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

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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
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.

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“An Inverted Telescope into the Earth”
“An Inverted Telescope into the Earth”
Offshore Deepwater Well Design Evolution

Traditional, Normal Clearance Well

Deepwater Tight Clearance Wells

Adopted from API RP 96, courtesy John Gradishar

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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

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Challenge 1 – New Plays

Deeper water, larger depths, longer wells, higher temperatures and pressures (lower Tertiary, Norphlet etc.)
Challenge 2 – Mature Plays

Drilling through produced / producing zones to reach deeper virgin reservoirs

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

Picture adopted from OTC 25437
Comparison of Arctic & GOM Deepwater Pore Pressure Environment

- Alaska OCS
  - Normal Pressure
  - Near Normal Pressure
  - High Pressure
  - Very High Pressure

- Deep water, GOM
  - Empire State Building

- Deep water
- High pressure
- More challenging well control

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New Technology – Dual Gradient Drilling

Dual Gradient and Standard Borehole Pressure Profiles

Dual gradient drilling = achieving better well control while requiring fewer casing strings

System trials by:
• Chevron
• Enhanced Drilling

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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

Adopted from API RP 96, courtesy John Gradishar

Tight Clearance Wells

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Offshore Deepwater Well Design Reversal

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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