Directional Drilling in Mining Training Course

Professional Development Training Course Outline

Category	General Training	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Directional Drilling in Mining Training Course is engineered to bridge the gap between legacy drilling practices and next-generation, precision-guided penetration methodologies. Participants will dive deep into the mechanics of steering mechanisms, real-time spatial data analysis, and geological risk mitigation, ensuring that modern operations can optimize asset utilization, minimize environmental footprints, and significantly lower the cost-per-meter drilled in challenging geological formations.

Integrating advanced telemetry and automated systems is no longer a futuristic luxury but a current operational necessity. This course offers an immersive, technically rigorous curriculum covering the entire lifecycle of directional drilling operations from high-fidelity kinematic modeling and **Measurement-While-Drilling (MWD)** sensor integration to the deployment of advanced rotary steerable systems (RSS) and specialized drilling fluids. By synthesis of theoretical fluid dynamics, geomechanics, and hands-on digital twin simulations, the training empowers engineers and supervisors to execute complex, multi-lateral, and curved boreholes with unprecedented spatial accuracy. standards.

Programme Curriculum

Directional Drilling in Mining Training Course

Introduction

Directional Drilling in Mining Training Course is engineered to bridge the gap between legacy drilling practices and next-generation, precision-guided penetration methodologies. Participants will dive deep into the mechanics of steering mechanisms, real-time spatial data analysis, and geological risk mitigation, ensuring that modern operations can optimize asset utilization, minimize environmental footprints, and significantly lower the cost-per-meter drilled in challenging geological formations.

Integrating advanced telemetry and automated systems is no longer a futuristic luxury but a current operational necessity. This course offers an immersive, technically rigorous curriculum covering the entire lifecycle of

directional drilling operations from high-fidelity kinematic modeling and **Measurement-While-Drilling (MWD)** sensor integration to the deployment of advanced rotary steerable systems (RSS) and specialized drilling fluids. By synthesis of theoretical fluid dynamics, geomechanics, and hands-on digital twin simulations, the training empowers engineers and supervisors to execute complex, multi-lateral, and curved boreholes with unprecedented spatial accuracy. standards.

Course Duration

10 Days

Course Objectives

1. Master Precision Spatial Trajectory Design
2. Optimize Real-Time Telemetry & MWD/LWD Systems.
3. Command Advanced Rotary Steerable Systems (RSS.
4. Mitigate Complex Geomechanical Risks.
5. Formulate High-Performance Drilling Fluids
6. Execute Advanced Mine Dewatering & Drainage Bored Holes.
7. Deploy Specialized Underground Coal Bed Methane (CBM) Drainage.
8. Leverage Digital Twin & Drilling Automation Technologies
9. Implement In-Mine In-Seam (IMIS) Exploration Techniques
10. Manage Drill Bit Kinematics & Selection Matrix.
11. Enforce Strict QA/QC Surveying Protocols.
12. Optimize Asset Lifecycle & Total Cost of Ownership (TCO
13. Drive Sustainable Eco-Drilling Initiatives.

Target Audience

- Directional Drilling Engineers & Project.
- Mine Planning, Exploration, & Resource Geologists.
- Drilling Superintendents, Rig Supervisors, & OperationsLeads.
- Geotechnical & Rock Mechanics Engineers.
- Hydrogeologists & Environmental Engineers
- Technical Directors & Chief Technology Officers (CTOs).
- Equipment Manufacturers & Service Providers.
- Safety, Health, & Environmental (SHE) Managers.

Course Modules

Module 1: Foundations of Directional Drilling in Mining

- Evolution from conventional vertical drilling to high-accuracy directional trajectories in modern mining.
- Fundamental terminology: True Vertical Depth (TVD), Measured Depth (MD), inclination, azimuth, and dogleg severity (DLS).
- Coordinate systems, map projections, and magnetic vs. true north reference frameworks.
- Economic and operational drivers: multi-lateral drilling, surface footprint reduction, and deep asset accessibility.
- Review of mining-specific applications: exploration, block cave pre-conditioning, and ventilation holes.
- *Case Study:* Transitioning a major Australian iron ore operation from vertical grid-drilling to multi-lateral directional exploration, resulting in a 40% reduction in surface environmental footprint and a 25% increase in core recovery efficiency.

