



Investigation of RMA Valves - Weld Defects

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UKOPA Members Meeting

February 2023



Engineering Bulletins received



Safety and Engineering Bulletin



SEB307 - Defective fillet welds in RMA HKSF – W100 Ball Valves (specified to V6)

Incident details

A high pressure gas leak was detected on a RMA HKSF-W100 valve. Upon inspection a hole was discovered in one of the fillet welds.

As a result of this defect, additional MPI was undertaken on all other HKSF-W100 valves to be installed on site which identified similar defects on three other valves.

Valve 1: Engineer detected an audible high-pressure leak. Upon investigation the valve coating appeared to be covering a circa 2mm diameter hole on the external surface of the fillet weld (Fig. 1).

Valves 2, 3 and 4: A defect of a similar size was identified on the fillet weld of a further three valves. (examples in Fig. 2 & Fig.3)

Specification and predelivery requirements

The valves were specified to V6. The supplier provided certification for NDT and pressure tests indicating the valves are acceptable.

Action taken

- All RMA HKSF-W100 valves for this installation, had additional NDT on the fillet welds
- Additional NDT will be undertaken on RMA valves in NGN storage for upcoming projects
- RMA have conducted an internal root cause analysis, with the list of potentially affected valves to be established by August 4th, and customers to be contacted.
- NGN is in the process of undertaking an independent incident investigation.



Fig.1. Valve no. 1 : defective weld

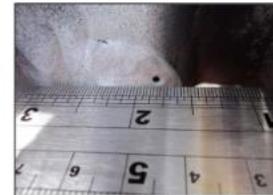


Fig. 2. Valve no. 2 : defective weld



Fig.3. Valve no. 3 : defective weld

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we are the network

Issued By: Ben Smith
Job Role: Network Integrity & Compliance Lead
Date: 02 August 2021

For general enquiries relating to NGN's technical policies and procedures contact the NGN Standards Team (standards@northerngas.co.uk). NGN's Standards website is accessed via standards.northerngasnetworks.co.uk

GT Engineering Bulletin		nationalgrid	
EB/681	Issuing Engineer:	Kirsty McDermott	Approved: 13 th September 2021
	Department:	Engineering & Asset Management	Target Audience: All GT
Subject: Weld Defects in RMA HKSF-W100 Valves			

Background:

Following commissioning, various weld defects, some resulting in gas escapes, have been found on T/SPN/6 qualified RMA HKSF-W100 valves across several UK gas networks.

HSKF series valves come in sizes ranging from DN15 to DN600 and can be found on >7bar installations and pipelines as stream flow control, on drain and vent points or as additional valves on stem extensions.

Caution: These defects lay beneath the coating and may not be immediately detectable, either visually or by NDE.



Fig.1



Fig. 2



Fig. 3

Cause:

It has been identified that there has been a problem with the manufacturing process. In addition to the GT QA team's non-conformance investigation, we are also working in collaboration with the distribution networks on an investigation to determine the root cause.

Defects include pin holes, surface breaking linear defects and insufficient weld metal on socket fillet welds at vent and drain connections to the body (Fig. 1 and 2), and fillet welds at the valve trunnion (Fig. 3). Currently the affected valves size range is DN15 – DN300 supplied between 2019 – 2021 and could have been received either direct from RMA or as components on assemblies from third-party suppliers.

The manufacturer has provided GT with a list of potentially impacted orders. Project teams with orders that may have been impacted are aware. Plans for inspection and potential remediation are now underway.

Action:

- No RMA HKSF-W100 of all size ranges valves are to be commissioned until further notice.
- Where potentially impacted valves have been identified, inspection plans are to be agreed directly with Engineering on a case by case basis.
- Where valves have already been commissioned these will require gas checks and leak detection solution applied to all weld areas. Only leak detection fluid to be applied to pressurised valves, no surface preparation should be carried out due to potential of an uncontrolled gas release.
- Existing stock of RMA HKSF-W100 valves not yet commissioned are to be quarantined with valve details (size and serial numbers) recorded via [VQRG_box](#).

For further information regarding this Bulletin, please contact Kirsty McDermott or the [Policy_box](#)
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SGN/SEB/943
Defective RMA Ball Valves (certified to V6)
Major Projects, Asset Management, Maintenance Operations, Maintenance Projects, Biomethane, Energy Futures, SHE

Following commissioning, various weld defects, some resulting in gas escapes, have been found on GIS/V6 certified RMA HKSF-W100 valves across several UK gas networks. HSKF series valves come in sizes ranging from DN15 to DN600 and can be found on >7bar installations and pipelines as stream flow control, on drain and vent points or as additional valves on stem extensions.

Caution: These defects lay beneath the coating and may not be immediately detectable, either visually or by NDE.

Investigations are ongoing to determine the root cause. To date defects have been found on valves 2" to 8" manufactured between Feb 2020 and Feb 2021. Defects include pin holes, surface breaking linear defects and insufficient weld metal on socket fillet welds at vent and drain connections to the body (Fig. 1), and fillet welds at the valve trunnion (Fig. 2 and 3). Affected valves could have been received either direct from RMA or as components on assemblies from third-party suppliers.

Actions*

- No RMA HKSF-W100 valves are to be commissioned until further notice; unless inspected, risk assessed and with prior written agreement of Asset Management.
- Existing stock of RMA HKSF-W100 valves are to be quarantined with valve details (size and serial numbers) recorded
- Projects which could include RMA HKSF-W100 valves dating back to June 2019 must be reviewed and valve details recorded
- All costs incurred through investigation or remedial action must be recorded clearly to aid any future claim

* Specific guidance for risk assessment, inspection and notification will be published separate to this bulletin.

Issued by: Chris Mattocks, Engineering Policy Manager Date of issue: 27/08/21

What was the impact to us?

Total impact 116 valves. 27 in service.

