



LOC Pinhole Gas Train Leak Between E37023 and E3704 Report

Upstream PS Controlled Document


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Revision history

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Rev.	Issue date	Revision summary	Originator	Reviewer	Approver



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1 References

Document code	Title
26/MN/INT/PC09/RG01	Northern Endeavour Defects Register Master
4900-FP-Q0022	ISR NE 2104 AU06.SYSPROCLIQ SBF Crack Inspection December 2016
4900-HS-H0071-03	Debutaniser Duplex Piping Repair
	Pipe Crack Indications 16 02 2014 in NE Piping Lines with SBF
	Filenote_Review of NE Piping and SBF Integrity for Transient Vibration Excitation 2015
	2014 SBF Inspection Scope
	Small Bore Fittings Register and Inspection Summary for Systems with Thin Walled Pipe
	NE SBF Inspection 2016 VER-51414-PI-001 High Pressure Flare (BH) System
	NE SBF Inspection 2016 VER-51414-PI-002 Fuel Liquid (FL) System
	NE SBF Inspection 2016 VER-51414-PI-001 Process Liquid (PL) System
	NE SBF Inspection 2016 VER-51414-PI-001 Low Pressure Flare (BL) System
	NE SBF Inspection 2016 VER-51414-PI-001 Process Gas (PG) System
	NE SBF Inspection 2016 VER-51414-PI-001 Fuel Gas (FG) System

2 Term definitions and abbreviations

Term or abbreviation	Definition
CST	Central Standard Time
DPI	Dye Penetrant Inspection
ECR	Engineering Change Request
FG	Fuel Gas
ISR	Inspection Services Report
OIM	Offshore Installation Manager
PG	Process Gas
PL	Process Liquid
SBF	Small Bore Fitting
WO	Work order



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3 Objective

To report on the “pin hole gas leak identified between E-37023 and E-3704 on the gas train” reported from the Northern Endeavour and as discussed with NOPSEMA on 05 December 2016. The report will give information on:

- What happened
- Why it happened
- Steps to be taken to prevent a re-occurrence



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4 What Happened: Detection and Response to Weld Failure on 150-PL-3052-03D01-3

Whilst performing rounds an operator noticed ice formation on a section of pipework in the process area at around 21:10 hours CST on 29 November 2016. On closer inspection, the ice appeared to be condensation formed from a hydrocarbon leak at the weld between the 6" main line and 2" weldolet [refer to Appendix B.1]. The presence of hydrocarbons was confirmed via a personal gas monitor. The central control room was immediately notified via radio and the control room operator immediately notified the production supervisor. Isolation points upstream and downstream of the leak were identified and put in place. The OIM was notified and the section of piping was blown down to a safe location. Depressurisation of the system was complete at 21:40 hours CST.



5 Why it Happened: History

In 2014, routine piping inspections picked up crack like indications on multiple SBF welds. A series of dye penetrant inspections were carried out on the PG, PL, and FG systems per historical WOs 2200147176 & 210015086. High risk piping was initially determined as duplex stainless steel thin walled pipe in hydrocarbon service. In 2016 [REDACTED] inspected the SBFs on the fuel gas, process gas, low pressure flare, process liquid, fuel liquid and high pressure flare system. Further cracking was found and the [REDACTED] results are summarized in Table 1.

After this inspection, on board inspector [REDACTED] performed additional DPI to three areas of immediate concern and confirmed the presence of unacceptable crack like defects. Operations then isolated those SBF locations as they posed an unacceptable risk:

- 200-BH-4021-01D01-0 TP2 – in service vibration fatigue cracking at weld toe on both sides. SBF is not supported.
- 200-BH-4015-01D01-0 TP1 – vertical indication on the SBF socket, possible fabrication defect.
- 080-BL-4131-01D01-0 TP1 – intermittent overlap and undercut at weld toe. SBF has a bolt on support.

