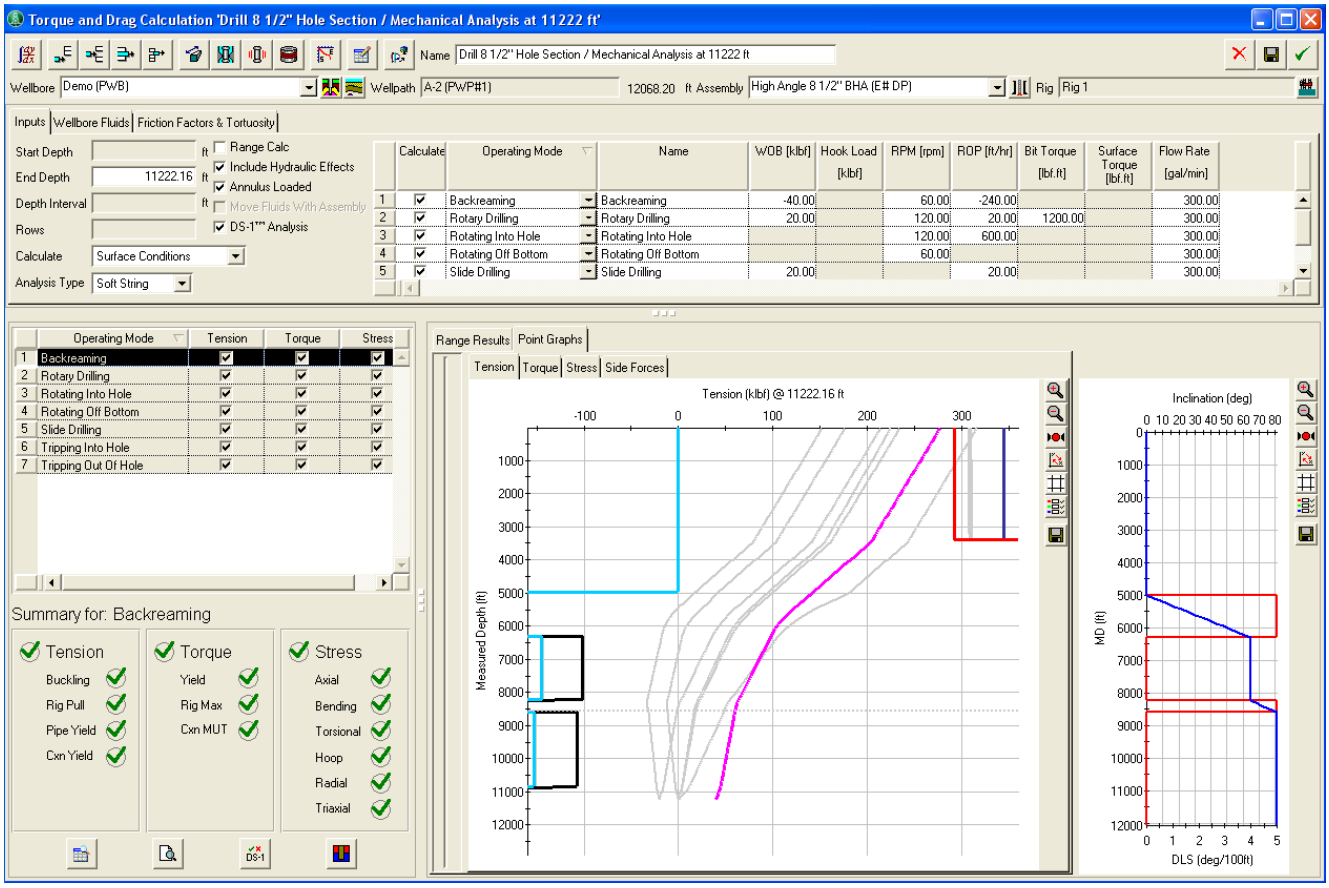

Fig. 4: New Torque and Drag Calculation Interface

Fluids, Friction and Tortuosity

New input pages allow data previously defined on the Assembly Analysis object (Wellbore Fluids, Friction Factors and Tortuosity) to be entered in relation to the calculation.

Multiple Operating Modes

A new spreadsheet allows the definition of any number of operating modes and/or operating conditions for use in the torque and drag calculation. A '**Calculate** checkbox allows selective inclusion or exclusion of defined operating modes in the analysis. To effectively manage the large amounts of data generated by the simultaneous analysis of

multiple operating modes, several changes have been made to the way in which results are presented. For more details, see “Updates to Graphical Results” on page 17 and “Updates to Tabular Results” on page 17.

Range Analysis Option

By default, the Torque & Drag calculation runs as a Static Depth Analysis. However, a checkbox allows the analysis to be run as a dynamic or Range calculation, based on a user-specified depth range and calculation interval value. Any calculation run as a Range analysis will automatically display a scroll bar to the left of the Point Results Graphs. This scroll bar can be dragged up or down to different calculation depths and the graph will automatically update to show calculated loads at the appropriate depth.

New Summary Features

The left side of the Results section now contains a summary table in which all operating modes included in the analysis are listed. For each entry in the table, checkboxes indicate a pass or fail in relation to general Torque, Tension, and Stress categories. By highlighting a particular entry in the summary table, a more detailed pass/fail summary is given for different aspects of Torque, Tension, and Stress for that entry. This allows fast identification of specific problems that might exist in the scenario being modeled.

Updates to Graphical Results

- Point and Range graphs now display by default the loads and limits for all operating modes included in the analysis. By highlighting a particular entry in the summary table, the corresponding load and limit curves will be highlighted in the graph. All other load and limit curves will be grayed out.
- A new reference graph describing inclination and dogleg values for the entire wellbore interval is included alongside the results graphs.
- The **Hook Load Range** graph now incorporates a **Buckling Hook Load** curve to indicate the minimum required hook load at different depths to avoid buckling.

Updates to Tabular Results

Tabular results for a Static Depth or Point Analysis are now displayed in a separate window, launched by a button located below the Summary Section. By implementing the Tabular Results as a separate window, it is now possible to view both graphical and numerical results side by side.

The Tabular Results window displays detailed numerical calculation results in relation to any operating modes and/or operating conditions included in the analysis. A drop-down menu located at the top of the window allows the user to view results for each available operating mode in turn. Highlighting of cells identifies intervals where operating limits have been exceeded.

Updates to String Graphical View

The String Graphical View is now launched from within the Tabular Results window (see above) and displays calculation results for the operating mode currently selected in the Tabular Results window. A read-only field has been implemented at the top of the String Graphical View window to make explicit the operating mode to which the results relate/

Enter and Display Actual Data

It is now possible to enter Hook Load and Surface Torque values gained at the wellsite for display within Hook Load and Torque Range graphs. This allows direct comparison of modeled loads with those observed while drilling. An editor window, launched from a new toolbar button, allows Hook Load and Surface Torque values to be entered by depth before or after the calculation is run.

DS-1 Compliance Module

DS-1 compliance is no longer run as a separate calculation. It is now implemented as a specialized analysis window that presents the results of the Torque & Drag calculation in terms of compliance with DS-1 Group definitions. It is launched by a button located below the summary section. Within the DS-1 analysis window the user is now able to update the selected DS-1 compliance level (group) and immediately see the results update accordingly without rerunning any calculation.

