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

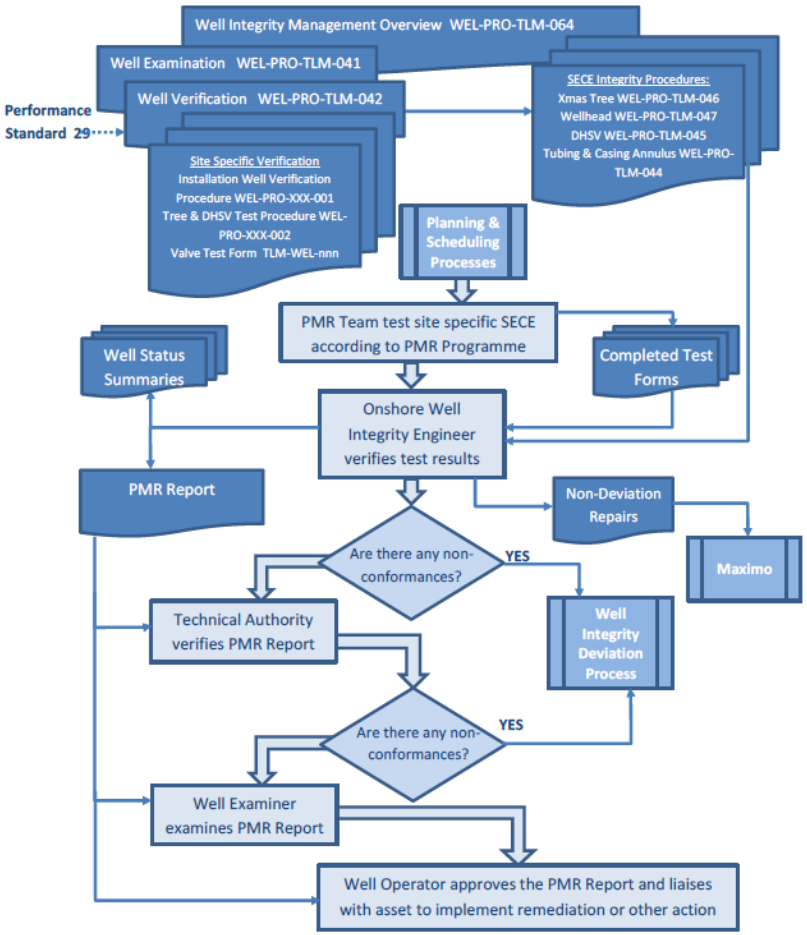
The Challenge

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

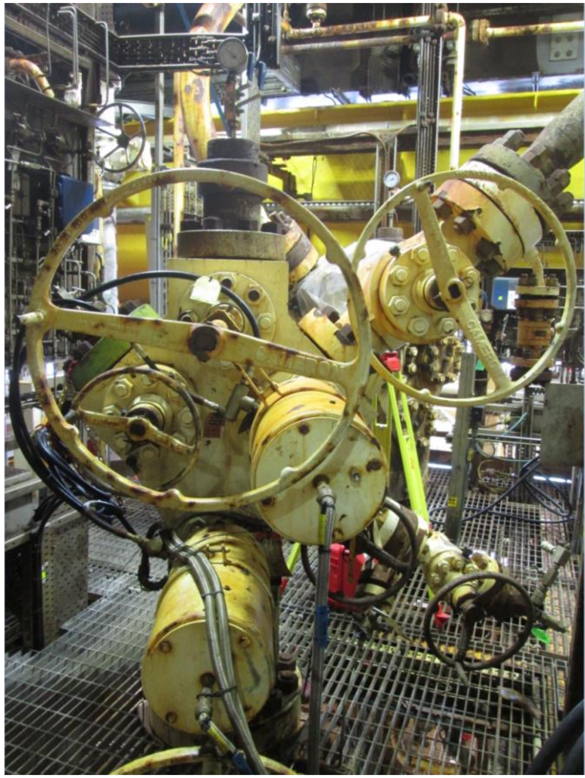
- Test all tree and wellhead valves
- Test DHSVs and Control Lines
- KP4 Survey

