MCEDD

DEEPWATER DEVELOPMENT

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Advancing Casing Drilling to Deepwater: Rethinking Top Hole Well Construction

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Executive VP/CTO

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Agenda

- Subsea Drive Corporation Intro.
- Top hole well design issues
- Leveraging the subsea geology
- Riserless casing drilling benefits
- Shallow hazard mitigation strategies
- Casing drilling system and operation
- Summary and Conclusions

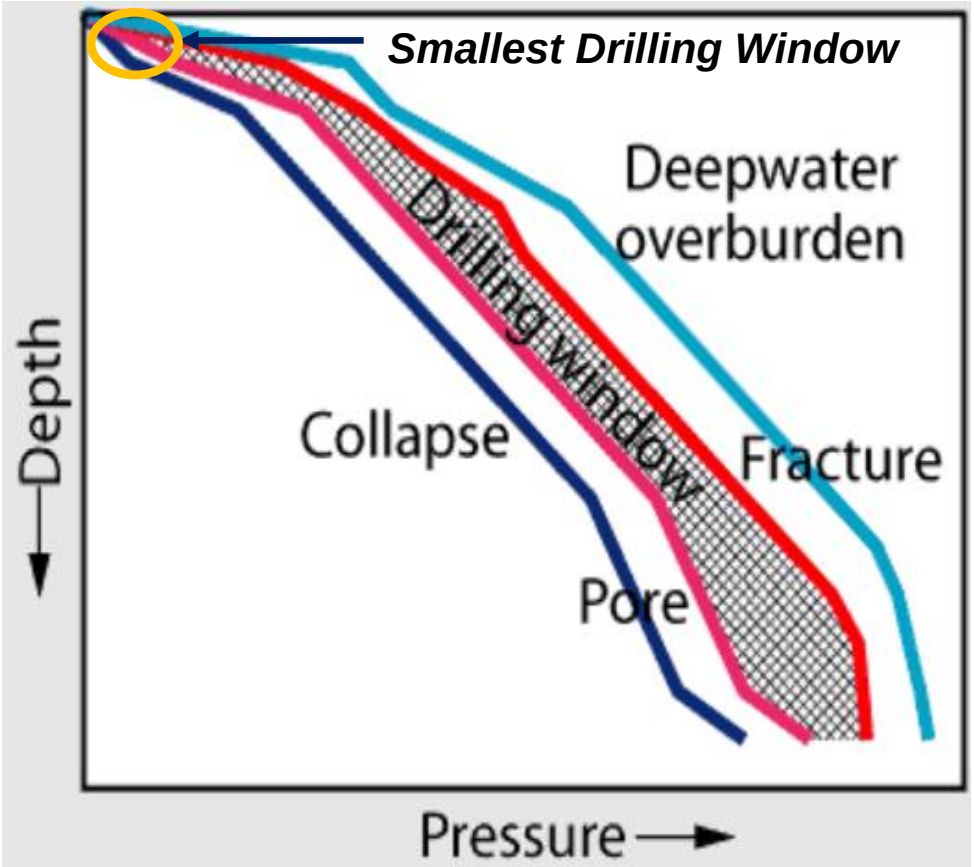
Courtesy Transocean

Subsea Drive Corporation

- Offshore technology company based in Houston, Texas
- Patented technology to deepen the initial conductor (structural) casing to increase well reliability
  - US 8,229,671 B2 July 24, 2012, Method and System for Riserless Casing Seat Optimization
  - US 11,542,791 B2 Jan 3, 2023, Systems & Methods for Casing Drilling Subsea Wells
- Completed conceptual design of riserless casing drive system
- Technology partners: Blade Energy Partners & Frontier Oil Tools

What are the Top Hole Well Design Issues?