Module 2: Directional Well Planning and Trajectory Design

- Geometric design profiles: build-and-hold, S-curves, continuous deep-build, and horizontal configurations.
- Mathematics of trajectory calculations: Radius of Curvature, Minimum Curvature, and Tangential methods.
- Target definition and target sizing criteria based on geological certainty and resource constraints.
- Anti-collision analysis: separation factor calculations, traveling cylinder plots, and proximity risk management.
- Software-driven 3D borehole trajectory design and integration with mine planning models (e.g., Deswik, Vulcan).
- *Case Study:* Resolving complex anti-collision challenges in a hyper-congested underground copper mine in Chile, safely planning 12 new drainage holes within 5 meters of existing production voids.

Module 3: Downhole Steering Mechanisms & Mud Motors

- Principles of Positive Displacement Motors (PDMs): rotor-stator configurations, torque generation, and power curves.
- Bent-sub and adjustable kick-off (AKO) housing mechanics for slide vs. rotary drilling modes.
- Rotary Steerable Systems (RSS): comprehensive breakdown of "Push-the-bit" vs. "Point-the-bit" technologies.
- Steering mechanics in hard-rock environments: overcoming high compressive strength and abrasive formations.
- Tool face orientation control: managing gravitational vs. magnetic tool face under varying dynamic loads.
- *Case Study:* Implementing point-the-bit RSS in an ultra-hard South African gold mine, increasing the Rate of Penetration (ROP) by 35% while maintaining a strict DLS limit of less than $4^\circ / 30\text{m}$.

Module 4: Measurement-While-Drilling (MWD) & Surveying Telemetry

- Telemetry architectures: Mud Pulse Telemetry (MPT), Electromagnetic (EM) telemetry, and wired drill pipe systems.
- Sensor physics: Tri-axial accelerometers and magnetometers for high-accuracy inclination and azimuth tracking.
- Magnetic interference mitigation: managing drill string magnetization and utilizing non-magnetic drill collars (NMDC).
- Gyro-While-Drilling (GWD) technology: operational principles and deployment in environments with high magnetic interference.
- Real-time data transmission constraints, filtering algorithms, and processing surface decoders.
- *Case Study:* Overcoming severe electromagnetic shielding in a deep Canadian nickel deposit by deploying an hybrid Mud-Pulse/EM telemetry system, ensuring uninterrupted 100% data streaming at 1,500 meters depth.

Module 5: Logging-While-Drilling (LWD) & Real-Time Formation Evaluation

- LWD sensor configurations: Natural Gamma Ray, dual-induction resistivity, neutron density, and sonic tools.
- Real-time geosteering techniques: utilizing boundary detection logs to actively navigate within narrow mineralized zones.
- Cross-functional interpretation of petrophysical data downhole to optimize casing points and core sampling targets.

- Correlation of LWD data with structural geological models for immediate structural revision and fault detection.
- Data compression, memory-versus-real-time resolution trade-offs, and QA/QC of downhole logs.
- *Case Study:* Real-time geosteering within a tabular platinum reef in Zimbabwe using azimuthal gamma logs, keeping the borehole within a 1.2-meter-thick target zone over a continuous horizontal distance of 600 meters.

