Offshore Energy – Offshore Drilling Update

Advances in Earth Science – Briefing Series

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Presentation Outline

- Industry efforts post-Macondo / Deepwater Horizon
- New BSEE Well Control Rule
- Offshore Gulf of Mexico (GOM) Challenges
- New Drilling Technology
- Go-Forward

Deepwater Horizon / Macondo prospect, GOM, April 20, 2010 – photo by US Coast Guard

11 lives lost, 134 million gallons of oil spilled, 43,300 square miles / 1,300 miles of shoreline affected

Industry Efforts after Macondo

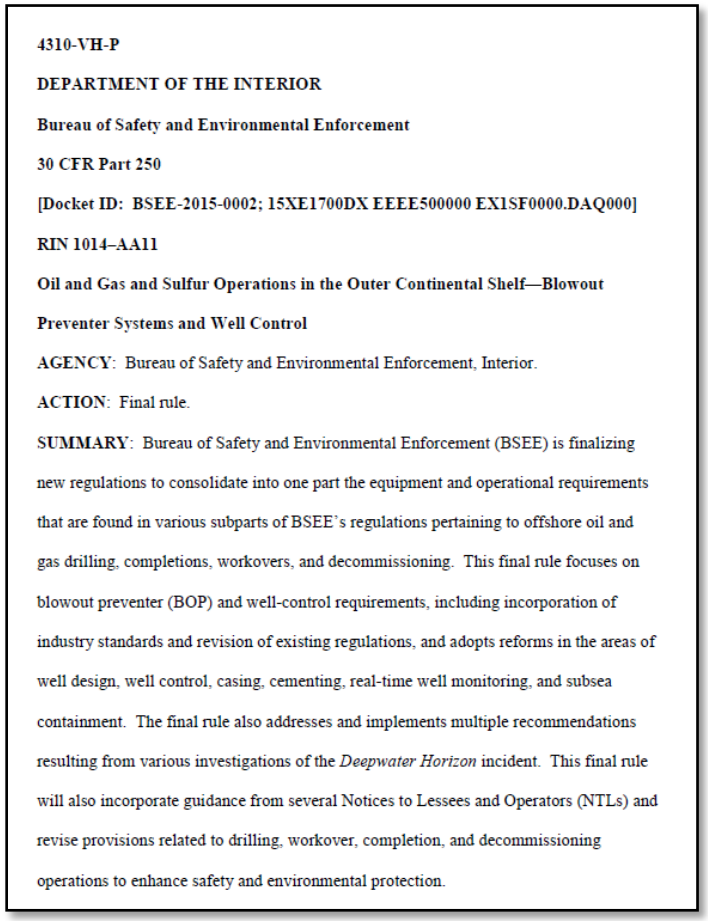
Industry response efforts include:

- Industry-wide well control incident database
- Task force on blow-out-preventer (BOP) reliability & BOP modifications (e.g. implementing shear ram redundancy)
- Marine well containment & Helix well containment (2010)
- Development and implementation of key international standards for well design and operations management
- The creation of the Subsea Well Response Project (SWRP)
- The creation of the Oil Spill Response Joint Industry Project (OSR-JIP)
- Center for Offshore Safety (COS) formed
- Mutual aid agreements and framework to enable operators to access additional resources in case of a major oil spills
- Improved human factors training and competences

Subsea Capping Stack - Source: NOLA

New BSEE Well Control Rule

- Final rule published 4/14/2016, effective 90 days after publications (requiring operator compliance)
- Addresses / implements recommendations from various investigations into the Deepwater Horizon / Macondo incident
- Focus on improving offshore safety through:
  - BOP and well control requirements (e.g. requirement of double shear rams)
  - Incorporation of industry standards (ANSI / API, e.g. API Standard 53) / revision of existing regulation (e.g. 30 CFR 250 subpart D *Oil and Gas Drilling Operations*)
  - Reforms in areas of well design & construction, well control, casing, cementing, real-time monitoring and subsea well containment, etc.
- Overarching theme:
  - Barriers (fluids, casing, cement, BOPs, plugs etc.) to flow of hydrocarbons to surface - barrier design and fabrication, construction and verification / testing, (real-time) monitoring, etc.



4310-VH-P

DEPARTMENT OF THE INTERIOR

Bureau of Safety and Environmental Enforcement

30 CFR Part 250

[Docket ID: BSEE-2015-0002; 15XE1700DX EEEE500000 EX1SF0000.DAQ000]

RIN 1014–AA11

Oil and Gas and Sulfur Operations in the Outer Continental Shelf—Blowout Preventer Systems and Well Control

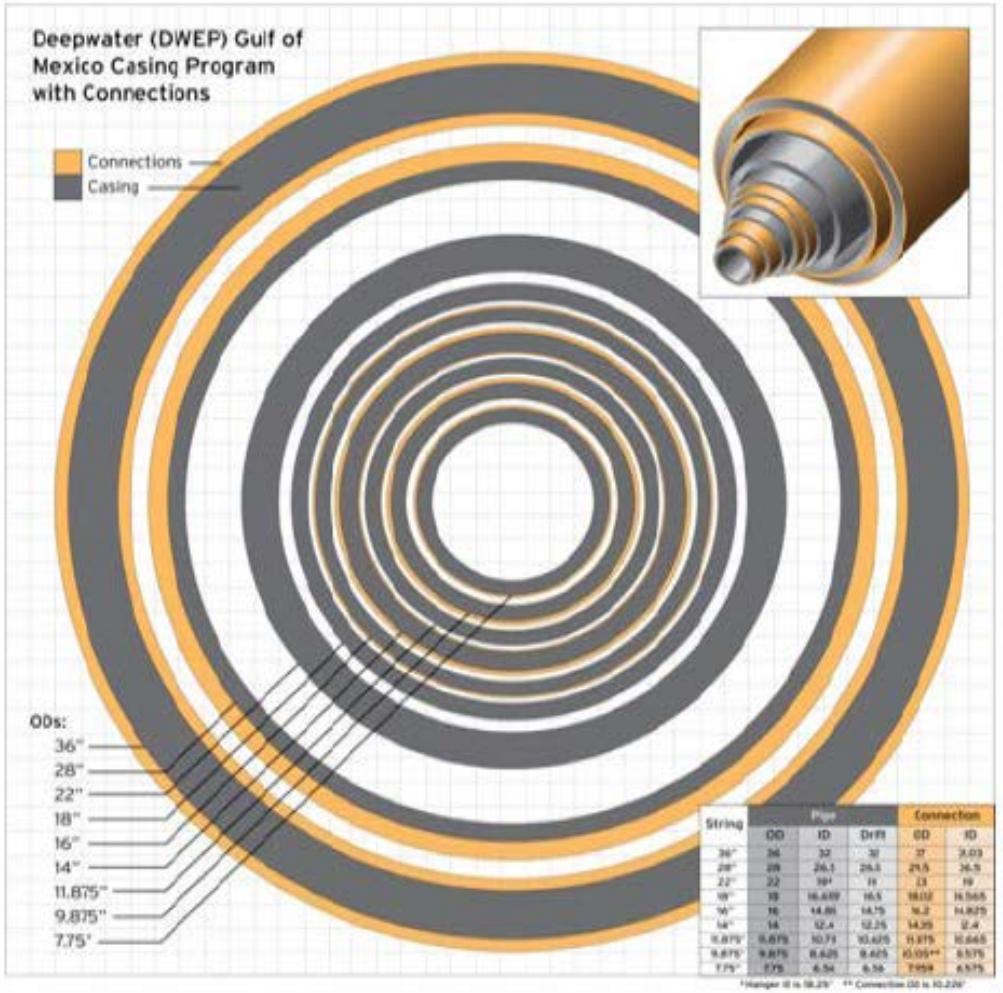
AGENCY: Bureau of Safety and Environmental Enforcement, Interior.

