Course Overview

This course has been written for entry level, young (typically graduate level) Operator Staff who require an understanding of casing design before they undertake casing design with Stresscheck on the computer. Understanding casing design in the traditional way is important so that computer generated mistakes are averted.

The following media are used:-

1) Lectures (the Trainer began his career 35 years ago as a Drilling Engineer and has designed many, many wells in the traditional way for land rigs, jack-ups, platforms and semi-submersibles);
2) PowerPoints (written by the Trainer);
3) Videos (particularly for casing connectors and expandable liners);
4) Casing Design Examples;
5) Teamwork Exercises & Manuals

Casing whilst drilling will also be covered in overview so that delegates become aware of this technology.

Provision is also made for delegates to discuss any aspect of their up-coming wells which are pertinent to their employer’s projects in order to attain success not just for the first time – but every time.

Reference is made to API Specification 5CT

Aims & Objectives

By the end of the course, delegates will understand those key drivers behind casing design so that they are able to design a string of casing for their well. They will also be able to select the appropriate connectors for their well and will be aware of the adverse effects of things like buckling, corrosion and wear.

Consultancy services can be provided both before the course (e.g. certain wells / problems can be looked at), during the course (e.g. certain problems can be reviewed) or after the course (e.g. advice / well review) should delegates require.

Who Should Attend

Entry Level Graduate Drilling Engineers

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Your Dedicated Coach

Michael Gibson (PhD)

**Overview**
- Seasoned professional with 35 years’ worldwide experience on drill-ships, semi-submersibles, tender-assist units, platforms, jack-ups and land rigs.
- Extensive experience both onshore and offshore in engineering and operations for Operators and Drilling Contractors on exploration, appraisal & development wells.
- Extensive risk assessment, advisory, planning and rig-site work experience ranging from Drilling Engineer through to Drilling Supervisor, Superintendent & Drilling Manager.

**Training**
Training experience worldwide ranges across Operators, Drilling Contractors and Service Companies both in-house and public in the following areas :-
- HPHT
- Stuck Pipe Prevention & Fishing
- Deepwater Well Engineering
- Deepwater Operations
- Directional Drilling
- Horizontal & Multilateral Wells
- Accelerated Drilling Programmes for Drilling Contractors
- Graduate Drilling Engineering for Operators
- Optimised Drilling Practices
- Well Planning & Engineering
- Well Construction
- Well Control (Advanced, Understanding, Deepwater & HPHT)

**Consultancy**
Engineering & Operations Advisor to Operators, Drilling Contractors, Banks & Insurance Companies worldwide re Drilling & Field Development, Risk & Blowouts
- Hazard Analysis
- Offshore Operations
- Technical Advisor for HPHT Developments
- Well Control
- Technical Advisor for Deepwater Operations

**Project**
- Project Manager for HPHT Field Development; Standard Field Development
- Production Optimisation
- Risk Mitigation
- Brownfield Re-development
- Deepwater
- Well Control
- Management Systems

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INTRODUCTION TO CASING DESIGN

During this introductory session you will gain an understanding of the forces and pressures at work downhole and how they can affect casing. We will cover the following subject areas:

- Functions of casing
- Key design considerations
- Typical loadings e.g. collapse, burst, tensile, buckling
- The life-cycle approach to casing design
- Running casing

CASING TYPES & FUNCTIONS

During this section we cover the various types of casing we use when planning and drilling wells both on land and offshore:

- Stove Pipe, Marine Conductor, Foundation Pile
- Conductor String (Typically 30” OD)
- Surface Casing String (Typically 20” OD)
- Intermediate Casing String (Typically 13 3/8” OD)
- Production Casing String (Typically 9 5/8” OD)
- Liners (e.g. 7”, 5” etc.)

We will also review the use of expandable liners, how they work and the advantages they bring to the industry.
GENERAL CASING PROGRAMME CONSIDERATIONS

In this section of the course we look at what’s important in terms of data / information in order to help us design the most cost-effective – and correct – casing design solution:-

- Seismic data
- Offset data
- The reservoir (oil, gas, condensate, pore pressure, fracture pressure, temperature, hydrogen sulphide, carbon dioxide)
- Influx volume size
- Geology
- The sea-bed (strength, mud volcanos etc.)
- Shallow gas

CASING DESIGN PRELIMINARIES

During this section we will study what we really must know in order to proceed with our design, namely:-