Packer Calculation

A new calculator has been implemented within the torque and drag dialog box to model both the setting of a liner hanger and any subsequent rotation of the string. The Packer calculation is launched via a new button in the toolbar of the torque and drag dialog box.

Although, the calculation can be run on strings where no hanger has been specifically defined, we recommend that the selected assembly has a hanger packer item explicitly defined. This hanger packer should be positioned at or near the top of an interval of casing with a running string defined above.

Hanger or **Packer** is available as a default equipment type option when defining components on a Casing string. It can also be found in the following location within the Equipment Selector Tree:

Casing, tubing and completion equipment\casing and tubing equipment\hanger packer

If activation weight or activation torque values have been associated with the hanger packer component (using the Details panel in the Assembly Editor) they will automatically appear as the default values within the relevant fields of the Packer Calculation.

String Construction

The Assembly Editor has been updated in several ways to improve the efficiency with which strings are defined and reused within the database.

String Creation Wizard

When a new string is created, a Wizard dialog box automatically appears. This allows the user to quickly specify the string type and identify the string definition source. Unless the user is defining a unique string within the database, this allows the string to be based on an existing definition stored on the Data Selector, within a database catalogue. Automatic searches of all relevant catalogues are made in a single operation based on key search criteria, or within an external DEX or WITSML source. As soon as the Wizard is complete, the Assembly Editor window opens.

Search by Filtering

The Find panel has been extensively redesigned and is now located at the bottom of the Assembly Editor window, implemented as **filter** fields. The ability to quickly display only items that match the specified search criteria provides a much more efficient approach to locating string components.

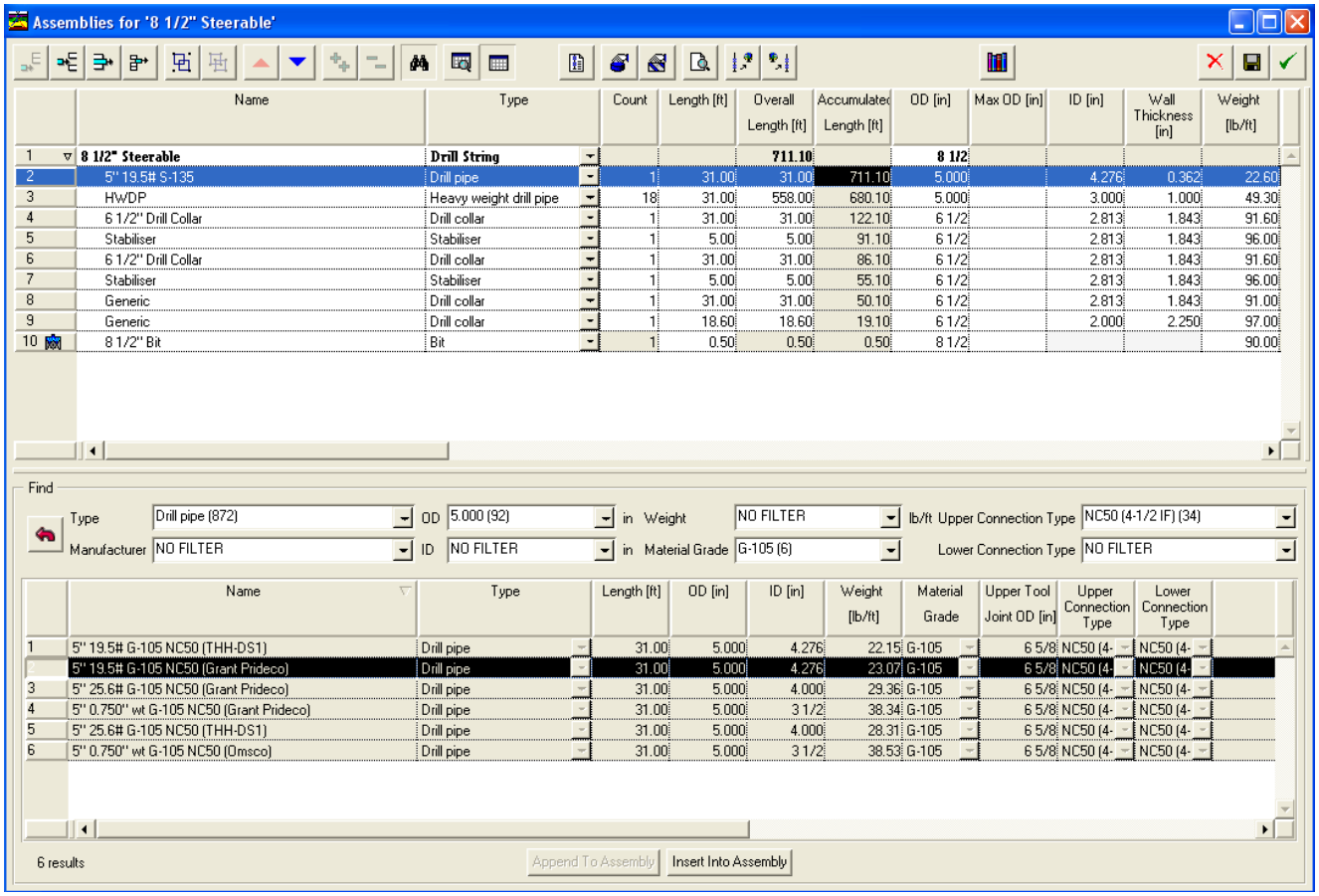

Fig. 5: New Component Search by Filtering

User-Defined Connection Types

For situations where a tool joint connection type does not exist as a default entry within the database, the user now has the ability to fully define the new connection type for use within a drill string definition. The Connection Type catalogue is launched from a new button within the **Assembly Editor** toolbar. Any new tool joint type defined here will be immediately available for selection in the **Upper Tool Joint Type** and **Lower Tool Joint Type** drop-down fields in the Assembly Editor spreadsheet. The specified connection type will influence engineering calculation results where relevant.

New Drilling Assemblies Catalogue

A new globally available equipment catalogue called **drilling assemblies** is included in the database by default. This catalogue contains fully defined generic drilling assemblies for a variety of common hole sizes.

Hydraulics Support

Several major changes have been made within Sysdrill to provide more comprehensive support for hydraulic analysis workflows. These changes include improvements to the way fluids are defined and reused, modeling of temperature effects and support for dual gradient drilling. This section outlines changes in relation to these supporting functions.

Dual Gradient Drilling Support

Sysdrill now allows modeling of both common dual gradient drilling scenarios. that is, **Mechanical** (wellhead hydrostatic pressure maintained equal to that of the of the water column in the riser annulus above by use of a mud lift pump) and **Dual Density** (fluid in the riser annulus maintained at a lower density than the rest of the circulating system by constant introduction of low density fluids via a booster line at the base of the riser). Dual gradient details are defined within the Rig editor and automatically included in Hydraulics and related calculations.

Temperature Modelling

- Sysdrill now allows optional modeling of thermal effects within the Hydraulics calculation. To support this feature, a Quasi-Steady State temperature model has been implemented.

  The Quasi-Steady State model is a finite element model that includes transient cooling effects. It is able to accurately model a number of drilling scenarios including boosted risers, deep water, dual gradient, inclined and horizontal well paths and complex geothermal gradients.

  To facilitate the definition of necessary input information, the following new features have been implemented.

