Bureau of Safety and Environmental Enforcement

Seal Assembly / Cement Failure Technical Evaluation

API's 2015 Exploration and Production Standards on Oilfield Equipment and Materials Summer Meeting

Doug Morris
Joseph Levine
Candi Hudson

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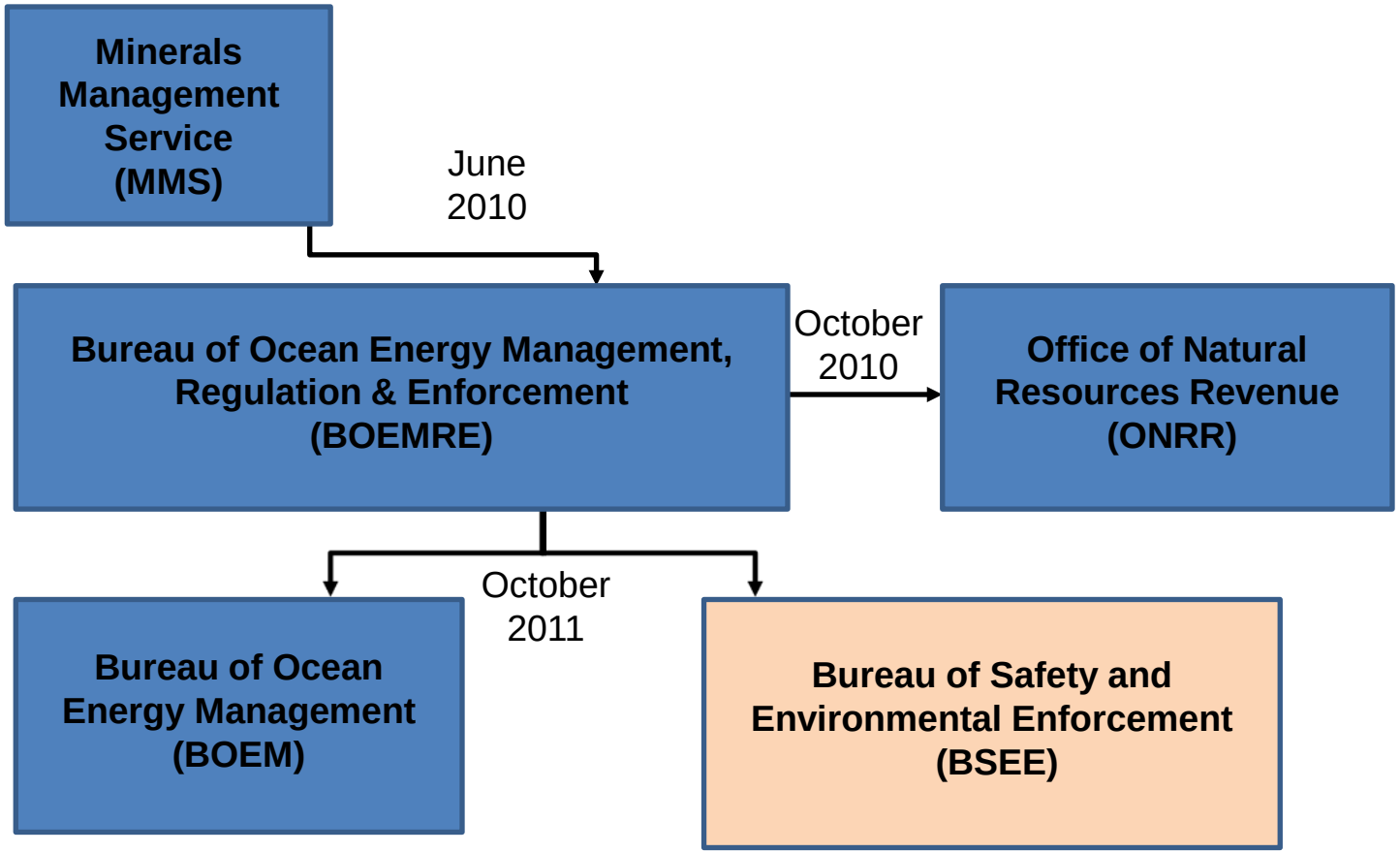
BSEE Mission Statement

“To promote safety, protect the environment and conserve resources offshore through vigorous regulatory oversight and enforcement.”