Biennial

- Annulus Top-Up/Pressure Test

Well Verification Routine

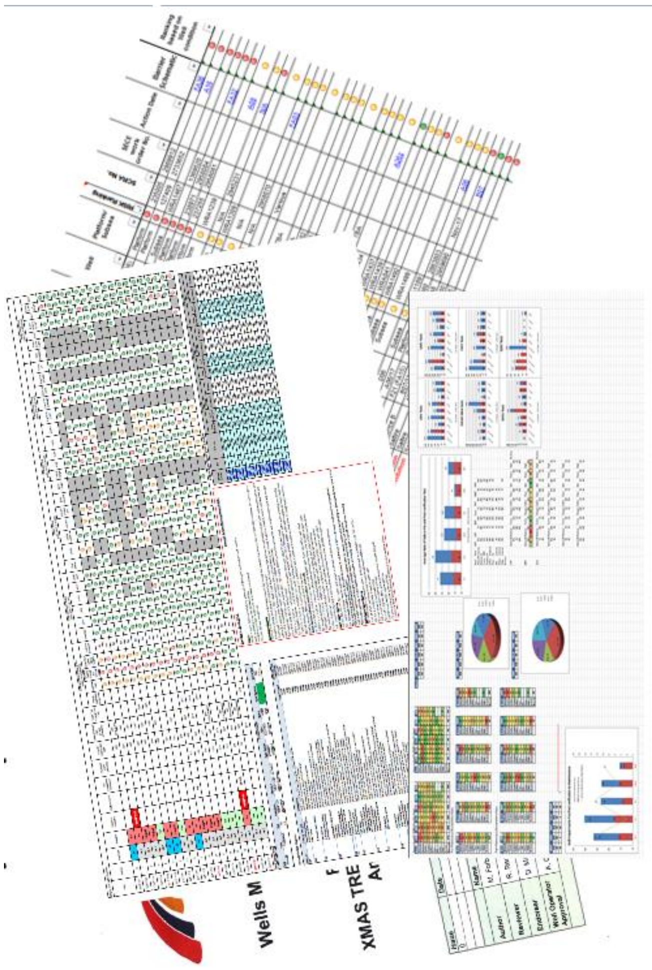
- Not Preventative Maintenance
  - We test, grease and function
  - Repair if we don’t need a tubing plug
  - **Verify the well condition, make sure there are barriers and make sure personnel are safe from the well**



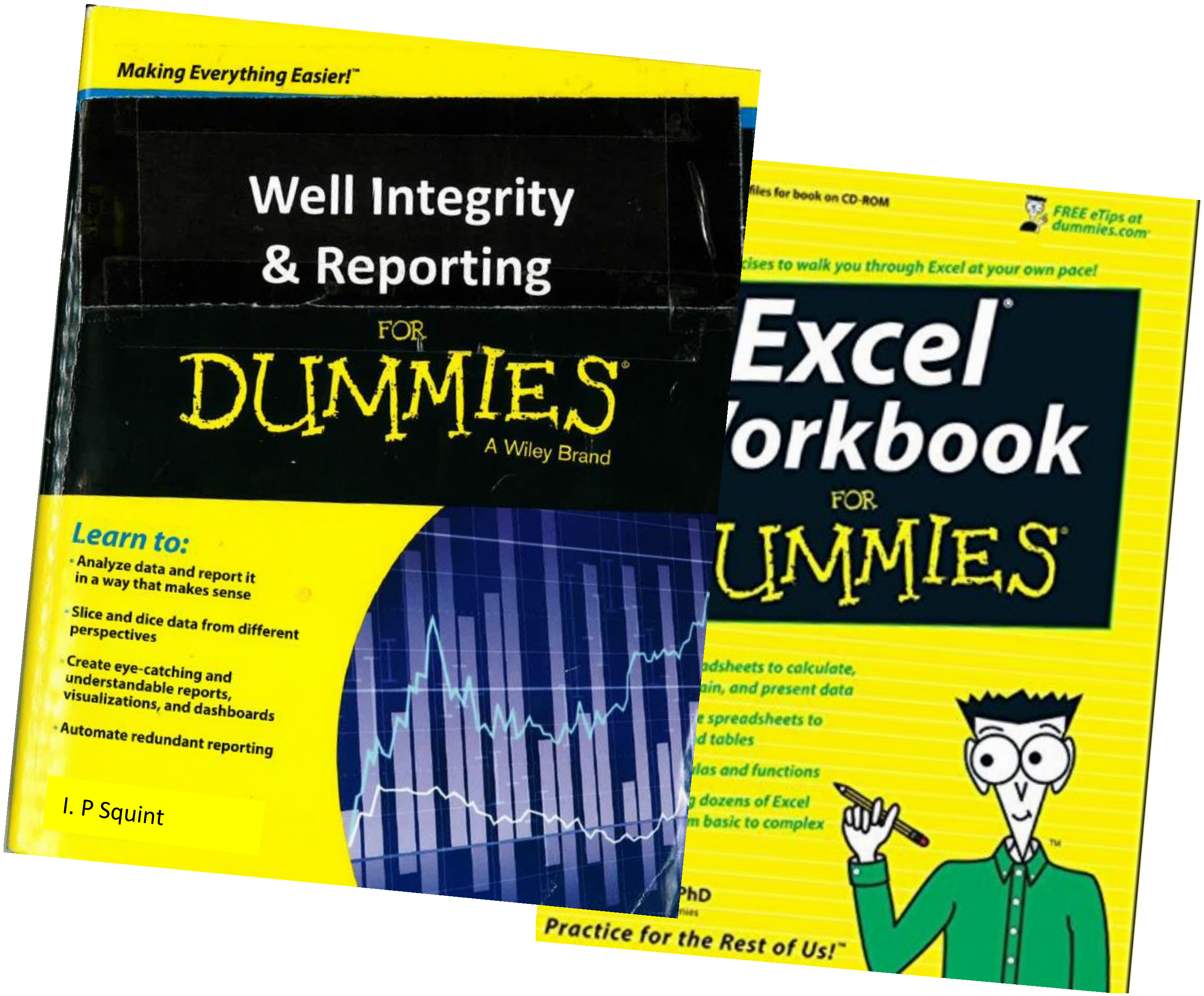
- Well Verification – aligned to:
  - Internal performance standard
  - Safety Case Regulations
  - Design and Construction