ACTION: Final rule.

SUMMARY: Bureau of Safety and Environmental Enforcement (BSEE) is finalizing new regulations to consolidate into one part the equipment and operational requirements that are found in various subparts of BSEE's regulations pertaining to offshore oil and gas drilling, completions, workovers, and decommissioning. This final rule focuses on blowout preventer (BOP) and well-control requirements, including incorporation of industry standards and revision of existing regulations, and adopts reforms in the areas of well design, well control, casing, cementing, real-time well monitoring, and subsea containment. The final rule also addresses and implements multiple recommendations resulting from various investigations of the *Deepwater Horizon* incident. This final rule will also incorporate guidance from several Notices to Lessees and Operators (NTLs) and revise provisions related to drilling, workover, completion, and decommissioning operations to enhance safety and environmental protection.

BSEE Final Well Control Rule Communication

“An Inverted Telescope into the Earth”



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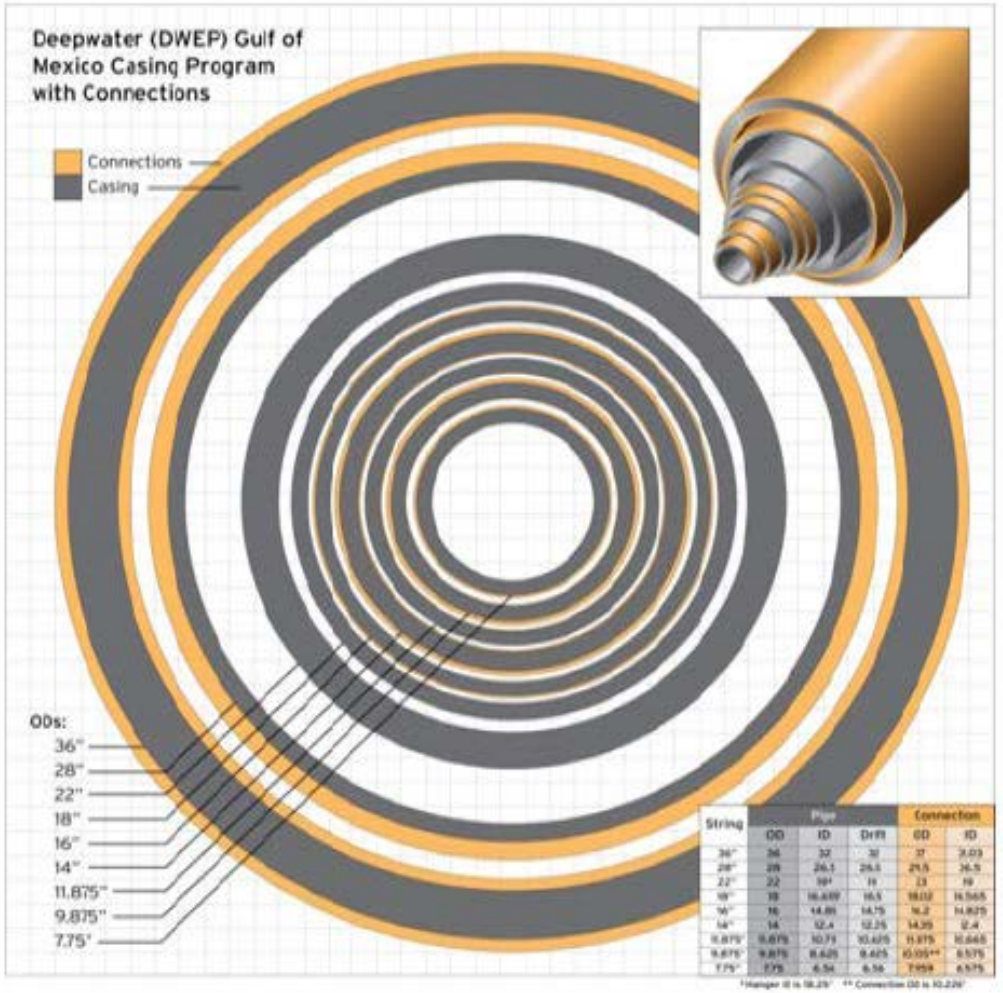
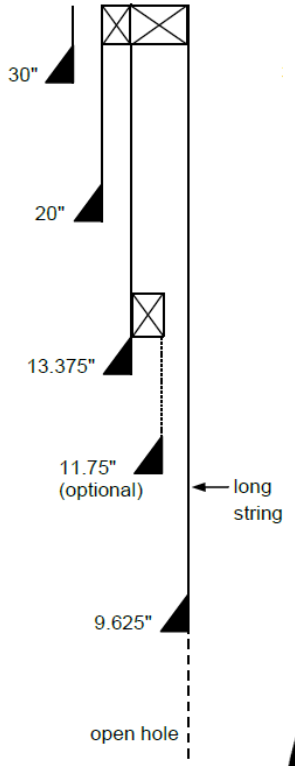
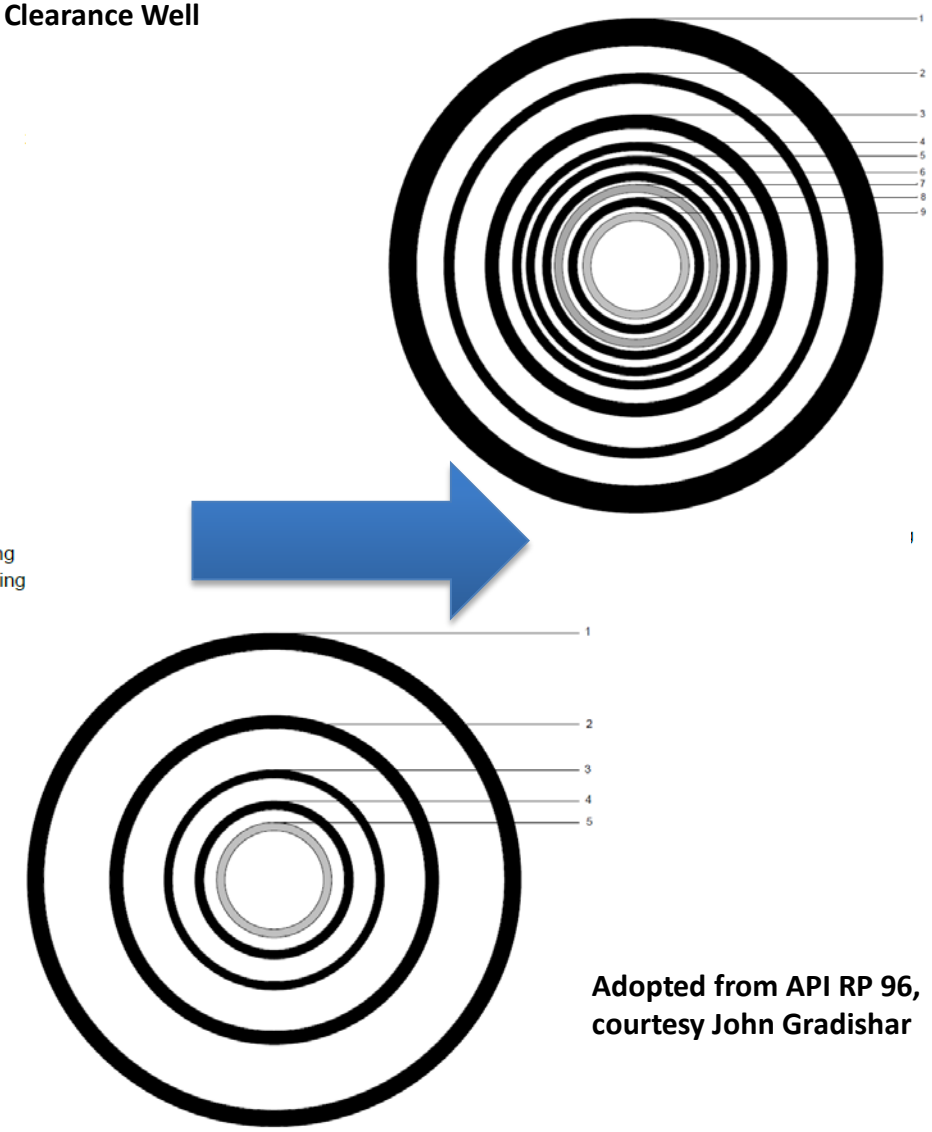


