Course Description:
The goal of the course is to enable participants to understand the operations carried out by directional drillers and contribute to the design of directional and horizontal wells. The course covers the fundamentals, design considerations and operational aspects of directional and horizontal drilling.

The course is conducted at the Schlumberger Stonehouse Technology Center (SHTC) which is Schlumberger’s Drilling Center of Excellence. SHTC provides innovative engineering and quality-driven manufacturing, with emphasis on rotary steerable systems, downhole mud motors, telemetry and power source products.

Numerous visits, workshops and practical exercises at SHTC will complement and illustrate the theoretical knowledge taught in class.

Topics Covered
■ Surveying
■ Geodetics
■ Defining the Geological and Drilling Targets
■ Anticollision
■ Directional Calculations
■ Steering the Well
■ Shock and Vibration
■ Drillstring Design to Prevent Failure

■ Geomechanics
■ Pre-warning of Wellbore Stability Issues
■ Hole Cleaning
■ Steering and the use of Toolface MTF/GTF and Gyro
■ Scribing a Survey Tool to a Motor or Whipface
■ Introduction to Geosteering
■ Introduction to TAML
■ Powering Downhole Tools

Audience:
Drilling Engineers, Drilling Supervisors, Trainee Directional Drillers personnel with basic drilling engineering skills.

Prerequisites:
Basic drilling engineering and 1 - 3 years wellsite experience. Prior exposure to directional drilling is recommended. Good mathematic skills are necessary, particularly trigonometry.

Cost: GBP £3,500
**DAY 1**

Review of the workscope of the directional driller and review of group exposure to directional techniques

**Surveying**
- Defining the objectives of the survey
- Understanding the survey tools. Focus on MWD magnetic surveying tools
- The components of a survey and the techniques used to check the quality of a survey *Visit to the survey tool manufacturing facility and a detailed look at the construction of both battery and turbine type MWD tools*
- Gyro tool principles and application *Practical exercise in the construction of a Gyro tool running checklist for use offshore*

**Error models and the role of ISCWSA**
- Understanding the importance and application of error models
- Building a survey program and the principle of surveying ‘by parts’
- The error ellipsoid and its defining features

**Survey corrections**
- SAG and alignment
- DMAG and nonmagnetic calculations
- GRS and IIFR, the principles of in field magnetic mapping, crustal corrections and solar interference

**Practical points to be addressed**
- Reading and applying a survey program
- Ability to understand the requirements for a valid survey
- Generate and apply a gyro tool run checklist

**DAY 2**

**Where are we and where are we going?**
- Geodetics: The science of geodesy and reference datums
- Targets: Defining the geological and drilling targets

**Anticollision**
- Principle concepts of a/c. EOU, Separation factor, Separation rules and the creation of No go circles
- The traveling cylinder *Practical exercise in the creation of traveling cylinder from model. Practical exercise looking at the importance of North referencing*
- Staying safe from the ‘hi tech approach’ avoiding the false security of pure ‘bright light’ systems

**Directional Calculations**
- Survey calculations and errors *Practical exercise and discussion on well planning*

**Practical points to be addressed**
- Well directional objectives
- Staying safe from collision during drilling operations
- Understanding and use of the traveling cylinder plot
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| **Steering the well**<br> - Basic BHA design principles *Practical exercise with BHA models to design different BHA behaviours*<br> - Mud Motors<br> - Rotary steerable systems *Visit to RSS manufacturing plant and witness construction of Point The Bit, Push The Bit and hybrid RSS systems*<br> - Sidetracking a wellbore, Open hole, whipstock, section milling, cement plugs<br> - Other BHA design considerations, MWD/LWD and Jars<br>**Shock and vibration**<br> - Basic modes of vibration<br> - Design to prevent shocks<br> - Mitigation at the rigsite<br>**Drillstring design to prevent failure** - *Visit to failure analysis lab to see the effects of Shock and vibration on downhole components*<br>**Practical points to be addressed**<br> - Selection and application of appropriate steering tools and techniques<br> - Planning a sidetrack strategy<br> - Preventing damage to bottom hole equipment and increasing run life
| **Geomechanics**<br> - Stresses in the rock, the effect of the borehole on stress *Practical demonstrations*<br> - Well planning to avoid geomechanical failure<br> - Breakout as an indicator of principle stress directions. Understanding how LWD data can assist the drilling<br>**Process by pre-warning of wellbore stability issues**<br> - Shale hydration and the effects of fluid type on stability of unconsolidated formations *Exercise in the basic calculation of stresses acting on the borehole*<br> - Managed pressure whilst drilling<br>**Hole cleaning**<br> - Basic principles of cutting movement and the effect of hole angle<br> - Boycott settling and the demonstration of avalanching in ‘boycott tube’<br> - Directional steering system selection to ensure adequate hole cleaning<br> - Understanding the fluid flow in directional and high angle wells<br> - Breaking the high RPM ‘always good’ myth. Preventing unnecessary drill pipe wear<br>**Drilling test facility visit** - *Visit to the drilling test facility for steering tool testing*<br>**Practical points to be addressed**<br> - When and why boreholes fail and what causes instability in high angle holes<br> - What needs to be done to avoid cutting related incidents in directional wells<br> - The effect of fluid type on stability
| **DAY 5** |
| **Steering and the use of Toolface MTF/GTF and Gyro**<br> - *Exercise in using MTF*<br> - Scribing a survey tool to a motor or whipface<br> - Introduction to Geosteering<br> - Introduction to TAML<br> - Powering downhole tools *Visit to battery centre and discussion of the safety implications for client reps*<br>**Candidate Subject presentations and Exam**<br> - Course recap and discussion<br>**Practical points to be addressed**<br> - Understanding directional steering decisions from toolface information<br> - Supervising the ever changing plans in a geosteering environment<br> - Managing the safety of the ever increasing numbers of Lithium batteries used in DD/MLWD tools
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