Inspection carried out on a number of the valves via the SPI's that were already deployed on site

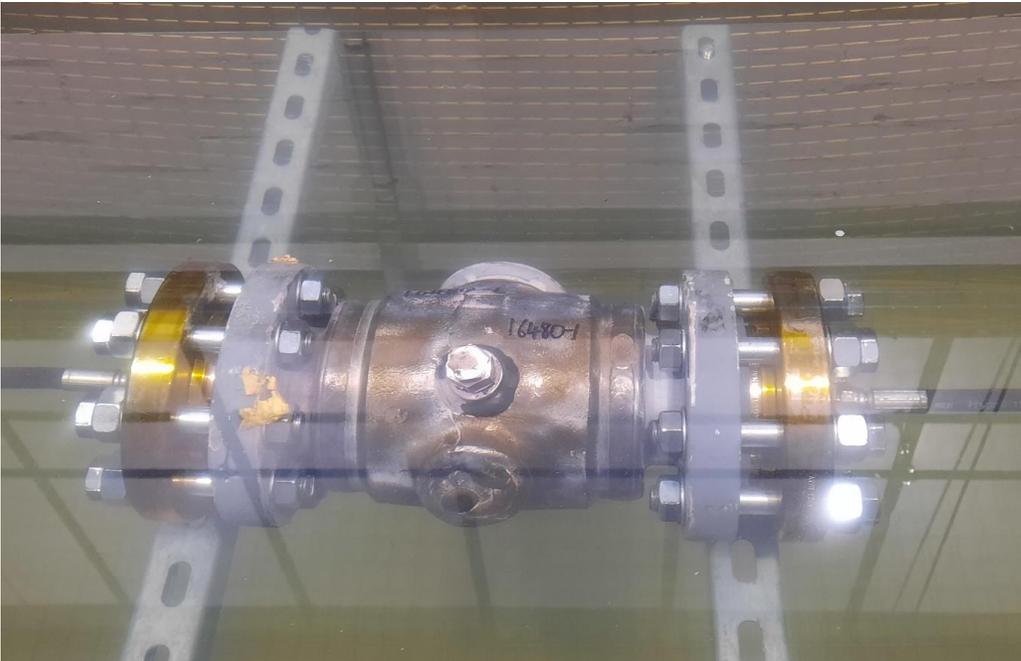
Ranges of defects were found highlighting signs of poor workmanship quality

Developed Engineering Investigation with ROSEN to understand the extent of the impact



Background and Scope

- Known issues were with the 2” valves supplied from the RMA Rheinau Facility
- Broadened the investigation to include:
 - Class 900 Valve
 - 10” Welded body Valve



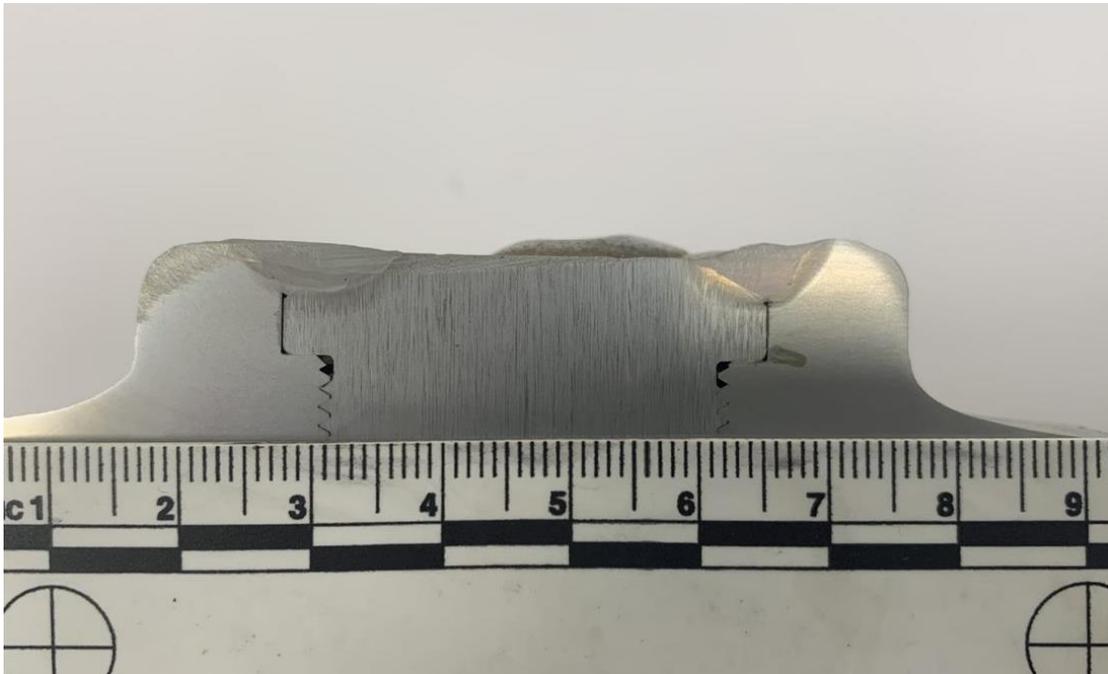
Stage 1 – All Valves Received

- a. Initial inspection of as-received valves
- b. Visual weld inspection
- c. Non-destructive testing including MPI and DPI
- d. Pressure testing – Pneumatic leak test
- e. Review of data books

Stage 2 – Selected Valves

- a. Metallographic examination of areas of interest
- b. Mechanical testing
- c. Engineering analysis

