

Oliasoft WellDesign

Standard RFI Response - Support
Document

1 RESPONSE TO RFI

To whom it may concern,

I hope the enclosed information will give you a good understanding of what Oliasoft's products may offer your organisation.

Oliasoft has developed its solution since 2015, with support from the entire oil industry in Norway, including operators, research organizations and government. The aim has always been to offer the oil industry the capability to perform all work related to D&W on a modern platform without the drawbacks of legacy systems. Since many players are contributing to our platform, everything is documented and published on our websites (calculations / simulations etc). This is done in order to avoid "black box" discussions.

The modern platform opens up completely new possibilities of automation, integration and autonomous systems, a necessity to reach the digital objectives of today. We truly believe that our modern engines are necessary to achieve many of the higher order effects that the industry is looking for, and we hope that you will recognize the difference between our modern engines and the "rebranded legacy systems" that we are competing with.

Looking forward to hearing your feedback.

2 THIS IS OLIASOFT - Background

Oliasoft was established in 2015 with the mission to automate well planning. This was initially based on our own disappointment with incumbent solutions.

Oliasoft want to make a change and is determined to support the modern oil industry with tools to extract maximum value from the ongoing technological transformation.

We firmly believe that many of the **new digital innovations** will come from young companies like ourselves, and not from the traditional oil service industry.

Automated and semi-automated well planning is a pre-requisite to enabling autonomous drilling operations. Oliasoft is therefore including the entire D&W calculation chain in its first product Oliasoft WellDesign™.

The initiative has received significant attention since the domain has been dominated by monopolists, old software and been fairly unresponsive to new requirements.

Oliasoft aims to solve complex problems and present them in a simple way and be **SUPER responsive** to new customer requirements.

We have had the luxury of building modern solutions from scratch, without the burden of legacy data. This have made it possible to design Oliasoft WellDesign™ as a **pure cloud based digital platform** (no hybrid solution), with open, documented API's that can be implemented in any system with very little effort.

Our hope is that the industry will take a bet and support Oliasoft. We are a humble company with a fantastic staff of people. We truly understand D&W software and we have a great ability to deliver.

Oliasoft's platform has been made from bottom-up to enable autonomous drilling and automated well planning. The modern infrastructure will also enable completely new possibilities and some examples are explained in the Appendices.

Oliasoft currently work with 6 global operators for validation of calculation engines and industry verification. Approximately 40 additional oil- and service companies continuously contribute actively with testing of new features.

In 2019, Oliasoft proudly received a price for being one of the 10 most promising start-ups in the oil industry, voted for by 140 oil companies and investors at Rice University.

INTRO: OLIASOFT PLATFORM

All Oliasoft engines and products are made on the Oliasoft Platform, a modern framework for application connectivity, automated scaling, security and handling of REST API's. The platform enables a range of digital capabilities, such as the following:



- **Cloud Agnostic Deployment**

All Oliasoft engines are “Cloud Agnostic”, meaning that all engines can run on any cloud, both hosted by Oliasoft and hosted by Operators. Oliasoft have extensive experience with deployment on Microsoft Azure, Google Cloud and AWS. Our infrastructure enables us to deploy updates several times each day on all instances, so every customer will always have the latest version.

- **Deep application connectivity**

Oliasoft makes sure all calculations and simulations carried out in applications are interconnected. For example, this enables automatic re-calculation when some dependent calculations are carried out.

- **Security and Reliability**

Oliasoft contains access control, revision control and connection to third party authentication and authorization systems, such as Azure App Service.

- **Automated scaling of calculation power**

Oliasoft handles automatic scaling and balancing of server loads, enabling heavy simulations such as Blowout & Kill, Conduction Analysis and Oil Drift Simulations to be carried out extremely efficiently by parallelizing the simulations over unlimited amount of servers. Oliasoft aim to keep all simulations below 15 minutes of calculation time.

- **REST API**

Oliasoft's REST API is fully documented and is controlled by Oliasoft framework. This enable any Oliasoft engine to be integrated into any third-party solution. Furthermore, it enables proprietary third-party calculations to be integrated with Oliasoft's overall workflow and construction of custom automation routines.

INTRO: OLIASOFT WELLDISIGN™

Oliasoft WellDesign™ is the first product being developed on Oliasoft ICE and aims to integrate all calculations necessary for well planning in a web-based solution. This is a key element to achieve automated planning and autonomous drilling operations.

Oliasoft WellDesign™ is a pure cloud based digital platform with open and documented API's that enables any other system to easily integrate with Oliasoft. Calculation engines are continuously added as chained modules. Every single calculation and simulation are openly published on our website. This is done to encourage an open industry discussion around best practices and to avoid subjective opinions around "black boxes", which is the norm for incumbent solutions.

