Effects of Water Depth Workshop

BSEE
Bureau of Safety and Environmental Enforcement

Topic 3 – Well Drilling & Completion Design and Barriers

(REPORT OUT)

* The opinions contained in this presentation are my own and do not necessarily represent the opinions or position of Anadarko Petroleum Corporation.

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Workshop Preparations

Topic 3 – Well Drilling & Completion Design and Barriers

Develop Findings on the White Paper Topics

- Coordination & Communication to help Align Industry & Regulators (16 Findings)
- Human Factors in Safety (4 Findings)
- Well Design – Technical Challenges (6 Findings)
- Operational Challenges Barrier Systems (5 Findings)
- Completion Design (3 Findings)

2-Day Workshop Process

Topic 3 – Well Drilling & Completion Design and Barriers

- Well Design Process

- Presentations and Discussions
  - The Structure – The Deepwater Well – BSEE
  - Safety, Risk and Regulations
  - Loads – Jim Raney, Anadarko
  - Strengths – Mike Payne, BP
  - Barriers (API RP/Std 96) – Rick Graff, Chevron
  - Cement as a Barrier – Craig Gardner, Chevron
  - Connections as a Barrier – Bob Sivley, Hunting
  - New Technology – John Kozicz, Transocean

Findings, Conclusions and Recommendations

Findings, Conclusions and Recommendations

Topic 3 – Well Drilling & Completion Design and Barriers

1. **Key Issues and challenges**
   A. Clarity on the difference between the Worst Case Discharge Requirements (NTL 6) and Blow-out containment (NTL 10) was clarified. This will impact future deep water well design.
   (This is a significant win-win)
   B. There is a need for more communications directly from the BSEE as was the EWD Workshop.

2. **Progress of the industry over the past year**
   A. New API JITF reports & standards delivery
   B. Delivery of the well containment systems

3. **Gaps/Recommendations**
   A. Need for on going communication and opportunities for meeting face-to-face

Findings and Conclusions

Topic 3 – Well Drilling & Completion Design and Barriers

1. Worst Case Discharge (Clarification of Requirements affecting Casing Design)

   a. NTL N10 –

      i. Assumes a Blow-out has occurred – you must be prepared to respond and fully contain the hydrocarbons

      ii. Well Design Must be able to Contain the Flow (using one of these methods)

         - Shut in Well with Capping Stack (with integrity)
         - Shut in Well with Capping Stack – Allows Underground Flow – No Breach to Mudline
         - Cap and Flow – Flow contained with flow to vessels – concern about surface handing of high gas volumes

Findings and Conclusions

Topic 3 – Well Drilling & Completion Design and Barriers

2. Well Containment Screening Tool (Clarification of Requirements affecting Casing Design)

   a. NTL N10 – Containment system must be designed and available to handle a Worst Case Discharge (using one of three options)

      i. L1 – BOP Shut-in or Capping Stack (simplified assumptions)

         High Collapse Casing Required in some cases

      ii. L2 – BOP Shut-in or Capping Stack (advanced analysis)

         - Underground Flow Allowed
         - Does not Broach to Mudline
         - Collapse can occur as long as it does not broach
         - Further analysis (Different gradients, Different Burst Rating/no APB)

      iii. L3 – Cap and Flow – Flowing Pressure Managed at Seafloor (a permit has been issued for this approach)

         - BSEE expected to routinely authorize this approach
         - Collapse can occur
         - Reduced Burst Load
         - Flow contained and collected

Findings and Conclusions

Topic 3 – Well Drilling & Completion Design and Barriers

3. Blow-Out Load Case (Clarification of Requirements affecting Casing Design)

   a. WCD (NLT 6) is not connected to NTL 10
   b. Blow-out Load Case is Not a BSEE Casing Design Requirement (APD guidelines can be used)
   c. Containment system for a subsea blow-out is required by BSEE
   d. Casing Collapse Allowed by BSEE
      i. Casing that will collapse under blow-out load is acceptable (as long as it does not broach to sea floor)
         - Note: Composite Structures (Casing/Cement) are Stronger than Casing Alone Provide Higher Collapse and Burst Capacity
      ii. Containment must be maintained
      iii. BSEE will not allow reduced blow-out rates based on predicted casing collapse (still need full flow containment capability)

Findings, Conclusions and Recommendations

Topic 3 – Well Drilling & Completion Design and Barriers

EWD Workshop: The workshop was worthwhile. Lots of clarity on issues in the industry.

Recommendation: **More workshops** – The workshops should be broken down into sub-categories so that more focused effort a be achieved.

1. Risk assessment on rules that add additional risk to the drilling and completions process. With a focus on total system reliability.
2. Further clarification on the NTL 6 and 10 and their impact on casing design.
3. Further clarity on barriers. (API RP 96 needs to get out and then placed into use. There will be a need for clarity once this document is placed into use)
4. Need to address issues not addressed in whitepaper

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Findings and Conclusions

Coordination & Communication to Align Industry and Regulators

C1a – Current Alignment Mechanisms

- High value of this Workshop
- Industry should request additional Workshops as needed
- Need to exploit existing alignment mechanisms

Gaps and Issues

C3a – Advance Notification of Proposed Regulation

Industry would like more involvement in the Rule Making process.