Stage 1 – Initial Inspection

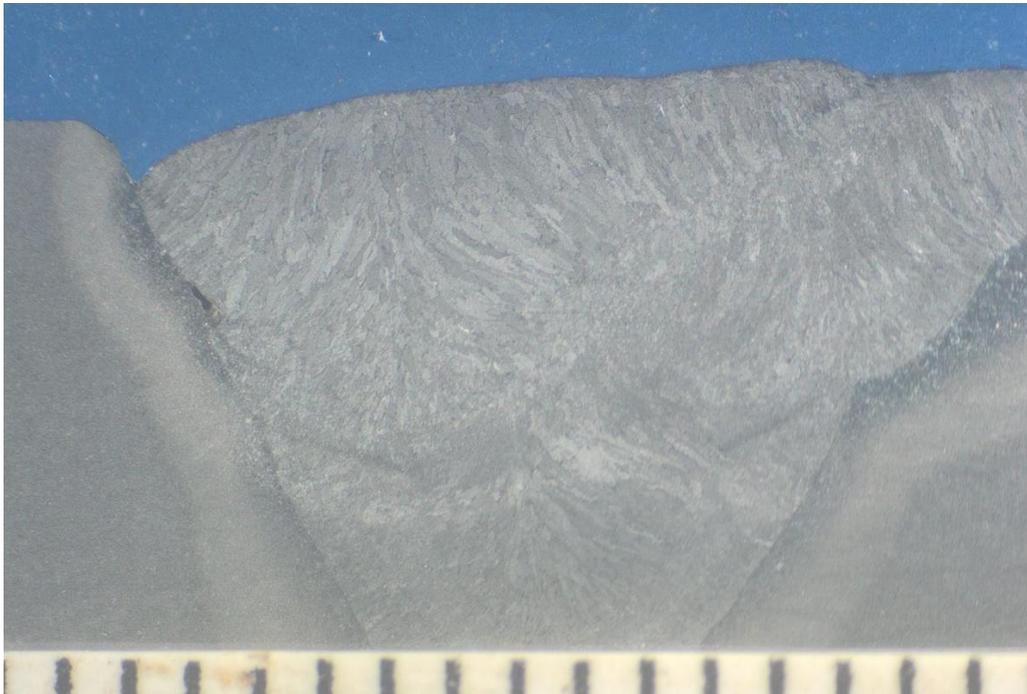


ROSEN I/D	Serial Number	Nominal Diameter	Class Rating	Databook	Comment
16480-1	19A038736	2"	600	RMA ref - A11900082, PO – 3400006749-2	Documentation provided suggests that one, some or all seven of these valves were subject to rework.
16480-2	19A038733	2"	600	RMA ref - A11900082 PO – 3400006749-2	
16480-3	19A038735	2"	600	RMA ref - A11900082 PO – 3400006749-2	
16480-4	19A038732	2"	600	RMA ref - A11900082 PO – 3400006749-2	
16480-5	19A038734	2"	600	RMA ref - A11900082 PO – 3400006749-2	
16480-6	19A038731	2"	600	RMA ref - A11900082 PO – 3400006749-2	
16480-7	19A038730	2"	600	RMA ref - A11900082 PO – 3400006749-2	
16480-8	21A003244	4"	600	RMA ref – A12100375 PO – 3400127257	Nameplate not attached upon receipt - Origin confirmed in email from Josh Blake dated 11th Feb.
16480-9	19A038725	4"	600	RMA ref – A11900082 PO – 3400006749-2	-
16480-10	20A082915	4"	900	RMA Ref – A12002564 PO – 3400090687-2	Surface breaking defect on branch fillet weld.
16480-11	19A038668	10"	600	RMA Ref – A11900082 PO – 3400006749-2	-

Stage 1 NDT Results

Sample	Visual	MPI	DPI
1 DN50 CL600 SN 19A038736	Poor restart, Crater crack	LOF	Surface pore
2 DN50 CL600 SN 19A038733	-	LOF	-
3 DN50 CL600 SN 19A038735	-	-	-
4 DN50 CL600 SN 19A038732	Poor restart / LOF/ cold lap Trunnion repair	LOF	Overlap
5 DN50 CL600 SN 19A038734	-	-	-
6 DN50 CL600 SN 19A038731	Poor restart / LOF/ cold lap	LOF	Overlap, Gas pore
7 DN50 CL600 SN 19A038730	Incompletely filled groove	LOF	-
8 DN100 CL600 SN 21A003244	Linear porosity Incompletely filled groove	Multiple pores, LOF Surface anomaly noted	Overlap
9 DN100 CL600 SN 19A038725	Incompletely filled groove	Overlap, LOF Incompletely filled groove	Overlap, Gas pore Incompletely filled groove
10 DN100 CL900 SN 20A082915	Porosity / elongated cavity	Crater crack LOF, Mechanical damage reported	Gas pores
11 DN250 CL600 SN 19A038668	Linear porosity / isolated pores Incomplete weld, Spatter	Crack like indications, Gas pores	Gas pores Incompletely filled groove

Stage 1 – Databook Review



Stage 1 – Databook Review

- Some high level documents do not correlate
- Generic ITP / QCP used across databook's states DN400 to DN1400
- NDT consistently reported to be to ASME.
 - No evidence of PD 5500 criteria, as per V/6 requirements
- Material Certification:
 - Have V/6 requirements for tensile and impact testing been met?
 - Regular use of “dual qualification” generated some inconsistencies.
- Reference to P355NL / Q&T contradictions

	DOCUMENT COVER SHEET Page de garde / Deckblatt
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Document No. **NG – HKSF W100 / QCP-1**
 Document N° / Dokument Nr.

Job number : **Standard document**
N° d'affaire / Auftragsnummer
Customer P.O. No. : **All**
N° de cde, client. / Kunden Bestell-Nr.
Customer name. : **National Grid**
Nom, client. / Kundennamen
Part description. : **Ball valve type HKSF – W100, DN400 up to DN1400**
Désignation pces. / Teilebezeichnung
Drawing (s) No. : **All concerned drawings**
N° de plan. / Zeichnungs – Nr.r

Document title. / Titre, du document / Dokumententitel.: Inspection and Test Plan Page 1 of 4
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		Quality Control Plan				Main reference documents: • API 6D and T/SP/V6 • AD-Merkblätter 2000 Edition • EN 1435 & EN 12517 • EN 1712 & EN 1714 / EN 10160 / EN 1291 • All procedures listed on page 4						
RMA Job-No. : /		Diameter : DN400 to 1400		Drawing : All relevant drawings		Page Page 2 of 4		8	14.12.16	Atsogue	Ebert	Föll
Client Job No. : Standard doc.		Design pressure : All pressures		Material : Acc. to relevant drawings				7	05.11.15	Ebert	Müller	Föll
Component : BALL VALVE HKSF- W 100		Document-No. : NG – HKSF W100 / QCP-1				Inspection by:		6	07.10.15	Müller	Atsogue	Föll
						Record Manufacturer Customer Nat. Grid Inspector Stamp.		5	10.08.15	Müller	Atsogue	Föll
								Rev	Date	Created	Checked	Approved