Currently, Oliasoft WellDesign™ includes the following:

- Well Trajectory Modelling
- Triaxial Casing Design
- Hydraulics
- Surge and Swab
- Torque and Drag
- Tubing Design and Thermal simulations
- Blowout & Kill simulations

The following modules will be added in version 2.0 depending on client requirements:

- Wear Analysis
- Conductor Analysis
- Time & Cost estimation
- Automatic barrier drawing generation
- Digital procedures to enable seamless communication with rig robotics*
- Oil drift simulations

A guiding principle for the system is integration, not only on the data side, but on the linking of calculations in chains. This allows entire calculation chains to be recalculated when changes occur. Additionally, the system allows complete customization of routing through Oliasoft API. This is all driven by the mission to enable operators achieve their digital objectives.

WellDesign™ provide powerful graphical user interphases and visualisations through charts and 3D WebGL. Managing WellDesign via the REST API enables the application to be operated purely via a machine-to-machine interface. This is Oliasoft WellDesign's main differentiator and enables a whole range of new possibilities.

Examples are automatically recalculated well designs based on actual data to monitor well status in real time, or integration with warehouse or accounting systems. Oliasoft WellDesign™ enables bulk processing of thousands of well designs at the same time in optimization routines, sorted based on time, cost, safety factor or other parameters.

Similarly, exports and data generation can take any shape or form. Oliasoft have standard reporting formats for results in HTML to easily view overall status and as JSON objects through our APIs. Custom exporting formats to Word, Excel or any other format on your company templates can easily be achieved via the APIs.

3 Oliasoft Technology Stack

Oliasoft WellDesign™ (WD) is a cloud based well planning and -construction software suite, utilizing networks and cloud computers for data storage and collaboration. It offers a set of application programming interfaces, enabling 100% automation, where whole or parts of the software can be operated by other computers. On top of this interface, WD offers an interactive rich 2D and 3D human graphical user interface, utilizing the latest in web technologies such as accelerated 2D (Canvas, 3D.js) and 3D (WebGL, three.js) graphics. WD aims to run on all kinds of computers (Windows, Macs) and other interactive devices supporting modern web browsers (tablets, phones and similar).

3.1 Server Technology

The core server technology in WD is being served by Node.js, which act as the integration layer between the various core technologies and services in use. Data storage is handled through the PostgreSQL database, using a mixed model architecture (relational + object based). Our application server runs on Linux, macOS and Windows; our developers typically develop it on macOS and Windows machines, but for production the application server is deployed on cloud-based Linux servers.

In production we host and serve our servers on Linux machines. We use nginx in front of our application servers, where nginx handles specifics around SSL (network transport security), service routing and similar.

Please note that we are currently finalizing migration of all our server-side software to use docker images and Kubernetes for orchestration. This is done to simplify deployment and make it easier to support private cloud initiatives when required.

For performance reasons, we may also support the capability to run some calculations/simulation engines outside of containerized environments for performance/resource reasons.

3.2 Security

We use strong SSL encryption for all network communication. No passwords are stored anywhere at our end. Authentication happens using comparisons with properly randomized salted password hashes.

For managing login, authentication and authorization, we use a Standalone Identity Provider (IdP) with full OpenID Connect and OAuth 2 protocols. The service supports all major login and authentication flows enabling SSO (single sign on, using existing services at customer locations) and Bearer Token based API access.

All data is stored in a PostgreSQL database. This database is not “exposed” directly to the network (external world) in any way. Only access through the server APIs is possible.

Database access is only done using parameterized queries, meaning the service is immune to classical SQL injection attacks. System level access is only possible through SSH and the control panel of the hosting provider.

Application data is stored and granted using three layers of security, company level, user level and dataset level. These access levels are enforced by the server API layer. Generally, all users in a company share access to all data within the company they belong to. Individual dataset access can be controlled at a per-user level (one user in a company can specify which other individual users are allowed to read or modify a dataset). Single users may be granted access to multiple companies if necessary (consultants working for multiple oil companies and similar).

3.3 Calculation Engines

WD uses various simulation engines. Some are developed in-house, others are provided by external parties through various commercial agreements. Simple simulations are done in javascript directly. These may be run both server side (through APIs) or client side (on browsers). Other simulations require access to compiled software or special platforms. These always have interfaces through our server and can be accessed using industry standard REST based JSON interfaces.

Finite element or CFD engines, such as our temperature simulation engine, is written in high performance portable C++. It compiles and runs on Linux and macOS (and can run on Windows as well). In production we run it on Linux servers.

Our Blowout simulation engine is written in portable C# code (for historical reasons) and currently runs on both Windows and Linux images (we will use Linux in production). We run it on the Microsoft Azure cloud.

It's important to note though that specific platform requirements for these engines is not something that users see or experience; everything is wrapped and served through our

application programming interfaces on our servers (REST based JSON APIs).

