COURSE OVERVIEW DE0849
Horizontal and Multilateral Wells: Analysis and Design (E-Learning Module)

Course Title
Horizontal and Multilateral Wells: Analysis and Design (E-Learning Module)

Course Reference
DE0849

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours
(3.0 CEUs/30 PDHs)

Course Description

This E-Learning is designed to provide participants with a detailed and up-to-date overview on the analysis and design of horizontal and multilateral wells. It covers the formation pressure & temperature and the causes of abnormal pressure; the fracture pressure determination methods, casing setting depth selection, intermediate casing and liner and surface casing setting depth selection; the economics and drilling analysis and identify the factor affecting drillability constant and efficiency; and the various types of drilling fluids, water base mud formulation and mud properties.

During this interactive course, participants will learn the e types and common size of casing; the production casing, hole conditions and physical properties; the cementing practices, flow patterns, effective centralization, evaluation of cement job and procedure for casing and primary cement jobs; the types of liners, stage cementing, cement plug guidelines, slurry design, workover fluids and drillable packers; the air and foam drilling, drilling fluid selection, practical well control, direct pressure indicators, methods of well control, well kill methods and the driller's method; the smart drilling and completion techniques; the well inflow performance and the factors affecting inflow performance; and the formation damage including its causes, sources of formation damage and rules.

Course Objectives

After completing the course, the employee will:-

- Apply and gain an in-depth knowledge on the analysis and design of horizontal and multilateral wells
- Identify the applications of horizontal, multilateral, and intelligent wells from geological and reservoir aspects
- Assess multidisciplinary inputs for successful screening of advanced well projects
- Predict horizontal and multilateral well productivity with integrated reservoir flow and well flow models
- Evaluate formation damage and well completion effects on advanced well performances
- Diagnose problems in advanced wells and conduct the necessary sensitivity analyses
- Evaluate well stimulation treatments, including multiple-stage fractured horizontal well performance and matrix acidizing results
- Intelligent well concept, design and field applications8- Minimize technical and economic risk in advanced well projects
- Discuss formation pressure & temperature and the causes of abnormal pressure
- Apply fracture pressure determination methods, casing setting depth selection, intermediate casing and liner and surface casing setting depth selection
- Carryout economics and drilling analysis and identify the factor affecting drillability constant and efficiency
- Identify the various types of drilling fluids, water base mud formulation and mud properties
- Review casing design as well as recognize the types and common size of casing
- Describe production casing, hole conditions and physical properties
- Apply cementing practices, flow patterns, effective centralization, evaluation of cement job and procedure for casing and primary cement jobs
- Identify the types of liners, stage cementing, cement plug guidelines, slurry design, workover fluids and drillable packers
- Determine air and foam drilling, drilling fluid selection, practical well control, direct pressure indicators, methods of well control, well kill methods and the driller's method
- Employ smart drilling and completion techniques as well as discuss well inflow performance and the factors affecting inflow performance
- Describe formation damage including its causes, sources of formation damage and rules
- Illustrate single curve design and well planning and identify the completion options and aspects in horizontal or high deviated sections
- Apply completion methods, case analysis, pipe centralization, sand control, data transmission methods, directional surveying and surveying guidelines

Who Should Attend

This course provides a complete and up-to-date overview of horizontal and multilateral wells analysis and design for drilling engineers, reservoir engineers, geologists, production and completion engineers and supervisors.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Fee

As per proposal

Course Contents

- Formation Pressure & Temperature
- Causes of Abnormal Pressure
- Formation Pressure Prediction
- Methods o Formation Pressure Predictions
- Formation Kicks
- Fracture Pressure Determination Methods
- Casing Setting Depth Selection
- Intermediate Casing and Liner
- Surface Casing Setting Depth Selection
- Surface Casing
- Economics & Drilling Analysis
- Drilling Cost Equation
- Penetration Rate Equation
- Factor Affecting Drillability Constant
- Factors Affecting Drilling Efficiency (Major, Minor, Controllable or Non-Controllable)
- Effects of Drilling Variables
- General Guidelines and Assumptions Used in Optimized Drilling