Stage 1 – Databook Review Welding

- Lack of detailed drawings and general weld plan present only in **some** Databooks
- Welding Standard not on WPS. ASME IX qualifications by agreement this needs to conform to BS EN ISO 15614.
- WPS are minimal information electronically generated documents.
- Supporting PQR are summary documents, i.e. ~3 pages detailing information extracted from other sources.
- Inconsistences between WPS and PQRs
- Observation on material Grouping system coverage to BS EN ISO 15614
- For drain and vent line welding – WPS is supported by butt weld PQR.
 - BS EN ISO 15614 states it shall be supported by a fillet weld test

Stage 1 – Databook Review Welding & NDT

- Weld plan states PT only for drain and vent fillet welds
- No evidence of PT being varied out on any of the drain and vent line welds
- Lack of impact testing in some PQRs
- No evidence of welder qualifications
- No accredited scheme reference to check signing NDT operators

8. Fillet welds and butt welds on nozzles for drain, vent and injection

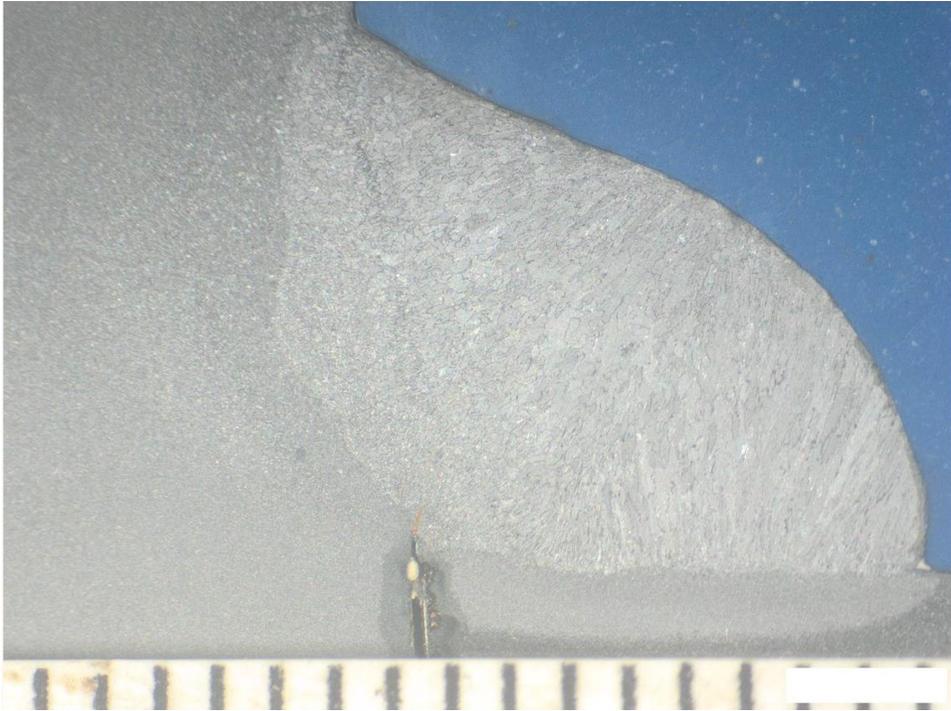
soudure piquages + bout à bout sur event, vidange et injection / Stutzennähte für Entlüftung und Entleerung

Weld seem not represented on weld sketch

	All DN		
Reference dia.	26,9 to 73,2 mm		
Reference thick.	4,3 to 8,7 mm		
Applicable WPS	WPS 346-1/06		
Applicable NDT	PT (As required on drawing)		

- Some supporting PQR's over 20 years old. This would typically require supplementary weld testing
- All welding multi pass qualified