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



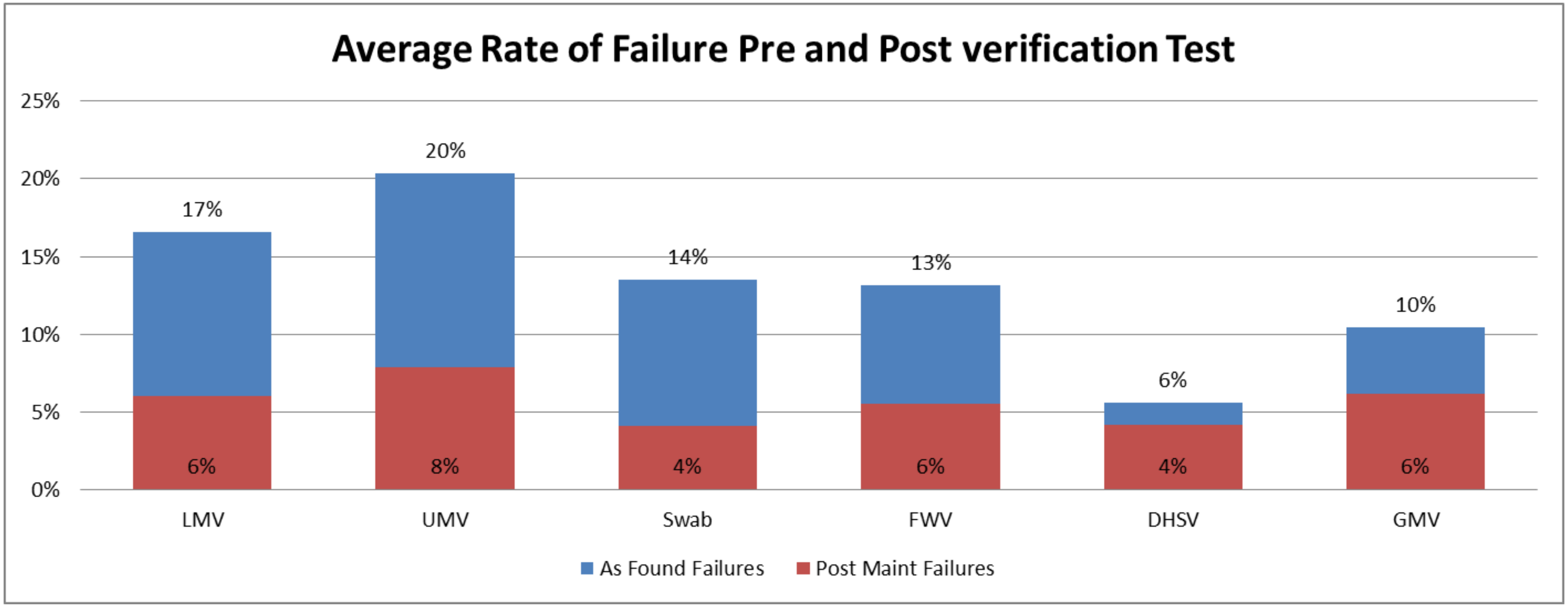
Well Verification - Evaluation

Pre									
Component	2013/	2014 / 1	2015/1	2015 / 2	2016 / 2	2017/	Averag	Failure	
LMV	5	2	3	5	5	3	4	27%	2.74E-01
UMV	4	2	3	4	4	2	3	23%	2.26E-01
FWV	7	3	1	7	7	1	4	31%	3.10E-01
Kill	2	1	0	2	2	0	1	8%	8.33E-02
Swab	2	0	0	2	2	0	1	7%	7.14E-02
GMV	2	0	3	2	2	4	2	15%	1.55E-01
MGMV	1	0	0	1	1	0	1	4%	3.57E-02
A-ann vlv (Live)	0	0	0	0	0	0	0	0%	0.00E+00
A-ann vlv (Offside)	1	1	1	1	1	1	1	7%	7.14E-02
B-ann vlv (Live)	0	0	0	0	0	0	0	0%	0.00E+00
B-ann vlv (Offside)	0	0	0	0	0	0	0	0%	0.00E+00
C-ann vlv	0	0	0	0	0	0	0	0%	0.00E+00
DHSV	0	0	0	0	0	0	0	0%	0.00E+00
DHSV Control Line	0	0	1	0	0	2	1	4%	3.57E-02
ADSV	1	1	1	1	1	0	1	6%	5.95E-02