Module 6: Geomechanics and Wellbore Stability

- Subsurface stress regimes: calculating overburden stress (S_v), maximum (S_{Hmax}), and minimum (S_{hmin}) horizontal stresses.
- Mechanical Earth Model (MEM) development: integrating sonic logs, core testing, and leak-off test (LOT) data.
- Borehole failure modes: analyzing tensile fractures, shear breakouts, and plastic formation squeezing.
- Safe Operating Windows: calculating optimal mud weight to prevent both breakdown/loss of circulation and borehole collapse.
- Trajectory-dependent wellbore stability: evaluating how hole inclination and azimuth interact with regional stress fields.
- *Case Study:* Stabilizing directional exploration holes through highly fractured, squeezing ground in a deep Peruvian polymetallic mine by dynamically altering mud weights based on real-time geomechanical stress indicators.

Module 7: Advanced Drilling Fluids and Rheology for High-Angle Holes

- Functions of drilling fluids in directional holes: cutting transport, friction reduction, and wellbore stabilization.
- Rheological modeling: Bingham Plastic, Power Law, and Herschel-Bulkley fluid dynamics for directional applications.
- Cuttings transport mechanics in inclined and horizontal intervals: managing the formation of cuttings beds.
- Lubricity and friction management: specialized solid and liquid lubricants to reduce torque and drag ($T\&D$).
- Environmental formulation: designing biodegradable, low-toxicity water-based muds (WBM) meeting strict mining regulations.
- *Case Study:* Overcoming critical cuttings bed accumulation in a 65° inclined ventilation pilot hole in an Indonesian copper-gold mine through the deployment of specialized mixed-metal oxide (MMO) fluid systems.

Module 8: Drill Bit Kinematics and Rock Destruction Mechanics

- Polycrystalline Diamond Compact (PDC) bit design: cutter layout, back-rake/side-rake angles, and chamfer configurations.
- Roller cone bit dynamics in directional mining application: bearing choices, gauge protection, and tooth geometry.
- Rock destruction mechanics: compressive shearing vs. tensile crushing in highly anisotropic mining formations.
- Bit walk and steerability: predicting and counteracting a bit's natural tendency to drift left or right based on rotation.
- Dull bit grading (IADC standard) and failure analysis: identifying thermal degradation, impact chipping, and ring-outs.

- *Case Study:* Custom engineering a matrix-body PDC bit with specialized premium cutters for a deep Arizona copper project, expanding bit life by 200% and eliminating mid-run trips.

Module 9: Torque, Drag, and Drill String Design

- Physics of torque and drag: calculating hook load limits, slack-off weights, and rotational torque allowances.
- Drill string component selection: heavy-weight drill pipe (HWDP), drill collars, stabilizers, and jar placement optimization.
- Buckling criteria: predicting and avoiding sinusoidal and helical buckling modes in high-angle trajectories.
- Critical speed analysis: identifying and mitigating destructive axial, torsional (stick-slip), and lateral drill string vibrations.
- Casing design and liner selection protocols for multi-stage, deep directional mining applications.
- *Case Study:* Resolving severe stick-slip vibration and structural helical buckling in an ultra-deep exploration program in Nevada by incorporating specialized aluminum drill pipes and dynamic dampening subs.

Module 10: In-Mine In-Seam (IMIS) Directional Drilling for Coal Operations

- Operational objectives of IMIS: proactive seam tracking, outburst prevention, and rapid methane drainage.
- Surface-to-In-Seam (SIS) versus underground-launched long-hole directional drilling methodologies.
- Navigating coal seam structural anomalies: tracking undulating seams, handling roof/floor drop-outs, and crossing faults.
- Gas drainage engineering: optimizing cross-panel hole spacing, drainage duration, and borehole vacuum pressures.
- Specialized explosion-proof (Ex d) intrinsically safe downhole surveying and steering equipment for coal environments.
- *Case Study:* Designing and executing an extensive underground IMIS methane drainage network in a high-gas coal mine in Queensland, decreasing seam gas content by 65% prior to longwall mining and ensuring zero gas-related stoppages.

