

Format and Duration Classroom - 5 Days

Instructor(s): Kevin Gray

Summary

This course will deliver an advanced understanding of modern directional drilling techniques and the industry standards used in well placement and wellbore surveying. The evolution of directional drilling tools and techniques that are used to achieve high accuracy well positioning are detailed with reference to the fundamental engineering that underlies the equipment we work with, and the procedures and practices we work to.

This is very much an operationally focused course which looks to deliver a detailed understanding of not just the narrow field of the Directional Driller's work, but all the associated areas of risk that can result from the practices, tools and techniques that they may use. The knowledge from this course can be directly applied to ongoing drilling operations or future well planning and will have a dramatic impact on drilling performance. All the topics are placed in their operational context and an understanding of how each topic is interrelated with the other subject areas in the course is developed throughout the week. Throughout the course areas in which directional drilling and surveying can adversely impact the well cost or increase the well risk are detailed and the mitigations for these risks are discussed.

The course can be delivered at Foundation or Skilled level depending on the audience.

This course is delivered in partnership with Black Reiver Consulting Ltd.

Learning Outcomes

Participants will learn to:

- 1. Understand why life threatening well to well collisions happen and how even large technically driven companies make mistakes. You will be given the knowledge to understand how to avoid these catastrophic events.
- 2. How the role of the Industry Steering Committee on Wellbore Surveying Accuracy has shaped the requirements for modern well placement. You will understand what these standards are and why we must work to them. The Consultation on an API standard for surveying.
- 3. When to use high cost technology like rotary steerable systems and when these systems all little value.
- 4. How to push the drilling envelope further and increase the drilling radius of any rig to deliver more fluids back to the asset.
- 5. How to use the evolving science of Geomechanics alongside the increasing volume of Formation evaluation while drilling data available in real time to deliver substantially lower NPT on any drilling project.
- 6. How work with a geology team to geoplace or geosteer a well path within specific lithology's or a specific fluid type.
- 7. Working with positional and geological uncertainty.



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Training Method

This is a classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.

- Practical demonstrations of all the key principles using models and simulations in the classroom.
- Mixed instructor led delivery of theoretical content with blend of PowerPoint overview, whiteboard explanations of detail and class interactive exercises.
- A narrative that runs through the course where each topic is interrelated and build on the previous learnings.
- Extensive allowance for class led questioning within the course delivery.

Who Should Attend

This course is ideal for drilling engineers, well site supervisors, tool pushesr, rig managers and field support personnel. Geoscientists or reservoir engineers looking to get better value from your interactions with the drilling team. Anyone involved with improving drilling performance and cutting drilling costs.

Course Content

1. Introduction to Directional Drilling

- Types of Directional Wells, Benefits, and Applications
- The Evolution of Directional Drilling Technology
- Historical advancements and modern techniques
- Key drivers for the use of high cost rotary steering tools

2. Pushing the ERD Envelope to Increase Step-Out Distances

- Extended Reach Drilling (ERD) capabilities
- Factors influencing maximum horizontal displacement

3. Wellbore Surveying and Positional Accuracy

- Introducing uncertainty of position
- Basic Positional Surveying Recap of tools and techniques
- Surveying Principles
- First Angle Corrections (FAC) and ISCWSA QA/QC Standards
- Understanding wellbore positioning quality assurance and quality control (QA/QC)

4. Surveying Tools: Types and Operational Principles



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- Measurement While Drilling (MWD) and Logging While Drilling (LWD)
- Inertial navigation, gyro surveys, and wireline survey tools

5. How Wellbore Surveys are Corrected and Accuracy Improved

- Grid Reference System (GRS), InField Referencing (+IIFR), and Multi-Station Survey Analysis
- How Mistakes in Well Positioning are Made
- Impact of survey errors and misalignment
- Influence of rig site practices on wellbore accuracy
- Surveying the Well: Key Technologies and Methods
- Magnetic, gravity, and inertial tool face measurements
- Comparison of survey methodologies and correction techniques

6. Geodesy and Cartography in Directional Drilling

- Impact of coordinate system distortions on directional accuracy
- Catastrophic errors in rig positioning

7. Anti-collision Awareness & Wellbore Uncertainty

- The Importance of Anti-collision Awareness
- Anticollision strategies and risk mitigation
- Avoiding wellbore intersections in congested fields
- The Principle of Uncertainty and Its Effect on Well Anti-collision & Target Sizing

8. Torque, Drag, and Hole Cleaning Considerations

- The Origins of Torque and Drag in the Wellbore
- Friction and mechanical interactions between the drillstring and wellbore

9. How Increasing Hole Angle Creates Significant Problems

- Hole cleaning challenges, Non-productive Time (NPT), and wellbore stability issues
- Mitigation strategies to optimize wellbore conditions

10. Bottom Hole Assembly (BHA) Design and Well Steering

- How to Design the Bottom Hole Assembly (BHA) for Low Angle Wells
- Key components: Drill collars, stabilizers, motors, rotary steerable tools (RST)
- How BHA Design Must Change as Well Inclination Increases
- Adjustments for high angle and horizontal wells
- BHA Tendency: Building, Dropping, and Holding Angle



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- How BHA design influences well trajectory and tortuosity
- Matching BHA to the planned well profile

11. Well Steering Methods and Techniques

- How Wells are Deflected and Steered
- Magnetic, gravity, and inertial tool face measurements
- Steering modes: Rotary vs. sliding drilling
- New Technologies in Directional Drilling
- Automated and Al driven directional drilling advancements
- Autonomous drilling systems and real time adjustments

12. Shock, Vibration, and Performance Optimization

- Shock and Vibration in Downhole Equipment
- Origins, impact, and common causes of vibration
- Effects on downhole tools, wellbore stability, and rate of penetration (ROP)
- How to Reduce or Remove Unwanted Vibration
- Best practices for mitigating shock and reducing tool damage
- Vibration damping technologies

13. Wellbore Stability and Geomechanics in Directional Drilling

- Stability issues in directional wells
- Principles of the stresses acting around the wellbore
- Effects of Formation Stress on Wellbore Deviation
- Managing geomechanical risks in high angle wells
- Avoiding Differential Sticking in Directional Wells

14. Drilling Fluids and Hydraulics Considerations in Directional Wells

- Effect of Mud Rheology on Directional Drilling
- Controlling pressure drops, hole cleaning, and wellbore stability
- Optimizing Hydraulics for performance

15. Types of Drill Bit and their Selection

- Advances in bit design and cutter technology improvements
- Stability, Steerability, Durability and ROP criteria for technical limit performance

This structured course outline provides a comprehensive approach to Directional Drilling, covering: Surveying principles and positional accuracy, BHA design and well steering strategies, Torque, drag, and



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hole cleaning challenges, Advanced technologies and Realtime data applications.