Confirmation was requested from offshore for the following SBFs that have not been isolated by operations, be dye penetrant inspected at the next opportunity as they also showed crack like indications in the [REDACTED] 2016 inspection but have not been isolated:

Line Number	CML	Isometric/ Comments
150-PL-4030-03D01-3	TP1	Marked as "H" on iso M5000DZPX00PL2000108 This line is >52°C
150-PL-4032-03D01-3	WOL	Marked as "T" on iso M5000DZPX00PL2000108 This line is >52°C
150-FG-4028-03D01-0	TP1	Marked as "B" on iso M5000DZPX00FG4400104
	TP2	Marked as "A" on iso M5000DZPX00FG4400104
150-PG-3037-03D01-0	TP1	Toe crack Marked as "P" on iso M5000ZPX00PG300103
	TP2	Toe crack Marked as "Q" on iso M5000ZPX00PG300103

The offshore inspector confirmed that braces had been installed and weld reinforcement had been completed to all the above lines. Photos in Appendix A.

6 Table 1 - Status of SBFs Investigated in 2016

Line No.	Isometric Drawing	CML	SBF ID	Inspection Notes
High Pressure Flare (BH) SBFs				
200-BH-4015-01D01-0	M5000DZPX00BH4500103	TP1	G	Crack like indication. Exceeds acceptance standard. BRACED AND DEISOLATED.
		TP2	H	Pinholes only. Previous recorded defect.
080-BH-4172-01M01-0	M5000DZPX00BH4500107	TP1	G	Poor weld profile only. Previous recorded defect.
200-BH-4021-01D01-0	M5000DZPX00BH4500104	TP2	G	2 x crack like indications in weld toe. BRACED AND DEISOLATED.
080-BH-4204-01D01-0	M5000DZPX00BH4500103	TP1	A	Undercut.
200-BH-4015-01D01-0	M5000DZPX00BH4500103	TP1	C	Ferrite contamination and pinholes.
250-BH-4137-01M01-0	M5000DZPX00BH4500104	TP1	F	Undercut.
080-BH-4138-01D01-0	M5000DZPX00BH4500104	TP2	G	Overlap and Crater pipe.
200-BH-4051-01D01-0	M5000DZPX00BH4500104	TP2	I	Overlap.
200-BH-4205-01D01-0	M5000DZPX00BH4500104	TP2	M	Overlap.
250-BH-4085-01D01-0	M5000DZPX00BH4500104	TP2	R	Incorrectly referred to as BH-4285 in report.
200-BH-4079-01D01-0	M5000DZPX00BH4500105	TP2	C	Undercut.
250-BH-4082-01D01-0	M5000DZPX00BH4500105	TP3	F	Poor weld profile.
080-BH-4172-01M01-0	M5000DZPX00BH4500107	TP1	G	Poor weld profile.
Fuel Liquid (FL) SBFs				
100-FL-5002-01S01-0	M5000DZPX00FL5300101	TP3	B	Ferrite contamination and pinholes.
		TP4	C	
	M5000DZPX00FL5300102	WOL	C	

Green = remediated, Blue = previously identified as a crack like defect and subsequently reviewed and reassessed as weld defects only