ADHSV Control line	1	2	1	1	1	0	1	7%	7.14E-02
	26	12	14	26	26	13			

Post									
Component	2013/	2014 /	2015/1	2015 / 2	2016	2017/1	Averag	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%	0.00E+00
GMV	1	0	3	1	1	4	2	12%	1.19E-01
MGMV	0	0	0	0	0	0	0	0%	0.00E+00
A-ann vlv (Live)	0	0	0	0	0	0	0	0%	0.00E+00
A-ann vlv (Offside)	0	0	0	0	0	0	0	0%	0.00E+00
B-ann vlv (Live)	0	0	0	0	0	0	0	0%	0.00E+00
B-ann vlv (Offside)	0	0	0	0	0	0	0	0%	0.00E+00
C-ann vlv	0	0	0	0	0	0	0	0%	0.00E+00
DHSV	0	0	0	0	0	0	0	0%	0.00E+00
DHSV Control Line	0	0	0	0	0	1	0	1%	1.19E-02
ADSV	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
	8	5	7	8	8	9			

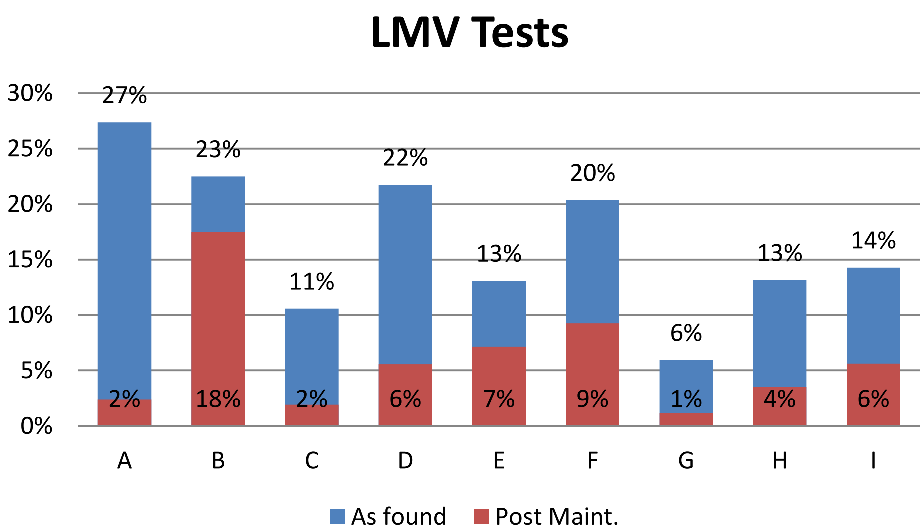
- 6 year review across all surface wells
- Looking at failures on all components
- Pre & Post grease and function

