a PPL company

Louisville Gas and Electric Company
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Gwen R. Pinson
Executive Director
Kentucky Public Service Commission
211 Sower Boulevard
Frankfort, Kentucky 40601

January 31, 2020

RE: ***Louisville Gas and Electric Company Alleged Failure to Comply with KRS 278.495, 807 KAR 5:022, and 49 C.F.R. Part 192***
Case No. 2017-00119

Dear Ms. Pinson:

In accordance with the Kentucky Public Service Commission's Order of March 16, 2018, Ordering Paragraph No. 4 in Case No. 2017-00119, please find Louisville Gas and Electric Company's ("LGE") 2019 Annual Report on the implementation of LG&E's Action Plan. This report will serve as the second annual report for the years 2018 – 2022.

Should you have any questions regarding the enclosed, please contact me at your convenience.

Sincerely,

Rick E. Lovekamp

Rick E. Lovekamp

Louisville Gas and Electric Company
2019 Annual Report
Case No. 2017-00119

In accordance with the Kentucky Public Service Commission's Order of March 16, 2018 in Case No. 2017-00119, Louisville Gas and Electric Company ("LG&E") submit the second annual report for the years 2018 – 2022. The annual report provides a status on the implementation of LG&E's Action Plan and the number of bolted-style coupling systems removed in 2019 from distribution lines having an operating pressure in excess of 60 psig along with observations of the removed couplings.

LG&E developed the Action Plan in collaboration with Daniel Ersoy of the Gas Technology Institute ("GTI"). The Action Plan focused on the removal of couplers in the LG&E transmission and high-pressure distribution systems, prohibited use of couplers going forward except in very limited circumstances and only in lower-pressure environments, and to improve the training and communication efforts to minimize the chances of coupler separations. The Action Plan items align with Section 3 of the GTI Report that was submitted in Case No. 2017-00119 as an attachment to Commission Staff's Second Request for Information.

LG&E had completed all action items in the Action Plan submitted in the 2018 annual report with the exception of one item which continues to remain open and in progress.

GTI Report Section 3, Part F: Continuous Process Improvement and Leading Indicators

Action 1: Continuous process improvement and leading indicators, including incorporating findings into Distribution Integrity Management Program ("DIMP").

Action Taken: The Gas Distribution and Information Technology teams have launched an initiative to implement a new risk analysis software to consider the suggested, among other, risk factors associated with the distribution system. As risk identification is improved, analysis will allow a better ranking of infrastructure to be utilized by the DIMP team members to initiate improvements.

Status: In Progress – The procurement process is in its final stages with the new risk software scheduled to be operational in the fall of 2020.

The couplings retired from LG&E's distribution system include the following listed. In accordance with the Action Plan Section 3, Part E, a program was implemented for the opportunistic bolted style coupling removal or encapsulation (for systems > 3 psig) in October 2017. In accordance with the Kentucky Public Service Commission's Order to the Louisville Gas and Electric Company on March 16, 2018 for Case No. 2017-00119, the Louisville Gas and Electric Company ("LGE") hereby notifies the Commission that the following six mechanical couplings were removed from service from LG&E's high-pressure gas distribution system in 2019. The two couplings were physically removed from the ground while four couplings were retired in place by terminating the pipeline in an upstream and / or downstream location.

Distribution Couplings removed from the ground:

1) 235 Abraham Flexner Way (Jewish Hospital) - A 6-inch bolted-style mechanical coupling installed in 1958 was removed from service on 4/4/2019 and removed from the ground on 9/4/2019 for inspection for defects. The lab report analysis is attached as in Exhibit A.

2) 830 South 13th Street (Greyhound Bus) - A 4-inch bolted-style mechanical coupling with an unknown installation date was removed from service and removed from the ground on 6/18/2019 for inspection for defects. The lab report analysis is attached as in Exhibit B.

Distribution Couplings retired in place:

1) 1807 Commerce Road (Universal Linen) – Two 4-inch mechanical couplings installed in 1960 were removed from service and retired in place on 10/09/2019.

2) South 7th Street and Commerce Road – Two 4-inch mechanical couplings installed in 1990 were removed from service and retired in place on 10/09/2019.

Bolt-Style Coupling (pressures > 3 psig)

This form will be completed when LG&E or LG&E contractors expose a bolt-style coupling in a system where the pressure is > 3 psig (medium and high pressure distribution and transmission) and the coupling will be backfilled. The purpose of the form is to provide Operations, Engineering and Gas Regulatory personnel with information about the bolt style coupling installation.

Part A- Discovery of Coupling

Precautions: D. Dilley #3348

1. Stop excavation upon discovering the bolt-style coupling in the excavation
2. Set-up a perimeter around the excavation to keep the public away from the excavation

General Information: * coupler is in Warehouse *

1. Contact Employee for the bolt style coupling found:
2. Date of exposure: 9-4-19
3. Location: 235 ABRAHAM FLEXNER WAY
4. Size of coupling (based on pipe size if not exposed enough to determine): 6"
5. Type of soil (circle one): Sandy Clay Gravel Topsoil Other (take picture and describe)
6. Soil Density test: ☐ Type A ☐Type B ☑Type C
7. Status: ☑Removed ☐Abandoned in place ☐Backfilled- left in service
8. Discovered How?: ☑Leak on Coupling ☐Other Maintenance Excavation ☐Facility Replacement ☐Facility Retirement ☐Other Leaking (?) coupler found back in March of 2019 SRTO isolated this section of Pipe by turning off 3-valves. It wasn't exposed if it really leaked until 9-4-19 when piping was replaced so I don't know if it

Pictures:

1. Take at least two pictures of the coupling. The pictures should be from different angles (additional pictures can be taken). Date Correction EJB 1/7/2020
2. Email pictures to supervisor. Ensure pictures are attached to this form:

Sketch: Provide a sketch showing the coupling orientation (vertical/horizontal), nearby branches, pipe, valves and fittings, other utilities or structures, etc.