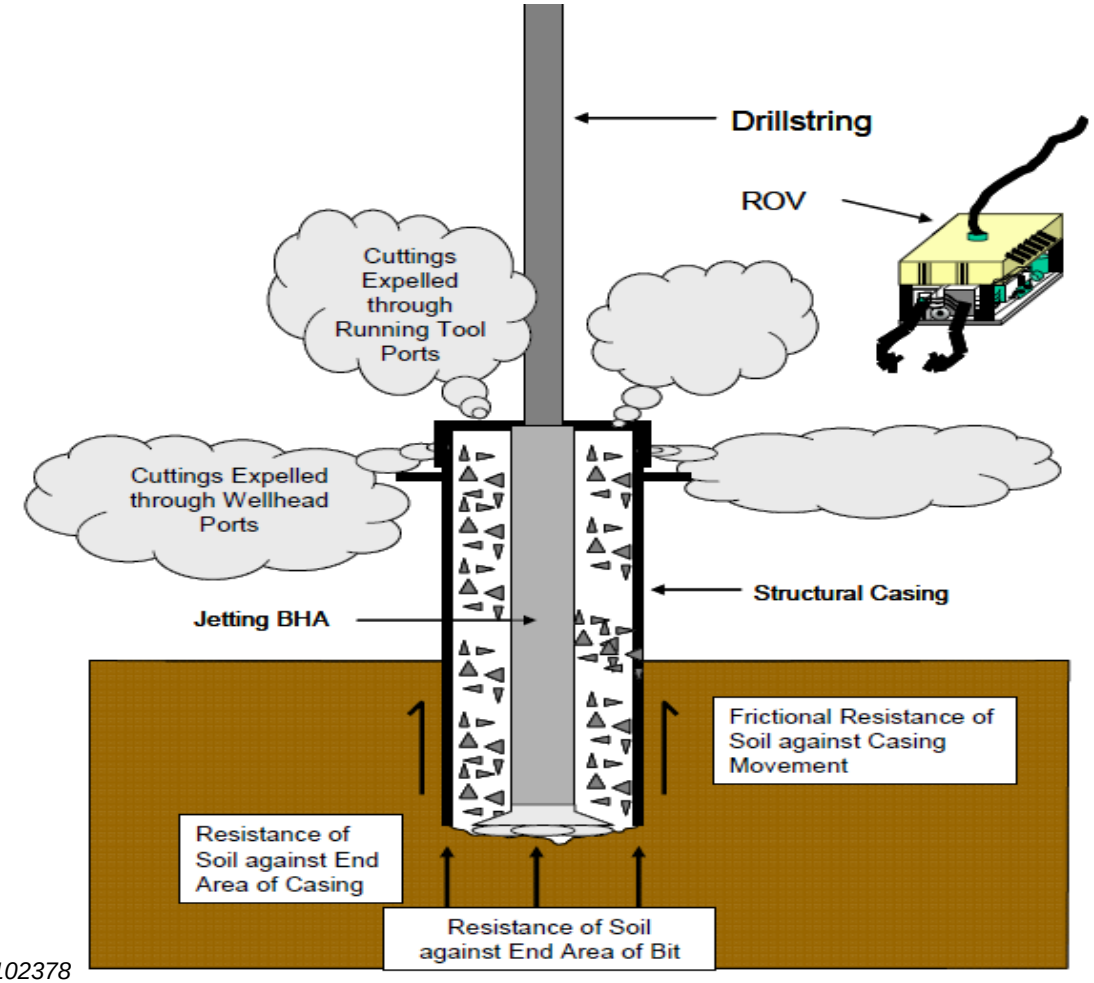
- Drilling window smallest near seafloor
- Riserless (shallow) casings not set at optimum depth
- Excess of riserless casing strings limit deeper hole geometry
- Inefficient shallow hazards mitigation
- Jetting process



Deepwater Pore Pressure/Fracture Gradient Profile

Jetting Process

- Jetting is the established process used for initial conductor casing installation
  - ➢Technically limited
  - ➢Bit driven by mud motor
  - ➢Casing is “pushed” into sediment
  - ➢Returns taken inside casing to seafloor
  - ➢Hard sediment exceeds jetting limit
  - ➢Conductor setting depth is based on jetting limitations, *NOT SCIENCE*



Source: SPE 102378

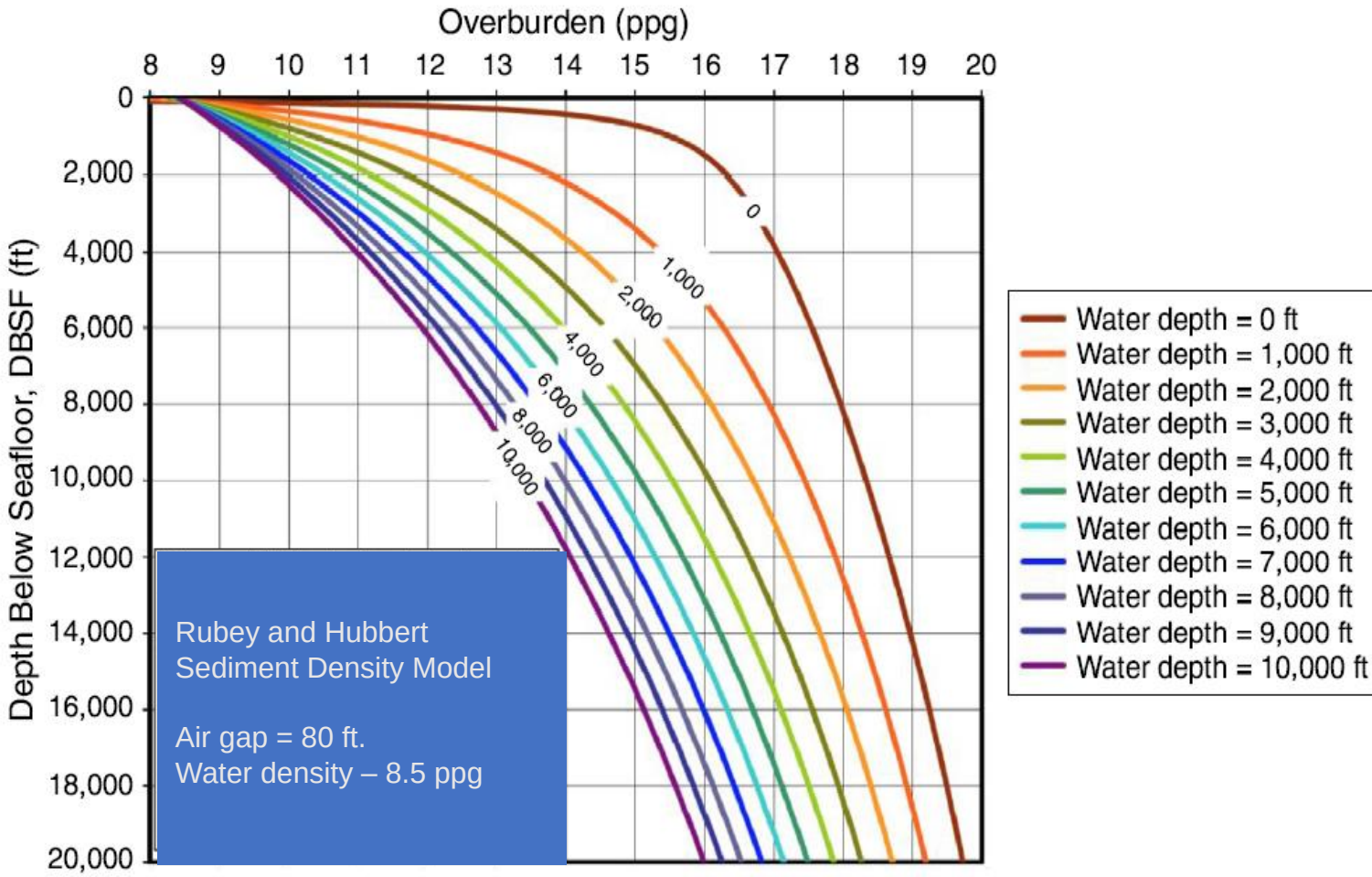
Jetting Process

"If you have always done it that way, it is probably wrong."

