BSEE Standards Workshop

Subsea HIPPS, Key Sticking Points

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KBR's Annual Report on Form 10-K dated February 20, 2013, Form 10-Q for the quarters ended March 31, 2013, June 30, 2013, and September 30, 2013, recent Current Reports on Forms 8-K, and other Securities and Exchange Commission filings discuss some of the important risk factors that KBR has identified that may affect the business, results of operations and financial condition. Except as required by law, KBR undertakes no obligation to revise or update publicly any forward-looking statements for any reason.

Granherne
A KBR Company

Topics

- Summary of Granherne Report: Evaluation of High Integrity Pressure Protection Systems (HIPPS)*
- Current Initiatives
  - Upstream subsea relief
  - Comments from recent experience

* Report Performed for MMS, Issued Apr. 12, 2010

Evaluation of High Integrity Pressure Protection Systems (HIPPS)

- Report covered the following subjects specifically for subsea HIPPS:
  - HIPPS Valve Leakage
  - HIPPS Valve Response Times
  - HIPPS Equipment Material Selection
  - Length of Fortified Section
  - Flowline vs. Riser Burst in Deepwater
  - Recommendations on Regulation
- Following summarizes critical aspects

HIPPS Valve Leakage

- New valves leak free
- If operation leads to wear and tear/leakage, what will operators/regulators need to assess?
- Identified Challenges
  - Realistically detectible leak rates in operation
  - Detection sensitivities
  - Packing duration to overpressure sensitivities
- Designs should consider sensitivities
- Consideration of leak contingency during system design would streamline assessment in operation

Leak Sensitivities Identified for Consideration

- Detection sensitivity to:
  - Pressure transducer capability and errors
  - High temperatures
  - Low test pressures
  - High test volumes
  - High test GORs
- Packing duration to overpressure sensitivity to:
  - High initial pressures
  - Low downstream volumes
  - Low production fluid GORs

HIPPS Valve Response Times

- Response times linked to:
  - Length/Volume of fortified section downstream
    - Smaller volume requires faster closure
  - Degree of fortification downstream
  - Impact of closure speed on pressure surges upstream for low GOR fluids
    - High speed yields greater surge in pressure

HIPPS Equipment Material Selection

- No HIPPS-specific material selection issues identified for:
  - Technical design
  - Regulatory requirements
- Use same methods and materials as other subsea oil field equipment

Length of Fortified Section

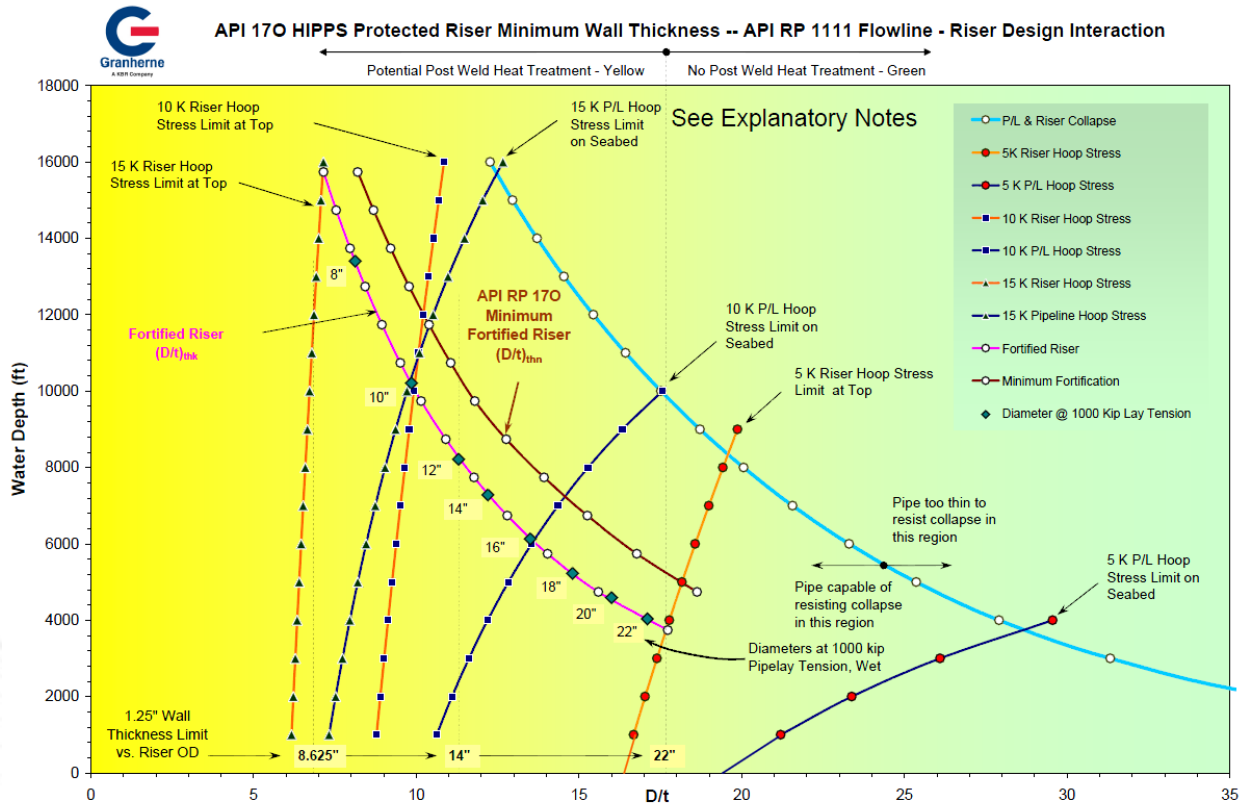
- Linked to valve response time
- Flow assurance assessment required
- Space less of a premium subsea than on a topsides

