WELL VERIFICATION FREQUENCY - JUSTIFICATION FOR CHANGE?

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Overview

• Objectives
• RSRUK Wellstock
• Verification process
• Historical data review
• Verification data - results
• Changes and budget planning
• Re-cap
Study Objectives

• To investigate failure rates for safety critical components on all platform wells
• Determine the ideal spacing between Well Verification Routines
• Identify any opportunity to extend the frequency or optimise activities
RSRUK Well Stock

• 10 Platforms / 241 wells - most legacy
• 4 different tree/wellhead vendors
• Equipment in excess of 30 years old
• Split & solid gate valves
• Loose spool & multi-bowl wellheads
• Metal to metal & elastomeric seals
• A range of well types
  – Natural producers / water injection
  – Gas lift / ESPs / Jet Pumps
The Challenge

The primary objective is to keep people safe, but:

• Well Verification costs:
  – Resources
  – Beds
  – Production Deferment

• We need to:
  – Optimise utilisation
  – Focus attention where needed
  – Minimise shut-in time

While ensuring the barrier envelope is intact
Well Verification Cycle

6 Month
- Test all tree valves
- Test DHSVs and Control Lines

12 Month
- Test all tree and wellhead valves
- Test DHSVs and Control Lines
- KP4 Survey

Biennial
- Annulus Top-Up/Pressure Test
Well Verification Routine

• Not Preventative Maintenance
  – We test, grease and function
  – Repair if we don’t need a tubing plug
  – Verify the well condition, make sure there are barriers and make sure personnel are safe from the well

• Well Verification – aligned to:
  – Internal performance standard
  – Safety Case Regulations
  – Design and Construction
  – Health and Safety at Work
Output & Issues

• Previously only provided assurance to continue
  – Verify the well, update a status summary, inform

• But:
  – Very little time looking for trends
  – No historical evaluation
  – What did all the data tell us?
Transforming Data to Information

Well Integrity & Reporting For Dummies

Learn to:
- Analyze data and report it in a way that makes sense
- Slice and dice data from different perspectives
- Create eye-catching and understandable reports, visualizations, and dashboards
- Automate redundant reporting

I. P Squint

Excel Workbook For Dummies

Practice for the Rest of Us!
## Well Verification - Evaluation

- 6 year review across all surface wells
- Looking at failures on all components
- Pre & Post grease and function

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<th>2013</th>
<th>2014 / 1</th>
<th>2015 / 2</th>
<th>2016 / 2</th>
<th>2017 /</th>
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<th>Failure</th>
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</table>

| Post Component | 2013 | 2014 / 1 | 2015 / 2 | 2015 / 2 | 2016 / 2 | 2017/1 | Average | Failure |
|----------------|------|----------|----------|----------|----------|--------|---------|
| LMV | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2% | 2.38E-02 |
| UMV | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 4% | 3.57E-02 |
| FWV | 3 | 2 | 1 | 3 | 3 | 1 | 2 | 15% | 1.55E-01 |
| Kill | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 4% | 3.57E-02 |
| Swab | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| GMV | 1 | 0 | 3 | 1 | 1 | 1 | 4 | 2 | 12% | 1.19E-01 |
| A-ann vlv (Live) | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| A-ann vlv (Offside) | 1 | 1 | 1 | 1 | 1 | 1 | | 7% | 0.00E+00 |
| B-ann vlv (Live) | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| B-ann vlv (Offside) | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| C-ann vlv | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| DHSV | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| DHSV Control Line | 0 | 0 | 0 | 0 | 0 | 0 | | 0% | 0.00E+00 |
| ADHSV | 2 | 1 | 0 | 2 | 2 | 0 | 1 | 8% | 8.33E-02 |
| ADHSV Control line | 1 | 2 | 0 | 1 | 1 | 1 | 1 | 7% | 7.14E-02 |

- Well Verification - Evaluation
- 6 year review across all surface wells
- Looking at failures on all components
- Pre & Post grease and function

- Component Analysis
  - LMV: 2013 - 2017
  - UMV: 2013 - 2017
  - FWV: 2013 - 2017
  - Swab: 2013 - 2017
  - GMV: 2013 - 2017
  - B-ann vlv (Live): 2013 - 2017
  - B-ann vlv (Offside): 2013 - 2017
  - C-ann vlv: 2013 - 2017
  - DHSV: 2013 - 2017
  - DHSV Control Line: 2013 - 2017
  - ADHSV: 2013 - 2017
  - ADHSV Control line: 2013 - 2017