- Variables Considered in Optimization
- Effect of Formation Properties
- Effect of Mud Properties
- Weight on Bit
- Rotary Speed
- Bit Tooth Wear
- Penetration Rate Equation
- Drilling Fluids Review
- Drilling Fluids
- Types of Drilling Fluids
- Water Base Mud
- Oil Base Mud
- Water Base Mud Formulation
- Gel Mud
- Gel Polymer
- Lignosulphonate or Lignite Mud
- Lime or Gypsum Mud
- Salt Saturated Mud
- PHPA Mud
- Glycol
- Non-Damaging Mud
- Mud Properties
- Mud Weight
- Rheology
- Fluid Loss
- Retort
- Ph
- MBT
- Ions Titration
- Review of Casing Design
- Running and Cementing Casing
- Types of Casing and Common Size
- Conductor Casing

- Recommended Cements
- Surface Casing
- Characteristics
- Summary of Surface Casing
- Intermediate Casing
- Purpose
- Characteristics
- Summary of Intermediate Casing
- Production Casing
- Summary of Production Casing
- Hole Conditions
- General Considerations
- Physical Properties
- Couplings
- API Couplings
- Non-API Couplings
- Casing Design
- Burst Loading
- Collapse Loading
- Tensile Loading
- Biaxial Loading
- Casing Design Chart
- Running Casing
- Conclusion
- Cementing Practices
- Cement and Cementing
- Why Use Cement
- Manufacture of Cement
- Properties of Cement
- Portland Cement
- Cement Requirements
- Thickening Time
- Strength-Time Requirements

- Cement Additives
- Lightweight Additives
- Heavyweight Additives
- Accelerators
- Retarders
- Low Water Loss Slurries
- Lost Circulation Materials
- Special Cements
- Diesel Oil Cements
- Perlite Cements
- Latex Cement
- Pozzolanic Cements
- Perforating Qualities
- Corrosion Resistance
- Bond Requirements
- Considerations After Cementing
- Primary Cementing Practices
- Flow Patterns
- Effective Centralization
- Well Cleaners
- Stop Collars
- Cement Contamination
- Evaluation of Cement Job
- Procedure for Casing and Primary Cement Jobs
- Cement Job
- Important Tips
- Liner Philosophies
- Factors Influencing Liner Cementing Jobs
- Planning Guidelines
- Types of Liners
- Liner String
- Purpose of Intermediate Liner
- Characteristics

- Common Cements
- Cementing Procedure
- Reciprocation Vs. Rotation
- Tie-Back Liners Purposes
- Characteristics
- Common Cements
- Tie Back Liners Cementing
- Scab Liners
- Problem Areas When Setting Liners
- Stage Cementing
- Summary of Stage Cementing Purposes
- Inner String Cementing
- Cementing Directional Holes
- Deep Well Liner Cementing
- Post Cement Job
- Plug Back Cementing
- Reasons for Plugging
- Areas of Concern
- Hole Considerations
- Placement Methods
- Balanced Plug
- Dump Bailer
- Two-Plug
- Modified Two-Plug
- Spacers and Additives
- Testing a Cement Plug
- Cement Plug Guidelines
- Squeeze Cementing
- Purposes of Squeeze Cementing
- Squeeze Terminology
- Bradenhead Squeeze Method
- Squeeze-Packer Method
- Squeeze Pressure Requirements

- Squeezing Fractured Zones
- Slurry Design
- Workover Fluids
- Drillable Packers
- Retrievable Squeeze Packer
- Testing Squeeze Jobs
- Summary
- Introduction to Lightweight Drilling Fluids Technology
- Drilling by Lightweight Drilling Fluids is Known in Oil Industry as - Under-Balanced Drilling
- What is UBD
- Additional Definitions
- Foam Operations
- Mist Operations
- Air Operations
- Mudcap Operations
- Why Drill Underbalanced?
- Historical Perspectives
- Under-Balanced Drilling in the United States
- UBD Definition - Formation Pressure Is Equal to or Greater Than Circulating Pressure
- UBD – Types
- Normally Pressured Reservoirs
- Depleted Reservoirs
- Regulatory Barriers to Underbalanced Drilling
- Barriers to UB
- Operators Barriers
- Reasons for UB Growth
- Technical Improvements
- Working on
- Completion Techniques
- Reasons for UB Drilling
- Effect of Skin On Production Rates
- Physical Limits To UB Drilling