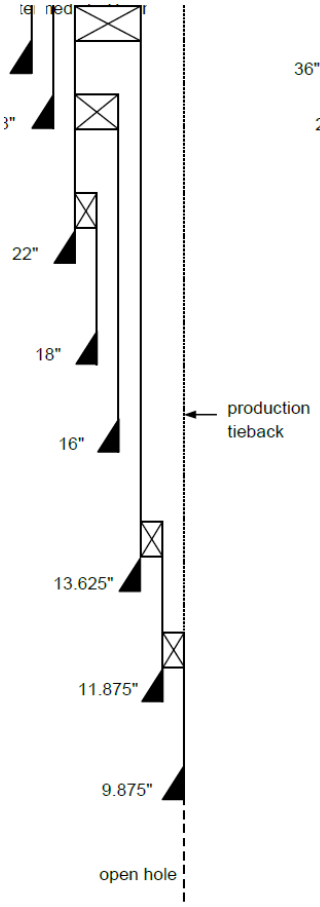
Offshore Deepwater Well Design Evolution

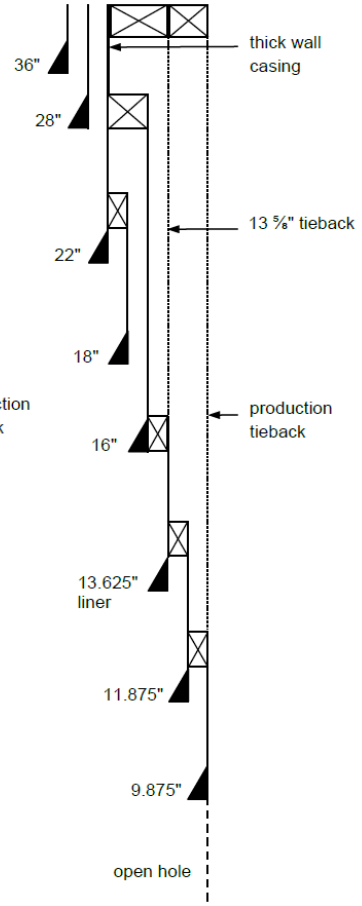
Traditional, Normal Clearance Well





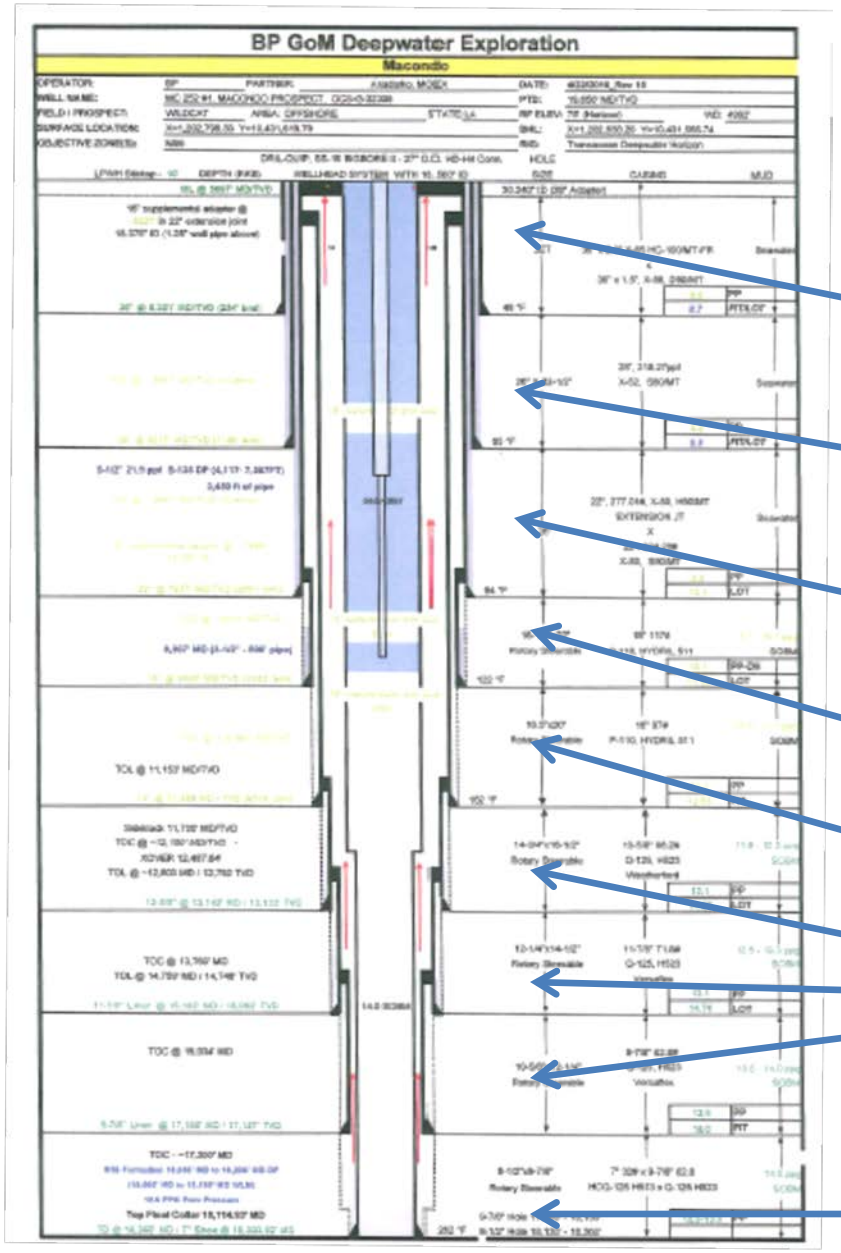
Deepwater Tight Clearance Wells





Adopted from API RP 96, courtesy John Gradishar

Casing Program Example: Offshore GOM / Macondo



36” Conductor / Jet Pipe

28” Surface Casing

22” Surface Casing

18” Drilling Liner

16” Intermediate Casing

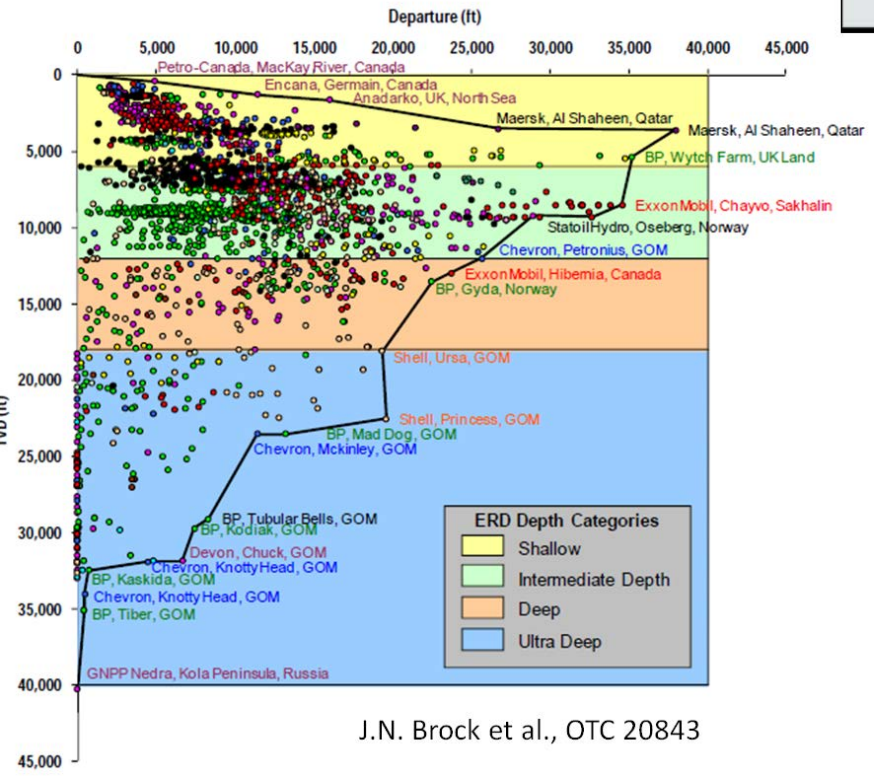