Yellow = weld defects identified

Line No.	Isometric Drawing	CML	SBF ID	Inspection Notes
Process Liquid (PL) SBFs				
150-PL-4030-03D01-3	M5000DZPX00PL2000108	TP1	H	Crack like indication. >52°C BRACED.
150-PL-4032-03D01-3		WOL	T	
150-PL-3023-03D01-0	M5000DZPX00PL2000101	TP1	B	Undercut and pinholes.
100-PL-3171-03D01-0		TP2	F	Undercut.
100-PL-4012-03M01-0	M5000DZPX00PL2000107	TP1	G	Overlap.
100-PL-3427-01D01-0	M5000DZPX00PL2000111	TP1	A	Ferrite contamination and pinholes.
100-PL-3426-01D01-0		TP1	B	
100-PL-4063-03D01-0		TP1	C	
100-PL-4052-03D01-0		TP1	E	
100-PL-4068-03D01-0		TP1	F	
100-PL-4067-03D01-0		TP1	H	
100-PL-3447-03D01-0		TP1	A	
200-PL-2108-01D01-3		TP2	K	
200-PL-2104-01D01-0	M5000DZPX00PL2000116	TP1	P	
200-PL-2105-01D01-0		TP1	T	
Low Pressure Flare (BL) SBFs				
080-BL-4131-01D01-0	M5000ZPX00BL4500102	TP1	K	Crack like indication. BRACED AND DEISOLATED.
Fuel Gas (FG) SBFs				
150-FG-4028-03D01-0	M5000DZPX00FG4400104	TP2	A	Crack. BRACED.
		TP1	B	
150-FG-4002-03D01-0	M5000DZPX00FG4400102	TP5	M	Overlap.
150-FG-4028-03D01-0	M5000DZPX00FG4400104	TP2	A	

Line No.	Isometric Drawing	CML	SBF ID	Inspection Notes
Process Gas (PG) SBFs				
150-PG-3037-03D01-0	M5000ZPX00PG300103	TP1	P	Toe crack. BRACED.
		TP2	Q	
100-PG-3231-03D01-0	M5000ZPX00PG300105	TP1	B	Ferrite contamination and pinholes.
150-PG-3027-03D01-0	M5000ZPX00PG300108	TP2	B	
450-PG-2157-01D01-0	M5000ZPX00PG300112	TP3	E	Poor weld profile.
400-PG-2141-01D01-3	M5000ZPX00PG300113	TP1	A	Overlap.
200-PG-2134-03D01-3		TP1	F	Ferrite contamination and pinholes.
150-PG-3081-03D01-0	M5000ZPX00PG300116	TP2	B	Overlap.
150-PG-3201-03D01-0	M5000ZPX00PG300119	TP1	A	Ferrite contamination and pinholes.
150-PG-3086-03D01-3	M5000ZPX00PG300121	TP2	E	



7 Steps Taken Immediately: Repair

The scope of work for the repair consisted of cutting and removing the failed section of duplex piping including the attached weldolet [Appendix B.2], and replacing with a straight piece of duplex piping [Appendix B.3]. The work was carried out and captured in WO M220050499.

Management of Change was captured via Engineering Change Request (M2000067) and was completed prior to the work being conducted. The ECR covered replacing the 6" SCH 10 duplex piping that had failed, with 6" SCH 10 duplex piping without the attached 2" weldolet. The piping system was flushed and purged, and a pressurised welding habitat was set-up prior to any hot work conducted. The existing 6" pipe was cut considering the heat affected zone. A replacement piece of 6" SCH 10 duplex was cut to length and welded into place using a qualified welder (DS 3001) and was pickled and passivated in accordance with A380/A380M-13. Following completion of the weld, 100% dye penetrant inspection (DPI) and 100% radiographic testing (RT) was conducted on both welds by a NATA certified technician. A hydrostatic pressure test on the repair was performed at x1.5 the design pressure as per ASME B31.3 and held for 30mins. Refer to Debutaniser Duplex Piping Repair Report [4900-HS-H0071-03].



8 Steps Taken Long Term: Follow up Inspections

To ensure the integrity of the process liquid system and identify future problem SBF welds in this hydrocarbon system, an inspection was carried out under WO M220050512 on December 2016 by the incumbent [REDACTED] inspector at the request of the Material Inspection & Corrosion engineer to perform the following:

- Dye penetrant inspect all accessible SBF welds on the PG piping system
- Identify SBFs that require Rope Access for inspection
- Identify SBFs operating hot that require a shutdown for inspection
- Identify insulated SBFs that require lagging removal / reinstatement for inspection

The results captured in ISR NE 2104 from December 2016 [4900-FP-Q0022] were as follows:

- 51 SBFs were found and assessed
- 27 SBFs were tested with Dye Penetrant and found to be Crack-Free; including the two SBFs adjacent to the failed SBF on line 150-PL-3052-03D01-3
- The remaining 24 SBFs could not be tested for the following reasons:
 - Operates too hot
 - Protected by Personnel Protection Mesh and inaccessible
 - Painted; these are carbon steel and deemed to be lower risk as the historical issue with SBF cracking on the Northern Endeavour has been on duplex stainless steel SBF welds
 - Requires scaffold

Further SBF weld dye penetrant inspections will be planned for 2017 based on the required access: lagging removal/ shutdown/ rope access.