Presentation Overview

- BSEE Mission
- BSEE History
- BSEE Regulatory Model
- Liner Seal and Cementing Failure Technical Evaluation

BSEE: History



BSEE: Who We Are

- Staffing: 795 Employees
  - 200 engineers
  - 100 inspectors
- Locations
  - Headquartered in DC & Sterling, VA
  - Three regional offices
    - Gulf of Mexico – New Orleans, LA
    - Pacific – Camarillo, CA
    - Alaska – Anchorage, AK
- Regional District Offices

BSEE Regulatory Model

- Hybrid regulatory system
- Program draws from a variety of concepts
- Model contains 3 key elements
  - Prescriptive requirements
  - Performance-based initiatives
  - Industry Standards

BSEE Technical Evaluations

- Conduct QA/QC evaluations on manufactured equipment
- Evaluate “Fitness for Service” of manufactured equipment
- Identify gaps in industry practices/standards and/or regulations
- Enhance regulator and industry knowledge through evaluation findings
- Focus on issues that have potential industry wide (global) impacts
- Not the same as traditional BSEE OIR, 2010 or panel report investigations

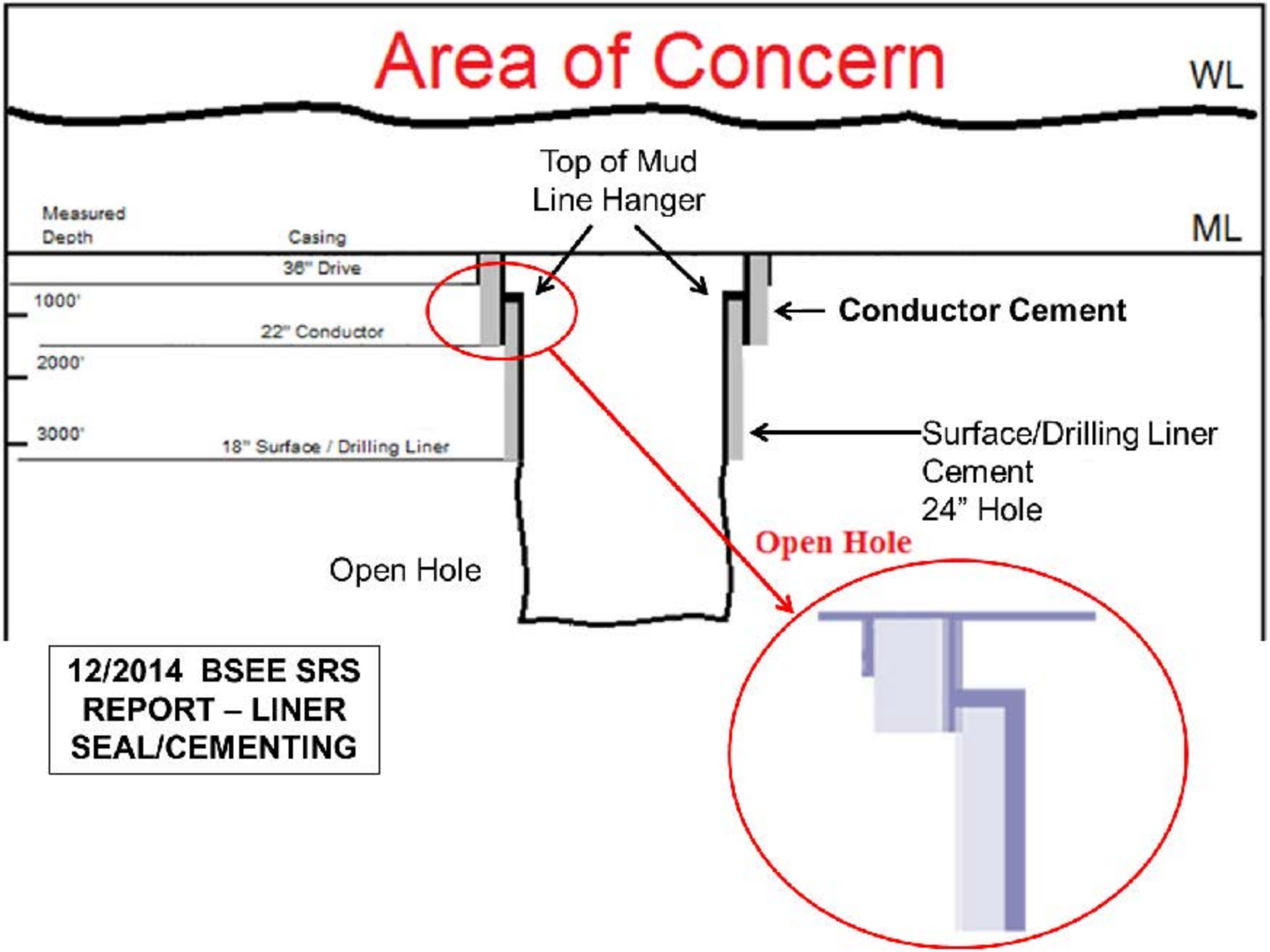
Technical Evaluations to Date

- Four evaluations since 2/2013
  - H4 Connector Bolt Failure
    - Completed 8/2014
    - Report posted on BSEE website
  - Seal Assembly/Cement Failure
    - Completed 12/2014
    - Report posted on BSEE website
  - Two evaluations in progress
    - Wing-Valve Assembly
    - HC Connector Bolt Failure
      - May have similar issues as the 8/2014 evaluation

Liner Seal/Cementing Failure Technical Evaluation

- While drilling operator took a gas kick (2/2013)
- Kick resulted in a gas flow into a shallow sand below the conductor casing shoe culminating in an underground blowout
- Event created risk of broaching to the seafloor
- Possible failure points
  - Casing hanger seal
  - Cement column in conductor/surface liner annulus
  - Hole in casing
  - Damaged casing threads