  - A Thermal Modelling checkbox option with associated **Circulating Time** and **Temperature In** fields is available within the Hydraulics Calculation editor.
  - A Thermal Modelling Details dialog box allows specification of include Heat Transfer Coefficients for the string, annulus and riser, and Specific Heat Capacity and Thermal Conductivity of the earth. This dialog box is launched by a button associated with the **Thermal Modelling** option.
  - The new Fluid Builder dialog box allows the necessary specific heat capacity, thermal expansion, and compressibility information to be defined for fluids involved in thermal modelling.

  For more detail, see “Thermal Modelling Option” on page 23.

Basic Fluid Definition

- A simplified rheology definition for all 4 supported fluid models is now defined in terms of Fluid Density, PV, and YP. For fluid models that utilize 3 parameters, a Yield Stress Value can be optionally specified for a more complete definition. This basic rheology definition is made within the **Wellbore Fluids** tab of engineering calculations.
- Defined fluids can be saved to or retrieved from Fluid Catalogues by way of buttons in the **Wellbore Fluids** tab of engineering calculations.

Complex Fluid Definition

- Alternatively, a fluid can be defined in greater detail to allow use of the more advanced fluid modeling options within the Hydraulics Analysis dialog box. This additional level of definition is performed within a new Fluid Builder dialog box and allows description of a fluid's rheology and density behavior with varied pressure and temperature. It makes use of calculated density, specific heat capacity, thermal expansion and compressibility of the fluid mixture based on defined constituent Fluid Materials. For more details, see "Fluid Material Catalogues" on page 21and '"New Fluid Builder" on page 27.
- Defined fluids can be saved to or retrieved from Fluid Catalogues by way of buttons in the **Wellbore Fluids** tab of engineering calculations.

Fluid Material Catalogues

- This new catalogue type allows storage of base fluids and additives for use in complex fluid definition. Fluid Materials are defined by Density and Specific Heat Capacity, which can be entered into the catalogue spreadsheet, and Density Model Coefficients, which must be defined within the Catalogue Details panel.
- New entries can be defined directly within the catalogue or copied from an existing populated catalogue. Fluid Materials are retrieved from catalogue for use in the Fluid Builder by way of a button on the **Composition** tab of the Fluid Builder.
- Globally available Fluid Material Catalogues are listed in the Data Selector by selecting **Catalogues** in the new Data Selector **Display** drop-down-menu. Operator specific Fluid Material Catalogues are listed by selecting '**Organizations**' in the new Data Selector '**Display**' drop-down menu and expanding the relevant Operator Organization within the data tree.

Fluid Catalogues

- This new catalogue type allows storage of both basic and complex fluid definitions for use in engineering calculations. Both basic and complex fluids can be saved to or retrieved from catalogue within the **Wellbore Fluids** tab of engineering calculations.
- New entries cannot be defined directly within the catalogue but can be copied from an existing populated catalogue. Fluids are defined within the **Wellbore Fluids** tab of engineering calculations.
- Globally available Fluid Catalogues are listed in the Data Selector by selecting **Catalogues** in the new Data Selector **Display** drop-down-menu. Operator specific Fluid Catalogues are listed by selecting **Organizations** in the new Data Selector **Display** drop-down menu and expanding the relevant Operator Organization within the data tree.

Catalogue Filtering

When retrieving fluids or fluid materials from catalogue, an automatic search is performed on all relevant catalogues based on key search criteria, implemented as 'filter' fields. The ability to quickly display only items that match the specified search criteria provides an efficient approach to locating fluids and fluid materials.

Hydraulics Analysis

Hydraulics analysis functions have been significantly enhanced to deliver a more powerful, flexible and efficient approach to detailed hydraulics analysis.

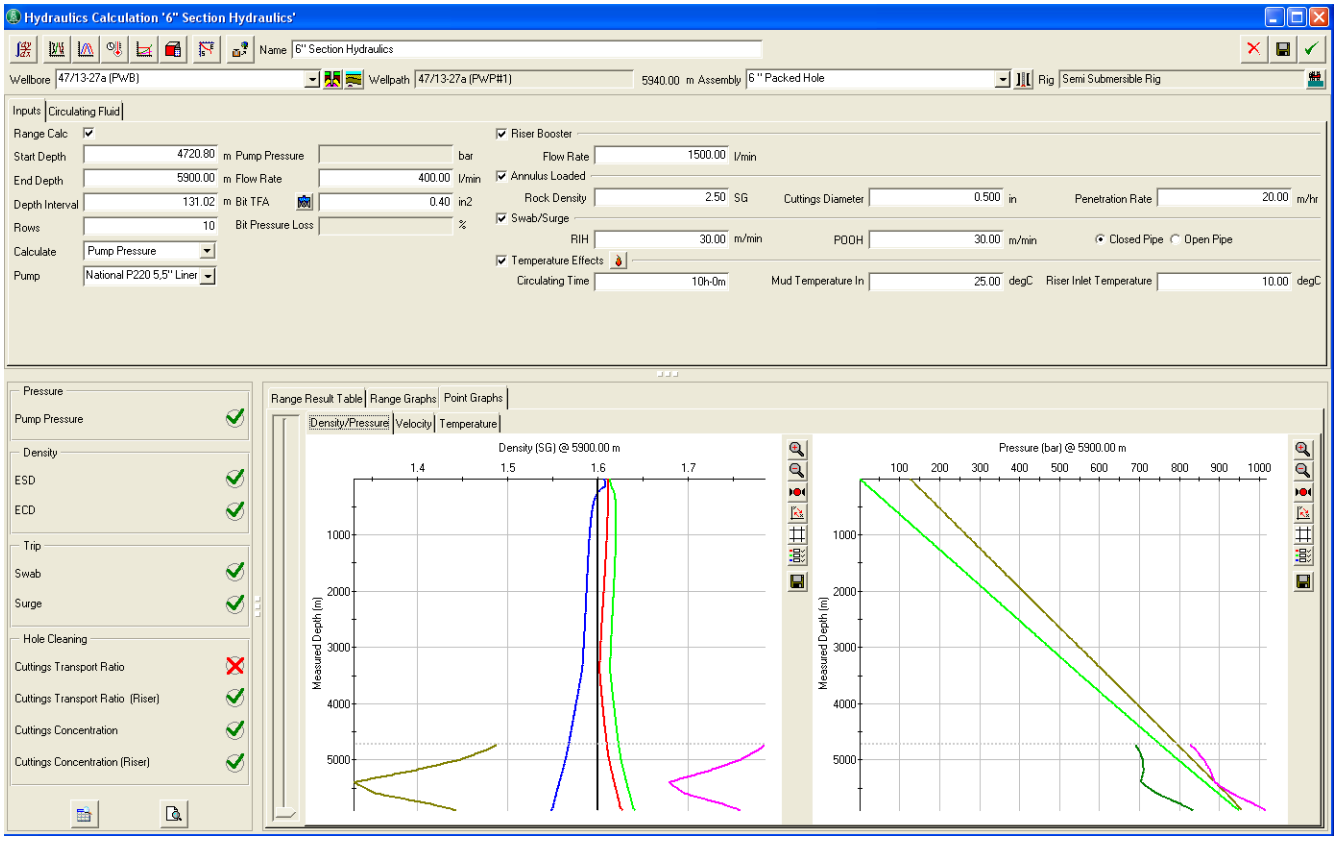

Fig. 6: New Hydraulics Calculation Interface

Update to Calculation options

The previously available **BHHP** and **JIF** calculation options have been removed from the **Calculate** menu in favour of the user specified **% Bit Pressure Loss** option. For optimization of BHHP or JIF within the hydraulics calculation, users are encouraged to use the BHHP/JIF Calculator to determine a value for optimized percentage bit pressure loss for the particular hole/string/fluid configuration being modelled. This value should then be used an input to the Hydraulics calculation.