Maximo Service Request	Description
M2000226	Remove and reinstate Personnel Protection Mesh to inspect SBFs as identified in 4900-FP-Q0022
M2000228	Opportunistic Eddy Current for painted DSS SBFs as identified in 4900-FP-Q0022
M2000229	Too hot – shutdown required to inspect SBFs as identified in 4900-FP-Q0022
M2000230	Requires scaffold to inspect SBFs as identified in 4900-FP-Q0022



Appendix A Previous Repair Photos

Figure 1 - 150-FG-4028-03D01-0 TP1 (B) confirmation of brace



Figure 2 - 150-FG-4028-03D01-0 TP1 (B) condition of small bore fitting weld





Figure 3 - 150-FG-4028-03D01-0 TP1 (B) condition of small bore fitting weld



Figure 4 - 150-FG-4028-03D01-0 TP1 (B) condition of small bore fitting weld

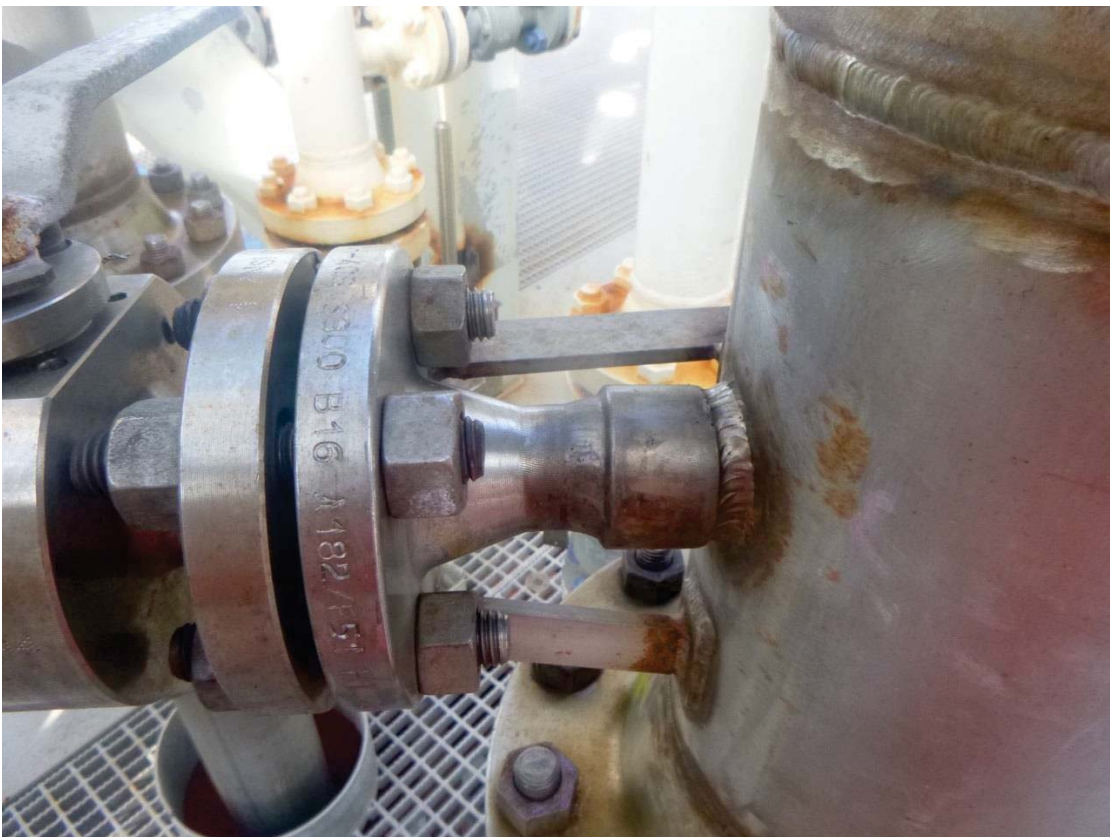




Figure 5 - 150-FG-4028-03D01-0 TP2 (A) condition of small bore fitting weld



Figure 6 - 150-FG-4028-03D01-0 TP2 (A) condition of small bore fitting weld