~ CHARLES KETTERING

Let's Talk About the Science

- Fracture gradient increases below seafloor
- *However, as water depth increases, <u>rate of frac gradient increase</u> is <u>actually decreasing</u>*
- Jetting cannot leverage this trend
- Result is more casings and premature slimming of well architecture
- How can we leverage this trend??



Overburden vs. Depth Below Seafloor Source: SPE-191724-PA

Riserless Casing Drilling:
A Simple Solution for Top Hole Drilling Challenges

Casing Drilling Basics

- Casing is the BHA*
- Casing provides mechanical force to bit
- Casing is the conduit providing hydraulic energy to the bit
- Hole can be drilled, cased, cemented in a single trip
- Simple rig up with minimal rig preparation
- Proven technology

30-in x 34-in. Casing Drilling

Source: SPE-185613-MS

** Bottom Hole Assembly*

Riserless Casing Drilling Benefits

- Deepen conductor seat based on frac gradient – “science”
- Wellbore strengthening attributes – “smear effect”
- Natural shallow hazard mitigation system
- Increased flexibility for well control events
- Could be compatible with RMR* systems
- Cement casing immediately after reaching setting depth

Shallow Water Flow Hazard Deepwater Trinidad

Source: IADC/SPE-208793-MS

** Riserless Mud Recovery*

Shallow Hazard Mitigation

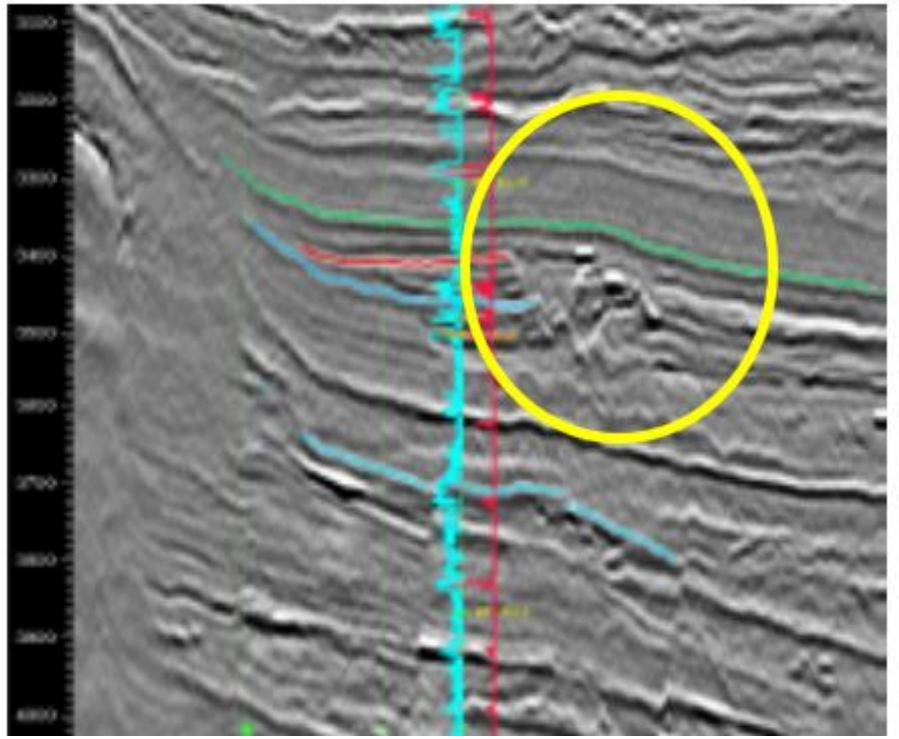
Shallow Hazards

IADC Definition:

"*adverse drilling subsurface conditions that may be encountered prior to the setting of the first pressure containment string and the emplacement of the BOP upon the well"*

Established Shallow Hazard Mitigation Strategies

- Pre-spud identification and avoidance
  - Geophysical means
  - Drill pilot holes prior to spud
- Top setting riserless casings above shallow hazards
  - Direct result of shallow conductor casing depth
  - Enable sufficient fracture gradient for > mud weight
  - “Wasted” casing string(s)???
- **Casing drilling**
  - Mitigate shallow hazards
  - Increased flexibility for well control events



Conventional 3D example of Potential Shallow Flow

Courtesy Chevron/BP Drilling Training Alliance

Pilot Holes vs. Casing Drilling

Pilot Holes

- Risk of swabbing in an influx
- More sensitive to incorrect filling
- Hole washout may preclude sufficient pump rates for dynamic kill
- Insufficient hole length to achieve required BHP for dynamic kill
- Still have to drill and case hole

Casing Drilling

- Minimal swab pressures
- Larger casing/hole geometry
- Wellbore strengthening benefits
  - Better hole integrity
- Higher pump rates = higher ECD/BHP created
- Hole is drilled, cased, cemented in a single trip