Flowline vs. Riser Burst in Deepwater

- External head in deepwater can cause pipeline to be more burst resistant than riser
  - Increases net pressure to burst flowline
  - Can change FL design limit state to collapse
- If HIPPS fails, critical zone may then migrate to the top of the riser due to:
  - Proximity to people and process
  - No external reinforcement from water head

Flowline vs. Riser Burst in Deepwater (Cont.)

- Evaluate complex depth, pressure rating and pipeline diameter interaction for FL and Riser



Flowline vs. Riser Burst in Deepwater, (Cont.)

- May need to reinforce riser
  - Not always practical
- Alternative is relief system
  - Upstream of boarding valve on riser raises safety concerns
  - Safely away from facility was expected to be impractically expensive
  - Area of ongoing KBR-Granherne research

Recommendations on Regulation

- Use API 1111 (i.e., Limit State Design) for pipelines

Current KBR Subsea Relief Initiative

- GOM storm abandonment scenario
  - Valve failures upstream of boarding SDV
  - Platform relief/flare shutdown/storm damaged
  - Packing time to overpressure > repair/restart time
- Unlikely all valves (SCSSIV, Tree, HIPPS) open
  - Contingency protection thus for leaking valves
  - Leaking rates likely low / full flow relief unnecessary
- Subsea solution must resist external pressure
- Provide Separation / Venting to mitigate pollution

Current KBR Initiative

- Patent Pending Device

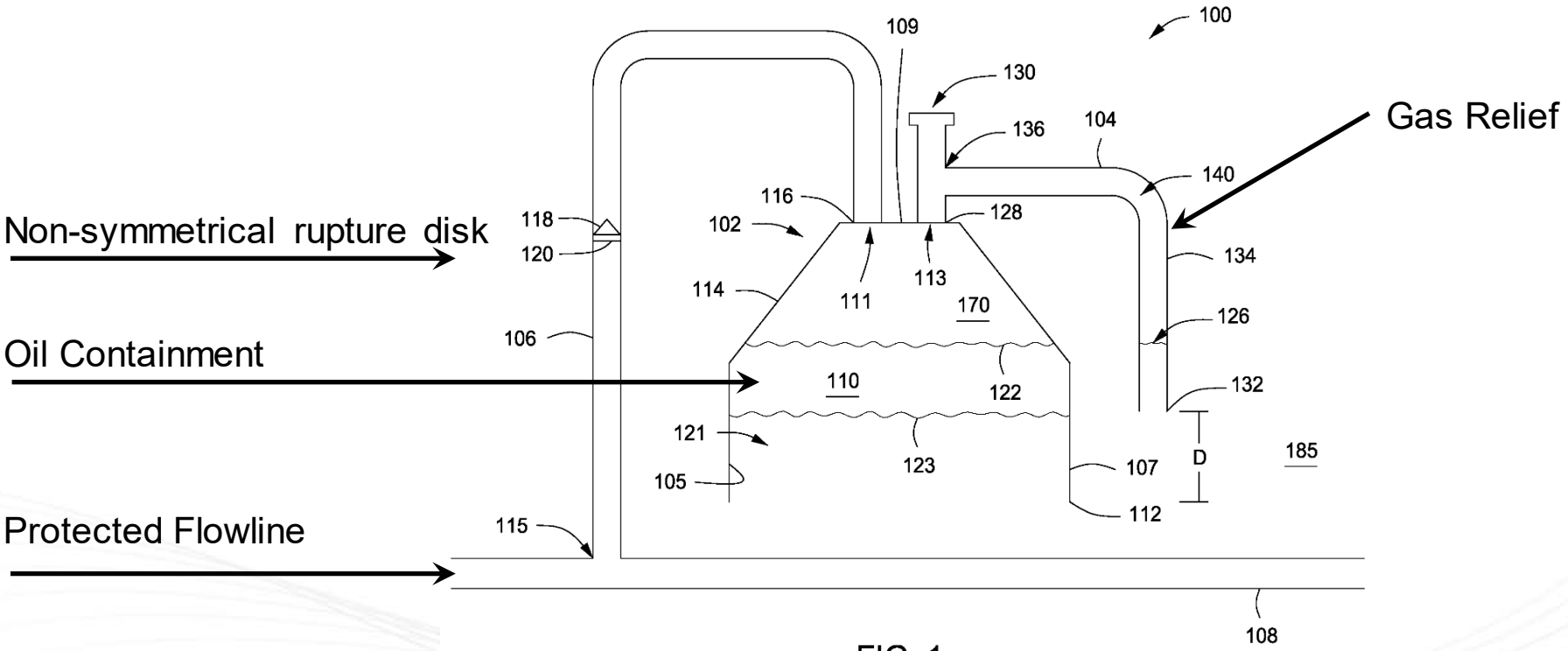


FIG. 1

* Patent Application PCT/US2013/044299