- Production Limits To UBD
- Types Of Flow Regimes
- Fluid Phase Continuity
- Generalized “Fluid” Systems
- Control Equipment
- Equipment - Rotating Head
- Closed Loop Circulation System
- Equipment - Gas Source
- Air Drilling
- Air Drilling Dusting
- Air Drilling Benefits
- Air/Dust Drilling Layout
- Misting
- Foam Drilling
- Foam Drilling
- Foam Drilling Benefits
- Mist Or Foam Drilling Layout
- Gaseated Or Aerated Drilling
- Aerated Fluid
- Parasite String
- Jet Sub
- Parallel Casing String
- Aerated Fluid Layout
- Aerated Drilling Problems
- Flow Drilling
- Drilling Fluid Selection
- Surface Equipment
- Surface Pits
- Operating Procedures
- Mudcap Drilling
- Snub Drilling
- Closed Systems
- Other Surface Equipment

- Factors Leading To Increased UBD
- Practical Well Control
- When And Why A Well Kick Occurs?
- Knowledge Of Pore And Fracture Pressures Leads To:
- Normally Pressured Formation
- Abnormal Formation Pressures
- Incomplete Compaction
- Diagenesis
- Differential Density In Dipping Formations
- Fluid Migration
- Tectonic Movement – Uplifting
- Tectonic Movement – Faulting
- Aquifers
- Salt Formations
- Shale Properties Used To Predict Pore Pressures
- Normally Pressured Shales
- Abnormally Pressured Shales
- Porosity Density
- Conductivity Sonic
- Temperature Gradient – Increases
- Pore Pressure Prediction Occurs:
- Before Drilling
- During Drilling
- After Drilling
- Direct Pressure Indicators
- Causes Of Kicks – Tripping
- Causes Of Kicks
- Causes Of Kicks – Drilling
- Causes Of Kicks – Others
- Kick Warnings – Drilling
- Detecting The Kick
- Kick As A Result Of Loss Circulation
- Shallow Gas

- Shallow Gas Kicks
- Gas Cutting
- What Causes Gas-Cut Mud?
- Well Shut-In Regulations
- Shut In Procedures – Drilling
- Shut In Procedures – Diverters
- Shut In Procedures – Casing
- Use Diverter When:
- Diverter Procedure:
- Pumps And The Kill Rate
- Why Kill Rate Is Less Than Normal Drilling Rate?
- Kill Rate Circulating Pressure
- Why Should SIDPP Be Used To Calculate Wt2?
- Methods Of Well Control
- Well Kill Methods
- The Driller's Method
- Driller's Method – Advantages
- Wait And Weight Method
- Wait & Weight Method
- Concurrent Method
- Horizontal & Multilateral Wells: Completions & Stimulation
- Smart Drilling
- Limitations Of Horizontal Wells
- Application Of Horizontal Drilling
- Types Horizontal
- Ultra Short Radius
- Short Radius
- Completion Techniques
- Horizontal Well & Reservoir Concerns - The "Skin Effect" Concept
- Possible Flow Models For Stabilized Well Inflow Vertical Well
- Pressure Drawdown In The Wellbore
- Well Inflow Performance
- Factors Affecting Inflow Performance

- Formation Damage
- Cause Of Formation Damage
- Sources Of Formation Damage
- Rules Of Formation Damage
- Damage Quantified Through Skin
- Positive Skin
- Horizontal Well Skin Damage
- Effective Wellbore Radius
- Productivity Index
- BHA Performance Considerations
- Dogleg Severity Limit
- Horizontal Well Path Design
- Short Radius Wells(SRW)
- Medium Radius Wells (MRW)
- Long Radius Wells (LRW)
- Well Profile Design Considerations
- Single Curve Design
- Design Equation
- Torque And Drag
- Well Planning
- Conclusion
- Case History - Long Radius Horizontal Well
- Building BHA
- Results
- Conclusion
- Reservoir Characteristics
- Formation Damage
- Formation Porosity
- What Is Porosity “Φ” ?
- Formation Permeability
- Permeability Of A Formation
- Impermeable Formations
- Absolute Permeability

- Effective Permeability
- Rock Properties
- Capillary Pressure (Pc)
- Definition
- Influence Of Capillary Size On Height Of Rise Of Wetting Fluid
- Typical Capillary Pressure Curves For Differing Rock Types
- Effect Grain Size In Permeability
- Oil Reservoirs
- Structural Traps
- Stratigraphic Traps
- Traps General –Structural Trap Example
- Stratigraphic Traps Example
- Various Types Of Reservoir Data Are Used
- Geological Factors Affecting Oil Reservoirs Properties
- Causes Of Low Productivity Wells
- Skin Effect
- Reservoir Model Of Skin Effect
- Reservoir Pressure Profile
- The Cost-Impact Of Formation Damage On Well Production
- Effect Of Skin On The IPR Curve
- Oil Viscosity "µO"
- Solution Gas-Oil Ratio "Rs"
- Reservoir Pressure < Oil Bubblepoint Pressure
- Productivity Index
- Flow Efficiency
- Reservoir Drive Mechanism
- Dissolved Gas Drive
- Gas Cap Drive
- Water Drive
- Water Drive - Main Producing Characteristics
- Gas Cap Drive - Main Producing Characteristics
- Solution Gas Drive - Main Producing Characteristics
- course recap