Range Analysis Option

By default, the Hydraulics calculation runs as a static depth analysis. However, a checkbox allows the analysis to be run as a dynamic or Range calculation based on a user-specified depth range and calculation interval value. Any calculation run as a Range analysis will automatically display a scroll bar to the left of the results graph. This

can be dragged up or down to different calculation depths and the graph will automatically update to show calculated hydraulics at the appropriate depth.

Riser Booster Option

If a riser has been specifically defined on the Hole Sections/Casings page of the relevant Wellbore editor, the Hydraulics calculation can optionally model the use of a booster within the riser interval. A checkbox is used to indicate inclusion or non-inclusion of a booster in the hydraulics calculation and an associated input field allows specification of the flow rate in the riser.

Thermal Modelling Option

A new Thermal Modelling option allows temperature effects on fluid density and rheology to be included in the Hydraulics calculation. Selection of the option has the following implications:

- Adjusted fluid density and rheology are used for calculation of equivalent circulating density, pump pressure (plus constituent pressures) and all derived hydraulic result values.
- Temperature–specific results graphs will be automatically displayed and populated when the Hydraulics calculation is run. These include Temperature, Density, and Plastic Viscosity graphs.
- The Thermal Modelling option is implemented as a checkbox with associated parameter fields. However, successful application of the option is reliant on sufficient definition for several sets of input data:
  - Appropriate values for **Circulating Time** and **Temperature In** must be entered to the parameter fields associated with the **Thermal Modelling** option. A **Riser Inlet Temperature** field can be optionally populated for situations where mud introduced at the bottom of a riser is significantly different to that in the pit.
  - A geothermal temperature profile for the entire wellbore must be defined in the Pressures and Temperatures dialog box.
  - Appropriate values must exist in the Details dialog box associated with the **Thermal Modelling** option. These values include Heat Transfer Coefficients for the string, annulus, and riser, and Specific Heat Capacity and Thermal Conductivity of the earth. The Details dialog box is launched by a button associated with the **Thermal Modelling** option. It contains default values for all parameters, however, these values can be updated as required. Values apply to all Hydraulics calculations under a particular Well.
  - The wellbore fluid definition must include density, specific heat capacity, density constants (Yp and Yt as a minimum) and at least one rheology curve. This data is defined within the Fluid builder.

Component-Specific Pressure Loss

For components that induce pressure loss through mechanical interaction with the fluid, such as **Mud Motors** or **LWD/MWD** tools, the calculated frictional pressure loss can be overridden by manual specification of a pressure loss value for the particular component within the string definition. Pressure loss can be defined directly within the Assembly Editor spreadsheet as a total pressure loss value for the relevant component, or can be defined as a pressure loss coefficient within the **Assembly Editor Details** panel. The use of a pressure loss coefficient allows flow rate-dependent calculation of pressure loss across the component. This coefficient can be entered using the manufacturer’s data or calculated using known parameters.

Cuttings Transport Ratio

The Hydraulics calculation now uses Cuttings Transport Ratio as a means of assessing cuttings removal in the annulus. The Cuttings Transport Ratio is described as 1.0 – (Slip Velocity / Annular Velocity). This value is then compared with inclination-dependent limit values. A limit of 0.33 is applied to vertical wellpath intervals (inclination less than 30 degrees) and a limit of 0.66 is applied to horizontal wellpath intervals (inclination over 30 degrees). The **Annulus Loaded** calculation option must be selected for calculation of the Cuttings Transport Ratio.

New Summary Feature

The left side of the results section now contains a summary feature in which checkboxes indicate a pass or fail in relation to all relevant aspects of the hydraulics analysis. The hydraulic aspects that are reported will be determined by calculation inputs. This summary feature allows fast identification of any problems that can exist in the scenario being modelled.

Updates to Graphical Results

Selection of particular calculation options will influence the number and type of results graphs displayed. A basic Hydraulics Calculation will display Density, Pressure, Velocity, and Cuttings Transport Ratio graphs under the **Point Graphs** tab. If the **Include Temperature Effects** calculation option is selected, additional temperature-related results graphs will be displayed on a separate page under the **Point Graphs** tab. If the **Range** calculation option is selected, Density and Pressure graphs will appear under a separate **Range Graphs** tab.

Updates to Tabular Results

Tabular Results are now displayed in a separate window, launched by a button located below the Summary Section. By implementing the Tabular Results as a separate window, it is now possible to view both graphical and numerical results side by side. Highlighting of cells within the table identifies intervals where operating limits have been exceeded.

Updates to String Graphical View

The String Graphical View is now launched from within the Tabular Results window (see above).

New Flow Range Calculator

The Flow Range calculator is launched from within the Hydraulics Calculation editor and allows the calculation of fluid pressures and densities against operating limits over a user-specified range of flow rates. To include the Cuttings Transport Ratio limit within the Pressure graph, the **Annulus Loaded** option must be selected within the Hydraulics Calculation editor. To include the Pop-Off limit within the Pressure graph, a specific 'Pump' must be identified within the Hydraulics Calculation editor.