- Formation breakdown gradient / Fracture Pressure
- Formation Strength Tests / Leak-off Tests

Plot of pressure against time during a Formation Breakdown Test

- Pore Pressure Prediction
- Determining Casing Setting Depths
- Influx Volumes
- Using API Nomograms
- Kick Tolerance

THE USE OF EXPANDABLE LINERS

This section looks at the 2 types of Expandable Liners on the market and the advantages of running them:-

- Solid Liner Expandables
- Lattice Expandable Liners

Rock Mechanics Understanding is Essential for Cost Effective Casing Design

- Exploration wells
- Appraisal wells
- Development wells
- Rig Capacity & Deck Storage
- Stocking arrangements

Casing Must Be Stacked Correctly

Problematic Geological Formations may need to be cased off with a Drilling Liner

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CASING DESIGN – FINAL SELECTION

This section of the course looks at:-

- Your company’s design factors for collapse, burst, tension and tri-axial loadings
- Your company’s design policies
- Collapse design
- Burst design
- Tensile design
- Tri-axial design
- Wear
- Corrosion
- Special design cases

FEA demonstrating collapse

Collapse Production Loads – Schematic Representation

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CASING DESIGN EXAMPLE

During this section we will go through a full casing design example. We can use either oil-field or SI Units. We will cover the following sections:

Intermediate Casing String

- Determine Formation
- Fix setting depth for projected influx
- Kick Pressure Profile
- Setting Depth Determination

Shoe Setting Depth

- Collapse Design Factor (usually 1.0)
- Calculate Surface Collapse Load
- Calculate Setting Depth Collapse Load
- Construct Collapse Load Line
- Select Casing: Check for lightest grade first
- Check maximum depth for lightest casing using collapse load line
- Calculate limiting depth
- Check for next heavier depth
- Repeat as necessary
- Complete design to setting depth

Burst Design

- Burst Design Factor (usually 1.1)
- Calculate the maximum allowable pressure at the shoe
- Find the ratio of the gas pressure at depth to that at the surface
- Calculate the internal pressure at the surface
- Find the external load
- Calculate burst load at the surface and at depth
- Draw the burst load line
- Select casing
- Check for heavier or lighter grades as necessary
- Combine Burst and Collapse criteria. (Doing this gives us a casing string which meets expected burst and collapse loads. It must now be checked for tensional loadings during the installation and cementing phases).

Tension Design

Casing must withstand four types of tensional loads:
- The casing’s own weight
- Effective weight of casing due to its weight in air & buoyancy
- Bending Force
- Drag Forces / Shock Loads (whichever is higher)

We will look at these and at the following:

- Design Factor (usually 1.3)
- Calculate true weight in air of each section based upon TVD
- Find weight at top of each section
- Calculate buoyancy factor
- Calculate the buoyant load at the bottom of each section
- Draw the buoyant load line
- Calculate the effective tension due to bending
- Calculate the static load at both surface and at depth
- Draw the static load lines
- Calculate shock
- Calculate installation load
- Draw installation load line
- Check that casing string can withstand loads
- Decide on pipe body yield strength or connection strength as criterion (Note:- Pipe body yield strength is typically less than joint strength and so must therefore be used)
- Compare pipe body yield strength with installation loads
- Pressure testing: tension check
- Determine weakest point
- Determine the additional load that can be applied
- Convert the additional load to a pressure
- Determine maximum allowable pressure for burst

Production Casing String

Will be covered similar to above format.

Surface Casing String

Will be covered similar to above format.
CASING DESIGN

DAY FOUR & FIVE

CASING CONNECTORS

During this section we will look at a variety of connectors from a variety of manufacturers in both digital film and PowerPoint format, looking at the design and functional advantages of each of them.

CORROSION CONSIDERATION

During this section we look at key areas of corrosion which the casing design engineer should be aware of – for example rust, pitting and hydrogen embrittlement etc.

OTHER CONSIDERATIONS

During this section we will cover other important key considerations such as:

- Casing wear (especially on directional wells)
- One-way trip situations
- Buckling etc.

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IDEAS (Independent Drilling Engineering Associates) is a **thinking** company. It **focuses** its in-depth and holistic knowledge, breadth of experience and expertise onto operators, drilling contractors and service companies’ drilling engineering and related work requirements, to provide top quality fast turnaround bespoke work packages on either an ad-hoc or long term basis, 24 hrs per day / 365 days per year, worldwide.

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