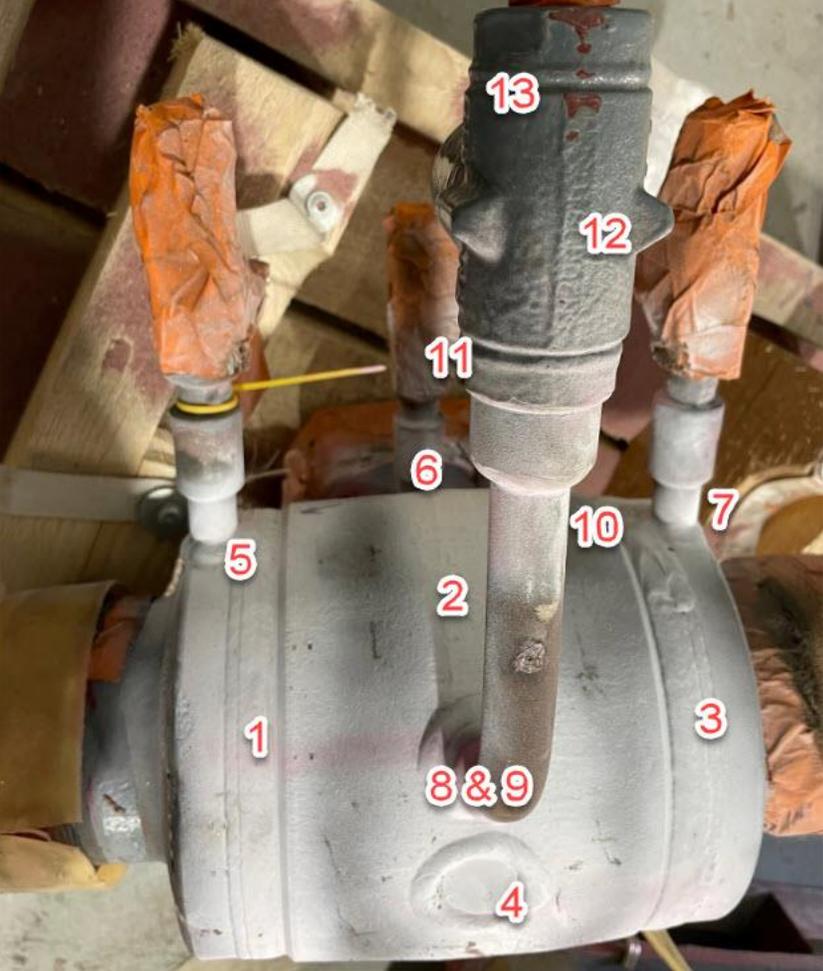
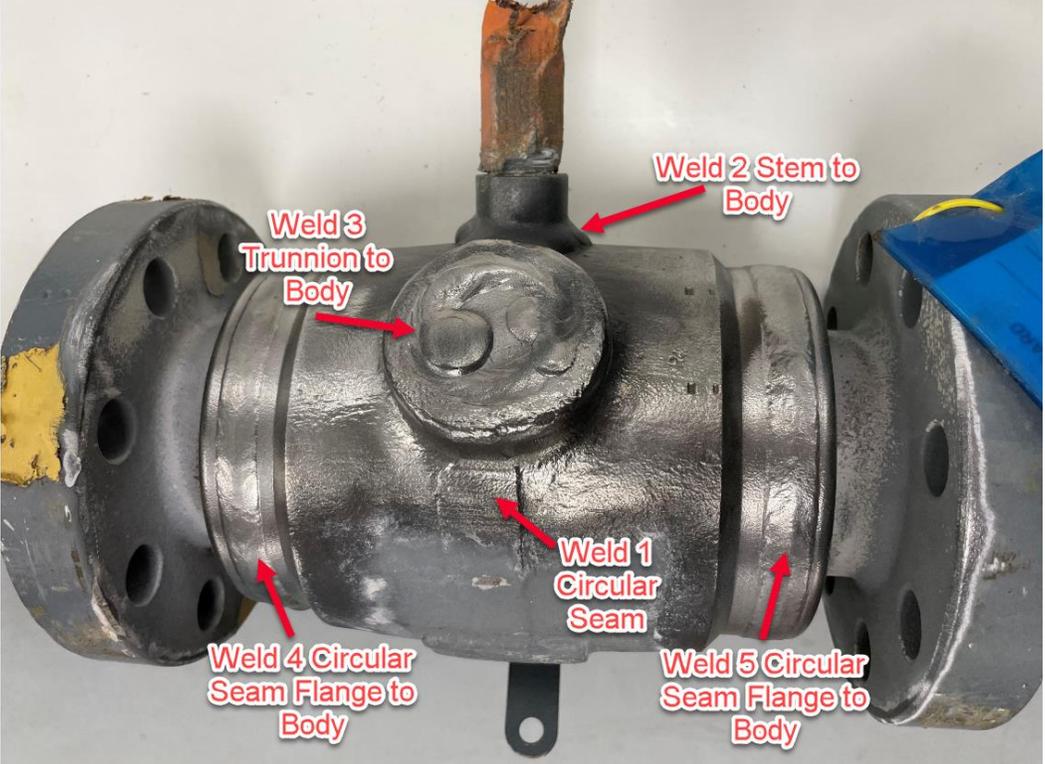
Stage 2 – Lab Findings



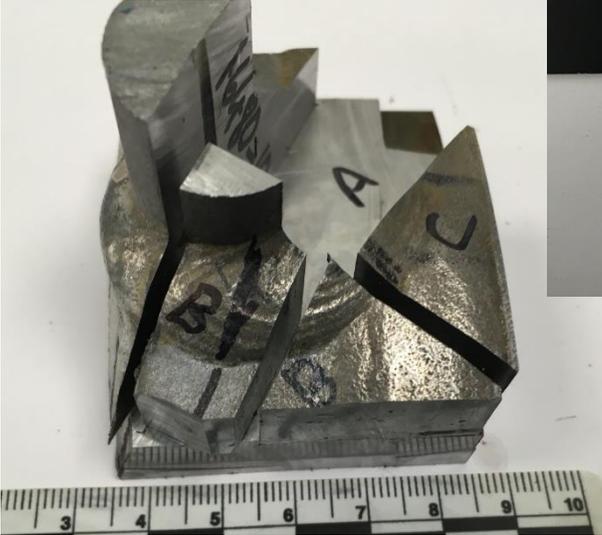
Lab Findings – Metallographic Examination

NDT Findings were sectioned and examined using metallographic techniques to gain information on the morphology and associated feature severity.