3.4 Cloud Platforms

None of our services requires specific cloud platforms. We use no proprietary cloud APIs. This means our services can run on any cloud; the only requirement is that we can spin up a Linux machine on it. As far as we know this is something absolutely all cloud platforms offer. We are currently running our servers on Digital Ocean (Linux Servers) and Azure (Microsoft Windows Servers).

The only exception for being “cloud agnostics” would be services that our customers typically depend on. Currently, we are doing work to support Single-Sign Ons (SSO) through Active Directory services from Microsoft’s Azure cloud.

3.5 Continuous Integration and Deployment (CICD)

We continuously develop our software and services and release updates many times per day. When a developer is done with a new feature or bugfix, it is first tested locally on the developers’ machine. Then the update is submitted to either our production servers or test servers. An automated procedure then runs the update through a suite of automated tests to make sure nothing has been broken during the update.

Assuming all tests pass, the developer is given the option to deploy the update simply by pushing a button. When deploying, our servers pull down the latest updates, run tests again, and on success the servers update themselves, rebuild software assets (javascript bundles etc) and finally restart any relevant services. We are currently using Gitlab for CICD.

4 Response to RFI

Support Model

Oliasoft is deploying the following resources to customers as part of the basic subscription:

- **Modern technology stack**
Meaning that we deploy updates and fixes many times every day. The user always have access to the latest versions of the software. We do not operate with development cycles with updates every x months / years.
- **Mattermost customer channel**
All customers get their own chat channel directly to our development team. Oliasoft operate 10 such channels with early customers already. Users that report issues to this channel typically get a response from the development team within a few minutes.
- **Oliasoft Community (community.oliasoft.com)**
Oliasoft Community consists of help / support forums and a feature request forum for users to report issues / request. This is also where we deploy user guides and documentation for our APIs and calculation engines.
Every single calculation and simulation will be documented here.

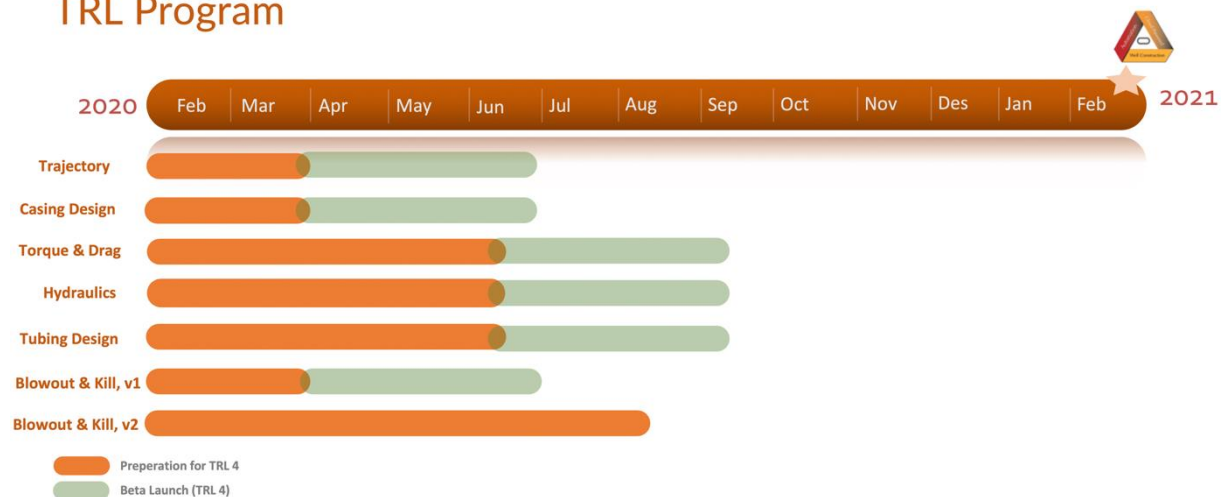
Product Development Roadmap

Oliasoft are currently completing Oliasoft WellDesign in a “verification and validation” program with 3 global operators.

This is being done according to the TRL philosophy (Technology Readiness Level) originally developed by NASA. Each of our modules are being validated by a board of industry experts before they are being approved by a chief engineer for use in the respective companies. Oliasoft has initiated this program because it will give Oliasoft the industry verification it needs to go our broader in the global market.

The chart below details the approximate dates for finalization of the TRL program for each module.

TRL Program



Catalogues and libraries

Oliasoft operate with 3 levels of libraries

- Oliasoft default library
- Company specific library
- User specific library

The Oliasoft library always consists of full catalogues from vendors who voluntarily give up such information, such as API catalogues, Tenaris, Vallourec, Sumitomo etc.