Casing Drilling – Hydraulics Benefits

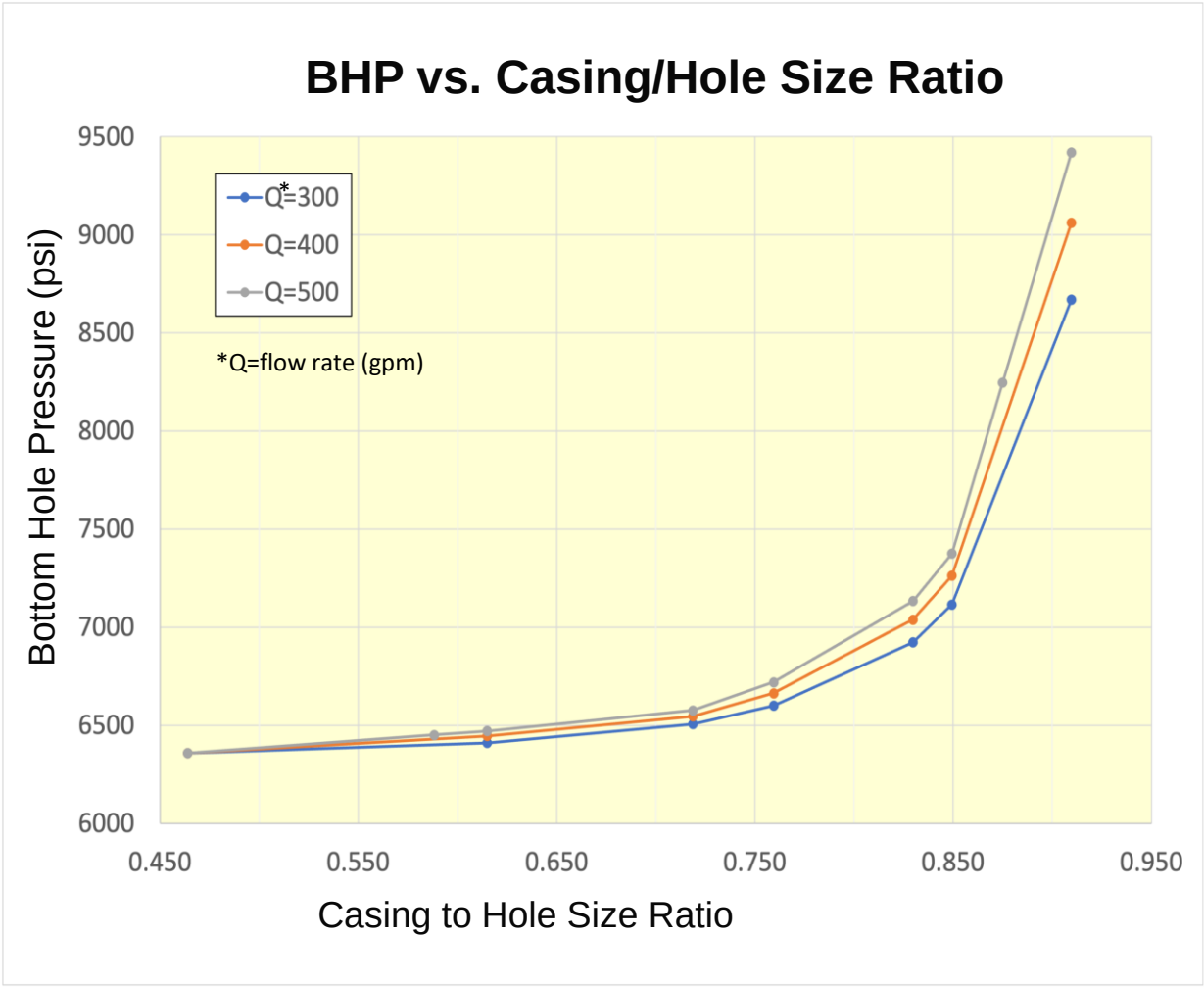
Bit Size	Pipe Size	Casing/Hole Size Ratio	BHP @500gpm	Annular Friction	Added ECD*
8-1/2''	5''	0.588	6450 psi	210 psi	0.50 ppg
32''	6-5/8''	0.207	6299 psi	59 psi	0.14 ppg
32''	28''	0.875	8246 psi	2006 psi	4.82 ppg

*Equivalent Circulating Density

"Hydraulic results show that a sharp increase in bottom-hole pressure (BHP) was observed when the casing to hole size ratio exceeded 0.8."

"Field observations have indicated that casing eccentricity is inherent, and this positively contributes to smear effect and lost circulation control."