13 5/8”, 11 7/8”, 9 7/8” Drilling Liners

7” x 9 5/8” Production Casing (Long String)

Source: Deepwater Horizon Study Group

Challenge 1 – New Plays

Deeper water, larger depths, longer wells, higher temperatures and pressures (lower Tertiary, Norphlet etc.)



J.N. Brock et al., OTC 20843

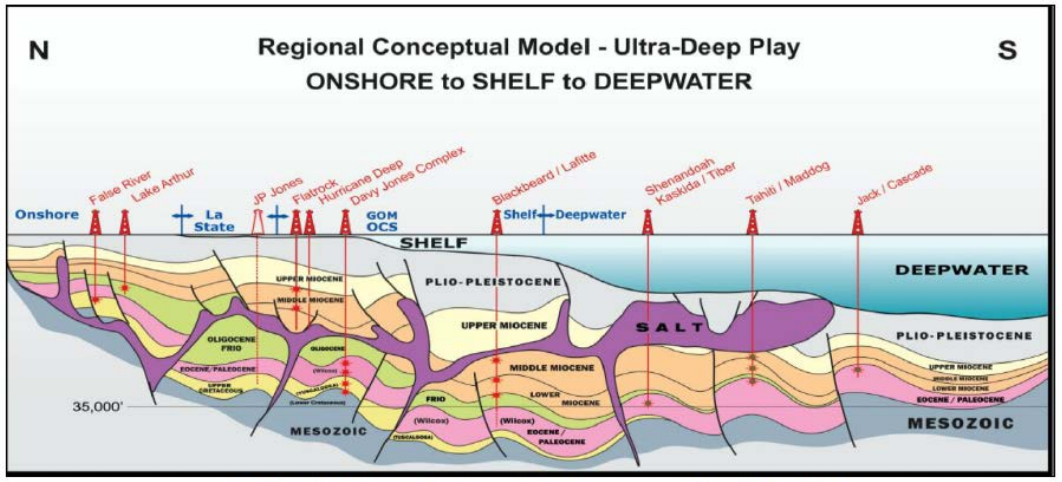
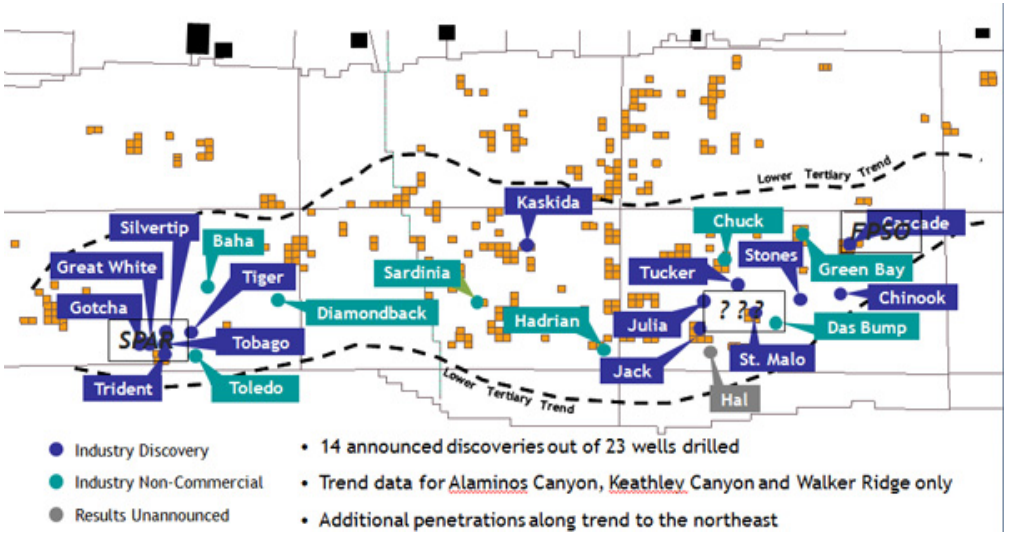
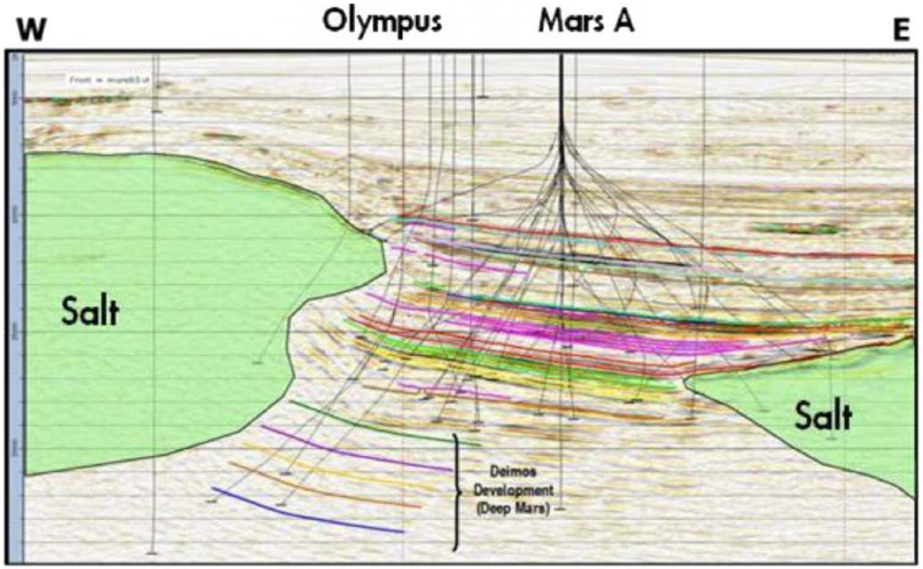


Fig. 5b- Gulf of Mexico, Onshore, Shelf and Deepwater Plays (Hale 2012).