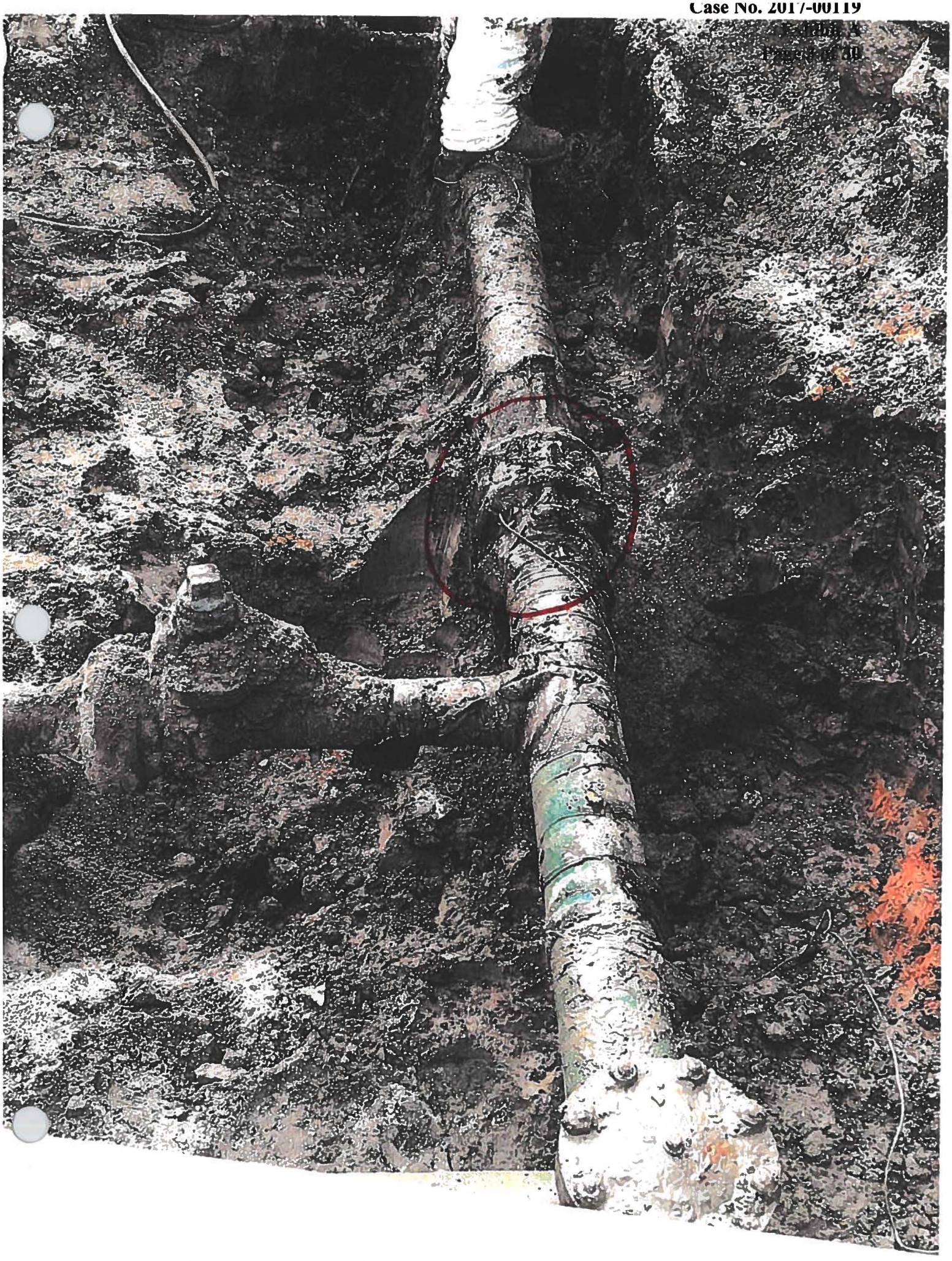
Leak Survey:

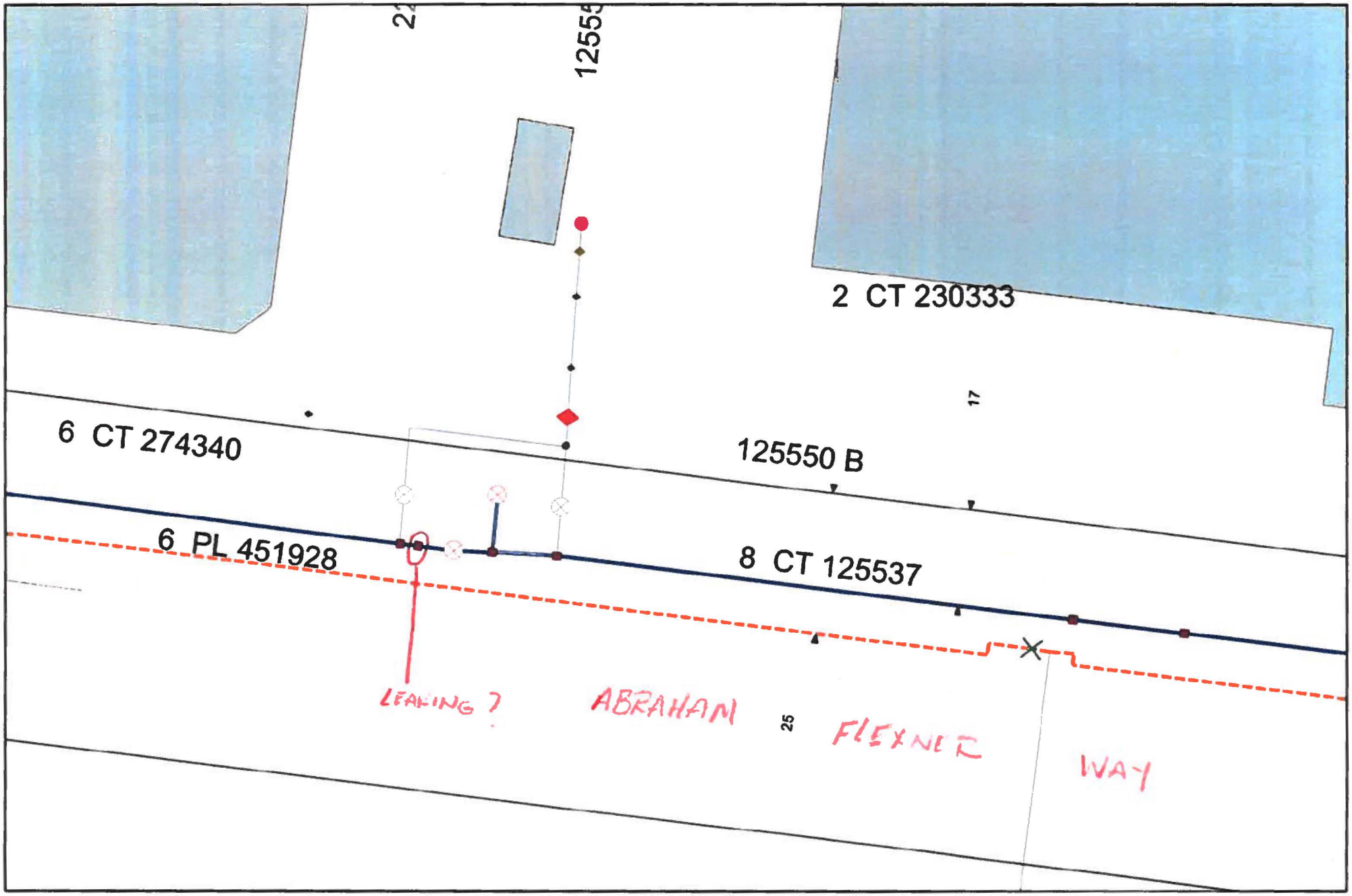
1. Use an instrument designed to detect natural gas to check for the presence of natural gas after backfilling the excavation. Include readings in the above sketch in relation to the coupling. If the contact employee is not leak survey qualified they should contact:
   a. Their supervisor to call Gas Regulatory to complete the survey after the excavation is backfilled. Call [redacted]
   b. If Gas Regulatory is not available contact Gas Dispatch to have the survey assigned to a Gas Trouble Technician.

EJB 1/7/2020

Leak Survey completed at time of backfill (circle one) (yes) no not applicable

Include completed form in the main report and email a scanned copy of the completed form (back and front) to the Distribution Integrity Management (DIM) group.





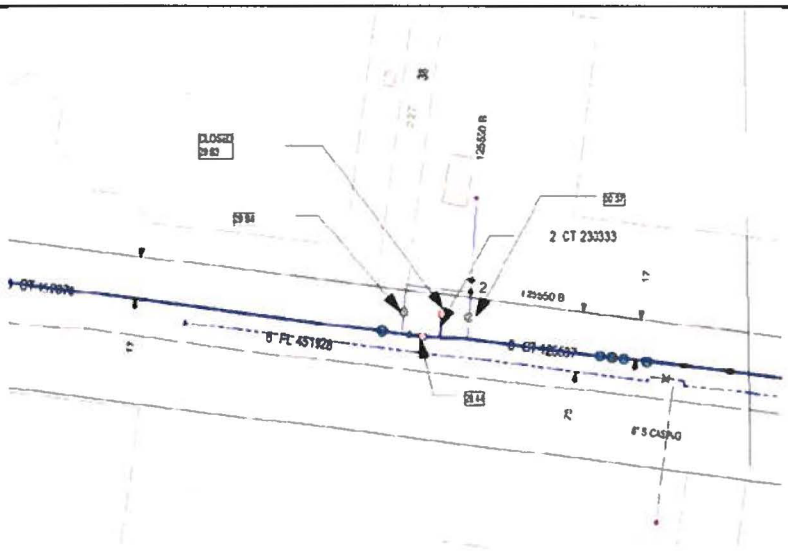
LGE&KU	e003348	1999169, 13891793	Scale: 1 IN = 21 FT	09/06/19 14:46

Part B- Coupling Information

General Information			Tracking #: 2019-008
PO Number 1040665	Expense Org 4610	Project 158276	Task COUPLER
Address/Location 235 Abraham Flexner Way at Jewish Hospital, Louisville, KY			
Size 6 inch	Material Steel	Coating Coal Tar	MAOP
Main/Service Number 125550	Soil Type (from Part A) Type C	Manufacturer Dresser	Model Style 39
Pipe Connection:	Steel to Steel	Steel to Plastic	Plastic to Plastic

Historical Information	
Installation Date 4/2/1958	Document Source Main Report
Installation Company None noted on main report	Document Source Main Report
Foreman W.R. Dawson (sp?)	Document Source Main Report
Welder None listed on main report	Document Source Main Report