Figure 7 - 150-PG-3037-03D01-0 TP1 (P) confirmation of brace



Figure 8 - 150-PG-3037-03D01-0 TP1 (P) condition of small bore fitting weld





Figure 9 - 150-PG-3037-03D01-0 TP1 (P) condition of small bore fitting weld

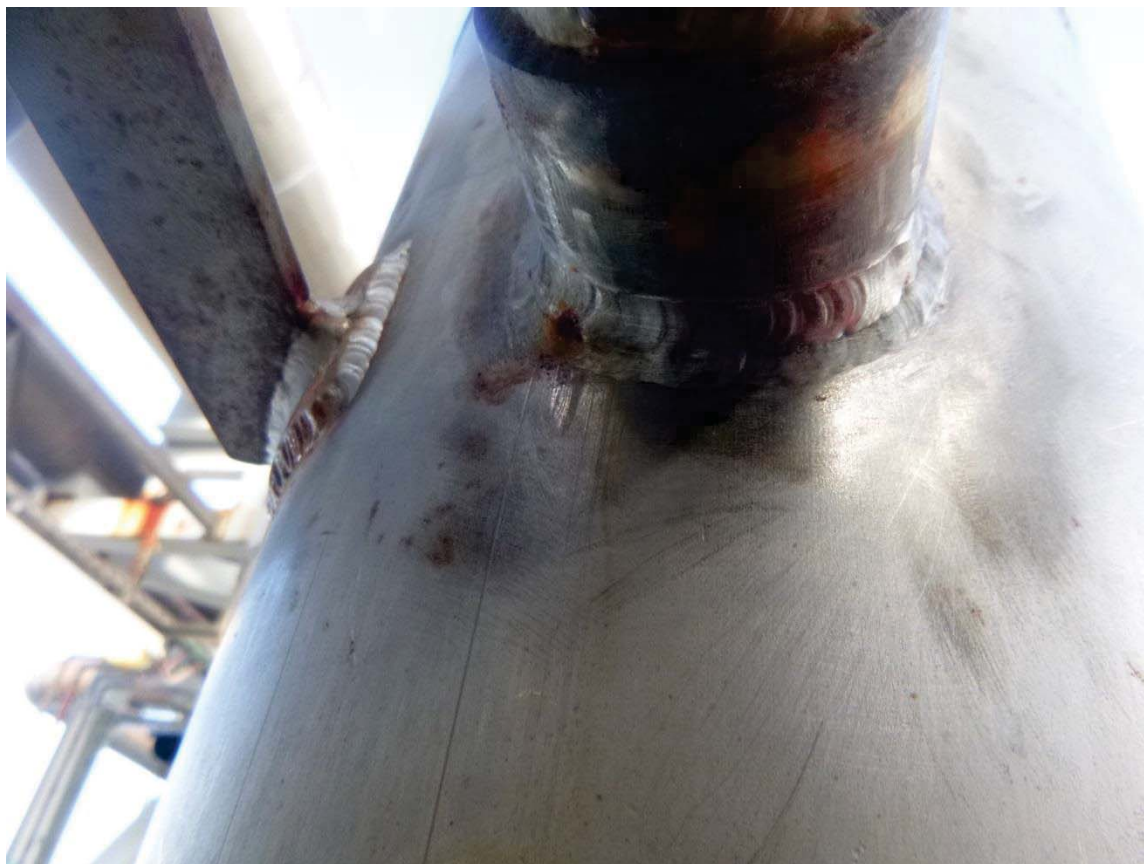


Figure 10 - 150-PG-3037-03D01-0 TP2 (Q) confirmation of brace

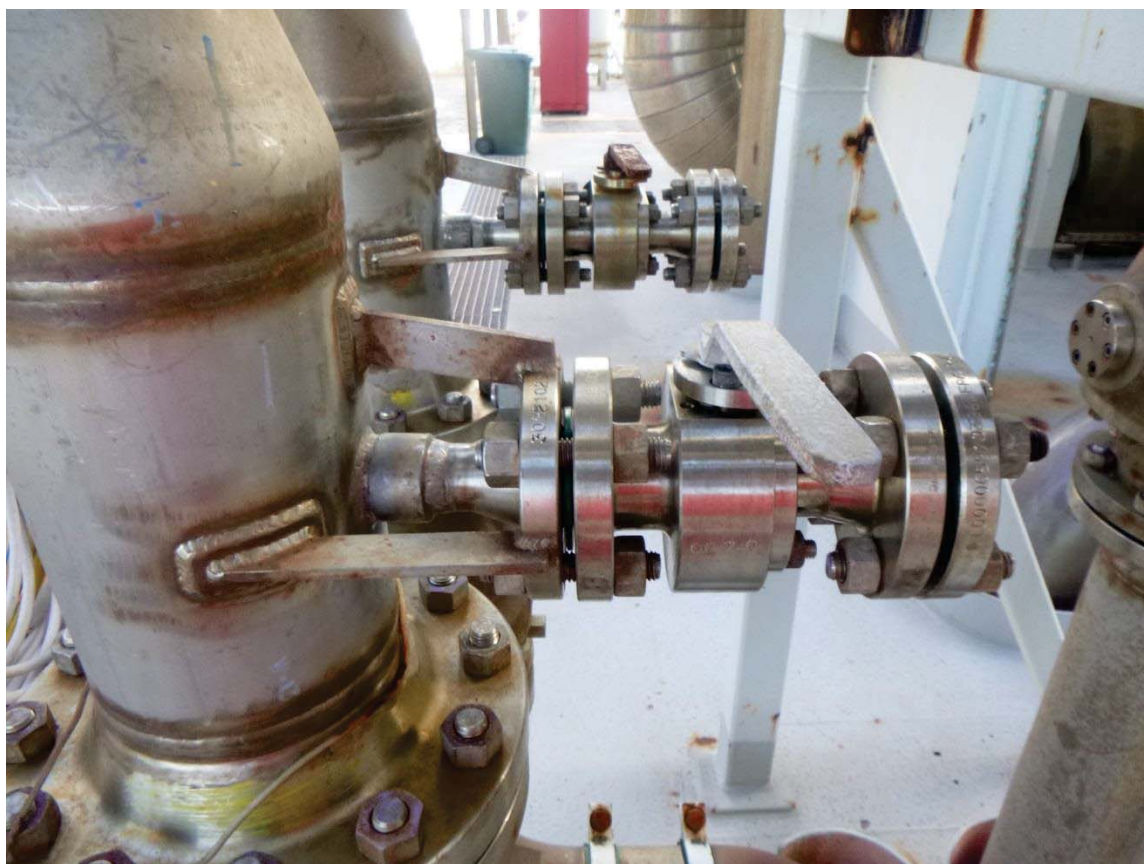




Figure 11 - 150-PG-3037-03D01-0 TP2 (Q) condition of small bore fitting weld