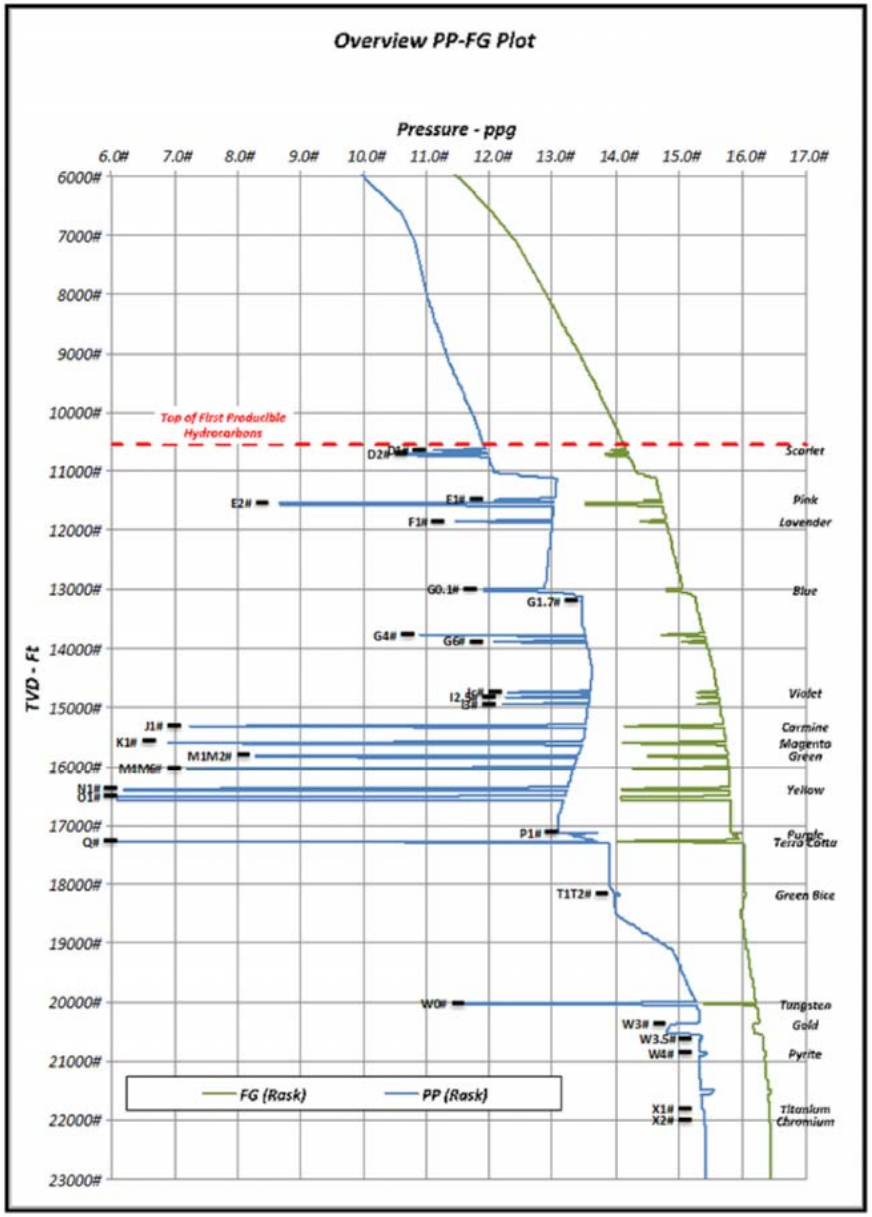


Challenge 2 – Mature Plays

Drilling through produced / producing zones to reach deeper virgin reservoirs

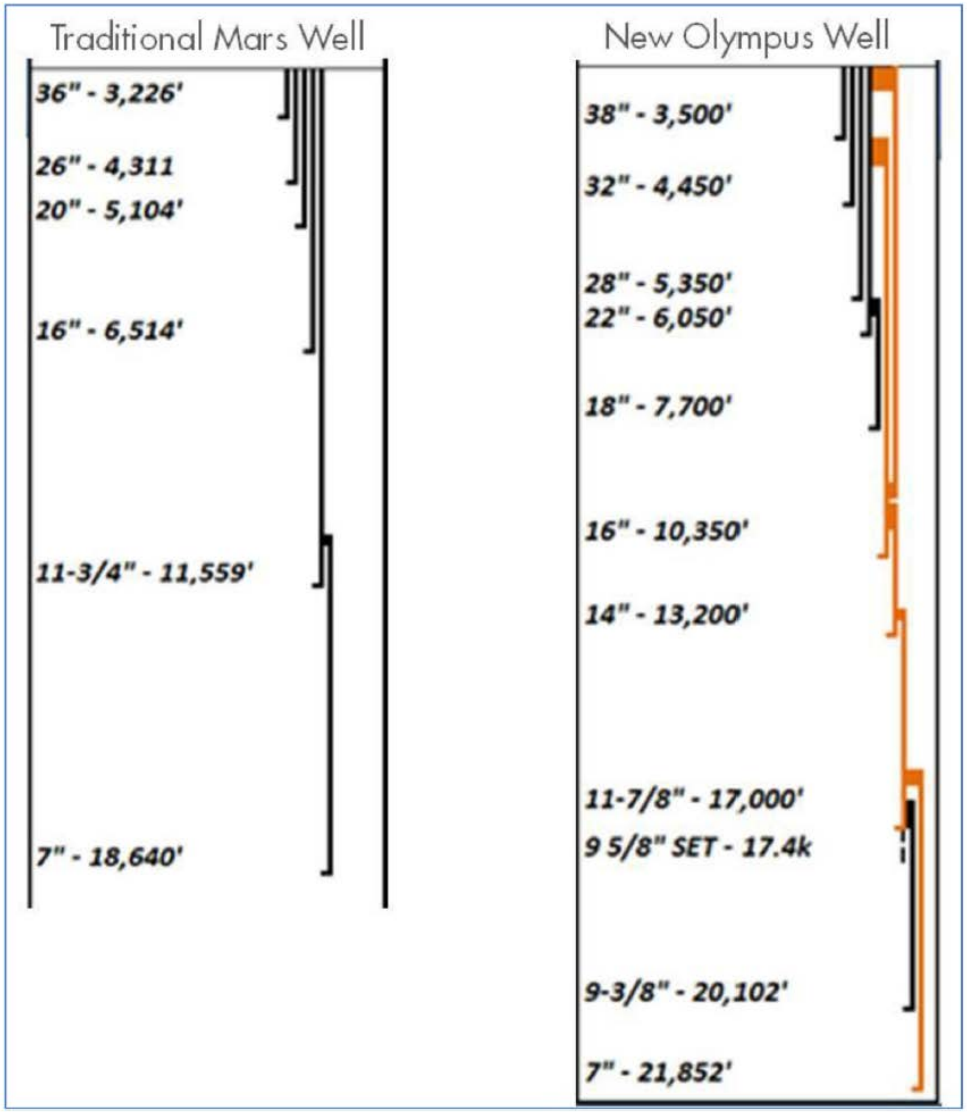


Picture adopted from OTC 25437



Picture adopted from SPE 170977