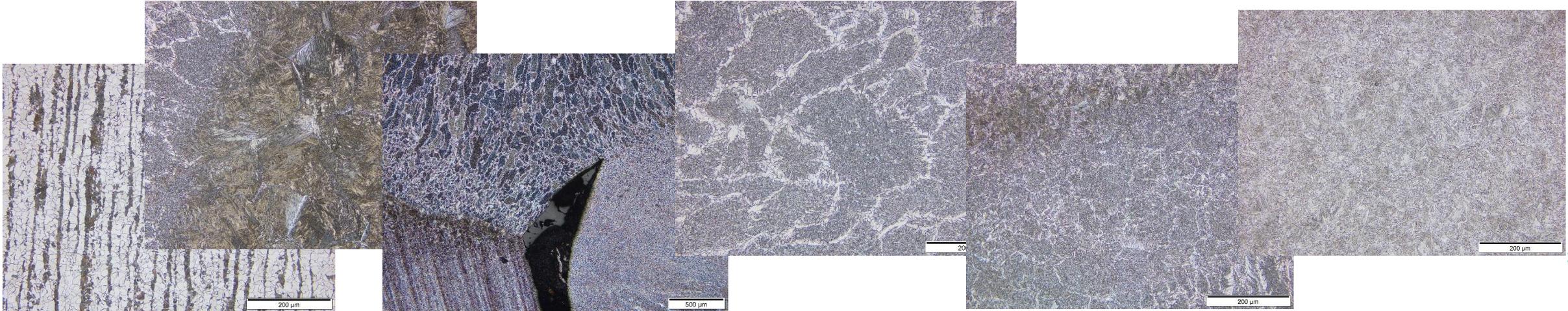
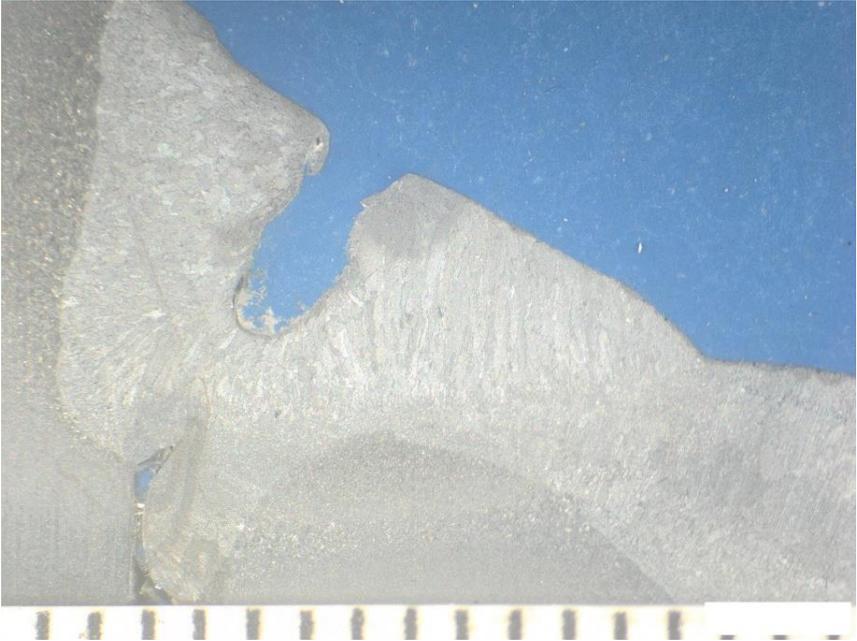
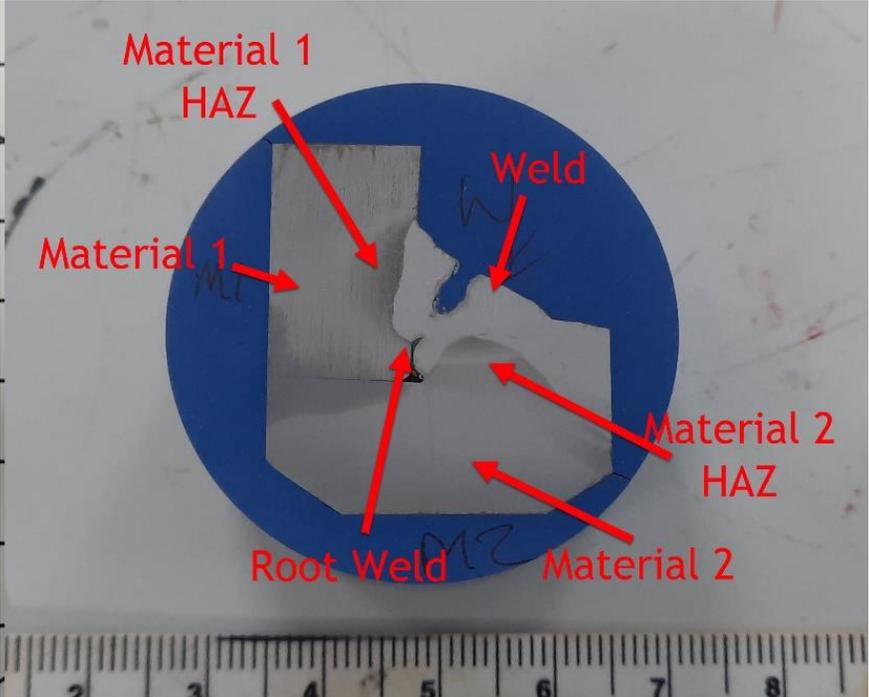
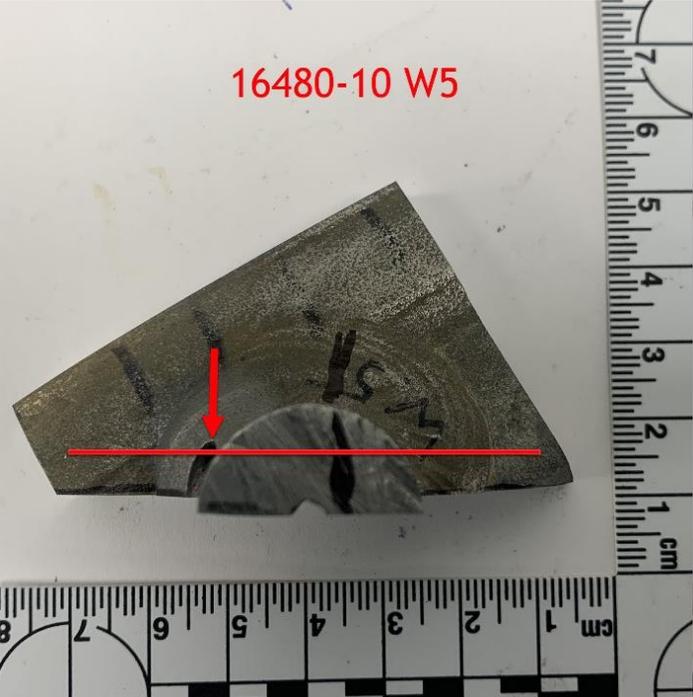
Weld Maps 2" & 4"