GIS Information
Sys Id (of Coupler) 73415330
Screen Capture



Pictures

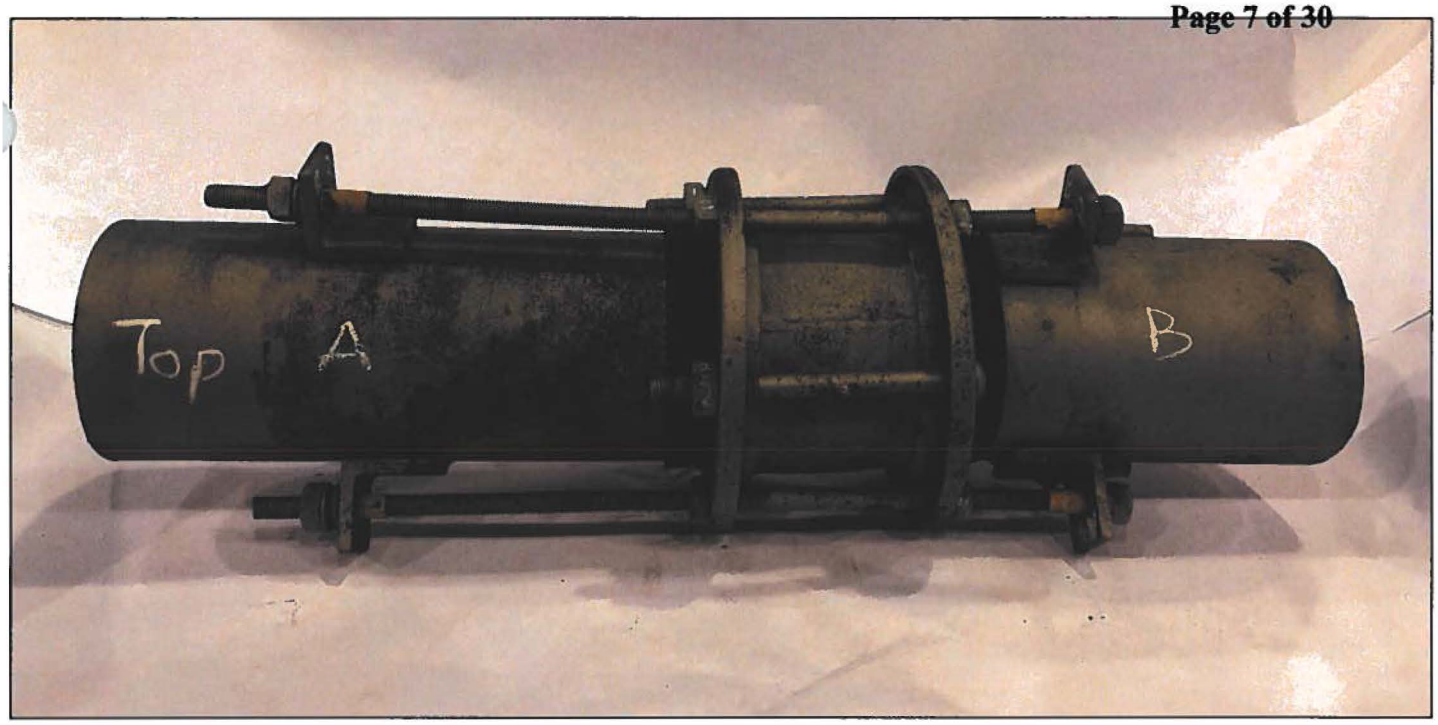


Figure 1- Top View

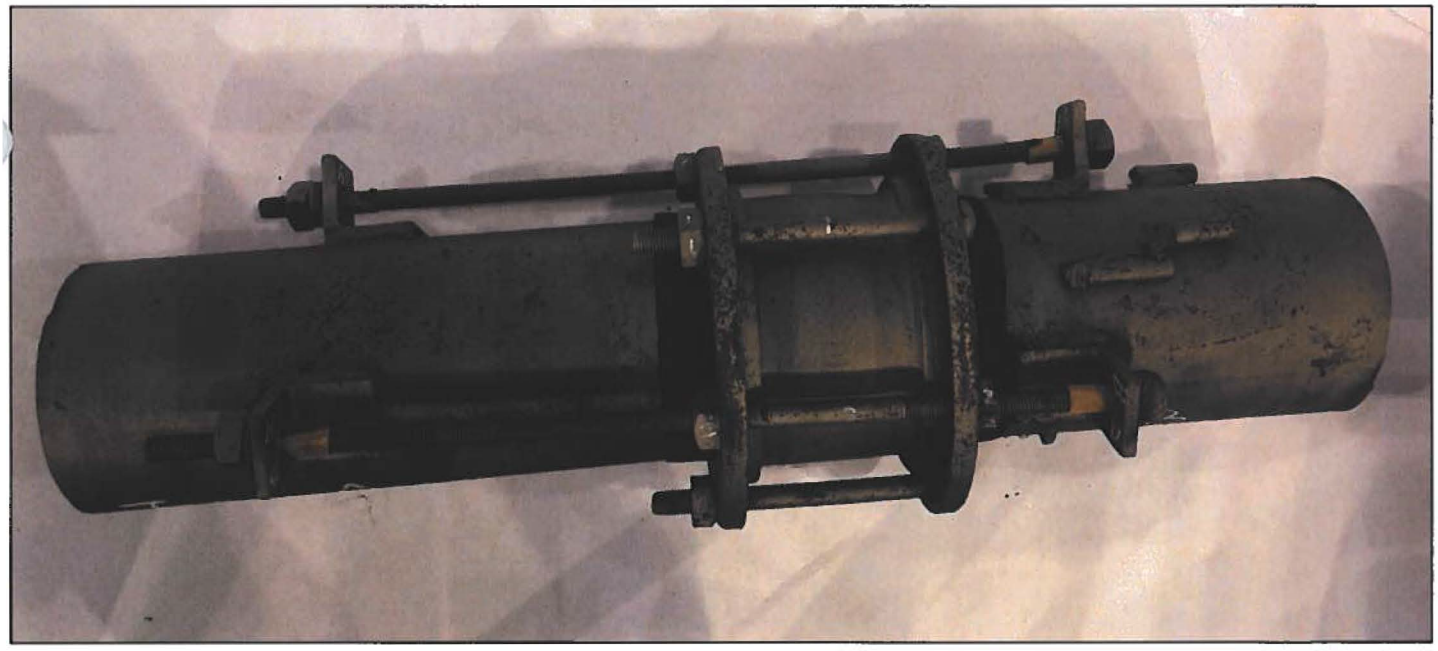


Figure 2- Front View

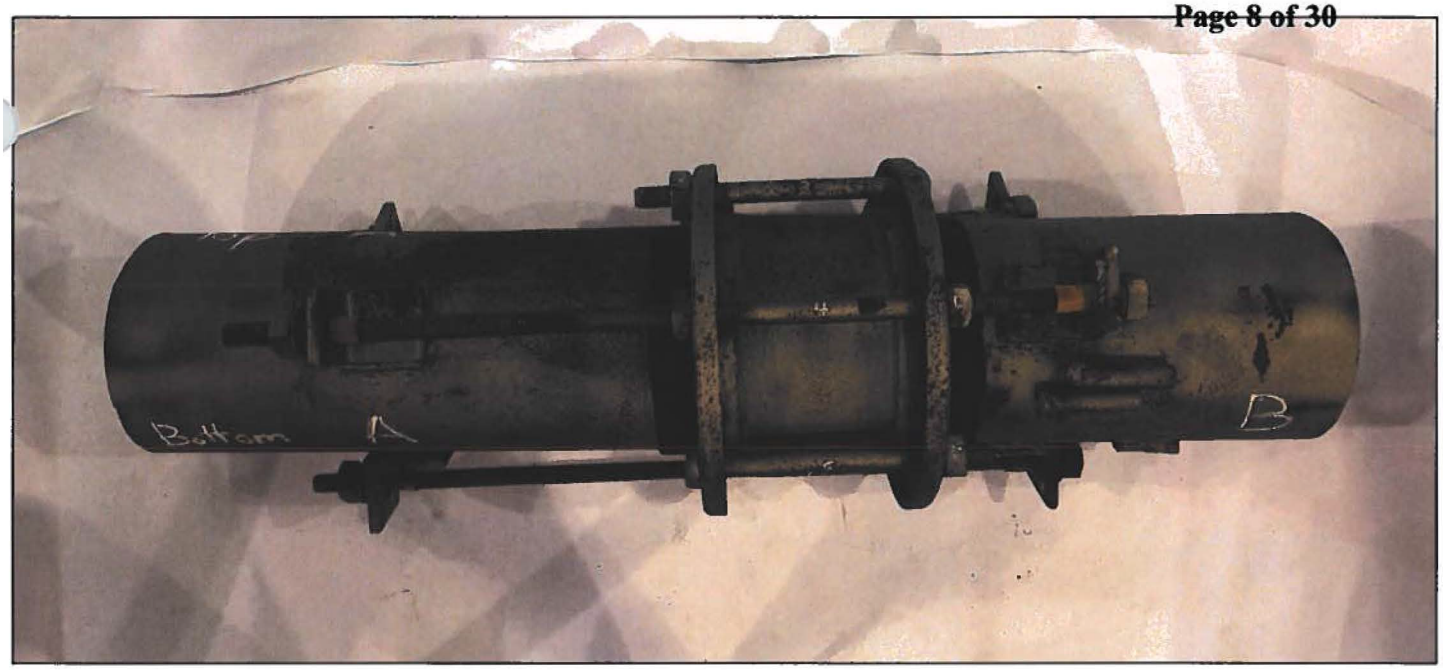


Figure 3- Back View

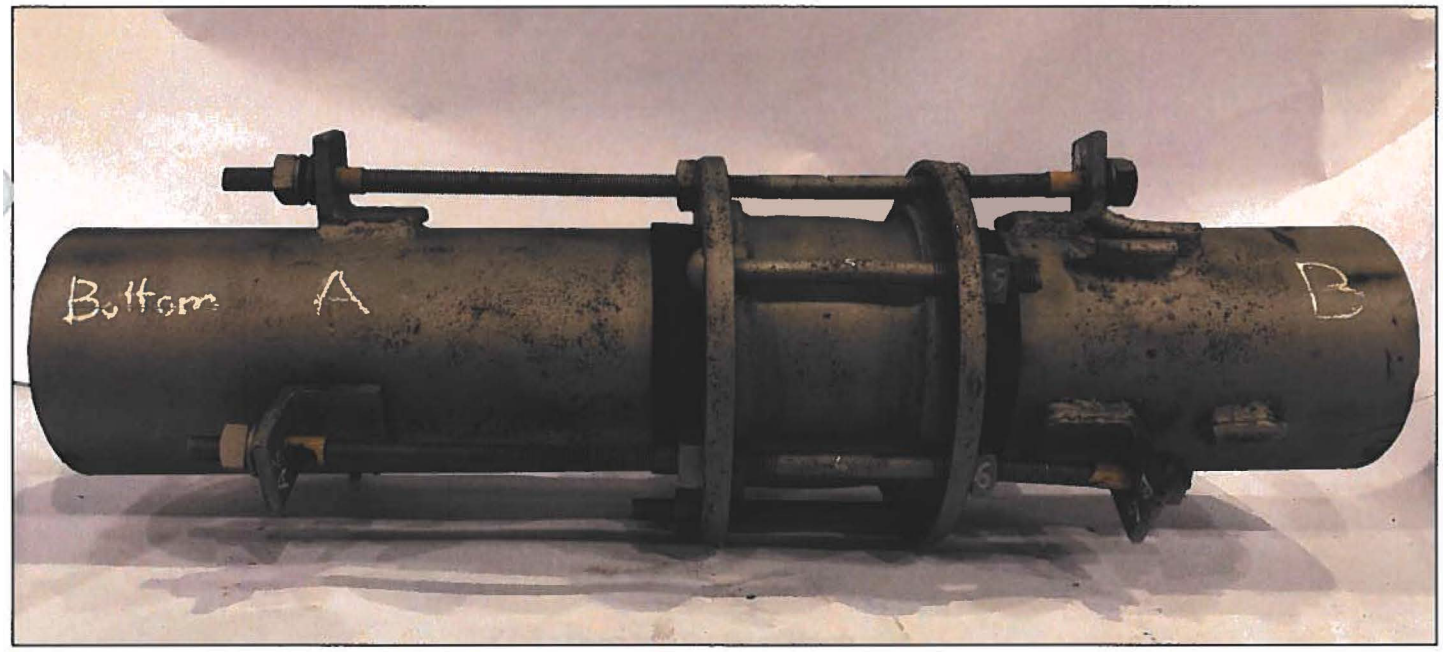


Figure 4- Bottom View

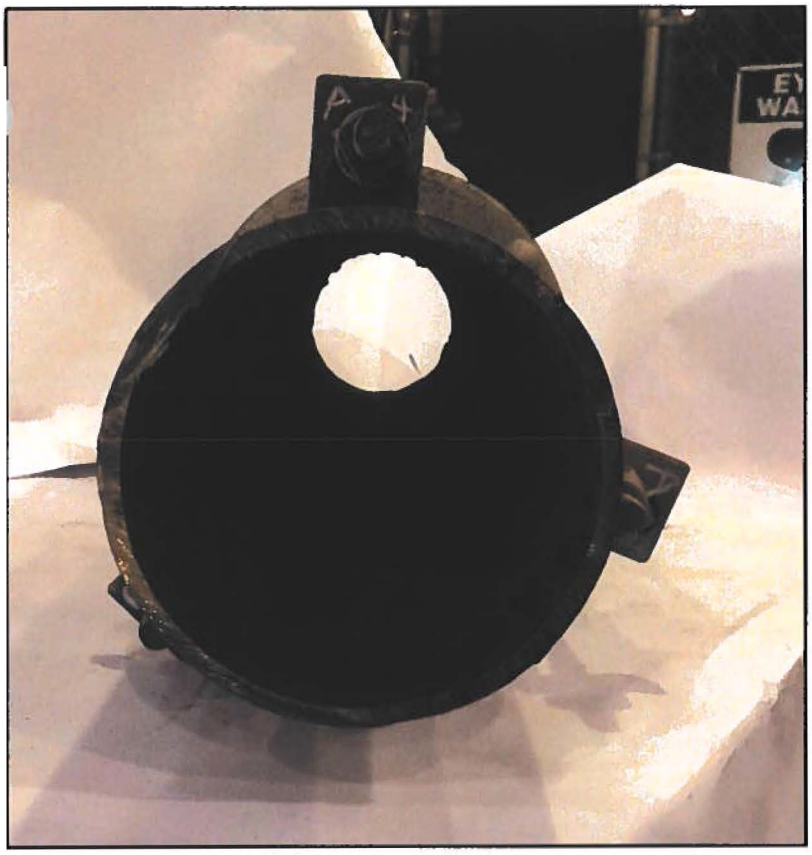


Figure 5- Left Side View

Figure 6- Right Side View

Part C- Visual Inspection of Coupling

Visual Inspection Performed by: Chad Augustine ([redacted]), Craig Meade ([redacted]) Date: 9/27/2019