- horizontal and multilateral wells: completions & stimulation
- completion options and aspects in horizontal or high deviated sections
- Pre-Completion & Completion Design
- Completion Methods
- Open Hole Completion
- Pre-Drilled Or Slotted Liner
- Pre-Drilled Or Slotted Liner With External Casing Packers
- Liner, Cemented And Perforated
- Open Hole With Pre-Drilled Liner & The Stand Alone Screen
- EXTERNAL CASING PACKERS
- CASE STUDY
- External Casing Packer (ECP) Description
- Annular Casing Packer
- Casing Drilling. Case Study
- Casing Drilling – Benefits
- Cwd. Benefits
- Cwd. Rig Type
- Conclusions
- Weatherford Case Study
- Casing To Drill Exploration Or Directional Wells.
- Disadvantages
- ECP'S
- Type Mandrel
- Continuous Mandrel Ecp
- Perforated Shoe
- Bulldog ACP From Weatherford
- Open Hole With The Stand Alone Screen
- Open Hole With Gravel Pack
- Horizontal Completions
- Horizontal Completions In Sandstones
- Multi Well Pad Drilling
- When This Mwp Drilling Is Applicable ???
- Disadvantages

- Costs
- Surface Limitations
- Completion Fluids
- Types Of Fluids
- Crude Oil
- Diesel Oil
- Clear Water Fluids
- Formation Salt Water
- Sea Water Or Bay Water
- Brines
- Types Of Brines
- Completion Of Horizontal Wells
- Completion Objectives
- Types Of Completions
- Open Hole Completion
- Pre-Slotted, Pre-Perforated Liner Completion
- Perforated Liner Completion
- Case Analysis
- Cementing A Horizontal Liner
- Functions Of Primary Cementing
- Factors Affecting The Displacement Of Drilling Fluid
- Displacement Velocity Of The Cement Slurry
- Cement Slurry Displacement
- Pipe Centralization
- Condition Of Drilling Fluid
- Difference In Density Between Drilling Fluid And Cement Slurry
- Condition Of Cement Slurry
- Pipe Movement
- Considerations In Cementing Horizontal Wells
- Drilling Fluid Properties
- Fluid Circulation
- Pipe Movement
- Pipe Centralization

- Spacers And Flushes
- Flow Velocity
- Hole And Pipe Size
- Free Water
- Slurry Density And Rheological Properties
- Sand Control
- Reasons For Sand Production
- Screen Types
- Wire Wrapped Screens
- Slotted Pipe Screens
- Gravel Pack
- Wash Down
- Reverse Circulation Pack
- Crossover
- Directional Down Hole Tools
- Mud Motor(DHM)
- Measurement While Drilling
- Types Of Information Sent
- Data Transmission Methods
- Retrievable Tools
- Drilling Mechanics Information
- Formation Properties
- Data Transmission Methods
- Mud Pulse Telemetry
- Positive Pulse
- Negative Pulse
- Continuous Wave
- Electronic Pulse Telemetry (EM Pulse Tool)
- Wired Drill Pipe
- Retrievable Tools
- Limitations
- Directional Surveying
- Surveying Guidelines

- Survey Tools
- Inclination Only Tools
- Magnetic Survey Tool Types
- Gyroscopic Survey Tool Type
- Minimum Survey Program
- Survey Program For A Development Well
- Survey Tool Selection
- Survey Tools Errors (Uncertainty Factor)
- Anti-Collision Planning
- Suspension Of Object Well
- Operations Integrity Management In Horizontal Wells
- Operations Integrity Management
- Steps Of Program Implementation
- Management Of Change MOC
- Program Generation
- Program Ammendments
- Points Of Consideration
- Definition Of Well Integrity
- The Foundation Of Well Integrity
- Why Is Well Integrity Important
- High Risk Well
- Well Integrity Assurance Task Force
- Well Integrity Assurance Task Force
- Well Completion Types
- Factors Affecting - Well Completion & Workover Design
- Completed Oil Well
- Completion Classifications
- Reservoir-Wellbore Interface
- Reservoir-Wellbore Interface
- Number Of Zones Completed
- Types Of Completion
- Completion Considerations
- Openhole Completions