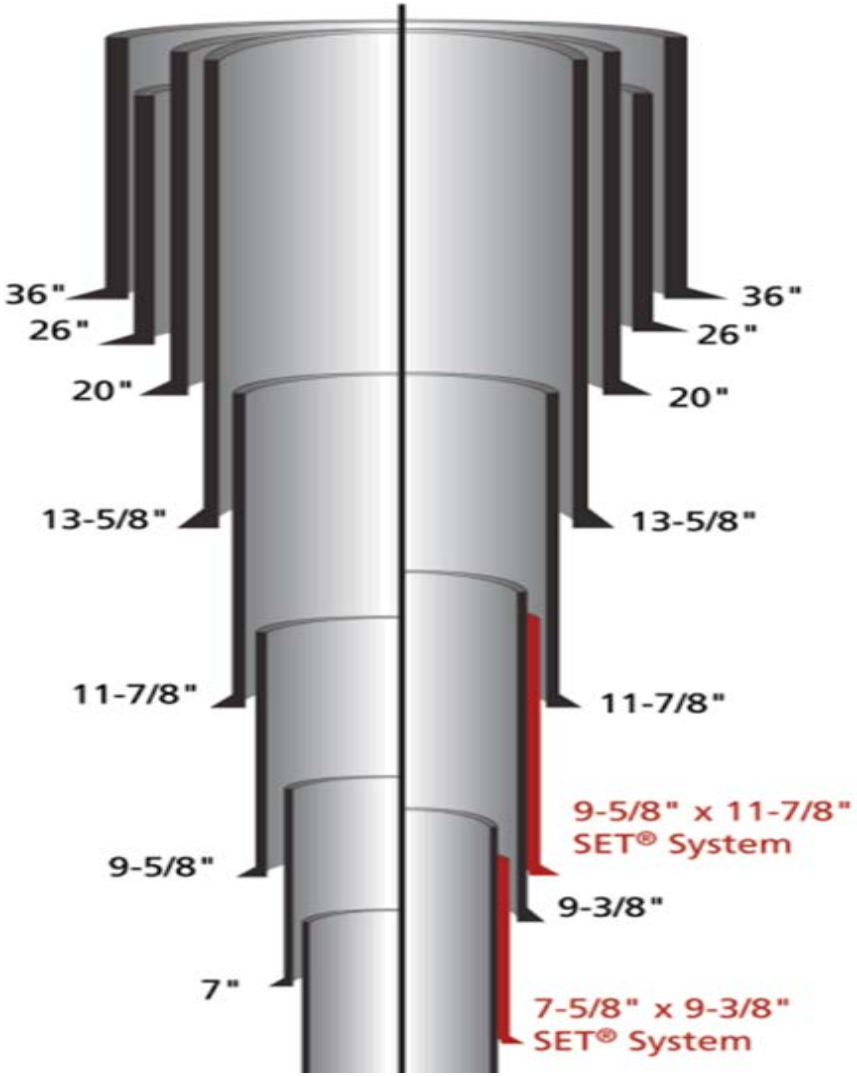
Area of Concern

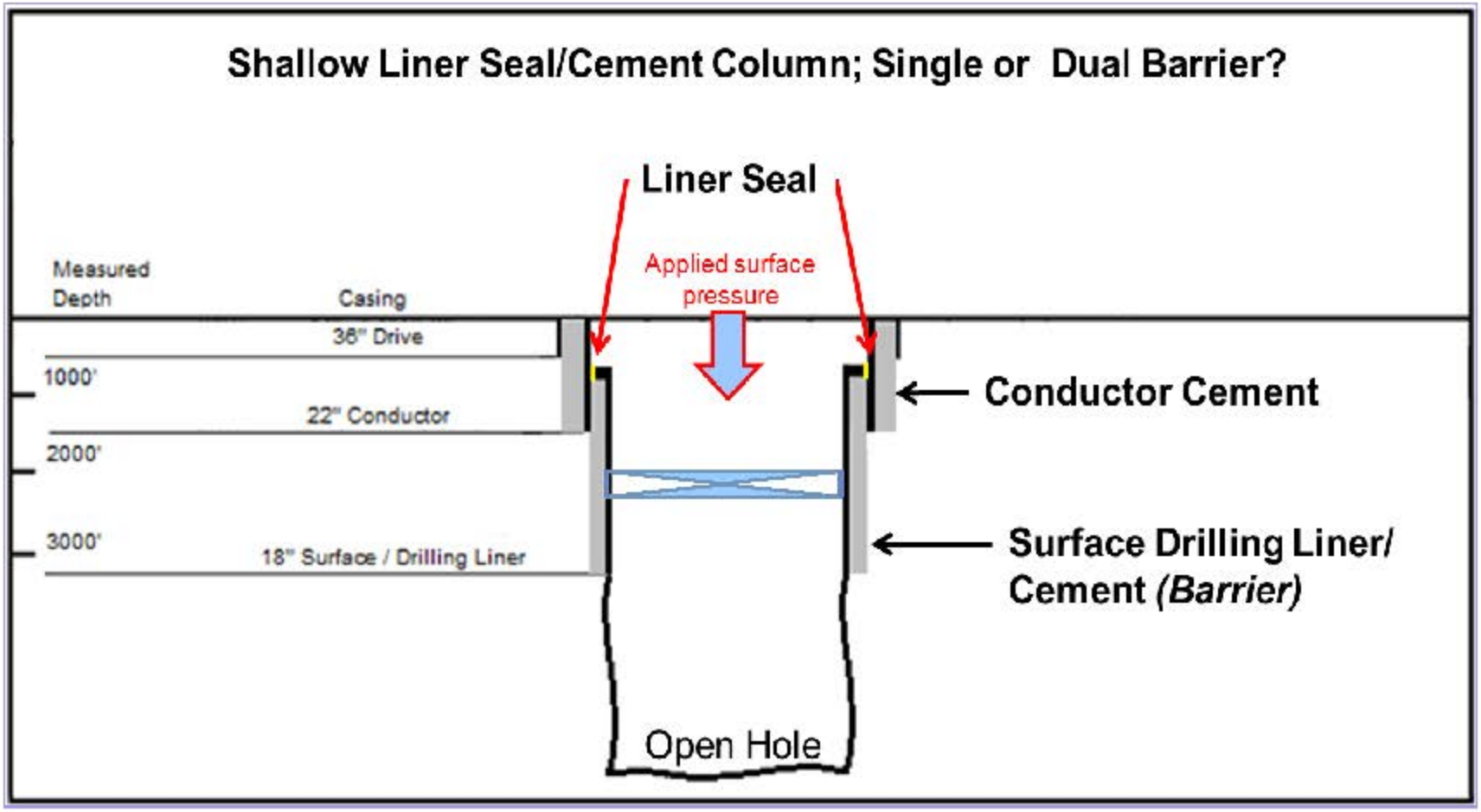


12/2014 BSEE SRS REPORT – LINER SEAL/CEMENTING

Liner Seal/Cementing Failure Technical Evaluation

- Major Issues
  - Are the Shallow Liner Seal/Cement Column a single or dual barrier system?
  - Can cement practices for shallow sections of a well be improved upon?
  - What criteria need to be evaluated to ensure Shallow Liner Seals are “Fit for Service”?




Shallow Liner Seal/Cement Column; Single or Dual Barrier?
Liner Seal
Applied surface pressure
Measured Depth
Casing
36" Drive
1000'
22" Conductor
2000'
3000'
18" Surface / Drilling Liner
Conductor Cement
Surface Drilling Liner/ Cement (Barrier)
Open Hole

Liner Seal/Cementing Failure Unanswered Questions

Are the Shallow Liner Seal/Cement Column a single or dual barrier?

- If the liner seal is faulty are you actually testing the cement column?
  - How would you know?
- Does a successful liner pressure test mask a poor cement job?
  - How would you know?
- Is the integrity of the cement column behind the liner truly understood?
  - How could you determine the cement integrity?