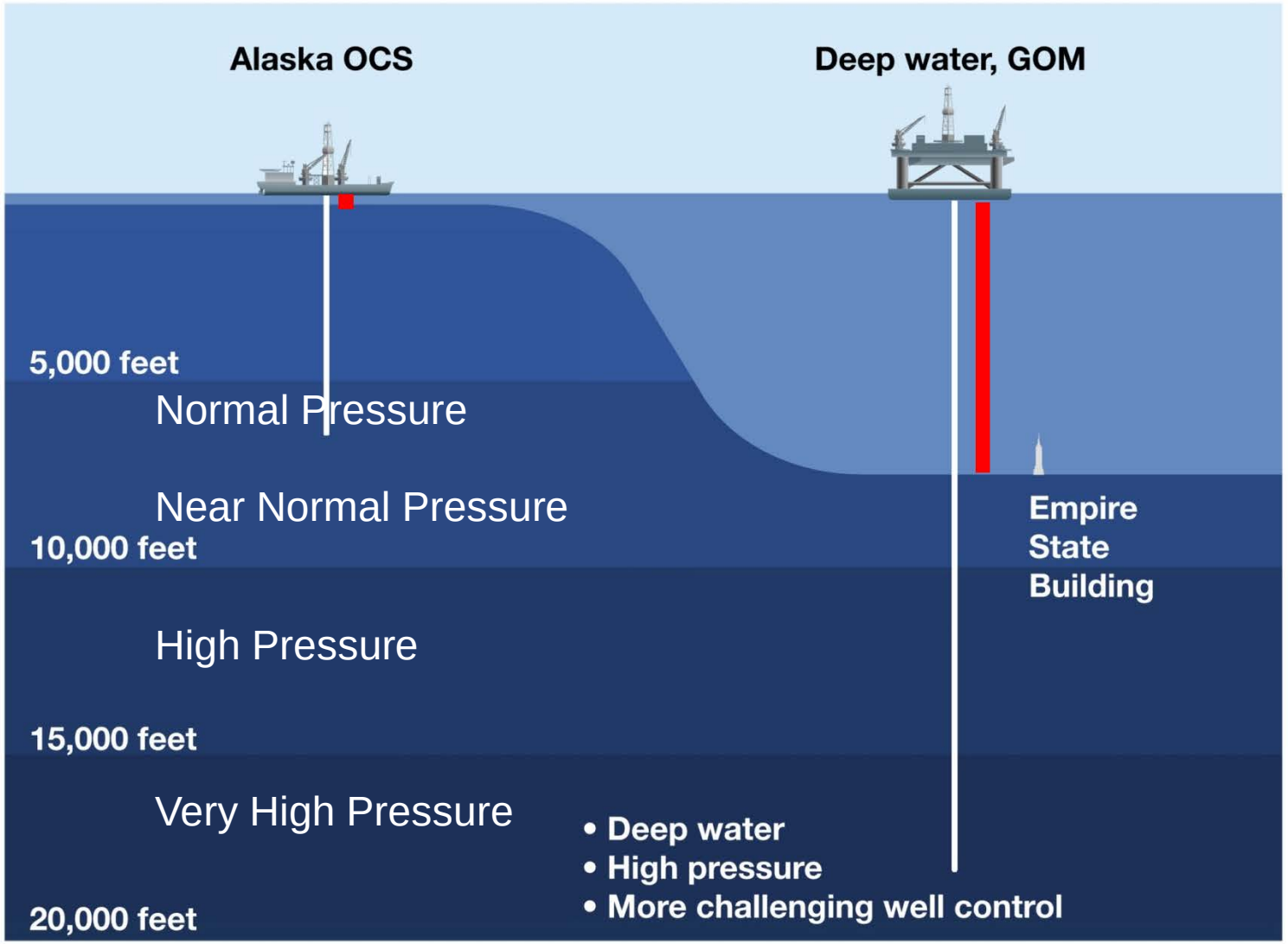
Shell Olympus Well Design



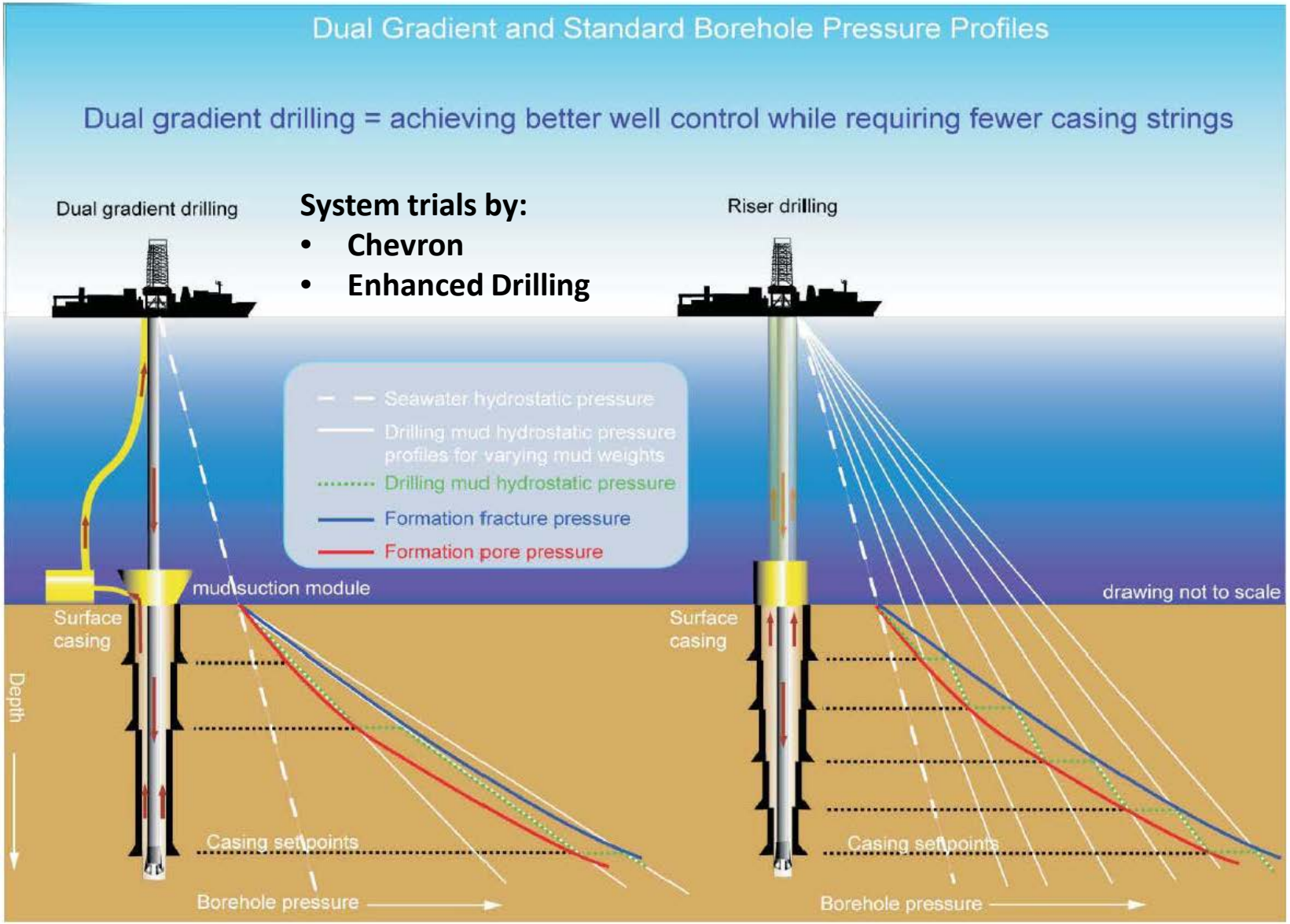
Picture adopted from OTC 25437

Tight clearance casing schemes are used to the fullest extent possible to drill through depleted formations (Example: Shell Mars/Olympus development)