Companies does not always want their employees to design wells with all these options however. Therefore, a Company library may be defined *in addition* or *instead* of Oliasoft default libraries. Some customers also link libraries to third party systems via Oliasoft API. Examples are casing warehouse systems, SAP or other systems which are used to track available equipment for the engineering departments.

Consulting and Training

Oliasoft provide documentation and user guides on Oliasoft Community. This is normally sufficient for new users and have proven valuable for users from 30+ companies who are currently using and testing the Oliasoft application.

Additionally, Jonathan Bellarby will provide specific training courses on Oliasoft for customers who are interested.

Oliasoft also provide ad-hoc consultancy work on a broad range of issues for customers, mostly relating to specific integration work with third party systems, in-house systems or migration projects.

References

Oliasoft currently have users from 30+ companies on its platform but have special programs with selected global companies for ongoing validation programs. This work is structured as JIPs (Joint Industry Projects).

These are:

Equinor

Reference person: Bjørn Bruun

Work:

- Full validation and verification of all calculations and simulations
- Full integration with in-house systems
- Deployment of automation routines through Oliasoft API

Chevron

Reference person: Anmar Nazhan

Work:

- Full validation of calculations
- Integration with rig-systems for realtime re-calculation of the entire calculation chain

OMV

Reference person: Dag Breivik

- Work: Full validation of calculations and use in actual operations

5 Feature lists currently being fully validated by global operators in our verification programme

Trajectory Module (estimated minimum required features)

Feature list

- Import survey listing (existing well trajectory)
- Export survey listing (every x m, MD, inc, Az, TVD, Northing, Easting, DL)
- Build well trajectory from scratch using parametric build with the following modes:
 - MD, inc, Az (specify each)
 - BT3 (build section with constant dogleg)
 - BT3 (turn section with constant turn)
 - DT1 (build/turn section with specified toolface)
 - Line MD (keep inc, az while extending well to specified MD)
 - Line TVD (keep inc, az, while extending well to specified TVD)
- Coordinate system support
 - Specify site, well and targets with relative coordinates, UTM, lat/long or decimal degrees
- Anti-collision
 - Import IPM files (MWD, gyro)
 - Apply any error model to whole wells or parts of well.
 - Apply different error models to different well sections
 - Calculate center-to-center distance between wells
 - Calculate Seperation factor between wells
- Visualizations
 - Full 3D-WEBGL interactive view of trajectory, trajectory sections, and error ellipses
 - Graphs of center-to-center distance between wells and separation factor
 - Export tables showing full survey listings at any depth

Triaxial Casing Design Module (estimated minimum required features)

Feature list

- Architecture able to handle casings, liners, tubings and open hole sections
- Unlimited amount of tapered strings in each section
- Unlimited number of packers for a tubing string
- Possibility of setting packers and cementing in the same string
- Incorporation of the following effects:
 - Anisotropy
 - Asymmetry
 - Critical Dimensions
 - Critical Wall Thickness Burst
 - Critical Wall Thickness Collapse
 - Critical Wall Thickness Axial
 - Critical Wall Thickness Hoop
 - Critical Wall Thickness Radial
 - Buckling
 - Temperature Deration
 - Custom loads
- Calculation of the following:
 - Initial Conditions (all dimensions)
 - Combined axial load profiles
 - Internal / External Ballooning
 - Internal / External Piston effects
 - Internal / External Thermal effects
 - Final axial load with and without bending
 - Axial Safety Factor
 - Burst Safety Factor
 - Collapse Safety Factor
 - Triaxial Safety Factor
 - Triaxial VME plot
 - Maximum Allowable Wear per load
- Calculation of the predefined load cases:
 - Displacement to gas
 - Drill ahead
 - Frac@shoe w/gg above
 - Gas kick profile
 - Gas over mud ratio
 - Green cement pressure test
 - Pressure test
 - P&A pressure test
 - Annulus pressure test
 - Injection down casing
 - Lost returns w/water
 - Perforating gun pressure
 - Stimulation surface leak
 - Tubing leak
 - Surface Protection (BOP)
 - Casing evacuation
 - Above/Below Packer
 - Gas migration
 - Lost returns with mud drop
 - ECST
 - Installation loads

Thermal Simulations (estimated minimum required features)

Feature list

- Full multiphase and thermodynamics package able to simulate accurate temperatures throughout the wellbore. The following effects are calculated:
 - Heat transfer between casing, fluids, cement, formation and water
 - Convection effects in closed annuli, such as free convection and forced convection
 - Strict energy balance and phase transition heat, such as Joule Thomson effects
- Multistring modes:
 - APB and AFE calculations
 - Wellhead Growth
- Modes:
 - Production (any fluid flowing up tubing or casing)
 - Injection (any fluid flowing down tubing or casing)
 - Circulation (any fluid flowing down inside drill string or tubing/casing and up annulus)
 - Reverse Circulation
 - Shut-in
 - Wait