Rule Making process is lengthy, hence NTL's (the industry would like to be able to comment on NTL's

Findings and Conclusions

- Recommend continued use of Emergency Response Program
  - Evaluate processes of how the industry works together on Emergency Response Drills and Events
  - Consider changing roles and responsibilites of BSEE and Coast Guard
- OOC/BSEE review of departure requests
  - Some departure requests will be denied, but BSEE will support change of Regulations (in some cases).
- Final Rule to clarify “shoulds” and “shalls”

Findings and Conclusions

- Regulatory interest in further information on Fracture Modeling in Salt

- OOC/BSEE review of departure requests
  - Some departure requests will be denied, but BSEE will support change of Regulations (in some cases).

- Final Rule to clarify “shoulds” and “shalls”

- Interest in further understanding of connection performance in collapse scenarios.

Findings and Conclusions

- Review API RP 96 discussion of Barriers (Operational Barriers, Shoe Tracks)
- Safer wells through an understanding of the physics of barriers (strength and resistance).
- Potentially interesting technology for monitoring pressure and temperature in trapped annuli.
- APB solutions still under development (shrinking fluid, memory foam)
- Continue to work together to build consensus on issues that were not worked in the Session due to time constraints.

Questions?

Findings, Conclusions and Recommendations

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1. **Long String versus Liner and Tieback** – A long string is a viable alternative to liner and tieback designs. The long string provides advantages in many deepwater well applications. Both designs have merit and should continue to be available to well designers.

2. **Production Liner – Well Control Design Options** – For well control scenarios, it is important to retain the design option to allow for production liner collapse. Liner collapse can be an effective way to mitigate flow from the reservoir under extreme well control conditions.

Findings, Conclusions and Recommendations

Topic 3 – Well Drilling & Completion Design and Barriers

4. **BOP and Wellhead Equipment for Deeper Water, Higher Reservoir Pressures** – There are technical, regulatory and operational challenges associated with the use of existing BOP systems in high-pressure applications. Without consideration for seawater hydrostatic back-up, current subsea BOP systems are not able to shut-in on wells with pressures exceeding 15 K psi at the BOP (note: backup pressures, which can be significant in deepwater, are not considered for the BOPs, though they are for casing design – see Question 1, Finding 6). Because of the extreme low probability of WCD occurrence, the load case associated with cap and flow well control operations should be permitted for high pressure exploration wells. Operational risk should be considered for management of cap and flow under severe weather conditions such as winter storms and hurricanes.

5. **Annular Pressure Build-up Mitigation** – Well designers want to retain the ability to choose APB mitigations that address credible risks during well construction and operation. Because of the extreme low probability associated with the Worst Case Discharge load case, it is recommended that WCD not be used to dictate APB mitigations.

6. **Working Pressure Ratings of Subsea BOP Equipment** – The prediction of the benefit derived from hydrostatic pressure back-up is straightforward for simple geometries such as tubulars. The benefit to more complex geometries, such as subsea BOP equipment, is not as easily predicted. Industry should continue to work to estimate the working pressure benefit that can reliably be provided to subsea BOP systems as a result of environmental pressure effects.

Findings, Conclusions and Recommendations

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1. **In-situ Verification of Barrier Integrity** – Regulations should change to require only one pressure test of a dual barrier system. Additional work should be undertaken to establish standards that improve the reliability of "negative" pressure tests.

2. **Reliability of Mechanical Barriers** – The reliability of a mechanical barrier can be established by various factors including quality in design, manufacture, installation and testing.

3. **Reliability of Cement Barriers** – The reliability of an annular cement barrier is in part a function of annular clearance and centralization. These attributes are particularly important in close tolerance casing programs.

4. **Mechanical Lock-Down of Hanger and Hanger Seal Assemblies** – The requirement to lock down seal assemblies should apply only to those seals with the potential for exposure to hydrocarbons.

5. **Casing and Cementing Equipment Reliability** – There is a need to identify and reduce common equipment failure modes; to increase the reliability of individual casing/cementing equipment components; and to improve the integration of these components into highly reliable barrier systems.

Findings, Conclusions and Recommendations

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1. **Stimulation of Deep Tight Formations** – The commercial development of deep tight formations will require special production stimulation techniques that may exceed current capabilities.

2. **Well Intervention Systems** – Intervention operations on deeper and higher-pressure wells may exceed the capacity of available equipment. Additional development will of intervention systems will be required.

3. **Low Cost Reservoir Access** – While low cost reservoir access techniques have been successfully used in recent years, the development of specialized equipment, systems and deployment vessels will be required to make full use of this approach to access deepwater Gulf of Mexico reserves.