Table 1- Component Quantities

Number of Bolts on Coupler Body	3[1]
Number of Reinforcement Rods	3
Number of Lugs	6 (3 each rod)

[1] The 3 reinforcement rods are threaded through the coupling body. They were used in place of 3 bolts. See Figures 1-4.

Table 2- Corrosion

	Pipe A	Pipe B	Coupler Body	Bolts	Rods	Lugs	Nuts
General External Corrosion Present?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Localized Corrosion Present?	No	No	No	No	No	No	No
Pit Depths	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Internal Corrosion?	No	No					

Table 3- Coupler Body

Bolt	Washer Present	Nut present?
1	No	Yes
2	No	Yes[2]
3	No	Yes
4	No	Yes[2]
5	No	Yes
6	No	Yes[2]

[2] For the rods that were serving as bolts for the coupling body, nuts were used on either side of the coupling braces. See Figures 1-4.

Table 4- Reinforcement Rods

Rod	Length (in.)	Diameter (in.)	Washer present at head of bolt?	Washer present at end of bolt?	Nut Present? Type?	Type of rod?
2	24	0.6220	Y	Y	Yes, square	Kit provided (?)
4	24	0.6215	Y	Y	Yes, square	Kit provided (?)
6	24	0.6140	Y	Y	Yes, square	Kit provided (?)