Hydraulics (estimated minimum required features)

Feature list

- The hydraulics engine is able to calculate a full fluid property table for each depth inside a string or annulus. In version 1.0 it will support the following Rheology models:
 - Newtonian fluids
 - Bingham Plastic fluids
 - Power Law fluids
 - Herschel Bulkley fluids
- Effects:
 - Drillstring eccentricity
 - Hole cleaning
 - Surge & Swab

Plots

- Pressure loss and ECD
 - Pump rate vs Pressure loss
 - Annular velocity vs depth
 - Pressure loss vs depth with any given pump rate
 - Total power losses (bar chart)
 - Total pressure losses (bar chart)
 - Pressure to break gel
 - Flow regime vs depth and pump rate
 - Equivalent circulating density vs run depth
- Bit optimization
 - Bit power vs flow rate
 - Bit impact force vs flow rate
 - Bit pressure loss vs flow rate
 - Bit nozzle velocity vs flow rate
 - HSI vs flow rate
- Hole Cleaning plots
 - Minimum flowrate vs depth to keep hole clean
 - Cuttings volume vs depth
 - Cutting bed height vs depth for any flow rate
 - Minimum flow rate vs ROP
- Surge and Swab
 - Time vs bottom hole pressure for any trip scenario
 - Trip speed vs run depth
 - Pressure vs run depth
 - Hook load vs trip time
 - Hool load vs Reciprocation time

Torque & Drag (estimated minimum required features)

Feature list

- Full soft string and hybrid string model, able to calculate torque, drag and side forces at any point in the string for a number of scenarios
- Full BHA editor and freedom to include motors and other torque generating components
- Supported operations:
 - Trip in / out
 - On / off bottom
 - Rotating on / off bottom
 - Slide Drilling
 - Backreaming
 - Reaming in
 - Drilling
- Plots:
 - Hook load
 - Torque
 - Drag
 - Tension
 - Buckling
 - Stress analysis (Yield, Von mises)
 - Full 3D plot with visualization of side forces and color maps of torque & drag levels

Blowout & Kill simulations v1 (estimated minimum required features)

Feature list blowout

- Ability to accurately predict flow potential from a reservoir using inflow performance theory and monte carlo simulations
 - Stochastic input of reservoir properties
 - Multiple reservoir definitions for oil/gas and gas/condensate scenarios
 - PVT models (Vasquez Biggs, Standing, De Ghetto)
 - Multiphase correlations: Hagedorn Brown, Beggs & Brill and Gray
- Plots:
 - Flowrate vs probability
 - Flowrate vs time
 - Volume vs probability
 - Volume vs time
 - Total weighted blowout potential

Feature list dynamic kill

- Dynamic kill is based on a numerical multiphase CFD calculation with the following abilities:
 - 1D drift flux model for 3-phase flow in wellbore
 - Mass conservation for gas and liquid using AUSM (Advection Upstream Splitting Method)
 - Mixture momentum equation solved using AUSM and Herchel Bulkley for flow in relief well
 - Mass conservation equation uses 1st order upwind method
 - Pressure is calculated using volume balance equation and equation of state for each phase
 - Slip between gas and liquid (or oil and kill fluid) employ Shi slip relations.

Blowout & Kill simulations v2 (estimated minimum required features)

Feature list dynamic kill

- Plots:
 - Bottom Hole Pressure vs time
 - Oil / Gas production from reservoir vs time
 - Kill rate vs time
 - Mud consumption vs time
 - Pump pressure and pump power vs time
 - Oil / gas / mud volume fraction in well vs time
- **Note:** Version 1.0 of dynamic kill is a “new” CFD engine and is relying on significant testing in order to become stable (just like any other CFD engine). Oliasoft has tested around 20 cases, but it is likely that Oliasoft must assist when simulating on a new type of case for some time until “most”-scenarios has been accounted for.
- The “tweaks” needed is calculation of number of grid-boxes and how many time steps is necessary to achieve a stable calculation.

Dynamic Kill Version 2.0

- Modifications to stabilize calculation for “any” scenario
 - Add pressure equation (instead of calculating pressure based on volume conservation)
 - Add drift flux model from Bhagwat and Ghajar (2014)
 - Add option to calculate accurate phase envelopes from PVT package or read input files from PVTsim and similar.
 - Calculate many scenarios at the same time (with different amount of time steps and resolution of grid) to minimize likeliness of crashing code.