API RP 96

- Deepwater Well Design and Construction
  - First Edition, March 2013

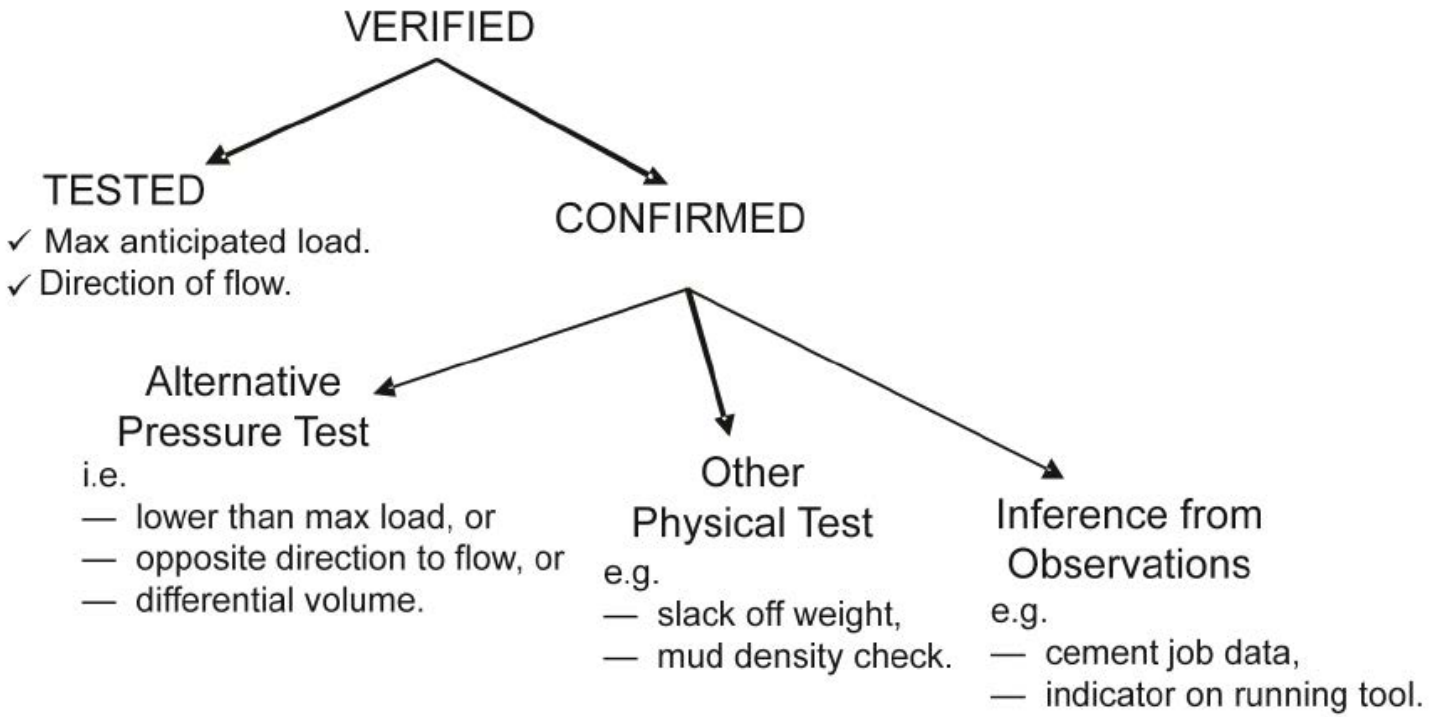


Figure 6—Representation of Barrier Verification Categories

Liner Seal/Cementing Failure Unanswered Questions

What criteria need to be evaluated to ensure Shallow Liner Seals are “Fit for Service”?

- Temperature Rating
  - Seal Assembly was rated to 75oF but was exposed to 90oF during operation
  - Inconsistencies between operator and OEM concerning seal’s temperature rating
- Gas vs Liquid Rating
  - Seal design was not qualified for gas, yet gas was “seen” in the well
- Are there other design criteria that need to be evaluated?
  - Pressure
  - Axial loads

API 17D
Hanger Industry Standards

- No current standards exclusively address all liner hangers or seals
- Shallow Liner Hanger hung off of a submudline casing hanger is considered part of the Wellhead
- **API Spec 17D Design & Operation of Subsea Production Systems Subsea Wellhead & Tree Equipment**
  - First Edition (2003)
    - Hydrostatic pressure tests shall be acceptable for all performance verification pressure tests
    - Liner hanger and seal were designed to First Edition
  - Second Edition (2011)
    - Gas shall be used as the test medium for pressure-hold periods for pressure-containing and controlling equipment
    - 3 pressure/load and temperature cycling tests required
- **Would incorporation of 17D second edition in BSEE regulations address our concern with shallow liner seal "Fit for Service" issues?**

API RP 19LH
Hanger Industry Standards

- API RP 19LH Liner Hangers
  - First Edition to be published in 2016
    - Will not cover shallow surface liners, only production liner hangers
- Scope (as of May 2014)
  - Provides requirements & guidelines for conventional and expandable liner systems including liner hangers, liner packers, tie back and polished bore receptacles, seal stems, landing collars & running/setting tool components
  - Provides minimum requirements for the functional & technical specification, including design, design verification and validation, materials, documentation and data control, repair shipment and storage.
- **Incorporation of 19LH in BSEE regulations will not address our concerns with shallow liner seal "Fit for Service" issues**