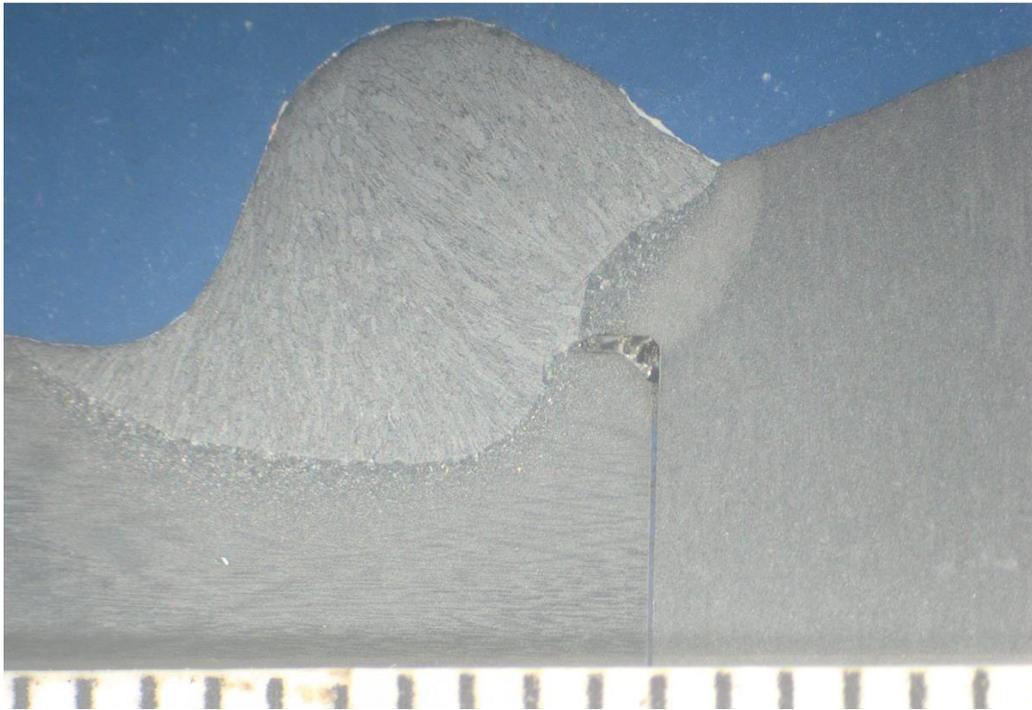
Lab Findings – Metallographic Examination



Lab Findings – Gas Pore



Stage 2 – Engineering Analysis



Stage 2 – Engineering Analysis

Background:

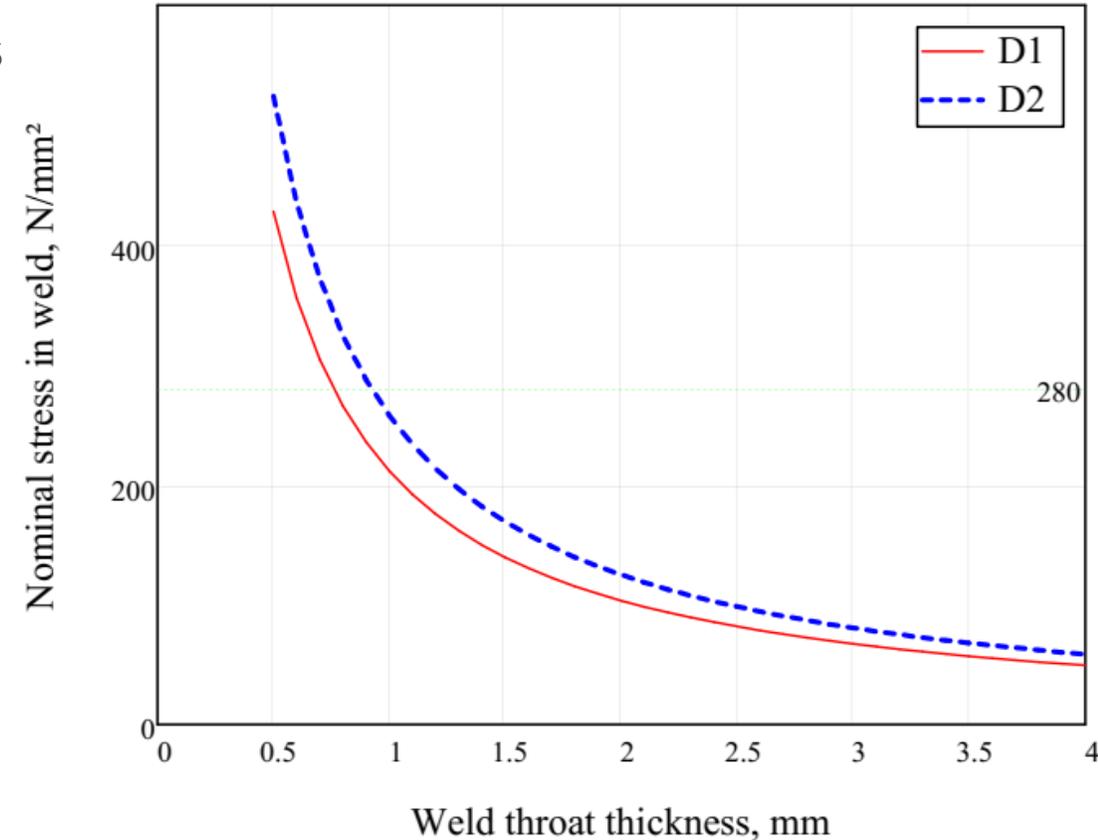
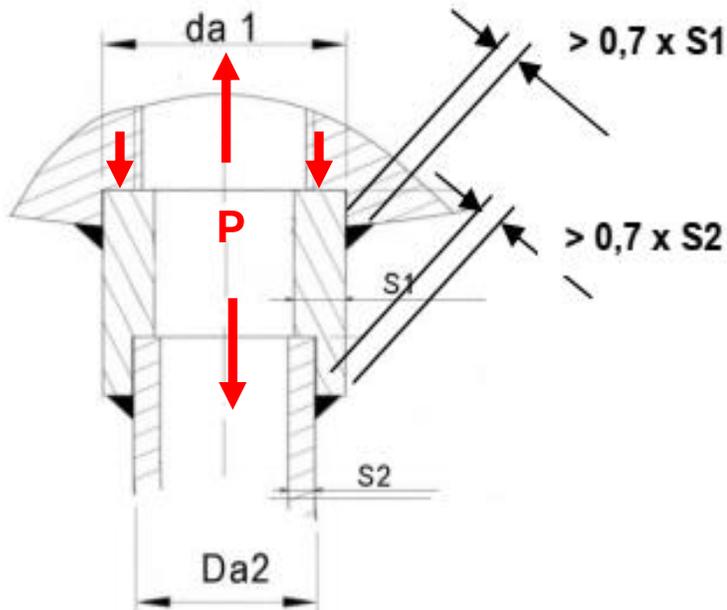
- Concern that poor quality welds could lead to disruptive failure of the pressure containment
- Calculations to assess:
 - Strength of socket welds for vent / drain / sealant connections
 - Implications of cracks in circumferential butt welds
- Models can predict if a crack or small weld is stable, but cannot predict leakage rates (or if leakage would occur from a through wall feature)
- Analyses do not consider functional aspects of the valves i.e. ability to seal or operate under pressure