Source: SPE/IADC 163514



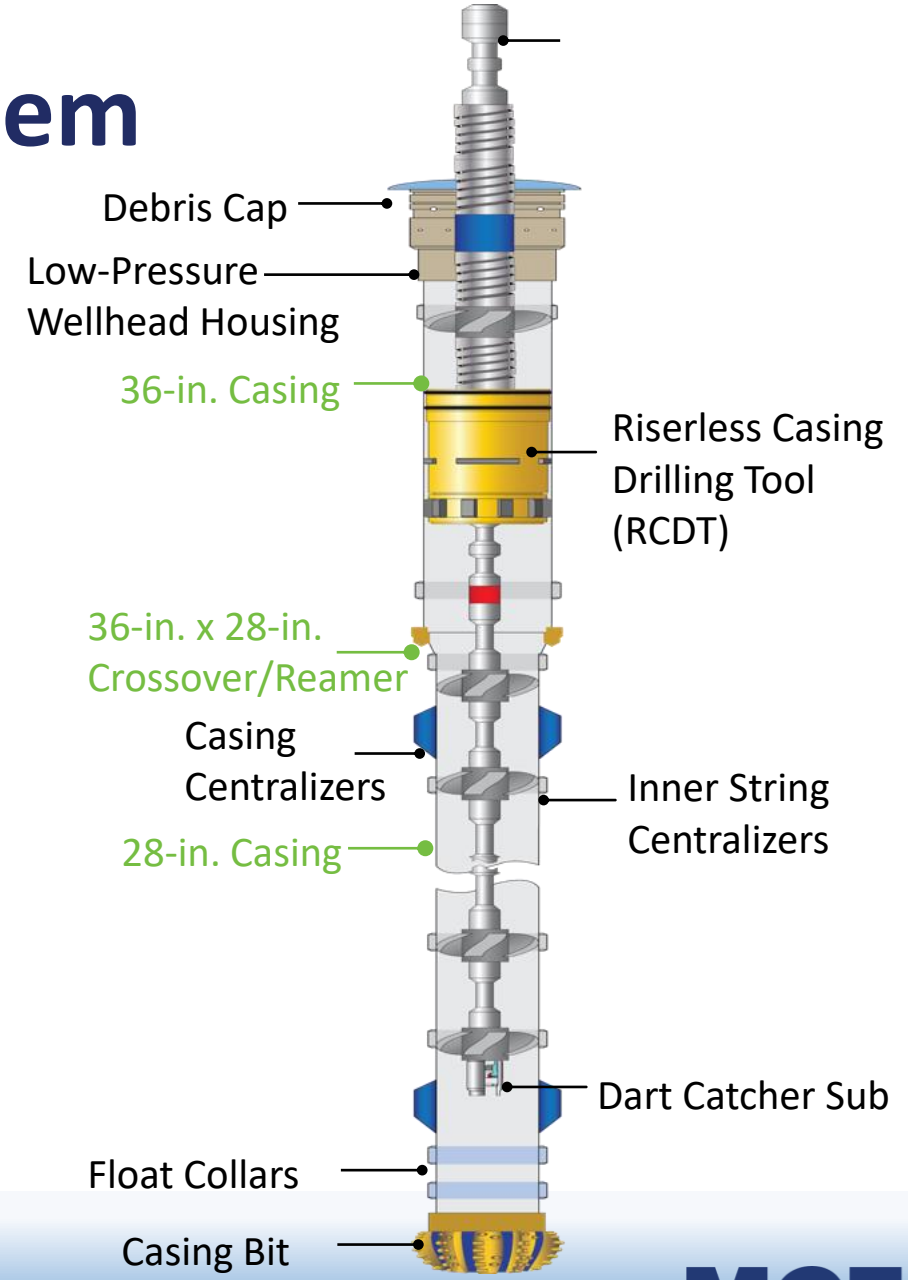
Riserless Casing Drilling System and Operation

Riserless Casing Drilling System

36” x 28”

- Top drive driven
- Basically, a liner drilling system
- LPWH* out of torque path
- No wellhead or rig modifications
- 36” x 28” Crossover with 41” Reamer Blades
- Inner string cementing system
- Float Collars
- Centralizers
- 32” Drillable Casing Bit

* Low-Pressure Wellhead Housing



Conceptual Design

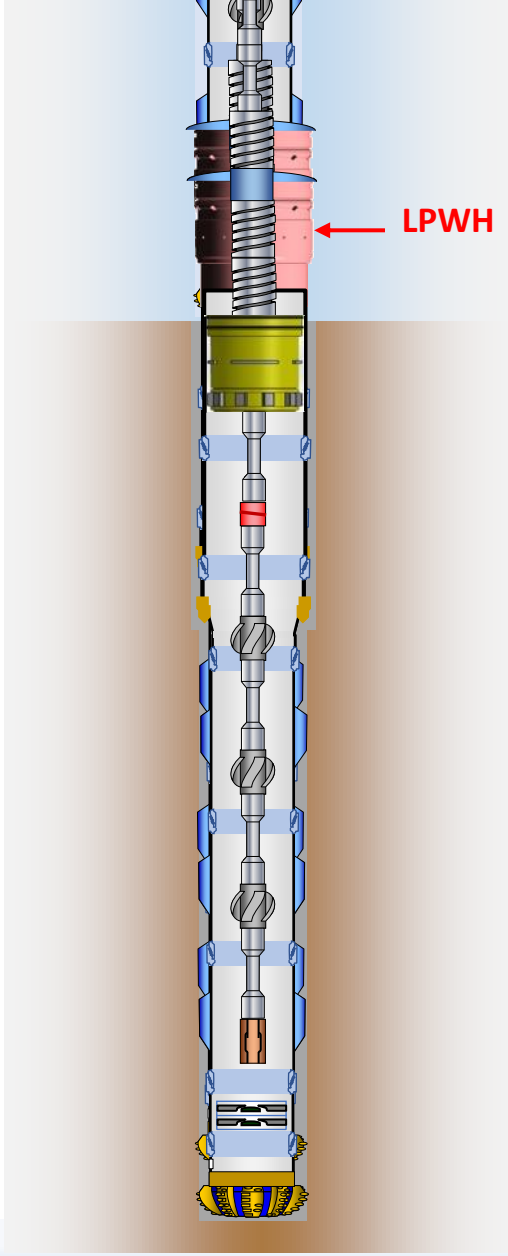
Courtesy Frontier Oil Tools

Riserless Casing Drilling

Initial Conductor Running Procedure

- Run assembly to mudline
- Drill-in conductor to place LPWH at depth
- Pick up off bottom
- Cement conductor
- Place conductor on bottom
- Release and retrieve RCDT*

