**WellPlan™ Software**

**OVERVIEW**

Designing complex well string operations requires rigorous analysis to define the key aspects of each pipe-related operation in the wellbore. Determining the appropriate rig and equipment specifications, string components, and fluid properties and parameters to drill safely and efficiently are just a few of the challenges the drilling engineer must address. To navigate these challenges, users require software solutions that can manage this complexity and provide a wealth of scientific capabilities while at the same time being simple and intuitive to use.

WellPlan™ software is the latest evolution in more than 25 years of innovations in well-construction information solutions. WellPlan extends and simplifies the science through dramatic advancements in ease-of-use and data visualization. Integrated with Engineer’s Desktop™ (EDT™) and Engineer’s Data Model™ (EDM™) applications, it provides a complete well engineering software tool kit that is unparalleled in the industry.

**BENEFITS**

**Well engineering integration**

Results and analysis performed in the WellPlan™ interface are stored in the EDM database, the world’s most widely used database for drilling and completions applications. This data is available across the Landmark suite of well construction applications for specific drilling, casing or costing analysis. The applications can operate in a standalone or multi-user environment, so they can be scaled from a single user to a corporate-wide system.

**Configure the right tools for any job**

Select the optimum rig and equipment, string components, and fluids to drill a full range of well types, including onshore, offshore, deep water, high-pressure/high-temperature, 3D directional profiles, horizontal and extended reach. Model pipe strings to define optimum windows of operation during the design and execution phases of your well. Anticipate risks and know how to drill faster without compromising the safety of the operation.

**Simplified process leads to better well decision-making**

For both the novice and expert user alike, the completely redesigned user interface provides a simple approach to inputting data and powerful graphical visualization capabilities for better and faster interpretation. Output-driven-input™ methodology identifies the required data and provides hyperlinks to the appropriate input panel. The user simply clicks on the hyperlinks and inputs the required data, and the application does the rest. The interactive wellbore schematic provides visual feedback throughout. With this simplified process, users can conduct faster and more accurate analysis to support better decisions. The dramatically enhanced usability typically requires minimal training, and new users can be brought up to speed quickly.

**KEY VALUE**

» Drill faster without compromising safety

» Simplified process leads to more accurate analysis and the opportunity for better decision-making

» Comprehensive tool kit optimizes well design and mitigates risk in routine or complex drilling scenarios
Sensitivity analysis
WellPlan provides a powerful method of performing generalized sensitivity analysis. Instead of performing manual iterations or running several analyses one at a time, users can define a range of values for the numeric variables wanted and perform the analysis simultaneously. Detailed graphical representations enable a quick review of the different alternatives.

FEATURES

Torque and Drag Analysis
Plan and analyze drilling, casing, and completion running operations, and assess the impact of predicted loads related to torque and drag. The main calculations are tension, torque, side force, fatigue, and tri-axial stress. A top-down analysis mode uses surface parameters to accurately understand forces acting along the string to the bottom of the well. It also accounts for the effect of hydraulic parameters such as fluid properties, flow rates, diverse fluid columns and pressures. Temperature effects on the string are also considered for pipe stretch calculations. Riserless and inner-string configurations are modeled, as well as the effect of stand-off devices such as centralizers and friction reducers. Soft, stiff or hybrid string models can be used for the analysis.

Hydraulics Analysis
This module can be used to model pressure losses across the rig’s circulating system and pipe string, estimate equivalent circulating density (ECD) across the annular space, and analyze formation cuttings transport and its effect on pressure and ECD calculations. Temperature effect is also considered using four different rheological models, fluid compressibility, Fann® Viscometer readings at different temperature points, critical fluid velocity, and bit-nozzle size calculations for optimized rate of penetration.

Underbalanced Hydraulics Analysis
Use of underbalanced drilling (UBD) and managed pressure drilling (MPD) to improve circulation, rate of penetration (ROP), and reduce formation and stuck pipe events requires control of bottomhole and surface pressures, making it critical to properly model multiphase, foamed and air mist fluids. Using well known industry engineering calculations, this module provides a set of comprehensive analytical tools to determine the feasibility and optimal parameters for operations where more than one fluid is mixed including the injection of gases, and/or continuous formation influx to effectively control the pressures of the entire system. It takes into consideration the effect of wellbore geometries and deviation, string components dimensions (including tool-joints), temperature effects, fluid properties and formation cuttings transportation. With this module operators can quickly determine pressure, ECD, velocity and cutting transport ratio profiles, and other relevant hydraulic calculations for multiphase fluids, foam and air mist circulation operations.

Transient Swab and Surge Analysis
When drilling wells with narrow mud weight windows, high pressure, high temperature scenarios or low clearance in the annular space, it is critical to control the speed and other movement parameters of the string within the wellbore to avoid induced formation kicks or formation damage due to excessive swab or surge pressures.