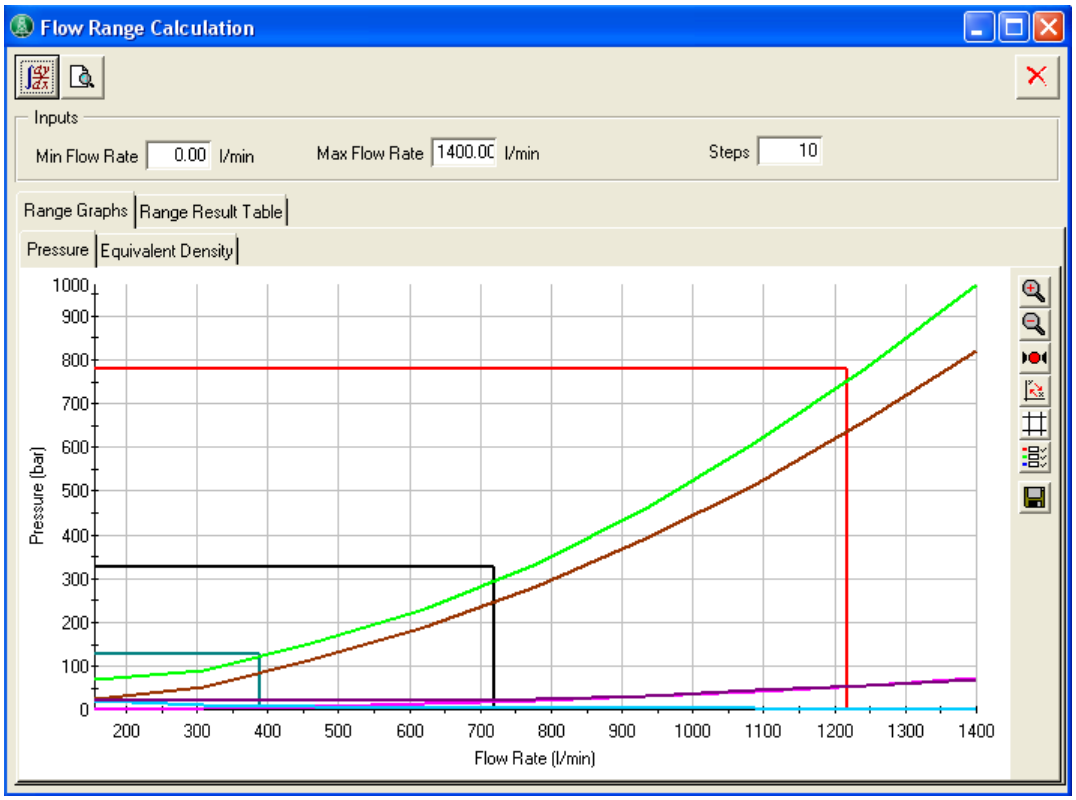

Fig. 7: New Flow Range Calculator

New ESD Calculator

If Thermal Modelling is enabled, an additional ESD pop-up calculator is enabled. It uses the transient cooling effects to calculate ESD, ECD, and Volume change with respect to Circulating Time for a given flow rate.

New Wellbore Volume Calculator

A new popup Volume Calculator is available from the Hydraulics and Cementing analysis. It calculates circulating volumes for the wellbore defined in the analysis. The user can enter start and end depths in either string or annulus to calculate the required volumes and strokes to displace. Additional volume calculations for pill spotting, cement plugs, washout, and spacer volumes are available.

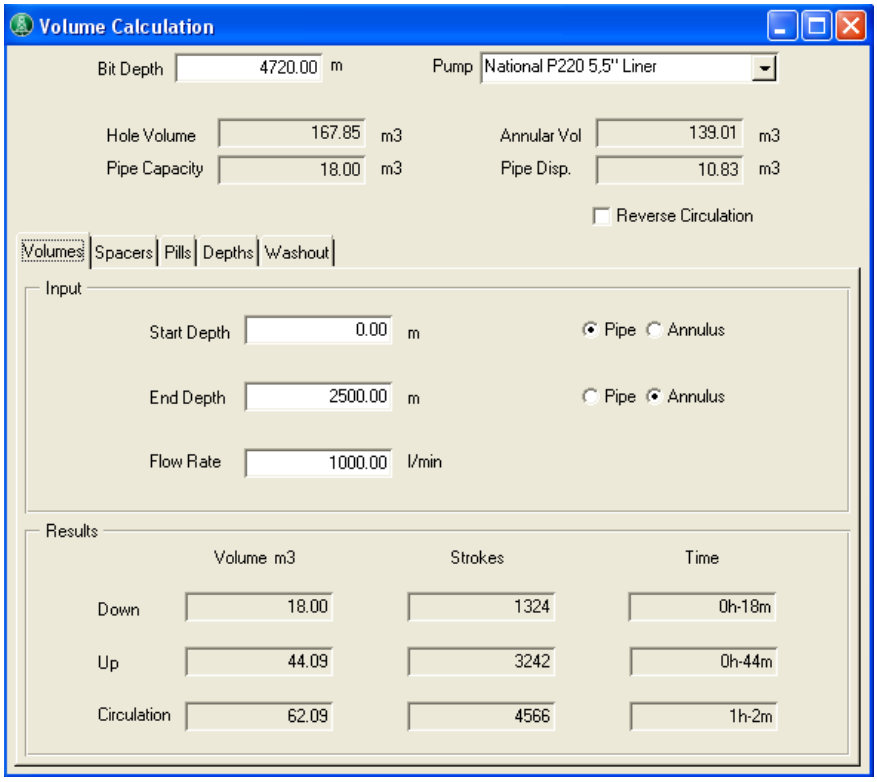

Fig. 8: New Wellbore Volume Calculator

Improved Trip Calculator

The Trip Calculation dialogue had been changed to calculate maximum trip speeds over the entire open hole. The user can also specify additional margins above pore and fracture gradients for use in the maximum run speed calculation. The calculation also has the option of including the gel shearing pressures in the trip calculation. The original plot has been replaced by a range graph showing swab and surge gradients with trip speed at the Casing Shoe and the Open Hole TD.

New Fluid Builder

The Fluid Builder is launched from within the **Wellbore Fluids** tab of engineering calculations in relation to a highlighted fluid. It allows description of a fluid's rheology and density behavior with varied pressure and temperature. It makes use of calculated density, specific heat capacity, thermal expansion, and compressibility of the fluid mixture based on defined constituent materials.

Fluid Composition

The Composition page of the Fluid Builder has two main functions. The first is to calculate the ratios and volumes of materials required to produce a fluid of a given density. The second is to determine the properties of the fluid using the law of mixtures. The density, specific heat capacity, compressibility, and thermal expansion coefficients of the mixture are calculated using the properties of the fluid materials defined in the catalogues.

Density Model Calculator

Sysdrill uses the following density model to predict the variation of fluid density and volume with temperature and pressure.

SPE 47806 Density Behavior of Drilling Fluids During High Pressure High Temperature Drilling Operations

This is an analytical model using the compressibility and thermal expansion coefficients of the fluid components. The model exists in two forms. The first is a linear model that uses the compressibility and thermal expansion values at standard temperature and pressure. The second uses HTHP values to produce a non-linear model.

The linear model can give adequate results and is mathematically similar to the widely accepted model proposed by Sorelle.

However, for best results we recommend that all the available model constants are populated and the non-linear model used. The authors claim that the model will give greater accuracy than other empirically-derived models.

Thermal Properties Calculator

Users should select the predefined materials and specify the ratios and fluid density. The **Calculate Specific Heat Capacity** button can be used to calculate the specific heat capacity of the mixture produced.

Gels Definition

Users can define the fluid gel strength values for various gel periods.

STP Rheology Calculator

Users can enter a full suite of viscometer readings to define the rheology of a fluid. Once entered, the fluid builder will fit the four available models to the data using a least squares fit technique and suggest the best-fitting hydraulics model. The parameters for each of the models are calculated allowing the user to select the hydraulics model used.

HPHT Rheology Calculator

To determine how the rheology varies with temperature and pressure the user can enter HPHT viscometer readings. The user can enter any number of viscometer readings at various temperatures and pressures in the same manner as the single reading. The various rheological parameters are calculated for each reading. Sysdrill uses advanced curve fitting techniques to determine how the parameters vary with temperature and pressure. Since all the rheological parameters are calculated for each set of viscometer data, the user has the option of using any of the available models for HPHT hydraulics.

Viewing the summary page of the Rheology dialog box allows user to view the individual curves against temperature and pressure. The user can also choose to view the isothermal planes (The interpolation of rheology against pressure for equal temperatures) and the full interpolation of shear rate, shear stress, pressure and temperature.