** Riserless Casing Drilling Tool*



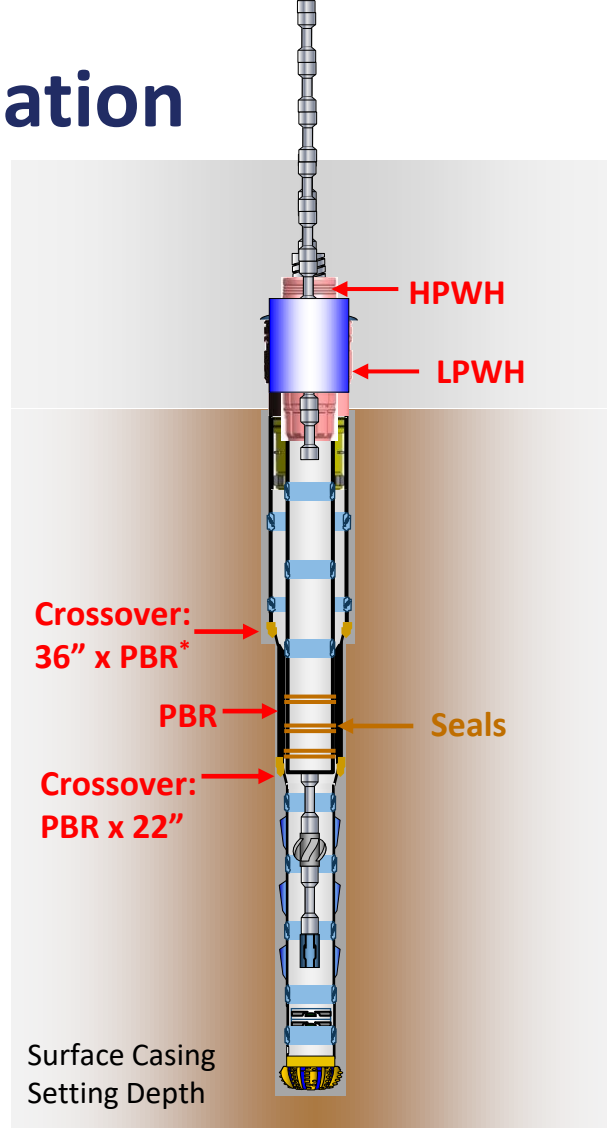
Can Surface Casing (HPWH* Casing) be Drilled In?

*High Pressure Wellhead Housing

Single Trip Surface Casing Installation

Drill-in HPHW Casing

- Drill-in 36” x 22” casing w/ LPWH and cement in place
- Retrieve riserless casing drilling tool
- Run 18-3/4” HPWH as a 22” tieback string
- Lock down HPWH and test casing
- Retrieve HPWH running tool
- Run blowout preventer stack



*Polished Bore Receptacle

Summary and Conclusions

- The initial conductor casing depth should be based on “Science” and not the limitations of the jetting process.
- The top hole challenge is effective management of well architecture.
- Casing drill conductor casing to depth based on prevailing fracture gradient:
  - No rig modifications required
  - Mitigate shallow hazards and wellbore instability in a single trip.
  - Increased flexibility for well control events
  - Expansion of drilling operating windows
- All of the above increases well reliability and the opportunity to meet well objectives

ACKNOWLEDGEMENTS / THANK YOU / QUESTIONS

Special thanks to:

Blade Energy Partners, Ltd. and Frontier Oil Tools

for their support

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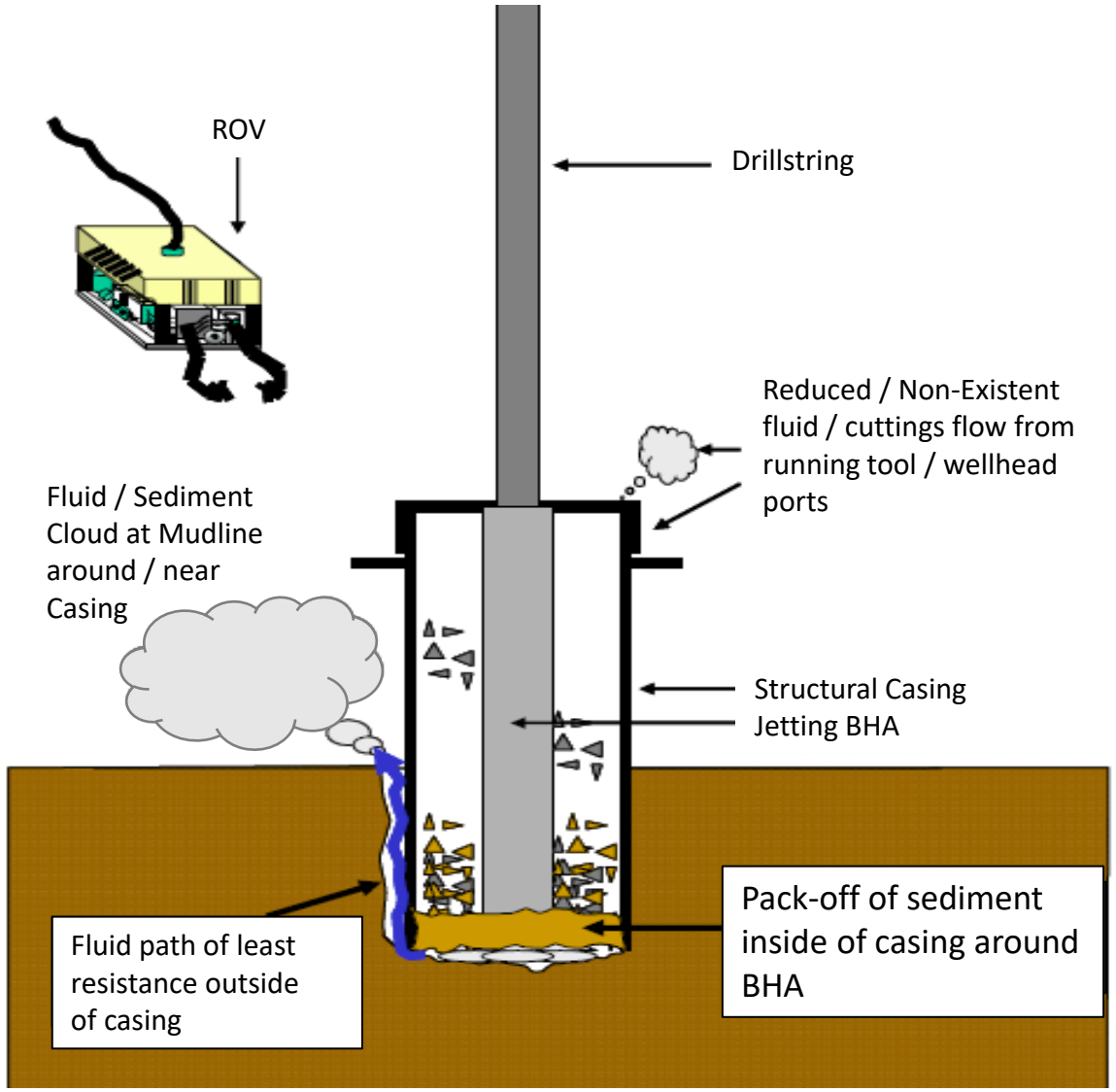
Extra Slides

Issues with Jetting

- Jetting conductor casing to ~350 ft. BML (below mudline) is accepted practice
- Some deepwater basins have hard seafloor exceeding jetting technical limit
- High success rate but risk of not reaching required depth
- Jetting depth limitation can result in early slimming of well architecture
- Conductor depth is not really “based on science”

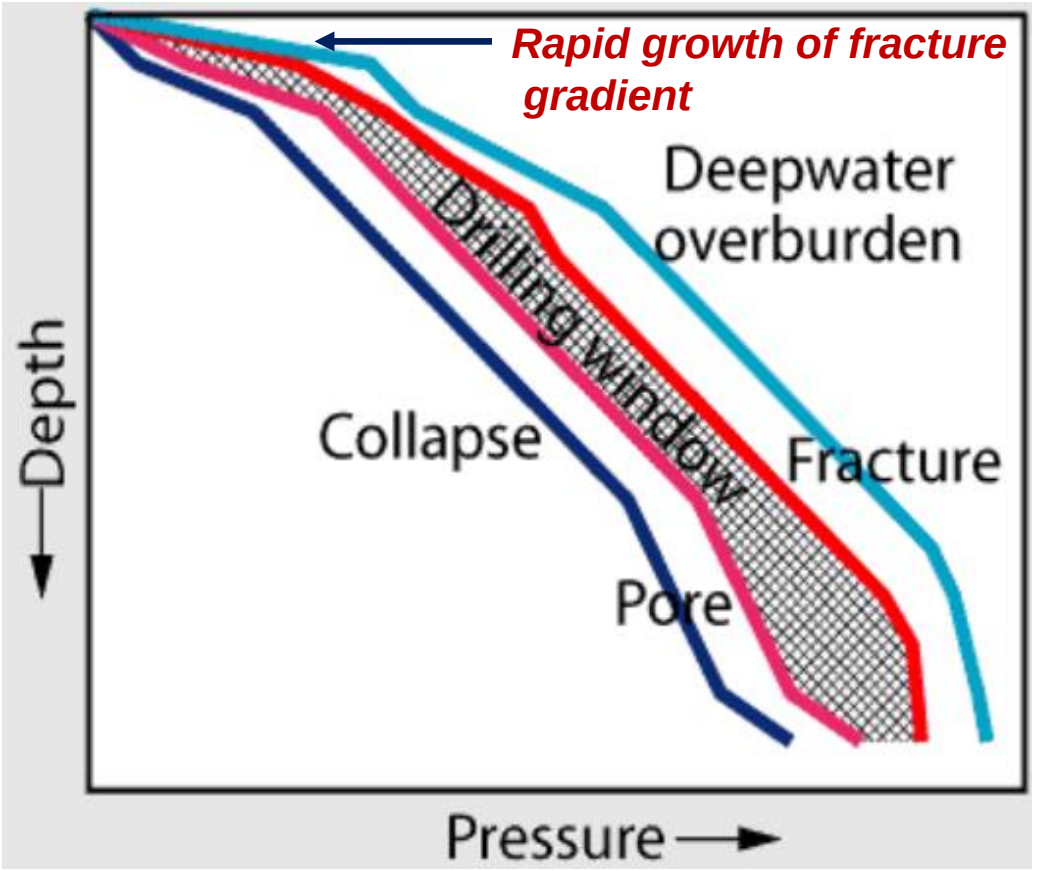


Source: SPE 102378

Jetting Packoff and Broaching Event

Use Subsea Geology to Our Advantage

- Establish deeper conductor setting depth
  - ➢Leverage increasing fracture gradient
  - ➢Effective mitigation of shallow hazards
  - ➢Fewer casings
  - ➢Expansion of drilling operating windows
  - ➢Meet well objectives
  - ➢How?