Type of Lug

(Please indicate the shape of the lug by circling one below. If the lug shape is different than any preset shape below, sketch the shape.)

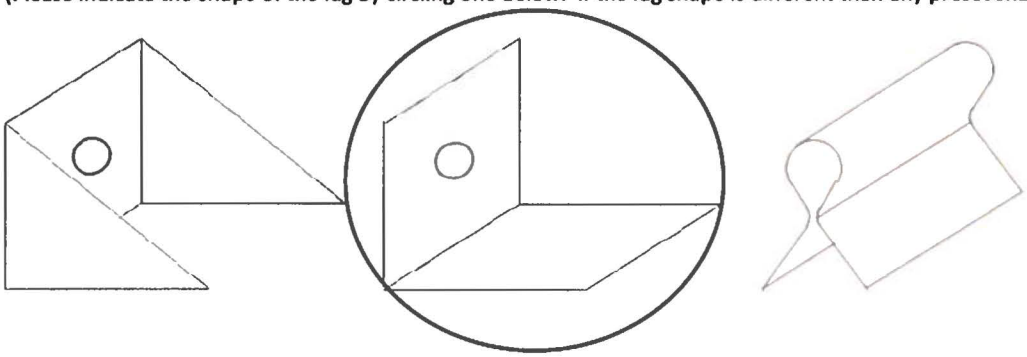


Table 5- Lugs (Measurements)

Pipe Side	Lug Number	Thickness (in.)	Circumference (in)	
			Distance to next lug, clockwise	Distance to next lug, counter-clockwise
A	2	0.3725	To A4- 7.25	To A6- 7.25
A	4	0.3725	To A6- 7.00	To A2- 7.25
A	6	0.3770	To A2- 7.25	To A4- 7.00
B	2	0.3885	To B4- 6.75	To B6- 7.25
B	4	0.3815	To B6- 7.75	To B2- 6.75
B	6	0.3785	To B2- 7.25	To B4- 7.75

Table 6- Lugs (Observations)

Lug	Lug	Assembly sets aligned?	Deformed?	Deflected? (angle of)
A2	B2	Yes	Yes, bent due to threading[3]	No
A4	B4	Yes	Yes, bent due to threading[3]	No
A6	B6	Yes	Yes, bent due to threading[3]	No

[3] The height of the hole in the lug is higher (further from the pipe) then the hole in the coupling brace. When the reinforcement rod was threaded through the coupling braces, the rod had to be bent slightly to thread it through the holes of the lugs.

Table 7- Lugs (Weld Quality)

Pipe Side	Lug Number	Any part detached from pipe?	Welded on all sides of exterior? If no, describe	Are welds on exterior continuous? If no, describe	Welded on all sides of interior? If no, describe	Are welds on interior continuous? If no, describe
A	2	Yes	Top help not welded[4]	Yes	Not Applicable	Not Applicable
A	4	Yes	Top help not welded[4]	Yes	Not Applicable	Not Applicable
A	6	Yes	Top help not welded[4]	Yes	Not Applicable	Not Applicable
B	2	Yes	Top help not welded[4]	Yes	Not Applicable	Not Applicable
B	4	Yes	Top help not welded[4]	Yes	Not Applicable	Not Applicable
B	6	Yes	No weld on back[4]	Yes	Not Applicable	Not Applicable

[4] These particular lugs do not conform with the curvature of the pipe, therefore it is not possible to weld all sides.

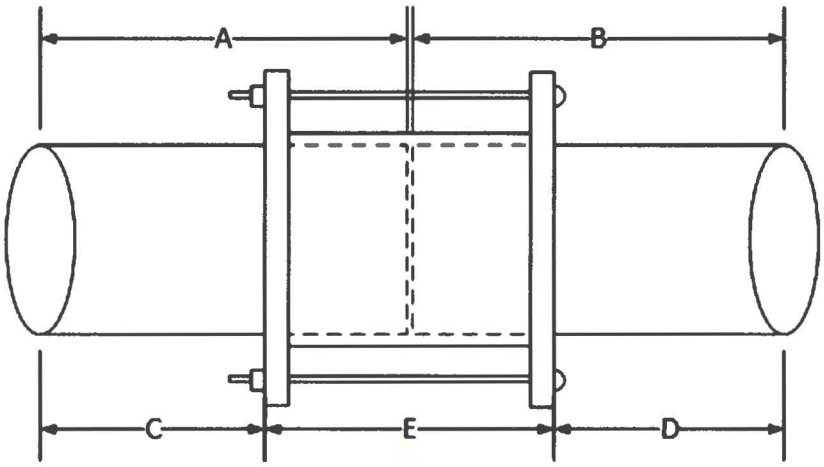


Table 8- Stab Depth

	A	B	C	D	Stab Depth (A-C) or (B-D)
Pipe Side A	19.125		16.375		2.750
Pipe Side B		14.375		11.250	3.125
	Sum of stab depths (should be closely equal to measurement E)				5.875
	Coupler Length (E)				6.500
	Difference				0.625

Additional Comments and General Observations

- Rubber Seals are intact
- The reinforcement rods are threaded through the body of the coupling instead of using provided bolts
- Some of the nuts on the rods are not fully threaded. In the worst case, the rod is not threaded half way into the nut. In figure 7, the pen is inserted more than 3/8 inch into the hole. The nut is almost 5/8 inch thick.