Technical Capabilities Questionnaire

Borehole surveying

Survey Data Management	
Support multiple planned versions of any well trajectory	✓
Manage in bulk a hierarchy structure i.e. areas/companies, fields, sites, wells, wellbores, plans, surveys	✓
Track changes	✓
Record audit trail	✓
Define Units of Measurement	✓
Toolbar with active main tool functionalities for survey data management and trajectory planning	✓

General Set-up	
Apply ISCWSA error model	✓
Apply tailored Instrument Performance Models	✓
Apply different anti-collision scan models	✓
Apply different anti-collision error surfaces	✓
Apply different confidence levels	✓
Apply difference survey calculation methods	✓
Apply 3rd party geomagnetic models	✓
Apply different North references (true, magnetic, grid)	✓
Apply water depth	✓
Apply permanent depth references	✓
Apply drilling depth references	✓

Apply rig elevation	✓
Comments	
Our trajectory module including anti-collision has been fully validated by Equinor (Erik Nyrnes) and Chevron, and in many cases contains more than Compass (f.ex continuous gyro error models). We are currently finalizing some missing plots ("travelling cylinder" etc).	

Trajectory design	
Construct a well trajectory using the following parametric build options and constraints: <ul style="list-style-type: none"> • Slant, S-well, Build - Turn, Dogleg Toolface, Hold, Optimum Align, Nudge 	✓

Trajectory planning tools	
Able to define the following targets: <ul style="list-style-type: none"> • Point target • Circular target • Ellipse target • Rectangular target 	✓ ✓ ✓ ✓
Thread targets	✓
Interpolate rate by true vertical depth or along hole depth	✓
Project ahead by using curve, curve+hold, curve+curve, optimum align or Ouija Board <ul style="list-style-type: none"> • to a target • to TVD • to a formation (lithology depth) 	✓ ✓ ✓
Define a lithology as function of true vertical depth	✓
Perform the following activities: <ul style="list-style-type: none"> • Geomagnetic calculator • Casing list editor • Lithology editor • Graph set-up • User set-up 	✓ ✓ ✓ ✓ ✓
Perform anti-collision by using geometric and probabilistic models	✓
Compare real time actual wellpath with planned trajectory	✓
Compare real time actual wellpath with planned trajectory real time through WITSML	✓

Import/export data:	
• cut and paste survey data from clipboard	✓
• cut and paste casing scheme data	✓
• cut and paste lithology data	✓
• cut and paste IPM data	✓
• through IOGP P7 format	✓

Visualization and reporting	
Display the following visualisations for one or more wellpath(s)	
• Plan view	✓
• Section view	✓
• 3D view	✓
• Spider view - Local	✓
• Spider view - Map	✓
• Separation view	✓
• Minimum Separation view	✓
• 3D proximity view	✓
• Minimum / Maximum inclination plot	✓
• Minimum / Maximum azimuth plot	✓
Able to display the following visualisations including the estimated uncertainty of one or more wellpath(s)	
• Plan view	✓
• Section view	✓
• 3D view	✓
• Spider view - Local	✓
• Spider view - Map	✓
• Separation view	✓
• Minimum Separation view	✓
• 3D proximity view	✓
Able to provide the following reports for planning ,surveys, anti-collision and summary	
• REST API Report	✓
• Planning wellpath report for general purpose	✓
• Survey wellpath report for general purposes	✓
• Survey wellpath versus planning wellpath report for general purposes	✓
• Error ellipse report	✓
• Anti-collision report for general purposes	✓
• Anti-collision report with probability of collision	✓
• Site summary report	✓
• Well summary report	✓

Tubular Design

Tubular design software needs to accommodate two key workflows within the companies' Well Delivery Process. Firstly, an engineer needs to be able to screen standard tubular designs, "Well Archetypes" quickly and effectively against the design criteria. Secondly, an engineer needs to be able to carry out detailed casing design analysis including sensitivity analysis to compare various options and design considerations. These features may be provided by two different suppliers. The table below outlines the requirements of a tubular design software.

Functionality:

- Confirm that a proposed design of well tubulars meets the criteria of the company, i.e. calculated safety factors meet or exceed the minimum required design safety factors for various triaxial burst loads, axial loads, and collapse loads, based on pre-defined load scenarios, such as those specified in Casing & Tubing Design Manual or other
- Optimize a well/tubular selection by tuning sensitivities and making comparisons
- Produce mathematically correct results, based on the industry accepted formulas (e.g. API 5C3) for tubular performance properties, thermal operations and loads on the tubulars.

Input:

- Allow efficient input of all parameters needed for tubular design e.g. well configuration details, selected tubulars, selected fluids, tubular and material properties, connection performance envelopes, design load scenarios, safety factors, imported files.

Calculations:

- Perform calculations needed for well design e.g. calculate temperature and pressure profiles for each tubular, calculate resultant loads and safety factors.

Output:

- Produce appropriate numerical data, tables with input parameters and result of design calculations, graphical displays of parameters vs depth, VME load diagrams, summary reports, export files, etc.

