Seal Assembly / Cement Failure
Technical Evaluation

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

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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

Minerals Management Service (MMS)

Bureau of Ocean Energy Management, Regulation & Enforcement (BOEMRE)

Office of Natural Resources Revenue (ONRR)

Bureau of Ocean Energy Management (BOEM)

Bureau of Safety and Environmental Enforcement (BSEE)

June 2010

October 2010

October 2011
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
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

Conductor Cement

Surface Drilling Liner/Cement (Barrier)

Open Hole

- Measured Depth
  - 1000'
  - 2000'
  - 3000'
- Casing
  - 36" Drive
- Conductor
  - 22" Conductor
- Surface/Drilling Liner
  - 18" Surface/Drilling Liner
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


VERIFIED

TESTED
✓ Max anticipated load.
✓ Direction of flow.

CONFIRMED

Alternative Pressure Test
i.e.
— lower than max load, or
— opposite direction to flow, or
— differential volume.

Other Physical Test
i.e.
— slack off weight,
— mud density check.

Inference from Observations
i.e.
— cement job data,
— indicator on running tool.

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 75°F but was exposed to 90°F 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 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?
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?
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?

  - 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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