Engineering Analysis – Socket Weld Results

D1 := 30

D2 := 25

- Plot shows nominal stress in the weld as a function of the fillet weld throat thickness for two diameters
- At the allowable stress of 280 N/mm² the required thickness is about 1 mm
- Result is not sensitive to allowable stress or connection diameter
- Assumed that the weld throat thickness is constant around the circumference

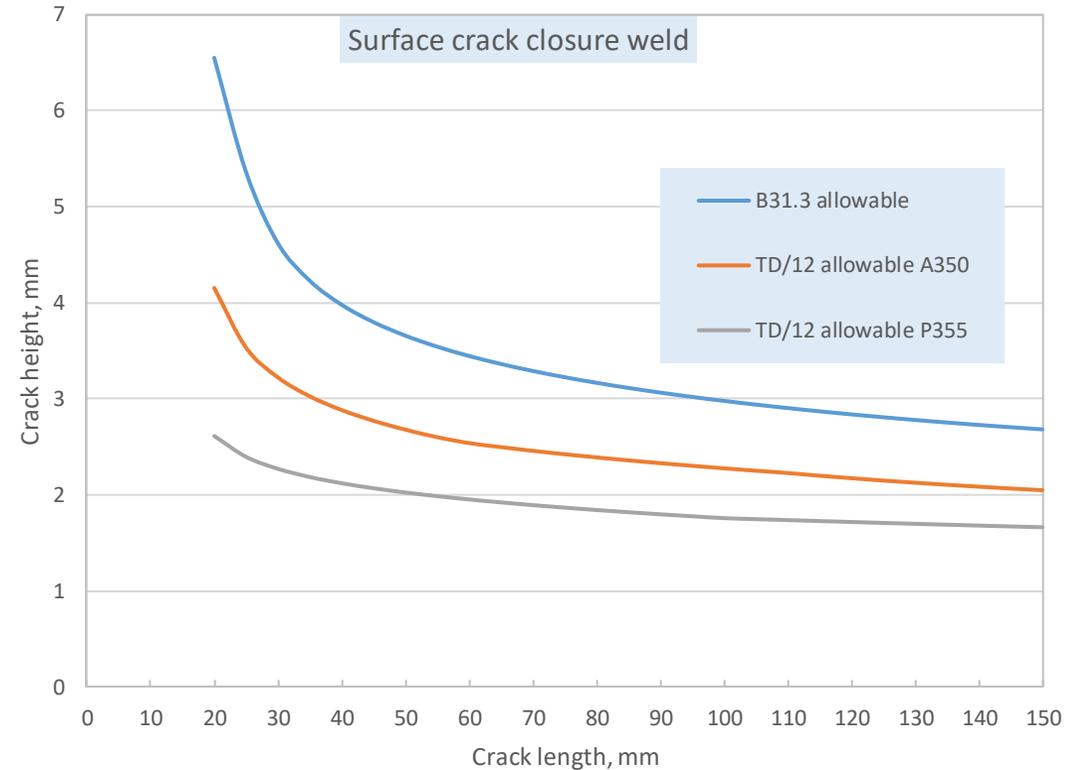


A loss of pressure containment will not occur at the socket weld attachments even if these welds do not conform to the design dimensions or contain small imperfections

Engineering Analysis – Butt Weld Cracks Results

Results vary with the design code

- B31.3 has the lowest allowable stress, hence the largest tolerable crack sizes
- P355 materials are not listed in B31.3 but allowable stress would be virtually the same A350
- TD/12 allowable stress depends only on the yield strength, so results vary depending on the grade
- Smallest sizes are found for P355 due to the higher SMYS



The analyses cannot predict leakage from undetected small weld imperfections, only whether a failure of the pressure containment will occur from gross imperfections.

Leakage can only be prevented by a combination of quality control of welding, for example identifying undersize welds or stop-start defects, together with the factory pressure test.

Conclusions & Next Steps



Conclusions

1. Systematic lack of process and quality control
2. Weld procedures and inspection reports are incomplete and lack detail.
3. No production welding traceability records in any of the documentation
4. Documentation relating to a single weld repair was insufficient and lacked important detail.
5. NGT surveillance is inconsistent across the documentation reviewed
6. There is evidence of failure to fully meet the requirements of V6
7. Material certification is incomplete or incorrect
8. Features in the welds that are consistent with poor quality welding, poor process control and poor quality control.
9. Catastrophic failure is unlikely to occur (cannot predict leakage)

Next Steps...

- Risk Assessment is being developed to review all the valves on the NTS.
- Monitoring existing valves
- Quarantined existing valves to be scrapped.
- Qualifications of new suppliers undergoing a more rigorous process
- Monitoring visits on existing manufacturers particularly Legacy contracts
- Standardise internal processes for review of Databook's from suppliers
- Further work looking at the defective valves in hydrogen to understand the 'acceptable' defect sizes that could be present can still maintain a design life in hydrogen environment
 - Functional Tests & Destructive Tests
 - Collaboration Opportunity?

Thank you