- Average Failure Rates:
  - LMV: 27%
  - UMV: 23%
  - FWV: 31%
  - Swab: 8%
  - GMV: 15%
  - A-ann vlv (Live): 4%
  - A-ann vlv (Offside): 7%
  - B-ann vlv (Live): 0%
  - B-ann vlv (Offside): 0%
  - C-ann vlv: 0%
  - DHSV: 0%
  - DHSV Control Line: 4%
  - ADHSV: 6%
  - ADHSV Control line: 7%

- Failure Rates:
  - LMV: 2013 - 2017
  - UMV: 2013 - 2017
  - FWV: 2013 - 2017
  - Swab: 2013 - 2017
  - GMV: 2013 - 2017
  - B-ann vlv (Live): 2013 - 2017
  - B-ann vlv (Offside): 2013 - 2017
  - C-ann vlv: 2013 - 2017
  - DHSV: 2013 - 2017
  - DHSV Control Line: 2013 - 2017
  - ADHSV: 2013 - 2017
  - ADHSV Control line: 2013 - 2017

- Evaluation Criteria:
  - Failure rate analysis
  - Grease and function verification
• Big range in valve reliability
• **Blue** – failure in as-found condition
• **Red** – failure after grease & function
Xmas Tree Master Valves

LMV Tests

- Breakdown by platform, A to I
- Variation between site and valve

UMV Tests
Swab & FWV Valves

- No pattern across assets
- Failure rates consistent within sites
DHSV & GMVs

**DHSV Tests**

- As Found:
  - A: 0%
  - B: 3%
  - C: 6%
  - D: 4%
  - E: 15%
  - F: 2%
  - G: 3%
  - H: 4%
  - I: 7%

- Post Maint.:
  - A: 4%
  - B: 5%
  - C: 4%
  - D: 12%
  - E: 2%
  - F: 0%
  - G: 5%
  - H: 7%
  - I: 4%

**GMV Tests**

- As Found:
  - A: 0%
  - B: 5%
  - C: 10%
  - D: 15%
  - E: 23%
  - F: 12%
  - G: 20%
  - H: 25%
  - I: 0%

- Post Maint.:
  - A: 0%
  - B: 3%
  - C: 0%
  - D: 4%
  - E: 0%
  - F: 0%
  - G: 4%
  - H: 0%
  - I: 3%

- **Notes:**
  - Same equipment used on a number of platforms
  - Failure rates different due to well conditions
Platform A: Failure Tendency

SWAB: 0%
DHSV: 0%
GMV: 15%
FWV: 31%
UMV: 23%
LMV: 27%
Results

• Verification routines identified impairment, failures drove reactive repairs

• Now looking for trends

• Historical evaluation
  – Failure rates on initial test are high
  – Failure rates post grease/ function are circa <10%
  – Now have reliability data
12 Month Verification Schedule

Evaluation of the failure rates have identified that, yearly well verification confirms:

• Well stock status is understood
• Compliance with barrier philosophy
• The health and safety of personnel is ensured
• Barriers are available during shut-down
6 Month Verification Schedule

Failure rates have identified that:

• Verification testing on a 6 monthly cycle confirms previously known failures if repairs have not been carried out

• Following grease and function failure rates drop to a predictable rate
## Predictive Failure Model

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Can’t predict which wells will fail, but we can predict which failures may happen, so:

- Better budget planning
- Identify required platform days
- Shouldn’t be a surprise
Summary

• 12 monthly Well Verification Routine
  1. Assures the well barrier envelope is sound.
  2. Identify repairs that must be carried out.

• Reactive repairs within required timeframe
  3. Assures compliance with company and industry best practice.
  4. See Point 1

• 6 monthly grease and function
  4. Confirms valves will close as required
  5. Failure data on how many valves will seal
  6. See Point 1
Conclusions

• Verification testing is essential to ensure the barrier envelope
• Evaluation of the data is critical
• From this data we changed to a risk based verification sequence, but not changed the frequency
• Historical data has now led to better budget planning.
Take Away

• Next focus is down hole
• The challenge is data acquisition using new technology
• This will complement the data we gather from verification testing of annulus, wellheads, trees and DHSVs
Re-Cap

- 241 wells on 10 platforms
- Good understanding of current status
- Verification is vital to compliance
- Historical data / statistical evaluation
- Failure rates understood
- Same schedule / different routine
- Predictive Failure Model
- Budget / resources optimised
Questions?