- Well Completion Types
- Open Hole Completion Types
- Advantages Of Openhole Completions
- Openhole Completions Are Particularly Attractive
- Uncemented Liner Completions
- Screen/Pre-Perforated Liner Completion
- Perforated Liner Completion
- Cemented Liner Completion
- Cased Hole Completion Type
- Perforated Completions
- Mode Of Production Flowing Artificial Lift
- Completions For Pumping Wells
- Application Range
- Typical Artificial Lift Application Range
- Number Of Zones Completion
- Single String Flowing Well Completion
- Single Completion
- Multizone Completions
- Multizone Completion Schematics
- Gas Producer Completions
- Water Injection Completions
- Horizontal Water Injection Completions
- Case Studies Exercises
- Workshop - Killing The Well
- Data
- Casing Leak
- Repairing Casing Leaks Using Small-Particle-Size Cement.
- Criteria For Determining The Adequacy Of Cement
- Results
- Gas Well Leak
- Gas Leak In Annulus
- Factors As The Main Causes
- Guides

- New Advanced Cement System (NACS)
- Comparison Of Horizontal And Fractured Vertical Wells
- Influence Of Well Eccentricity
- Eccentricity
- Reservoirs W/ Water Or Gas Coning
- Comparison Of Horizontal And Fractured Vertical Wells
- Conventional Unconventional Reservoirs
- Vertical Well Stimulation
- Benefits Of Horizontal Wells Are:
- Disadvantages Of Horizontal Wells Are:
- Marginal Oil Wells
- Water Coning In Carbonate Reservoir
- Conclusions
- Horizontal And Multilateral Applications Overview
- Tight-Gas Formations
- Maximize Pay Zone
- Improve The Productivity Of Wells In A Fractured Reservoir.
- Rock Units That Benefit Most From Horizontal Drilling
- Relief Well For Well Out Of Control
- Horizontal Drilling And Hydraulic Fracturing In Shales
- Multilateral Drilling
- With Injection Of Co2
- Using Logs For Corrections In Drilling
- Real-Time Geosteering Takes Multilateral Wells
- Five Branch Multilateral Wells
- Multilateral Applications
- Logging For Horizontal Wells
- Production Logs
- Logging
- The Transient Behavior Of Fluid Flow
- Extreme Production Logging In Long Horizontal Wells With High Flow Rates Using Downhole Tractors
- Extreme Logging With Tractors
- Multiphase Log. Horizontal

- Coil Tubing Logging
- Multi-Lateral Completions Review
- TAML
- TAML Classification
- TAML Level 1 Definition
- Open Hole Trunk And Laterals
- TAML Level 2 Definition
- Cemented Mainbore And Openhole Lateral At The Junction
- TAML Level 3 Definition
- Cased Hole Mainbore, Mechanically Connected Lateral Liner
- TAML Level 4 Definition
- Main-Bore & Lateral Cased & Cemented
- TAML Level 5 Definition
- Pressure Integrity At The Junction
- TAML Level 6 Definition
- Pressure Integrity At The Junction
- Development Of Multilateral Wells
- Case Study Sumatra
- Offshore Southeast Sumatra
- Completion Characteristics
- Development Cost Summary
- Location Of Multilaterals
- Level 6 Completion
- Intelligent Completion In Multilaterals
- How To Optimize Well Production?
- Optimization Method:
- Completion Schematic
- Tapping On Reserves, Upper Lateral
- Production Scenario
- Summary
- Coiled Tubing Operation In Horizontal Wells
- Coiled Tubing Unit
- Circulation

- Pumping
- Coiled Tubing Drilling
- Logging And Perforating
- Coiled Tubing Rig Up
- Coiled Tubing Unit On Truck
- Perforating In Horizontal Wells With Coiled Tubing
- Coil Tbg Perforating
- Subsea Well Perforating
- Gun Activation
- Perforate Long Intervals
- Logging
- Pumping
- Clean Out And Circulation
- Coiled Tubing Rig Up
- Production
- Drilling With Coil
- CTD
- Injector Head Of Coiled Tubing
- Coiled Tubing Rig Up
- Onshore Light Coiled Tubing Unit