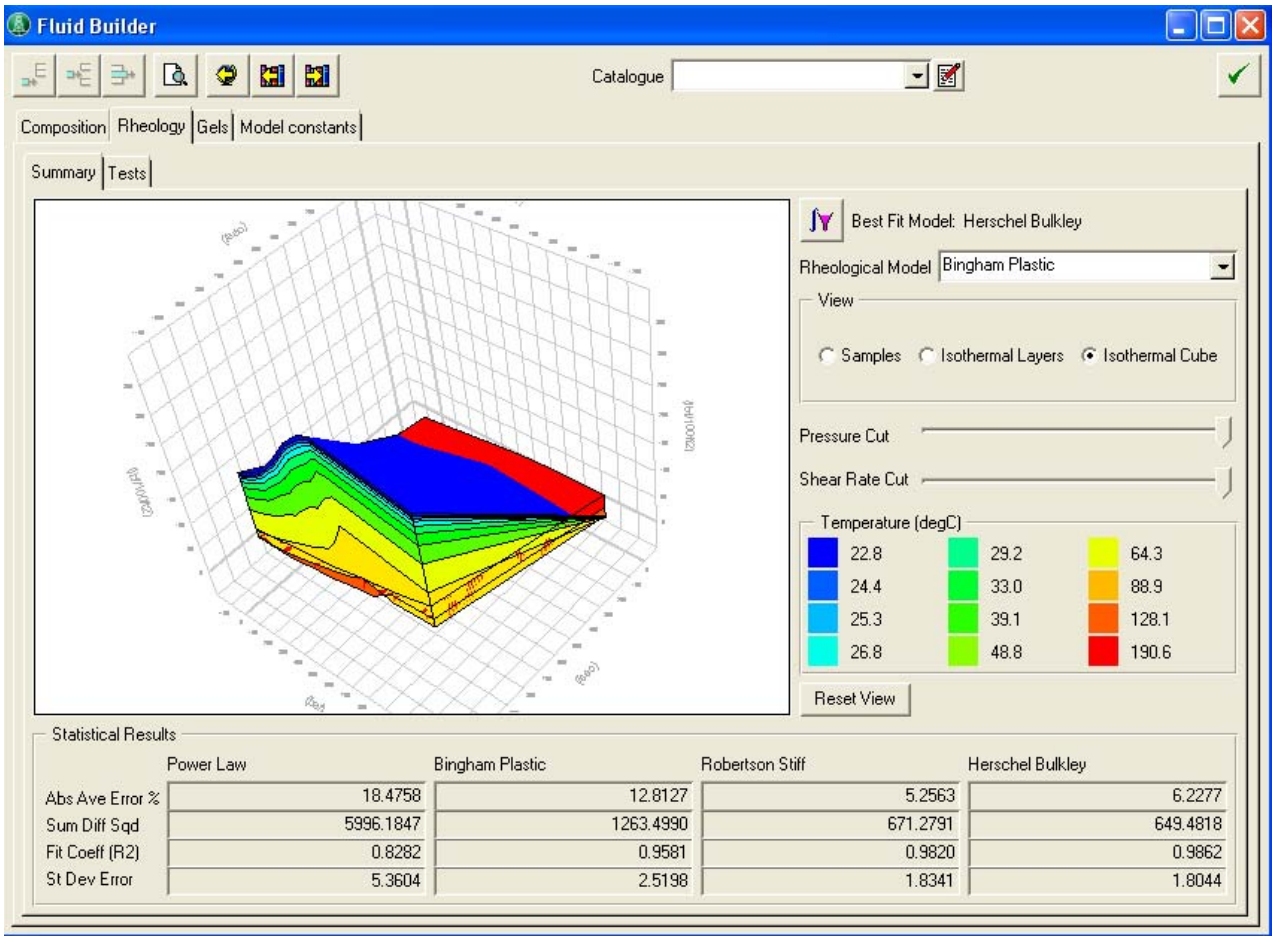

Fig. 9: HPHT Rheology Display

Well Control

The following enhancements have been made in relation to well control analysis functions.

Merged Kick and Kill Calculators

The previous Kick and Kill Calculators have been enhanced and implemented as separate pages within a common Well Control Analysis dialog box.

Improved Kill Calculator

The Kill Calculator can automatically generate a Kill Sheet based on the user inputs for Shut-In pressures. It will calculate Choke Line friction based on the Choke Line ID input and the fluid parameters using the hydraulics modelling. A pressure step-down plot and table is produced. The Kill Sheet results include the relevant volumes required for killing the well.

Casing Seat Calculator

The following enhancements have been made in relation to the Casing Seat Calculator.

Updated Calculator Location

The Casing Seat Calculator has been separated from the Casing Analysis functions and is now launched from the Hole Sections/Casings page of the Wellbore editor. This provides a more efficient and logical workflow in terms of establishing casing intervals for the wellbore.

Automatic Diameter Selection

The Casing Seat Calculator has been enhanced to allow a user-specified diameter to be defined for the final hole section or casing string. This allows automatic assignment of default hole sections and casing sizes for each of the calculated intervals above. This information can then be copied to the Hole Sections/Casings page of the Wellbore editor.

Casing Analysis

The following enhancements have been made in relation to Casing Analysis functions.

