Annular Pressure Management During Gas Lift Operations

- Coll Brodie; Sales and Operations Engineer
- Petroleum Technology Company
Annulus Pressure Management

• Traditional Well Barrier Envelope
  – Both the primary and secondary barrier must be able to back the other up, in all of the failure modes that may affect each barrier.

• Sustained annulus pressure
  – Gas lifted wells
  – Leaking casing or completion equipment
  – Gas venting in pumped wells

• Traditional Solution
  – Wing Valve (single barrier to annulus volume)
  – Downhole Annulus Safety Valve
Traditional approach, Wing valves
Traditional approach 2, DASVs

OBJECTIVE
Petroleum Safety Authority Norway (PSA) categorizes hydrocarbon leaks into 3 groups:

- Large: Greater than 10 kg/s
- Medium: 1 – 10 kg/s and
- Small: 0.1-1 kg/s

PSA statement:

- It was a medium-sized gas leak caused a gas cloud which was ignited.
- There are four to five leaks each year on the Norwegian shelf of a size equal to the one which started the 'Piper Alpha' accident

Norsok D10 - Well integrity in drilling and well operations

- The large volume of pressurized hydrocarbon gas in both surface lines and in the A-annuli represents a substantial risk to a platform. The volume of released hydrocarbon gas due to accidental damage to the tree, wellhead or surface lines shall be minimized. All gas lift wells shall have two barriers to prevent release of the A-annulus gas volume.

Requirement for Annular Safety Valves
Exprosoft Risk Analysis Performed for a Norwegian Operator

- **Leak from 1.25mm release point (1/16”)**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>With an ASV</th>
<th>Without an ASV</th>
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<tbody>
<tr>
<td>Total Release during the first hour</td>
<td>302kg</td>
<td>345kg</td>
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<td>Equivalent Gas BBQ Bottles</td>
<td>22</td>
<td>27</td>
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- **Leak from 2.725” release point**

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<tr>
<th>Time to ASV closure</th>
<th>after 0 sec</th>
<th>after 15sec</th>
<th>after 30sec</th>
<th>No ASV</th>
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<tbody>
<tr>
<td>Total Release</td>
<td>963kg</td>
<td>2039kg</td>
<td>2815kg</td>
<td>5343kg</td>
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<tr>
<td>Equivalent Gas Bottles</td>
<td>64</td>
<td>136</td>
<td>188</td>
<td>356</td>
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<tr>
<td>Duration till annulus is evacuated</td>
<td>Approx 45 seconds</td>
<td>Approx 70 seconds</td>
<td>Approx 80 seconds</td>
<td>Approx 250 seconds</td>
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<table>
<thead>
<tr>
<th>Example</th>
<th>PKR MD (ft)</th>
<th>Tubing OD (in)</th>
<th>Casing ID (in)</th>
<th>Pann (psi)</th>
<th>Vgas (MMscf)</th>
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Solution to meeting the objective
Master Surface Annulus Safety Valve

- A new primary barrier is installed in the VR Profile.
- Secondary barrier becomes GV
- Hydraulics into the rig ESD system
- Enhance annular integrity under normal operating conditions and in the event of a catastrophic event.
- The system is capable of bi-directional flow of gas and fluids.
Gas Lifted Annulus Monitoring

Pressure gauge behind valves

- Weakest link in barrier envelope?
- Blockage by valve lubricant
- The valves are “normally” closed
- Requirement for continuous monitoring
- Gate valve reliability
  - Leak over the ring gaskets
  - Leak through the bonnet seals
  - Leak through the stem seals
  - Failed gate
Solution to meeting the objective

VR Sense

- A new primary barrier is installed in the VR Profile.
- Secondary barrier improvement with leak path reductions
- Never blind to annulus pressures
- Enhance annular integrity under normal operating conditions and in the event of a catastrophic event.
Traditional System for dry wellheads

1. Single Barrier
2. Un-protected from dropped objects
3. Blind to annulus pressure during ESD
4. Manual operation
5. Large footprint
A-PRO
Complete System for dry wellheads

1. Dual Barrier
2. Protected from dropped objects
3. Read to annulus pressure during ESD
4. Automated operation
5. Small footprint
PTC Data Acquisition & Control System

- It acquires data from 28 annulus P&T sensors and transmits the data onshore via GSM link
# PTC Data Acquisition & Control System

## DACS REPORT SYSTEM

### WELLS

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<th>PIP2</th>
<th>PIP3</th>
<th>PIP4</th>
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### A-03

#### Warning Levels:

- TH: 1.46
- AA: 9.04
- AB: 0.27

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#### Graph:

WELL 3

- TH
- AA
- AB
GOM Operator MSAS History

Operator Risk Statement during development:
• 200 – 1000 Mcf of gas inventory in a single Gas lifted well
• Concern of Hurricane damage to gas injection lines
• Single Annulus outlet, requirement to bleed down and control annulus pressure

Operational History in GOM
• The first installation was April 2008
• 28 systems have been installed across 4 TLPs:
  • Operator procedure for planned maintenance of the MSAS system includes inflow testing and actuating each MSAS valve annually.
  • Longest operational system is 8.9 years.
  • No operational issues or integrity test failures.
  • As of August 1st 2017, the valves currently operating have a combined operational days off 115.6 years with a mean of 5.2 years per system.
VR Sense installs
- 156 installed across and A & B annulus

MSAS installs
- 53 Spools installed
• Traditionally ASVs are required in the region by the operator as the secondary barrier to the reservoir.
• Gas lift pack off system introduces higher risk of potential leak path through the tubing
• MSAS system viewed as a retrofit ASV, avoids requirement for tubing pull.
• To date 12 MSAS installs over 6 wells
Questions?
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