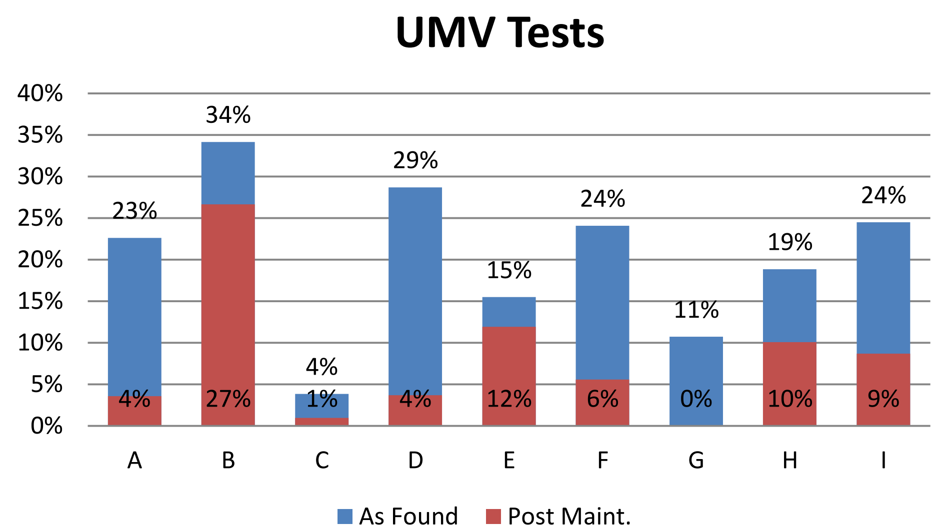
Average Rate of Failure



- Big range in valve reliability
- **Blue** – failure in as-found condition
- **Red** – failure after grease & function