Comparison of Arctic & GOM Deepwater Pore Pressure Environment

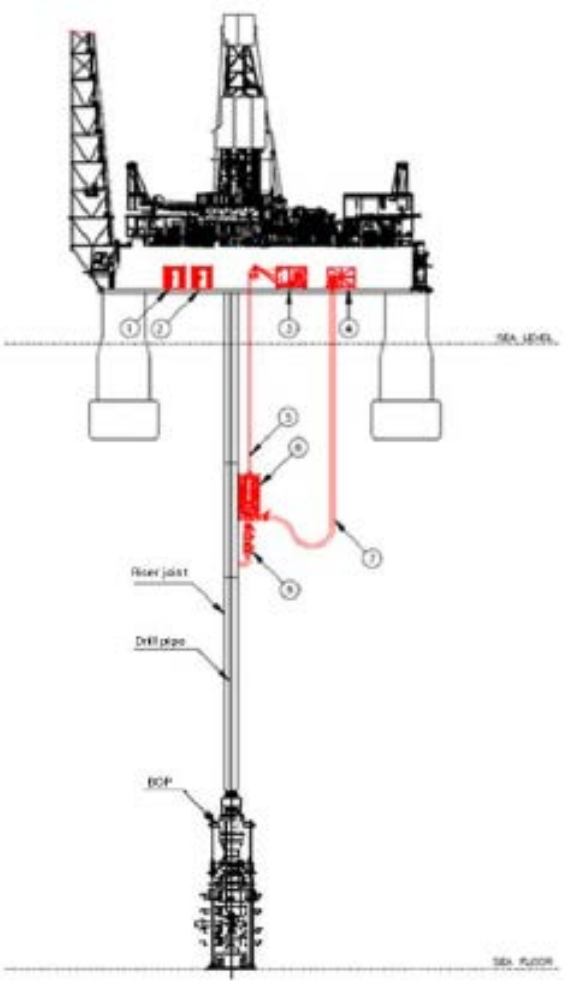


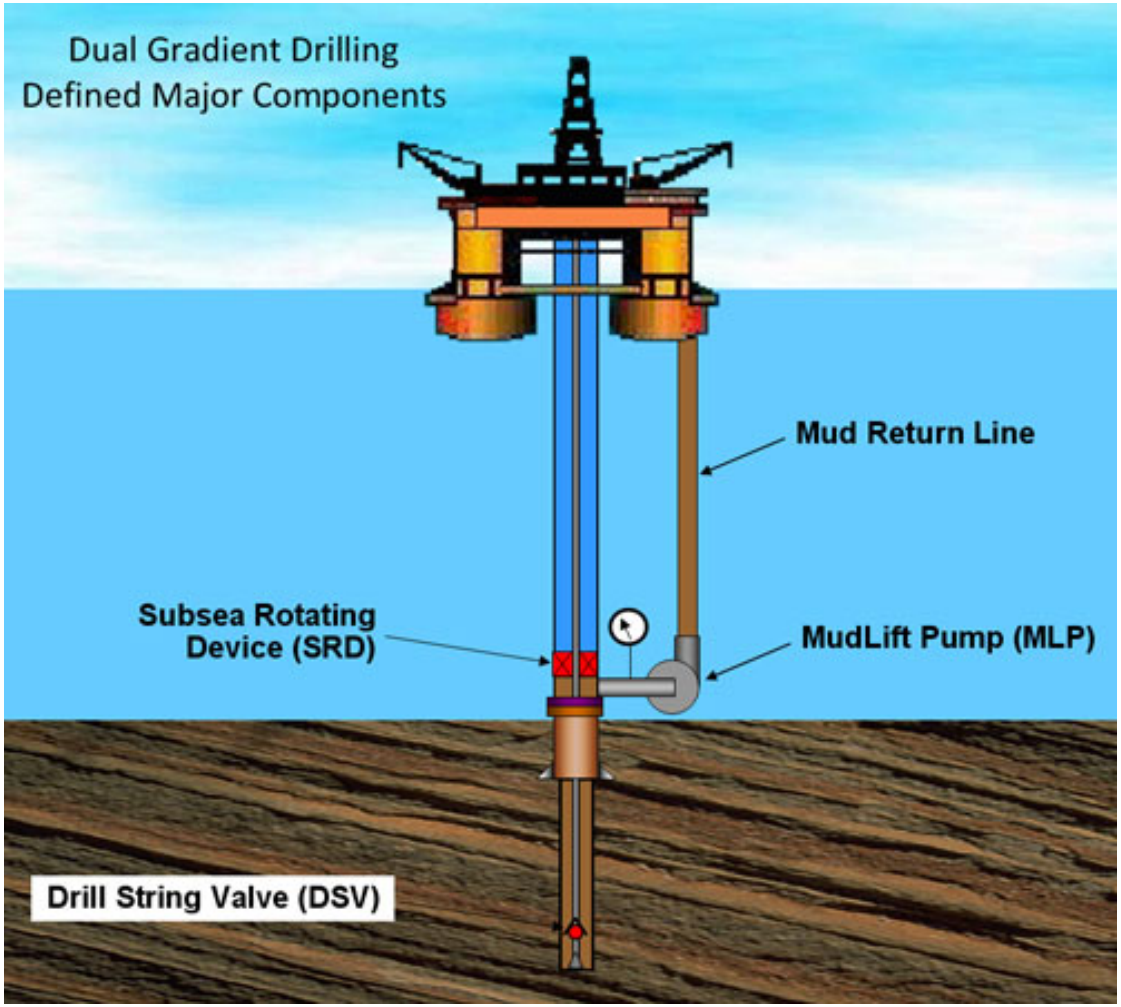
New Technology – Dual Gradient Drilling



Source: Blade Engineering

DGD Systems



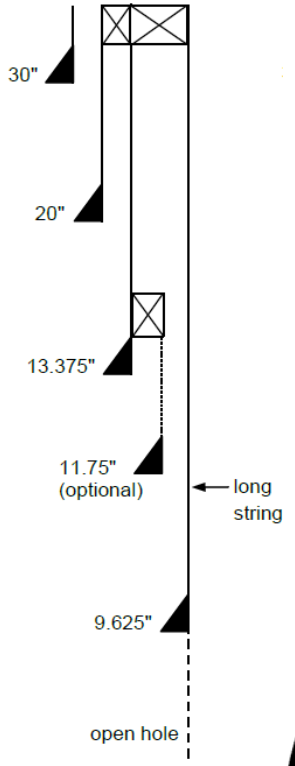


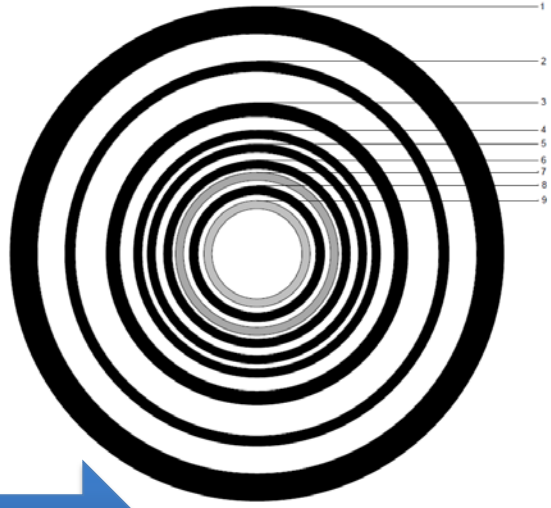
Riser Pumping DGD System (EC-Drill by Enhanced Drilling)

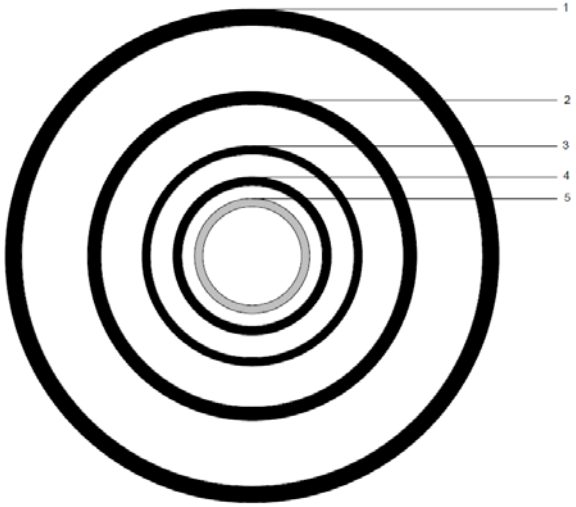
Subsea Mudlift System (by Chevron consortium)