General	
Tubular inventory <ul style="list-style-type: none"> • Nominal tubular dimensions • Critical tubular dimensions for burst, axial and collapse loads • Wall thickness reduction for assumed wear • Tubular material properties 	✓ ✓ ✓ ✓
Fluids inventory <ul style="list-style-type: none"> • Drilling fluids • Produced fluids 	✓ ✓

<ul style="list-style-type: none"> • Other fluids • Including mechanical, thermal & thermodynamic fluid properties 	✓ ✓
Tubular grade inventory <ul style="list-style-type: none"> • Minimum yield strength • Density • Young's modulus • Poisson's ratio • Thermal expansion coefficient • Tubular material yield strength deration • Anisotropy (Radial / Hoop) • Heat capacity and thermal conductivity 	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
Tubular material yield strength deration	✓
Thermal properties inventory <ul style="list-style-type: none"> • Formation • Cement • Fluids • Tubulars 	✓ ✓ ✓ ✓
Multiple unit systems that can be customized	✓
Import / export data files	✓
Document Generation: customisable report formats	✓

Input	
Well Setup / Case Setup <ul style="list-style-type: none"> • Define a custom well • Select predefined well template ("Well Archetype") 	✓ ✓
Well Type <ul style="list-style-type: none"> • Onshore / Offshore (Subsea) / Onshore (Surface) • Water depth • Riser details 	✓ ✓ ✓
Hole section diameters and depths	✓
Tubular details <ul style="list-style-type: none"> • Casing, liner, tubing, cemented completion • Conductor, surface, intermediate, production, tie-back • Dimensions, grade, connection 	✓ ✓ ✓
Top of cement in each annulus	✓

Annulus fluid for each tubular	✓
Produced fluids	✓
Geothermal temperature vs depth	✓
Pore pressure and fracture gradient vs depth <ul style="list-style-type: none"> • Able to show high / low scenarios 	✓ ✓
Minimum required design safety factors: Triaxial burst, Collapse, Tension, Compression <ul style="list-style-type: none"> • Pipe body • Connection 	✓ ✓
Well construction thermal operations <ul style="list-style-type: none"> • Including tubular running, circulating and cementing 	✓
Production thermal operations <ul style="list-style-type: none"> • Including tubing flow or casing flow • Including production or injection • Including perforation depth, pressure, phase model, fluid composition, friction details 	✓
Thermal operations transient and/or steady state	✓
Load cases <ul style="list-style-type: none"> • Standard load cases (e.g. Production tubing, Intermediate casing, Production casing) • Custom load cases • Internal and external pressure profile vs depth • Initial conditions (loads, temperatures, int. & ext. pressures) • Link to thermal operations • Tubular cementing and landing details 	✓
Well trajectory	✓
Tortuosity	✓
Packer and hanger depths	✓
Ability to change calculation coefficient for buckling, multi-string, and material properties	✓

Calculations	
Thermal operations <ul style="list-style-type: none"> • Well construction operations • Production operations 	✓

Load analysis for each tubular <ul style="list-style-type: none"> Calculate internal and external pressures, loads, safety factors vs depth 	✓
Include bending	✓
Include ballooning and reverse ballooning and effect on axial loads	✓
Include buckling effects	✓
Annulus thermal effects <ul style="list-style-type: none"> Annulus pressures during thermal operations Annulus fluid expansion volumes during thermal operations Venting option 	✓ ✓ ✓
Wellhead movement and tubular displacement during thermal operations	✓
Wear or corrosion wall thickness reduction tolerance analysis	✓
Comments	
We can easily add the option to enable / disable various effects.	

Output	
Reports, tables and graphs <ul style="list-style-type: none"> Input and output parameters Specific load case Multiple load cases 	✓
Calculated results versus depth, for each tubular, for each load case or operation <ul style="list-style-type: none"> Loads (force and pressure) Axial load with and without bending Internal and external pressure Temperature vs depth Minimum required design safety factor Calculated safety factors: Triaxial burst, Axial, Collapse (Pipe body) Calculated safety factors: Triaxial burst, Axial, Collapse (Connection) 	✓ ✓ ✓ ✓ ✓ ✓ ✓
Temperature vs time for each tubular	✓
Well schematic	✓
Loads displayed on VME graph <ul style="list-style-type: none"> Effective loads (temperature normalized to display on single graph) Pipe body performance envelope Connection performance envelope 	✓ ✓ ✓

<ul style="list-style-type: none"> Performance envelopes with Minimum required Design Safety Factor applied 	✓
Comments	
We are currently working on a “general” reporting module, which would allow any user / company to define their own reports with any table / plot from our platform.	