Module 11: Directional Drilling for Block Caving and Pre-Conditioning

- Introduction to block caving mechanics and the vital role of pre-conditioning deep, competent rock masses.
- Directional hydrofracturing: designing parallel and fan-shaped directional hole arrays to induce micro-fracturing.
- Pre-conditioning via targeted directional blasting: hole layout, charge placement, and detonation sequencing.
- High-accuracy intersection of cave boundaries and monitoring of fracture propagation via microseismic arrays.
- Equipment selection for massive, high-diameter directional pre-conditioning hole programs.
- *Case Study:* Implementing a comprehensive directional hydrofracturing pre-conditioning matrix at a major block cave operation in Chile, achieving uniform cave propagation and reducing seismic hazard events by 50%.

Module 12: Dewatering, Drainage, and Hydrogeological Control

- Designing subsurface hydrogeological control networks using long-range directional horizontal boreholes.

- High-wall depressurization techniques: drilling precise upward-inclined drainage holes to prevent catastrophic slope failure.
- Grout curtain installation via directional arrays: drilling and pumping high-pressure grout to seal off massive water inflows.
- Sump-targeting and underground water transfer boreholes: planning high-angle, tight-tolerance connection holes.
- Managing severe sand production, borehole scaling, and acid mine drainage (AMD) during dewatering operations.
- *Case Study:* Preventing a catastrophic open-pit high-wall failure in an African copper mine by rapidly deploying a fan of 400-meter directional drainage holes, dropping pore water pressure by 60% within 30 days.

Module 13: QA/QC, Surveying Accuracy, and Geomagnetic Modeling

- Ellipsoid of Uncertainty (EOU) concept: understanding error propagation downhole and its impact on geological modeling.
- Multi-Station Analysis (MSA) for post-processing magnetic survey data to remove systemic drill string errors.
- In-Field Referencing (IFR) and Interpolated In-Field Referencing (IIFR) using real-time geomagnetic observatory data.
- High-precision laser and optical gyro systems for initializing surveys in deep underground environments.
- Borehole intersection validation protocols: ensuring target intercepts meet strict mineral resource reporting standards (e.g., JORC, NI 43-101).
- *Case Study:* Utilizing advanced IIFR data corrections on a deep exploration project in Scandinavia, reducing target intercept EOU radius from 22 meters down to 4.5 meters at a measured depth of 2,200 meters.

Module 14: Digital Transformation, AI, and Autonomous Drilling Automation

- The architecture of modern autonomous drilling rigs: surface control networks, downhole edge computing, and cloud analytics.
- AI algorithms for real-time ROP optimization: machine learning models dynamically adjusting WOB and RPM.
- Digital Twin integration: pairing real-time downhole data streams with live structural and mechanical simulations.
- Automated slide drilling loops: utilizing automated software to execute precise steering corrections without human error.
- Predictive maintenance via IoT sensors: tracking component vibration and temperature to forecast downhole tool failures.
- *Case Study:* Deploying an autonomous AI-steered directional system on a multi-rig exploration project in Western Australia, which boosted overall drilling efficiency by 28% and completely eliminated human-induced steering over-corrections.

Module 15: Contract Management, Economics, and ESG Frameworks

- Key commercial drilling contract frameworks: day-rate, meter-rate, performance-bonus, and turnkey agreements.
- Structuring Key Performance Indicators (KPIs) to align drilling contractor incentives with mine safety and efficiency goals.

- Cost engineering: conducting rigorous lifecycle cost-benefit analyses comparing conventional versus directional programs.
- ESG integration: reducing greenhouse gas emissions through optimized rig power systems and minimizing surface water consumption.
- Regulatory compliance, risk allocation matrices, and insurance provisions for high-risk directional drilling operations.
- *Case Study:* Restructuring a multi-million dollar exploration contract for an ESG-focused mining major, integrating dynamic performance bonuses tied to carbon footprint reduction and local community water-protection metrics.

Training Methodology

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Ready to enroll or request a customized program? Book online or contact us:

Register Online Now

Email: info@fineskilltrainingcenter.com | Website: www.fineskilltrainingcenter.com