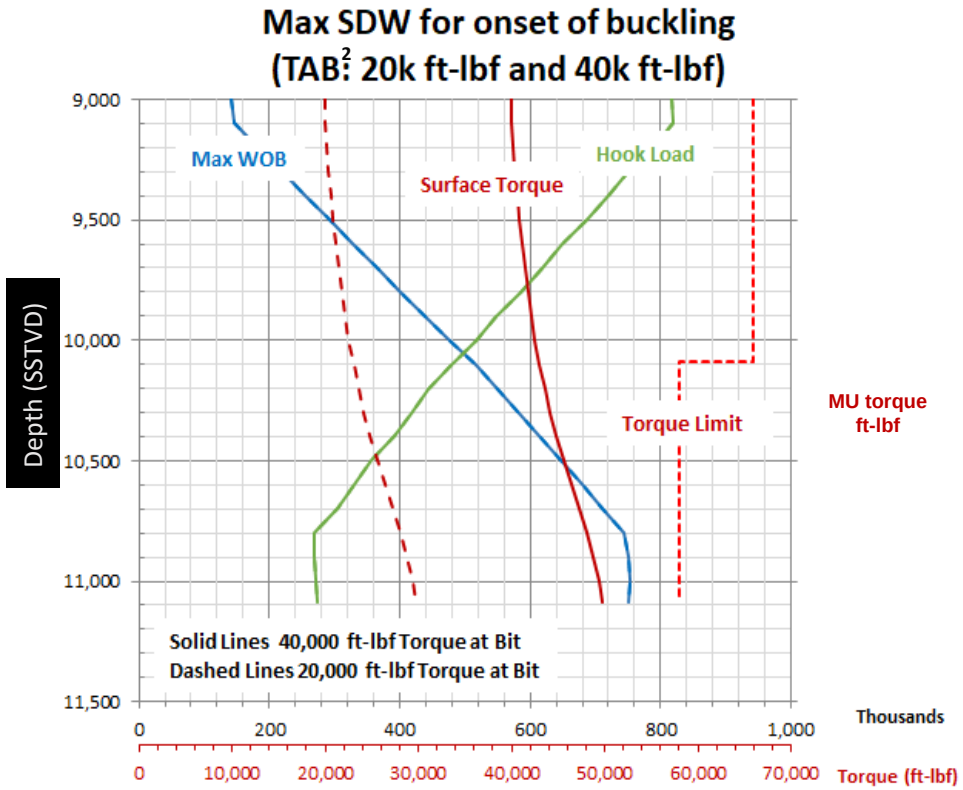
Deepwater Pore Pressure/Fracture Gradient Profile

36-in. x 28-in. Casing Drilling Feasibility~Torque

Assumptions

- Drill in 2000 ft. of 36 in. x 28 in. initial structural casing
- Water depth 9,000 ft.
- Casing drilled interval 9,000 to 11,000 ft. SSTVD*
- Torque at bit (20k ft-lbs and 40k ft-lbs)
- Typical offshore rig top drive capacity 75,000 ft-lbs.

*Subsea True Vertical Depth



Maximum Set Down Weight vs. Subsea True Vertical Depth

Courtesy of Blade Engineering

[1] *SDW = set down weight*

[2] *TAB = torque at bit*

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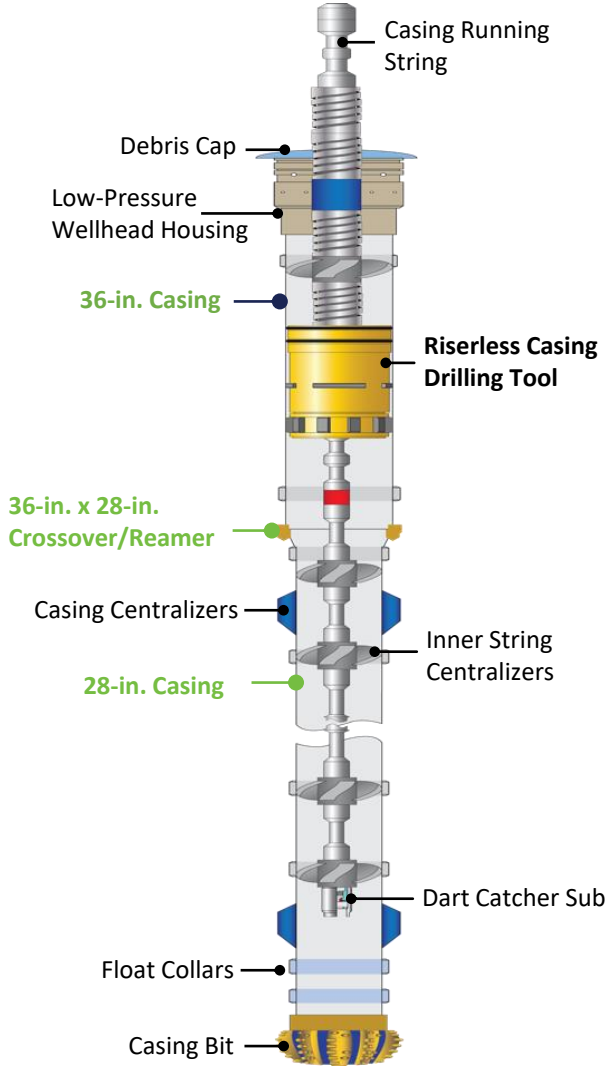

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** Low-Pressure Wellhead Housing*

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