Offshore Deepwater Well Design Reversal

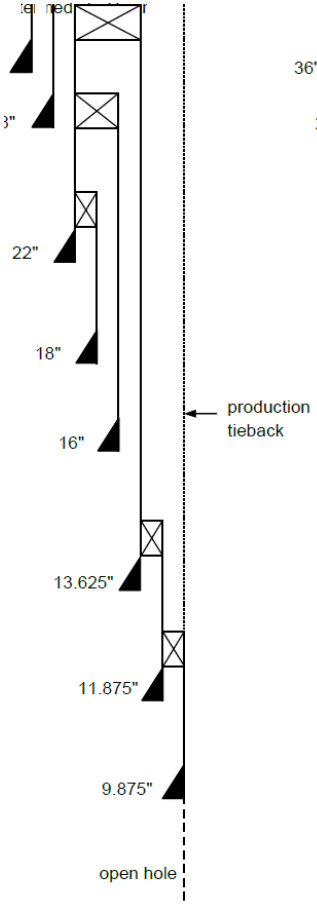
Normal Clearance Well

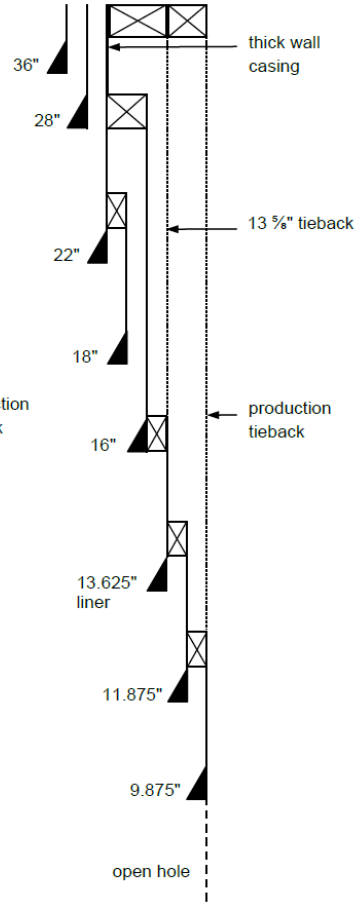






Tight Clearance Wells





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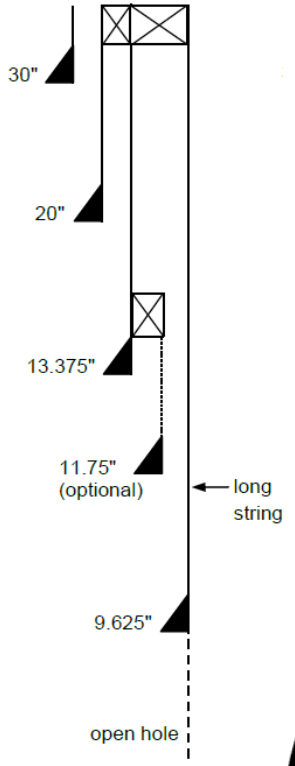

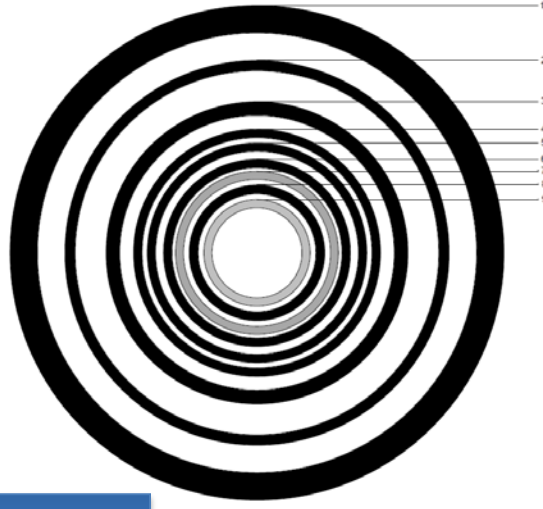

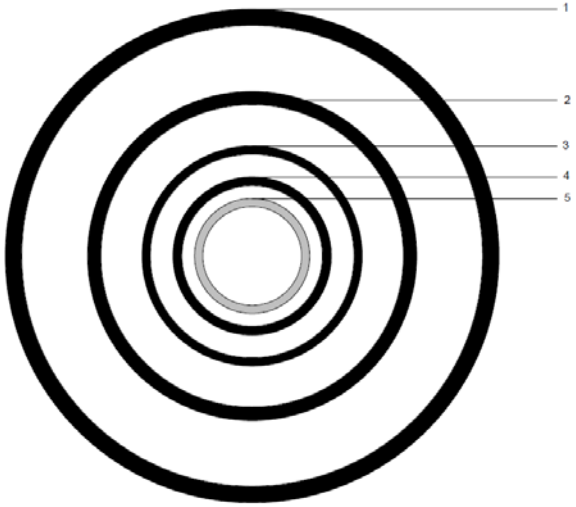

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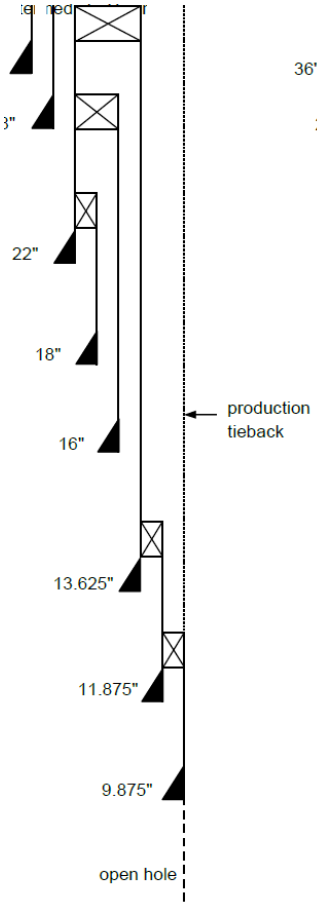

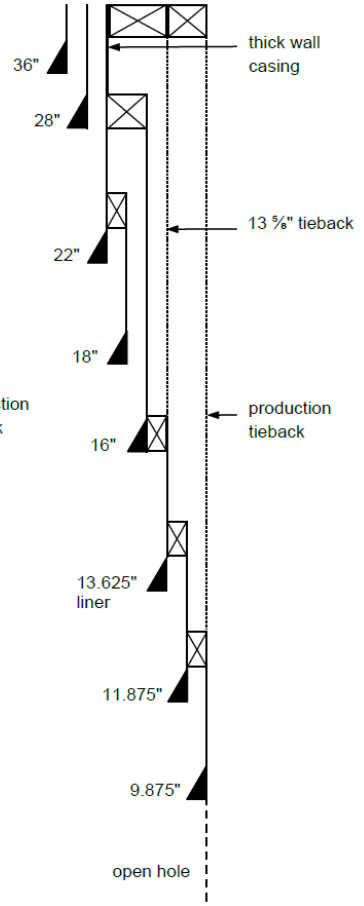

Adopted from API RP 96, courtesy John Gradishar

Go Forward

- Implementation of / compliance with new Well Control Rule
  - 90 days for operators to comply (with later dates for specific compliance elements, e.g. specific equipment/rig modifications, RTM)
  - Better understanding of implications / consequences of rulemaking (more conservative casing designs, drilling margins, etc.)
- Addressing issues not currently in the rule-making (well control training and certifications, human factors, SEMS, zonal isolation, etc.)
  - Requires continued effective operator / regulator dialogue
- BSEE support for real-time monitoring efforts (through OESI / UT Austin)
- Continue to address new deepwater technological challenges
  - Developing systems / practices / standards for Deep / High-Pressure-High-Temperature (HPHT) well conditions
  - Progressing promising new technologies (e.g. DGD-MPD, expandables)
  - Developing standards and rulemaking for new technologies in a timely fashion