Liner Seal/Cementing Failure Unanswered Questions

Surface Drilling Liner/Shallow Hole Section Cement Concerns

- Is BSEE liner lap/liner pressure test sufficient to prove reliability of the barrier(s)?
  - Can not decline more than 10% in a 30-minute test
  - What is the engineering basis for this metric?
- Is annular fill to at least 200 feet above conductor shoe adequate?
- Is WOC of 12 hours with cement held under pressure adequate?
  - WOC times shall be adequate to achieve a minimum of 500 psi compressive strength at the casing shoe prior to drilling out
  - How is this determined? (in a lab, estimation)
- Is there an ideal open hole diameter/surface liner OD ratio?
  - What annular space is too large/small?
- Other suggestions?

API RP 65
First Edition, September 2002

Cementing Shallow Water Flow Zones in Deepwater Wells

Incorporated in BSEE Regulations

- Appendix B.2- Hole Size
  - Define optimum hole size to achieve effective mud removal and annular isolation
  - Consider annular dimensions with casing in the hole to allow for placement of cement at desired rates
  - Control drilling mud properties to minimize large washouts
- Appendix F; Table A-2 – Hole Diameter
  - Hole diameter should be a minimum of 3.0 inches greater than the casing outer diameter

Does this provide sufficient guidance in planning open hole geometry?

API STD 65-Part 2
Second Edition, December 2010

Isolating Potential Flow Zones During Well Construction

Incorporated in BSEE Regulations

- Section 5.2: Hole Quality
  - Where hole quality could compromise cementing quality
    - Avoid severe doglegs, hole enlargement, and spiral patterns to improve drilling fluid displacement during cementing
    - Use of directional survey data when modeling centralization & drilling fluid displacement to improve the simulation accuracy
- Annex D
  - Hole Diameter - Is hole enlargement minimized sufficiently to allow for adequate centralization?
  - Centralizer placement simulations shall be performed
  - Have the centralizer simulator results been considered during the cementing design and execution?

Does this provide sufficient guidance in planning open hole geometry?

30 CFR 250.420 – What Well Casing and Cement Requirements Must I Meet?

- BSEE Blowout Preventer Systems and Well Control Proposed Rule
  - Proposed Change:
  - Add new paragraph (a)(6) - require adequate centralization to help ensure proper cementation
- Will this requirement be of value in improving cementing of shallow casing/liner sections of a well?
- Can centralizers be run in shallow sections of a well?

Opportunities for Improvement with Standards

- Are existing standards adequate for seal design/qualification?
  - API 17D - Second Edition (2011)
    - Should this be incorporated into BSEE regulations?
  - API 19LH - First Edition (Publish 2016)
  - Should they be modified? How?
- Are existing BSEE regulations and standards adequate for cementing?
  - RP 65 - First Edition
  - STD 65-2 - Second Edition
  - 30 CFR 250
  - Should they be modified? How?

Possible Research

- Shallow Liner/Cement JIP to Evaluate if Seal and Cement are a Single or Dual Barrier
  - 1) Scaled laboratory testing of liner seals with associated annular cements to help determine if we are dealing with a single or dual barrier
    - Vary type of liner seal, open hole diameter/surface liner OD ratio
    - Test at various pressure and temperature combinations
    - Test with different classes and densities of cement
  - Evaluate performance of seals and cements ability to hold applied pressure in regards to preventing leaks
  - Develop performance curves for seals and cements at pressure and temperature combinations
  - 2) Investigate/evaluate different sealing system options for use downhole in shallow sections of a wellbore

Are Additional Clarifying Regulations Needed?

BSEE Website: www.bsee.gov

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