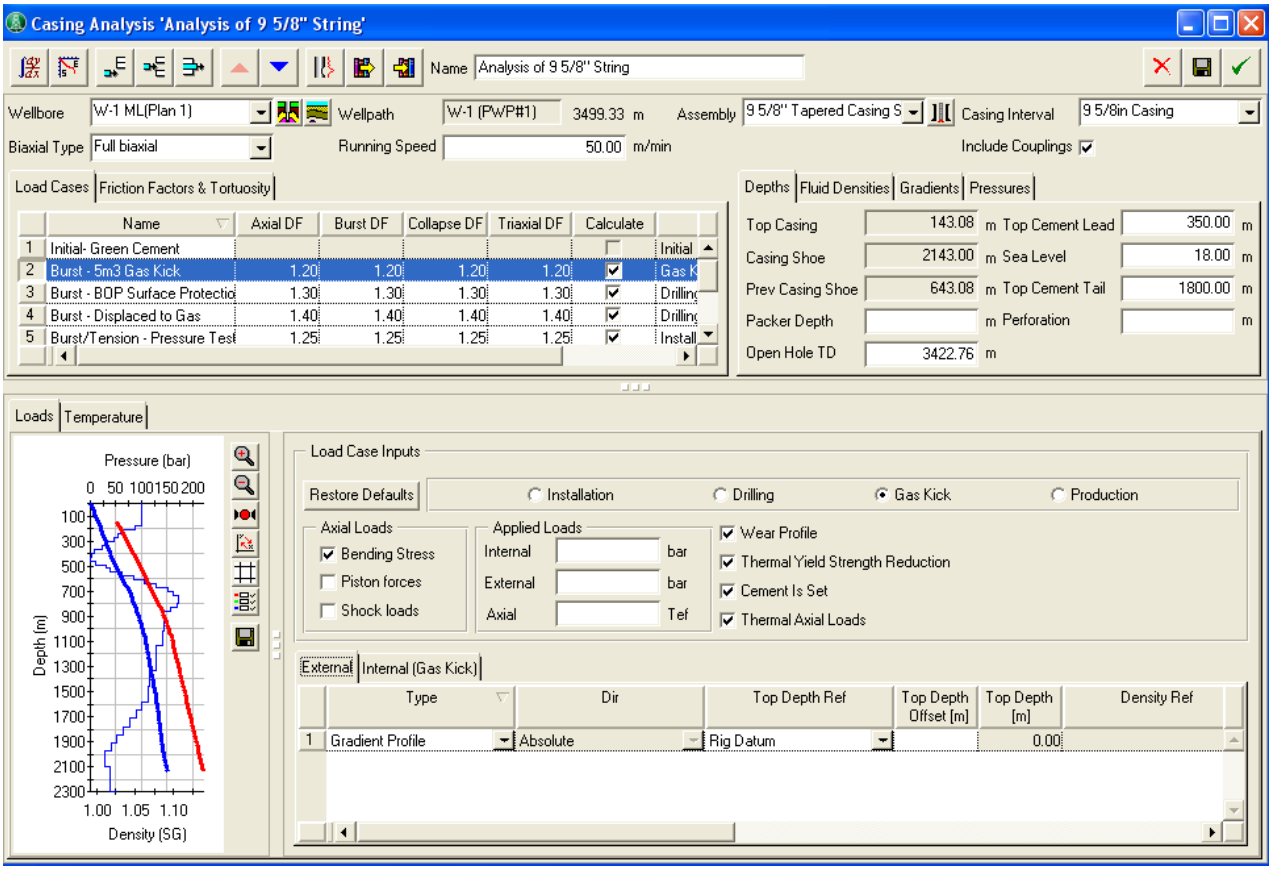

Fig. 10: New Casing Analysis Interface

Load Case Profile Definition

The definition of Internal and External load case profiles can now be created using symbolic depths, pressures and densities. This allows load cases to be applied to any number of casing analysis without the need for editing of the profiles.

To support the use of symbolically defined load cases, a new input panel has been implemented within the Casing Analysis editor. This allows entry of specific values in relation to depth, density, gradient and pressure for the selected casing interval. These values are automatically picked up by any load cases included in the calculation.

Default Initial Load Case

All Casing Analysis Calculations now contain a default Initial Load Case which appears as a non-editable entry in the Load Case table. Once defined, the Initial Load Case is referenced by any other load case that includes the **cement is set** option.

Default Profile Rows

When appending a new row to the Load Case table, both the Internal and External profile tables will be automatically populated with a single default row for use in defining the internal and external pressure profiles associated with the load case. This feature will either remove or significantly reduce the number of append operations required define any given load case.

New Casing Wear Calculator

The casing wear log in the Casing Analysis dialog box has been replaced by a calculation window in which the casing wear profile can be calculated based on multiple defined operating runs of a specified drill string in the subsequent hole section.

The calculation window also allows storage of an actual wear log. Calculated wear values can be used to replace or add to the values of the actual log.

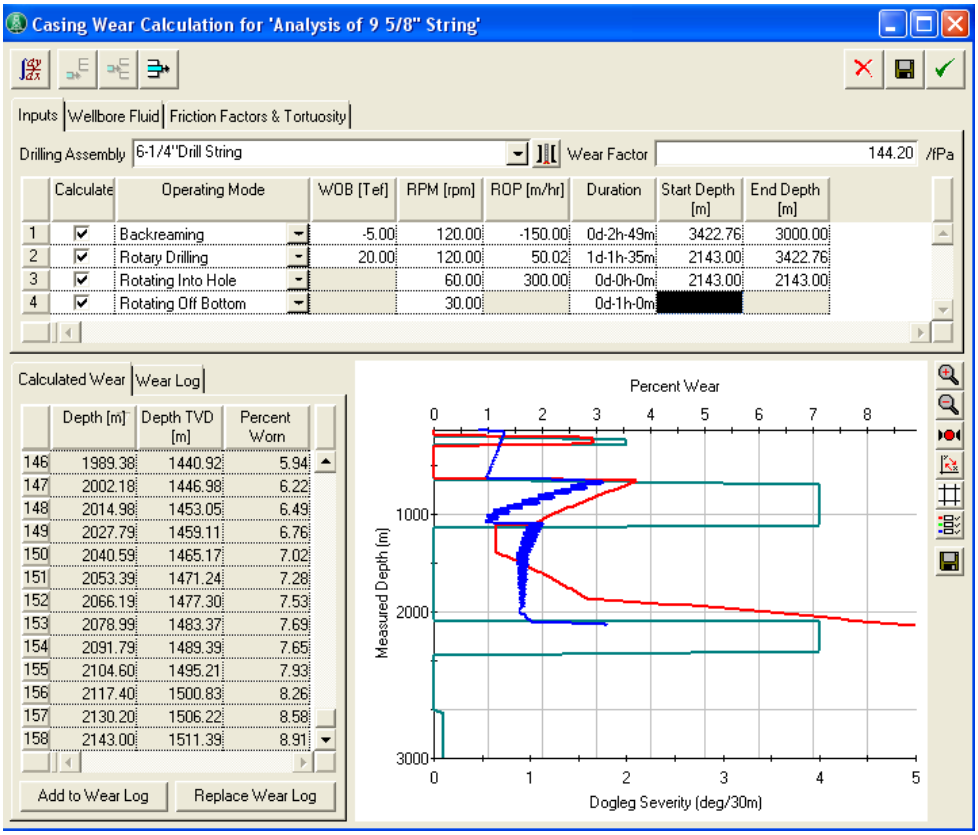

Fig. 11: Casing Wear Calculator

Improved Interoperability

Sysdrill 3.0 further extends the ability to import and export engineering data to and from other sources, including WITSML, DEX and WDS. Available import and export options are summarized below.

Editor	Data Type	Formats	Import	Export
Pressure & Temp	Pressure	DEX	x	x
		EPOS (WDS)	x	x
		WITSML	x	x
	Temperature	DEX	x	x
		EPOS (WDS)	x	x
		WITSML	x	x
	Pressure & Temp	DEX		x
		EPOS (WDS)		x
		WITSML		x
Assemblies	Assembly	DEX	x	x
		WITSML	x	x
T&D Calculation	Calculation Results	EPOS (WDS)		x
		WITSML		x
Hydraulics Calculation	Calculation Results	EPOS (WDS)		x
		WITSML		x

Other Updates

The following section outlines changes not covered by the previous enhancement descriptions.

Rig Editor

- The Rig editor includes new interface elements that allow the definition of dual gradient drilling parameters. For more details, see ‘“Dual Gradient Drilling Support” on page 20.

- The Pump Details table now allows additional pump parameters to be defined for use in Hydraulics and Cementing analyses.

Calliper Log Creation

New calliper log objects are now created by a **Create New** option in the **Calliper Data** drop-down field of the Hole Sections table in the Actual Wellbore editor.

Active Wellpath Setting

The concept of the **active wellpath** is no longer used in engineering calculations of any type. For situations where multiple wellpaths have been defined on a single Wellbore, the user must update the **active wellpath** setting within the Wellbore editor to run an engineering calculation on an alternative wellpath.

Calculation Duplication

All calculation objects can be duplicated within the same Project. This function is available as an option within the MB3 shortcut menu when a calculation object is highlighted in the Data Selector. This provides a potential mechanism for quickly applying multiple defined operating conditions to another hole section to be analyses as part of the Project. (Simply update the **Assembly** field in the duplicate calculation editor.)

Assembly Duplication

Assembly objects can be duplicated within the same Project. This function is available as an option within the right-click shortcut menu when an assembly object is highlighted in the Data Selector. This is faster than any of the existing methods for copying an assembly within a Project.

Graph Legend Updates

Graph legends (containing the display and appearance options for graph curves) are now implemented within a separate window, launched by a standard graph toolbar button. This allows graph extents to be maximized within the application interface.

Graph Color Palette

The colors available for use in results graphs have been updated to allow better contrast between results curves.

Other Components

The following section outlines changes to other components associated with the Sysdrill 3.0 release.