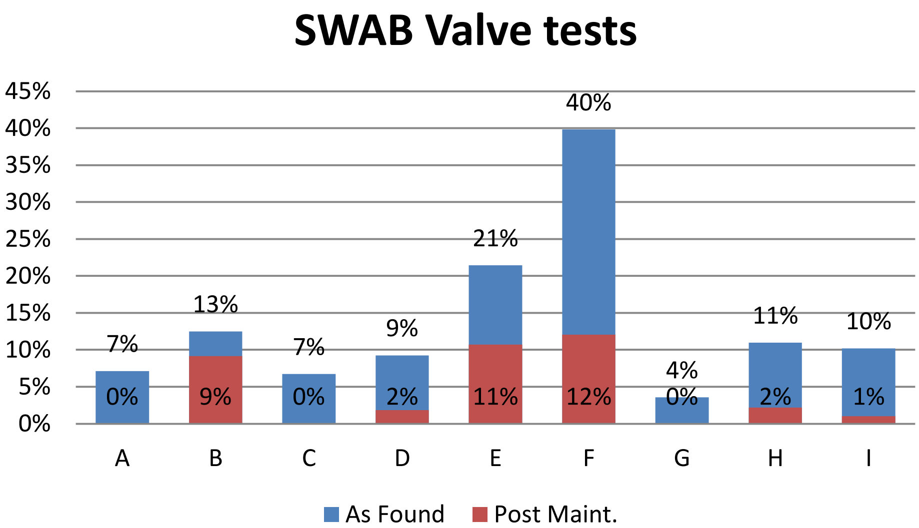
Xmas Tree Master Valves

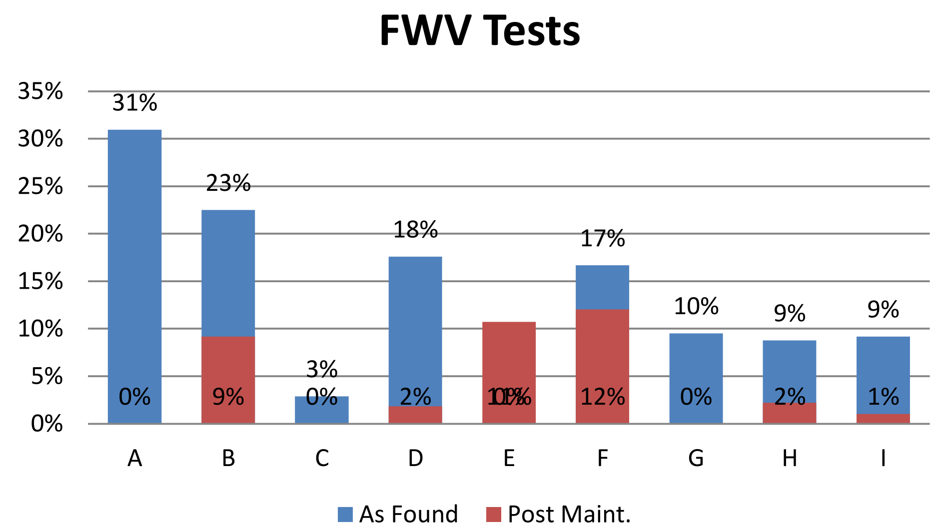




- Breakdown by platform, A to I
- Variation between site and valve

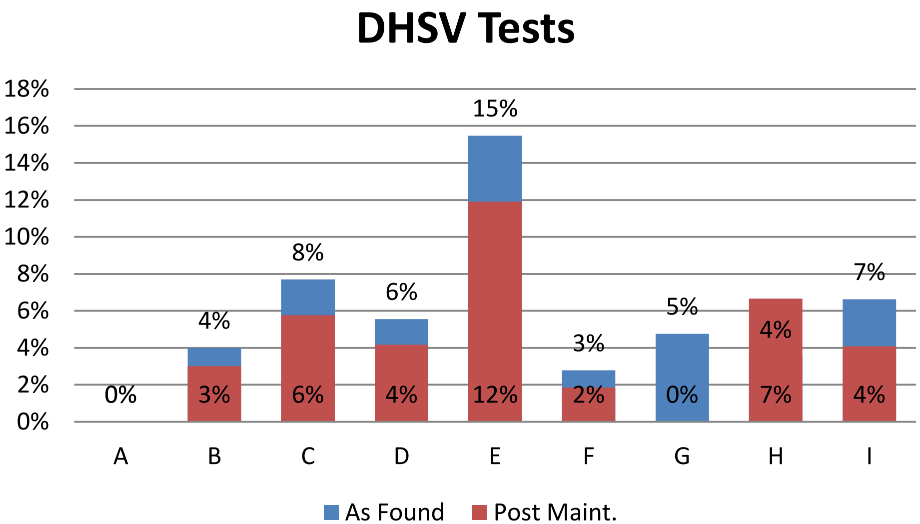
Swab & FWV Valves

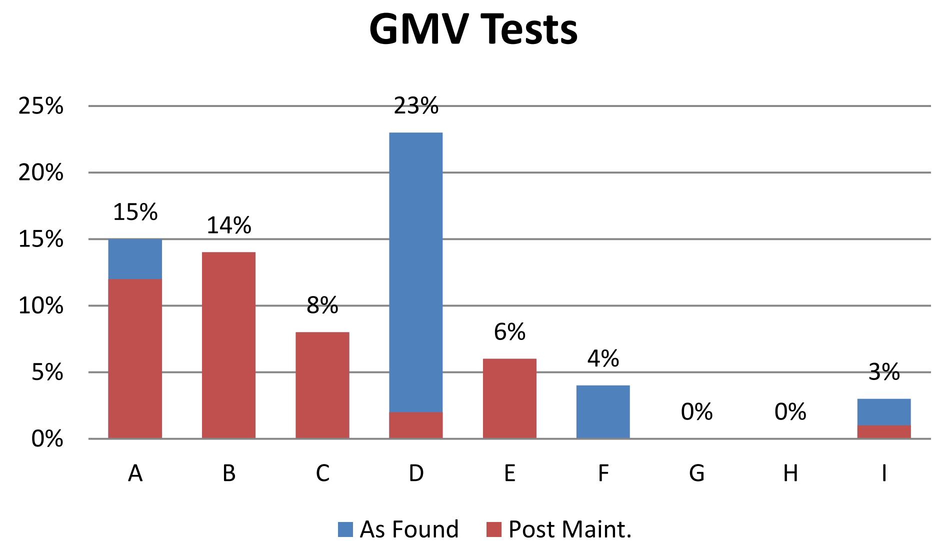


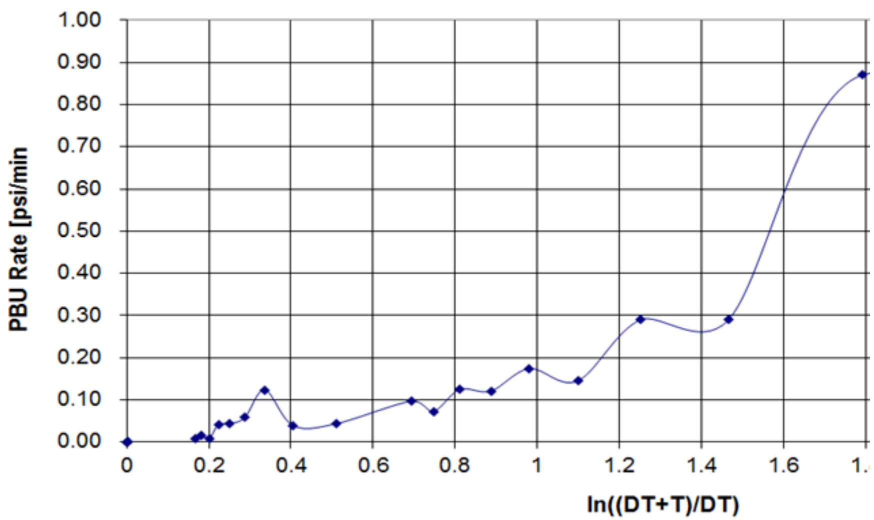


- No pattern across assets
- Failure rates consistent within sites

DHSV & GMVs

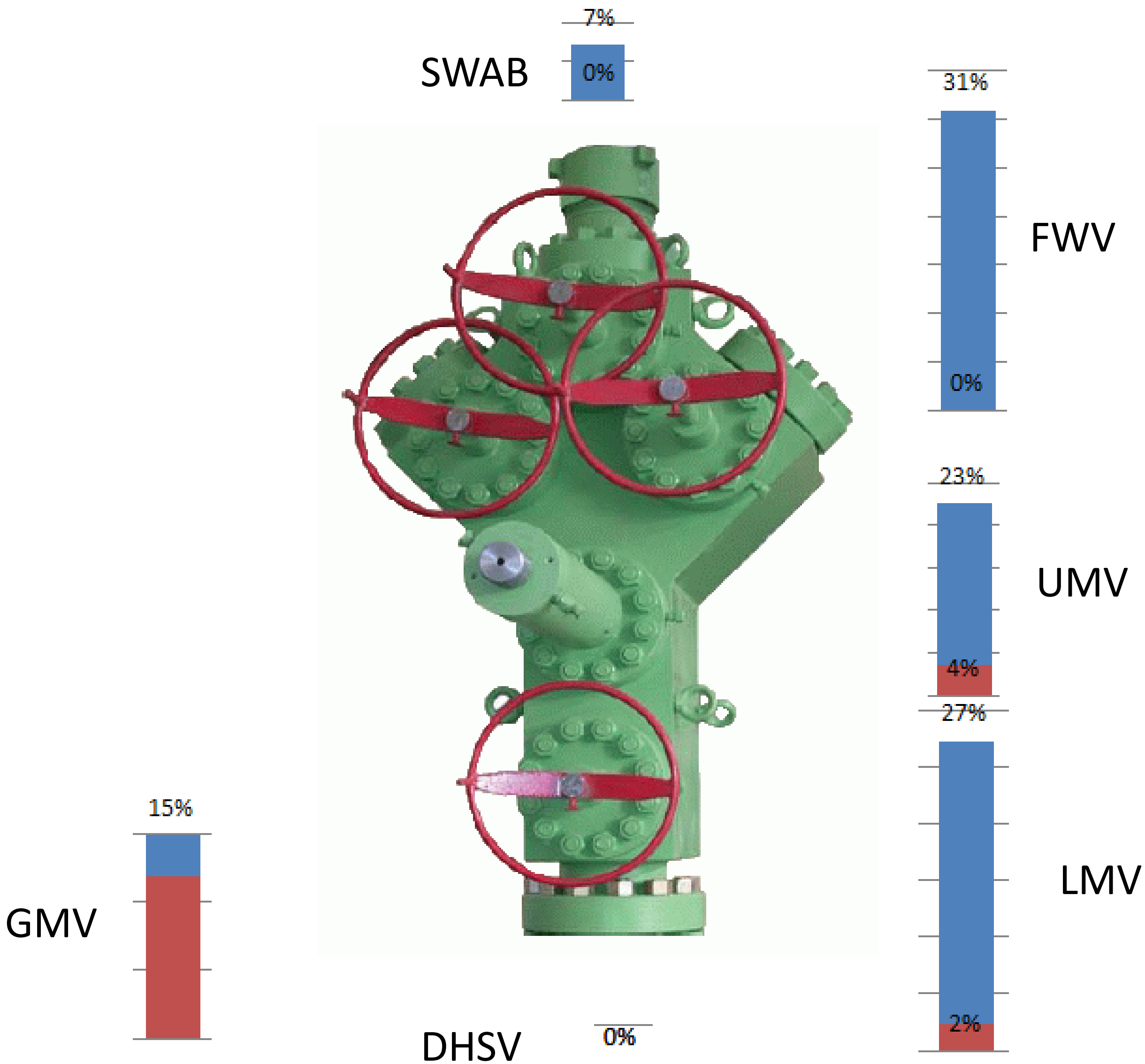






- Same equipment used on a number of platforms
- Failure rates different due to well conditions

Platform A: Failure Tendency



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

WELL / SLOT	A01/17
PURPOSE OF ACTIVITY	
ITEM	
Tree Cap Inspection	
Xmas Tree Body	
Upper Master Valve – UMV	
Lower Master Valve – LMV	