Figure 12 - 150-PG-3037-03D01-0 TP2 (Q) condition of small bore fitting weld





Figure 13 - 150-PL-4030-03D01-0 TP1 (H) confirmation of brace



Figure 14 - 150-PL-4030-03D01-0 TP1 (H) condition of small bore fitting weld





Figure 15 - 150-PL-4032-03D01-0 WOL (T) confirmation of brace

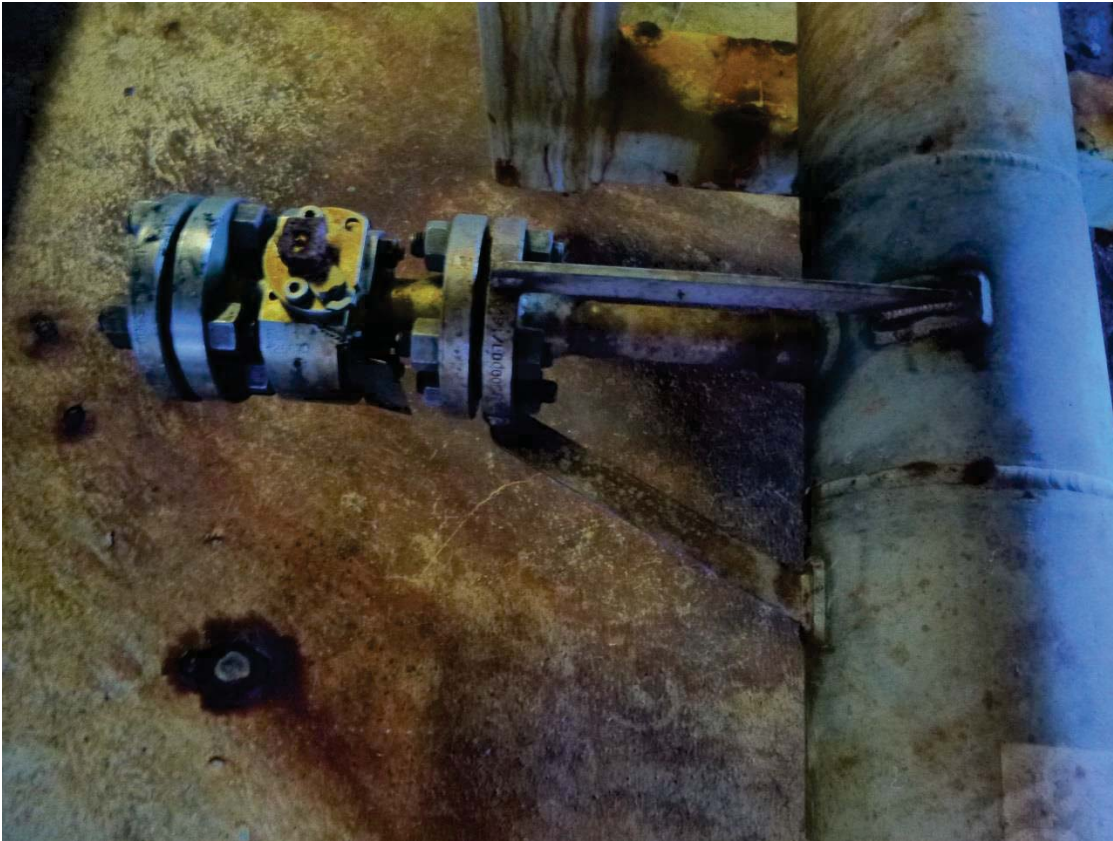


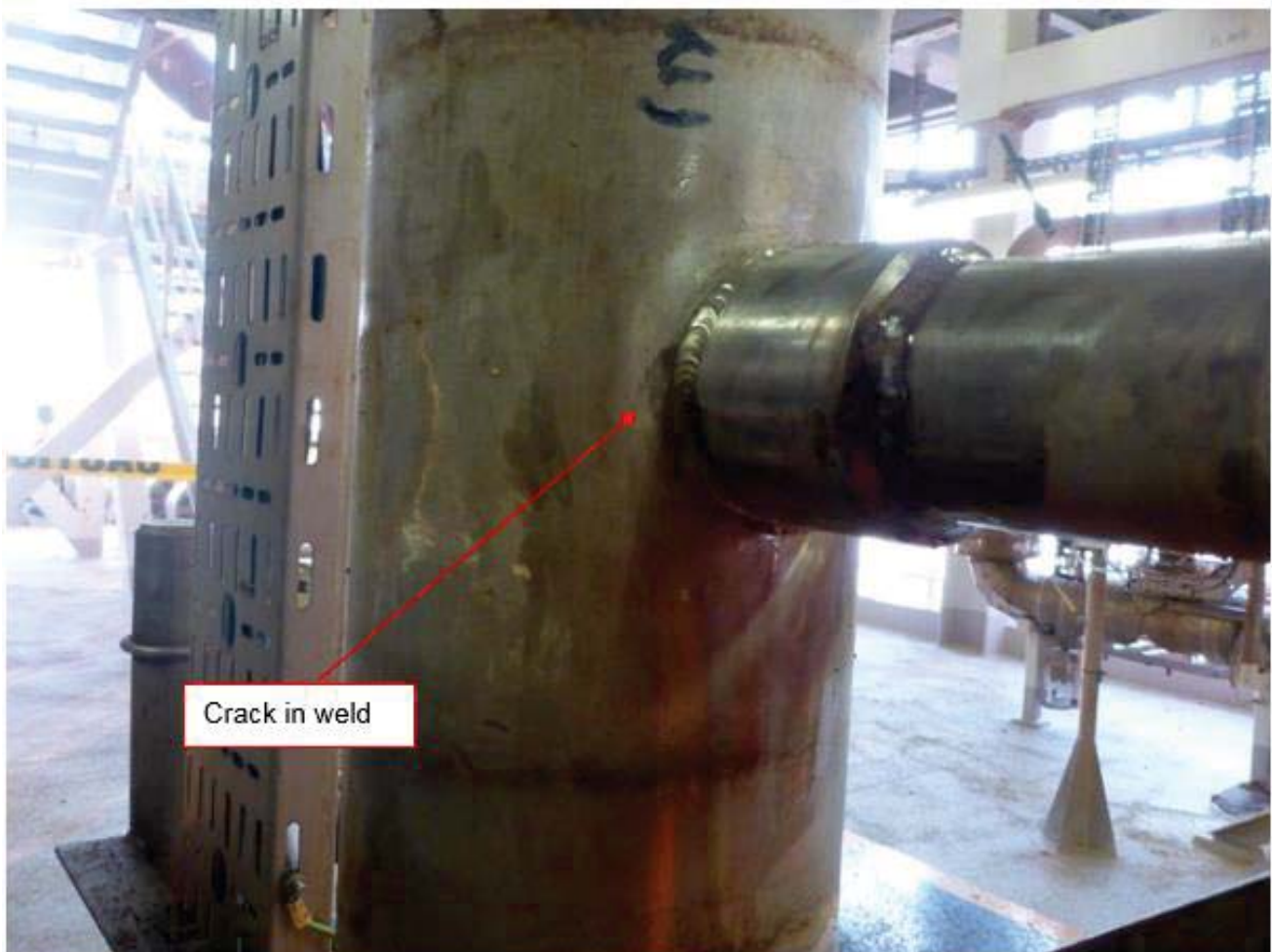
Figure 16 - 150-PL-4032-03D01-0 WOL (T) condition of small bore fitting weld



Appendix B Weld Repair Photos

Appendix B.1 Image of Weld Failure

Figure 17 - Failed weld at SBF 37PI072 on line 150-PL-3052-03C01-3





Appendix B.2 Process Piping Prior to Repair

Figure 18 - Previous brace configuration at 37PI072 on line 150-PL-3052-03D01-3





Appendix B.3 Process Piping Following Repair

Figure 19 - Replacement spool piece on line 150-PL-3052-03D01-3 with SBF designed out