WellPlan offers the capability to calculate transient pressures within the wellbore caused by pipe movement during tripping and cementing operations.
Highlights:
» Optimized tripping speed schedule.
» Detailed pressure transient response at any wellbore depth and at any string depth.
» The model considers temperature and pressure effects on the compressibility and viscosity of water- and oil-based muds.
» Pipe movement while circulating, displacing and pumping slurries, taking into account the axial elasticity of the moving string as well as the formation and previous casing and cement elasticity.
» Work string input allows for drillstring, casing, liner, tubing, coiled tubing and packer assemblies.
» Supports both conventional and auto-fill float equipment.

Well Control Analysis
This application’s well control module provides the most intuitive workflow in the industry to determine the kick tolerance of well designs and kill sheet calculations. The module offers a large set of modeling capabilities and variable effects such as temperature, complex wellbore and string geometries, to reduce uncertainty when planning a well and/or performing a well control operation.

Highlights:
» Extremely intuitive user interface with high standards on result visualization expediting the usage learning curve and interpretation of results.
» Kick class determination and kick tolerance calculations.
» Revised kill sheet application based on latest standard IADC forms.
» Three types of influx (gas, oil and water).
» Safe drilling depth, maximum allowable kick volume, wellbore kick circulation animation with synchronized pressure profiles, pit volume gain, formation breakdown gradient charts.

Cementing Job and Centralization Design
WellPlan™ cementing allows users to identify potential difficulties and tune the cementing design before pumping begins, starting with the casing centralization workflow which is a key factor in completing an optimal and safe cementing job. With this module, users can calculate centralizer placement for any combination of type and hole and pipe size to determine the optimal spacing between centralizers for the desired casing stand-off. By employing interactive schematics, users can design the final placement of fluids and then evaluate pressure and ECD changes along with hookload variations.

Highlights:
» Centralization placement includes the effect of torque and drag forces and survey tortuosity.
» The simple visual interface provides a fast and effective method to input the appropriate data and then clearly visualize the results for easy comparison of different alternatives to optimize placement along the casing string.
» Use of interactive schematics for fluid placement (drag and drop selected fluids) and input job details (stages and events).
» The most relevant time and volume information for the cement job is summarized in the plot footer.
» Reference lines for the fluid being pumped can be seen on cementing time or volume pumped outputs.
» Supported jobs: conventional, reverse/annulus injection, foam, with inner string.

Stuck Pipe Analysis
The stuck pipe module locates the sticking point and conducts fast, accurate failure analysis by calculating back-off force, force delivered to stuck points, and forces required to set and fire jars.

Pressure transient versus time is shown while reciprocating the pipe on bottom.

New kick circulation animation and kill sheet is based on the latest IADC standard form.

Use of interactive schematics enables fluid placement (dragging fluids) and input of job details (stages and events).
Highlights:
» Accurately locates stuck point and quickly produces a failure table for a range of
  hookloads and torque that can be applied when attempting to free the string.
» Performs yield load analysis to calculate the initial status at surface, stuck point
  and minimum over-pull or slack-off-to-load stuck point.
» Performs back-off force analysis to calculate conditions prior to back-off, initial
  surface action for back-off setup and final surface action for back-off.
» Determines the safe over-pull that can be applied to freeing the string and,
  unlike stretch charts, uses a 3D friction model.

BHA Dynamics Analysis
This module uses finite element analysis (FEA) to visually identify drilling
parameters (weight-on-bit, revolutions-per-minute and torque) that produce high
stress concentrations. Knowing these high-stress areas helps engineers minimize
large displacements, vibrations and fatigue, and avoid expensive string failures.
The module also helps predict the directional tendencies of the bottomhole
assembly (BHA).

Highlights:
» The BHA dynamics module facilitates 3D analysis.
» The BHA can be configured according to various wellbore geometries at
different inclinations and directions.
» Vibration analysis identifies critical rotary speeds and areas of high stress
  concentration in the drillstring.
» Results obtained can be used to avoid critical rotary speeds that accelerate
  pipe fatigue resulting in catastrophic drillstring failure.
» Includes effects due to ballooning, contact/friction, finite displacement,
  buoyancy, stress stiffening and damping.
» Damping includes effects such as formation interaction, drilling fluid,
  acceleration of mud outside the drillstring, mass damping produced by
  the BHA structure.
» Evaluate and predict directional behavior of the BHA.

Output-driven-input™
Input only the data needed for specific calculations to generate desired outputs.
WellPlan™ provides clear step-by-step guidance to the user on what data is
required and leads them through the input panels in just a few clicks. Dynamic
navigation and notifications highlight what is needed and how to enter it on the fly,
enabling users to know what needs to be done next. Outputs are only calculated
when all the right data is input. This enables engineers to use the system faster
and easier while supporting more accurate results.

Interactive wellbore representations
Results are displayed graphically as part of interactive wellbore representations
making interpretation of the results easier to visualize and understand.

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