Flow Wing Valve – FWV	
Offside Wing Valve – OWV	
Swab Valve – SV	
Gas Master Valve – GMV	
Manual Gas Master Valve – MGMV	
A Annulus Valve – OSCV	
A Annulus Valve – Left	
A Annulus Valve – Right	
B Annulus Valve – Left	
B Annulus Valve – Right	
C Annulus Valve	
D Annulus Valve	
INRV / SAS – Live Side	
INRV / SAS – Offside	

12 Month Verification Schedule

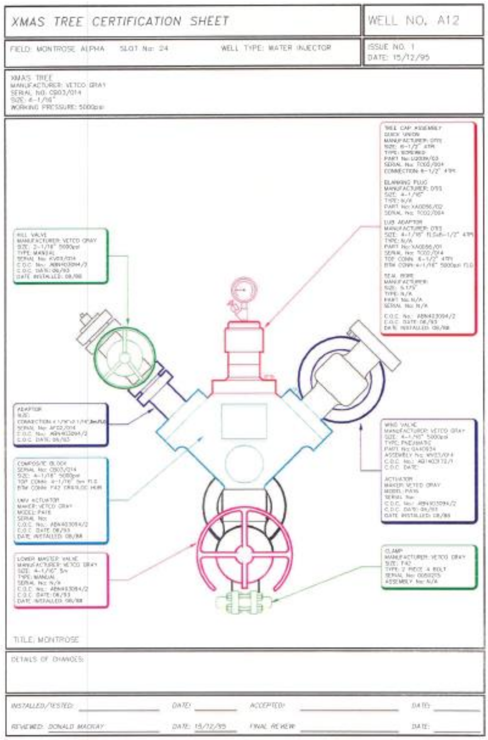
Evaluation of the failure rates have identified that, yearly well verification confirms:

- 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

Count of DAT		DAT											Average No
ASSET	**TYPE OF FAILURE**	**2006**	**2007**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**failures/ Year**
xxxx	A-Annulus Valve Failure							3	1		2	8	3.50
	Actuator Failure							1					1.00
	Actuator piston seal weep								1				1.00
	B-Annulus Valve Failure						1					3	2.00
	C-Annulus Valve Failure							16				2	9.00
	Control Fluid Leak										1		1.00
	Control line block failure											1	1.00
	FWV Failure					1	4	5	2	2		3	2.83
	GMV Failure						1			1	2	1	1.25
	INRV Failure									2		1	1.50
	KP4 inspection finding											2	2.00
	KWV Failure						1					1	1.00
	LMV Failure			1							2		1.50
	Needle Valve											1	1.00
	Stem Packing failure						1		2		1	10	3.50
	Test/injection fitting failure											7	7.00
	Tree valve stem seal leak									1			1.00
	Tie Down Pin										1		1.00

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 <u>must</u> 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 ?