Importer/Exporter

- The Importer and Exporter utilities have been updated to reflect changes to the v3.0 Data Selector.
- If connecting to a database in which only the default **`admin`** User ID is defined, no login is required.

User Manager

- The User Manager has been updated to reflect the data features and functional features associated with the Sysdrill v3.0 application.
- If connecting to a database in which only the default **`admin`** User ID is defined, no login is required.

Help System

The Sysdrill help system has been enhanced to include all the new features of this release.

Known Problems

#151 - Graph Y axis Labels Not Displayed on XP with Clear Type

Rotated (vertical) text labels within XRT graphs do not display when running on an XP Operating System. **Workaround**: Switch the **Appearance** setting to any other option.

#469 – Dipping Targets Not Interpreted Correctly by Geosteer

There is discrepancy between Sysdrill and Geosteer in terms of handling rotation and dip heading. Result is that dipping targets sent from Sysdrill do not display with correct orientation within Geosteer. Recommendation is to not use dipping targets in geosteering workflows.

#597 - Duplicate Target Names Cause Geosteering Target Fetch Issue

If the same name is used for more than 1 target at field level, target fetching (by **Create New** or **Reposition** methods) might not update the correct target. Current workaround is to ensure that each target on a field has a unique name. This is only an issue for geosteering workflows.

#640 - Cannot Copy and Paste between Load Case Catalogues

Internal copy and paste of load case catalogue content is not enabled. Current work around is to use catalogue export/import options available as MB3 short cut menu options on the Data Selector.

#1656 - Bad Filter on Scratch Wellbore 'Fulfils Plan' Pop-Up

The **Fulfills Plan** pop-up associated with an Actual Scratch Wellbore picks up all planned wellbores on the slot, that is, all planned scratch wellbores in the database rather than just those associated with the well.

#1758 – Copy and Paste of Pressure Data from Clipboard

For **Copy** and **Paste** operations to the Pore Pressure and Fracture Pressure pages of the Pressure and Temperature dialog box, when pressure (as opposed to gradient) is the reference dataset, values are lost if all 4 default columns are displayed in the spreadsheet. **Workaround:** Hide the **gradient** column prior to the paste operation and redisplay afterwards. There is no equivalent problem if gradient is the reference dataset.

#1804 – Missing Object Types in 3D View Options, Detailed Settings Page

Not all object types available on the All Settings page are replicated in the Detailed Settings page. For consistency, the following object types should be made available on the Detailed Settings page: Surface, Geosteer Picks, Lease Boundary. **Workaround**: Use the All Settings page to define display settings for these objects.

#1805 – Lease Line Clipping in Retrieved Plots

In the following two situations block-defined boundary data will not be correctly clipped to the Plan View Extent within a retrieved plot:

- If the Wellbore Editor has not been closed since the plot was saved.
- If the retrieved plot is the result of a plot re-save operation.

Workaround: Switch off and then switch back on the ‘Display Lease Lines’ option within the GenPlot ‘Edit Annotations’ dialog box in relation to the Plan View. This will restore appropriate clipping of boundary data.

#1915 – Missing Depth Values with Copy & Paste from Pressure/Temp

Copy and paste of pressure data to Excel does not copy the non-reference depth values, only the header. All other spreadsheet values are copied. This problem does not apply to copy and paste of temperature data.
Workaround: Use the export to file option.

#1934 – Regional View Tooltip Behaviour

The tooltip feature in the Regional View window currently interpolates on line segments. In future this should be disabled to give more useful nearest corner point position.

#1951 – Survey Editor Dialog Box Issues

If the Survey Editor is launched from within the Actual Wellbore Editor, the ability to swap between unit systems is disabled. **Workaround**: Launch the Survey Editor from the Data Selector.

#1960 – Focus Issue with Map Table on the Location Editor

Following an edit operation on an entry within the Map Table, attempting a second edit operation on the same entry cannot be achieved without clicking elsewhere in the dialog box and reselecting the entry.

#1962 – Intermittent Block Extent Table Highlighting Issue

In certain circumstances, the highlighting applied to a row in the Block Extent table is not removed when another row in the table is selected. Further investigation is required.

#1970 – Recreate Hardline for Block Extent

When deleting a license boundary, an intermittent bug might prevent instant recreation of a hardline. Reopening the dialog box will fix the problem.

#1973 – Application of Snap Option in GenPlot

- Snap seems to be applied for creation of detail objects regardless of setting in the 'Edit Detail Attributes' dialog box.

- Snap does not seem to be applied for repositioning of detail objects, regardless of setting in the ‘Edit Detail Attributes’ dialog box.

#1978 – Potential Issue with Wellpath Offset Alignment for Circular Targets

If a target is initially created as a shape that allows rotation (Rectangle, Semi-Circle, Elliptical) and attributed with a rotation value, then swapped to a circle shape, the rotation value is retained despite the target shape not supporting a rotation definition. The result is that Wellpath offsets for this target will be defined on a rotated axis.
Workaround: Reset rotation to zero on the initial target shape before swapping to a circular target shape.

#2174 – Installer Interacts with Geolog Installation

If Geolog is installed on the host machine, running the v3 installer (installing, removing, etc.) results in Geolog being unable to launch. A simple reboot of the host fixes the issue. Further investigation required.

#2179 – Inconsistent Equipment Filtering Logic

If beginning an equipment search in the Assembly Editor with a filter option other than Type, the generated results might not represent an exhaustive list. Workaround is to always begin an equipment search by specifying the equipment Type.

#2183 – Hydraulics WITSML Export

Export of Hydraulic calculation results to WITSML does not include an explicit depth datum reference.

#2188 – Detail Scale of Targets in GenPlot

It is currently possible to resize drilling target objects using the detail scale option. This should not be supported.

#2191 – DS-1 Result Graphs

Within the tension graph, no curves are displayed for components in compression. Also, the tensile limit line appears to be derated, but this is not explicitly identified by the curve name or associated tooltip.

#2192 – No Context Menu on the Load Case Sheet

The Load case Spreadsheet in the Casing Analysis dialog box does not support the standard MB3 spreadsheet option menu.

#2195 – Potential Stiff String Non-Calculation

A Stiff String calculation will fail if applied to a string in which the following is true: The length of a defined external accessory item plus the specified distance of that accessory from the bottom of the parent component is less than the combined tool joint length associated with the parent component.

#2199 – Torque and Drag Report Templates Contain ‘Include Connections’ Field

As connections are now automatically included or ignored on the basis of assembly definition, this calculation option is obsolete. The option should be removed from all torque and drag report templates.

#2200 – Temperature Gradient Does Not Update on Delete

Gradient profile values do not recalculate if one or more rows are deleted from the Temperature spreadsheet in the Pressure and Temperature dialog box.

#2208 – Casing Analysis Results Above Top of Casing

If the depth interval does not correspond to a whole number of joints, an extra joint is generated at the top of the casing. This can yield poor results at the top of the interval. **Workaround**: Space out joints correctly with a pup joint.

#2208 – Rotation of Moved Details in GenPlot

Attempting to select a moved detail for rotation can be difficult as the center of rotation is offset from the moved object.

#2215 – Cannot Duplicate Hydraulics Calculation With a Defined Pump

If a pump has been associated with Hydraulics calculation, the association is lost in the duplicate calculation and the duplicate cannot be saved. Re-associating the pump does not resolve the issue.