General	
Able to modify type of rig (offshore or subsea)	✓
Able to modify datum, rig elevation	✓
Able to modify water depth	✓
Able to read well trajectory from Database	✓
Able to import trajectory from different design	✓
Able to import trajectory from text (ascii, csv, excel)	✓
Able to read/write trajectory via WITSML	✓
Able to add tortuosity to planned trajectories	✓
Able to recognize out range DLS due to applied tortuosity	✓
Able to use tortuosity models (Random inclination and dependent AZ- RTOC preferred)	✓
Able to use Tortuosity magnitudes by depth	✓
Able to display DLS plot w/applied tortuosity	✓
Able to display trajectory plots	✓
Able to add hole sections	✓
Able to copy/insert hole sections	✓
Able to import hole sections within the same design	✓
Able to import hole sections from different wells	✓
Able to generate hole sections auto from WTS (Well Tech Specs)/Well Prog	✓
Able to add different open hole size in same hole section	✓
Able to apply friction factors/hole section	✓

Able to apply friction factors/operation	✓
Able to display the hole section drag/drop graphic interactive	✓
Able to add hole section from casing catalogue	✓
Able to define configuration with/without riser	✓
Able to display well schematic	✓
Able to read BHA from a database	✓
Able to import BHA from text (ascii, csv, excel)	✓
Able to read/write BHA via WITSML	✓
Able to add/duplicate/move BHA components	✓
Able to read/create/modify catalogues	✓
Able to add fluids (mud, brine, base mud, base fluid)	✓
Able to create fluid libraries	✓
Able to calculate down hole conditions from density at surface conditions	✓
Able to use Fann Data for Rheology calculations	✓
Able to import mud reports	✓
Able to use Temperature/pressure effects	✓
Able to select between different Rheology model (Herschel Bulkley, Power Law, etc)	✓
Able to read PP/FG from Database	✓
Able to import PP/FG from text (ascii, csv, excel)	✓
Able to read/write PP/FG via WITSML	✓
Able to use other type of PP/FG curves (i.e. stabor, shmin)	✓
Able to define LOT/FIT values at previous casing shoe	✓
Able to import LOT/FIT data from database/other sources	✓
Calculator for MD\TVD\PP\FG	✓
Able to display PPFG Mud weight plot	✓
Able to create custom plots or choose different variables	✓

Comments
Any such “able to use” questions are possible to do through the API. We also have support for most of them through our GUI.

Drilling Mechanics

Torque & Drag Modelling	
Able to calculate down hole conditions from density at surface conditions	✓
Able to model different operations	✓
Able to model slackoff/pickup during drilling operation sensitivity option (5 lines or more)	✓
Able to apply temperature deration on yield strength	✓
Able to run user defined operations	✓
The model allows for the use of dual mud gradient (i.e. two or more fluid columns in the well)	✓
Able to create custom plots	✓
Able to change colour for actual data in plots	✓
Able to add annotation	✓
Able to generate reports from plots	✓
Able to plot case sensitivities in software to check against RT data	✓
Able to run friction factor sensitivity	✓
Able to plot tension at specific component while running in/out of hole	✓
Able to run casing with inner string and landing string	✓
Able to use MPD in T&D Analysis	✓
Comments	
Chevron and Equinor are helping us validate the models against actual well data	

Hydraulics	
Able to calculate down hole conditions from density at surface conditions	✓
Able to account for fluid compressibility	✓
Able to create custom plots or choose different variables	✓
Able to create roadmap plots: ECD vs Run depth	✓
Able to create roadmap sensitivity ECD vs ROP (3 or more)	✓
Able to create roadmap plots: Circulating Pressure vs Run Depth	✓
Able to copy and paste to excel file (1 step) Broomstick	✓
Able to read/write Broomstick via WITSML	✓
Able to import/export WITSML	✓
Comments	
Chevron and Equinor are helping us validate the models against actual well data.	

Surge & Swab	
Able to select different type of PP/FG curves (stabor, shmin, etc)	✓
Able to identify weak point on the entire hole section for a Swab/Surge	✓
Able to run Optimized trip speed	✓
Able to select different depth at ECD transient	✓
Swab/Surge module allows to use dual mud gradient (i.e. two or more fluid columns in the well)	✓
Able to check the floater auto fill or conventional	✓
Able to read/write BHA via WITSML	✓
Comments	
Chevron and Equinor are helping us validating the models against actual well data	

Blowout & Kill

Blowout & Kill	
Able to present all reservoir parameters using probability distributions	✓
Able to simulate with multiple reservoir definitions for both two-phase oil & gas and gas condensate fluid characteristics	✓
Able to simulate with either oil/gas or gas/condensate reservoirs	✓
Automated model selection based on well configuration	✓
Probabilistic event modeling compliant with latest guidelines and NORSOK-D10	✓
Able to present the results as a probability range	✓
Dynamic kill simulation for operations through existing drill string or relief well	✓