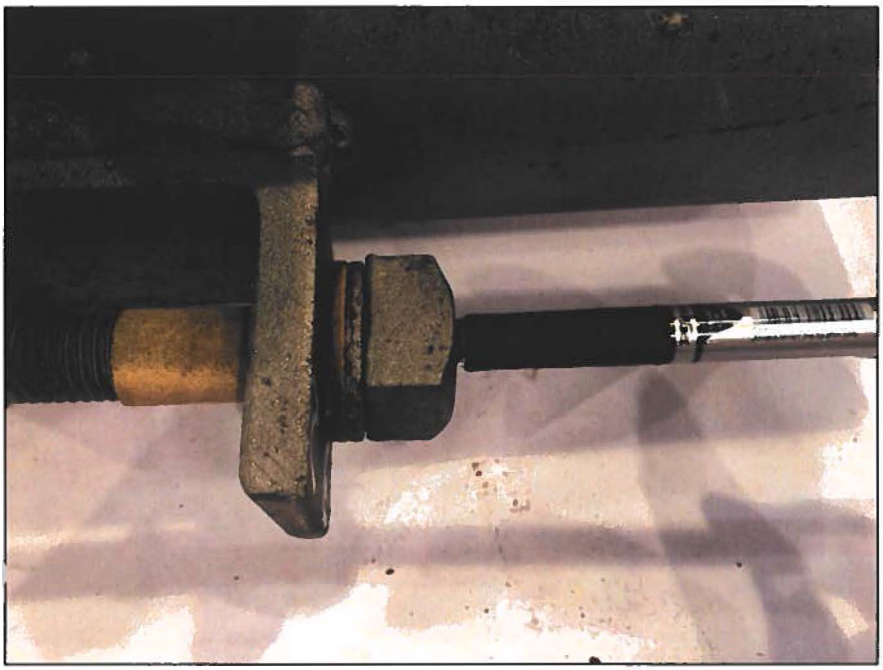


Figure 7- Depth of pen in nut

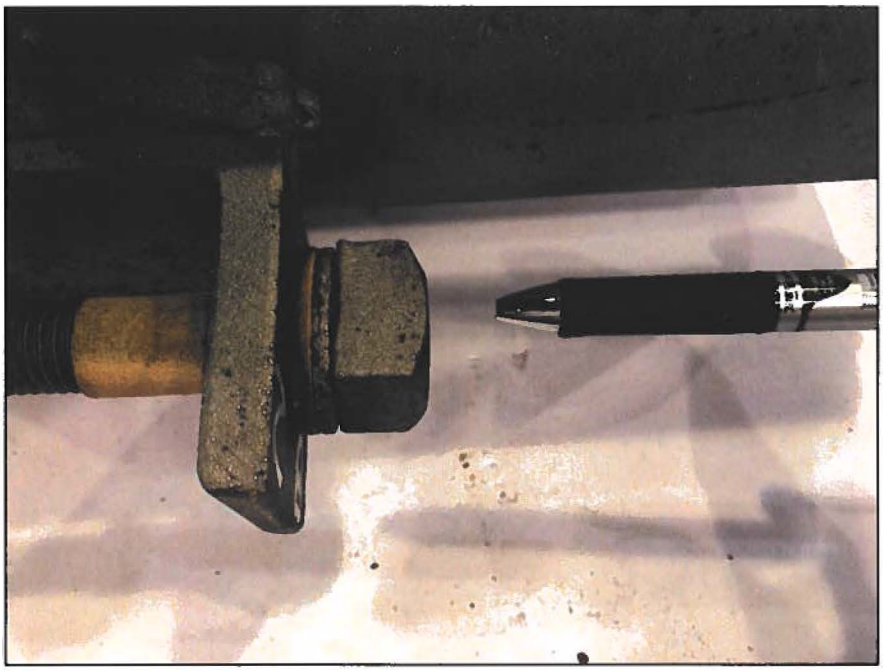


Figure 8- View of pen outside of nut

IMR TEST LABS
A Curtiss-Wright Business Unit
ww.imrlouisville.com

4510 Robards Lane
Louisville, KY 40218
T: 1.502.810.9007 | F: 1.502.810.0380

LG&E - Kentucky Utilities
6900 Enterprise Drive
Louisville, KY 40214

October 30, 2019

Attention: Chad Augustine

Report No. 201902215

Metallurgical Evaluation of an 6" Coupling and Associated Hardware

Location: 235 Abraham Flexner Way

DESCRIPTION AND PURPOSE

A natural gas pipe section including a coupling was submitted for metallurgical evaluation. The section was a 6" pipe with a Dresser Style 39 Insulating Coupling. Three joint harnesses were also affixed to the pipe section. Copies of the installation information for the coupling and harnesses were provided for this investigation. It was reported that the coupling had been installed in the field at 235 Abraham Flexner Way on April 2, 1958. The pipe section was subsequently excavated after substantial service duration without failure. It was requested that the general dimensions, weld quality, corrosion condition and mechanical properties of the coupling components be determined as directed.

RESULTS

The submitted pipe section with the coupling is shown in Figures 1 through 4. Three lugs of the joint harnesses had been fillet welded to both pipe segments. Three rods and associated nuts had been affixed through the welded lugs to apply compression to the coupled joint. The coupling consisted of a steel coupling with an interior nonmetallic gasket / sleeve. Prior to receipt, the ends of the pipe segment were labelled as Ends A and B, as shown in Figures 1 through 4. The top and bottom of the coupling section were also marked. Lugs A2, A4 and A6 were welded to Pipe A, and Lugs B2, B4 and B6 were welded to Pipe B. The rod between Lugs A2 and B2 was identified as Rod 2. The remaining lugs were identified in a corresponding fashion.

Atypical for the couplings, three of the coupling holes accommodated the rods with standard bolts through the remaining three coupling holes. Many secondary welds without lugs were evident.

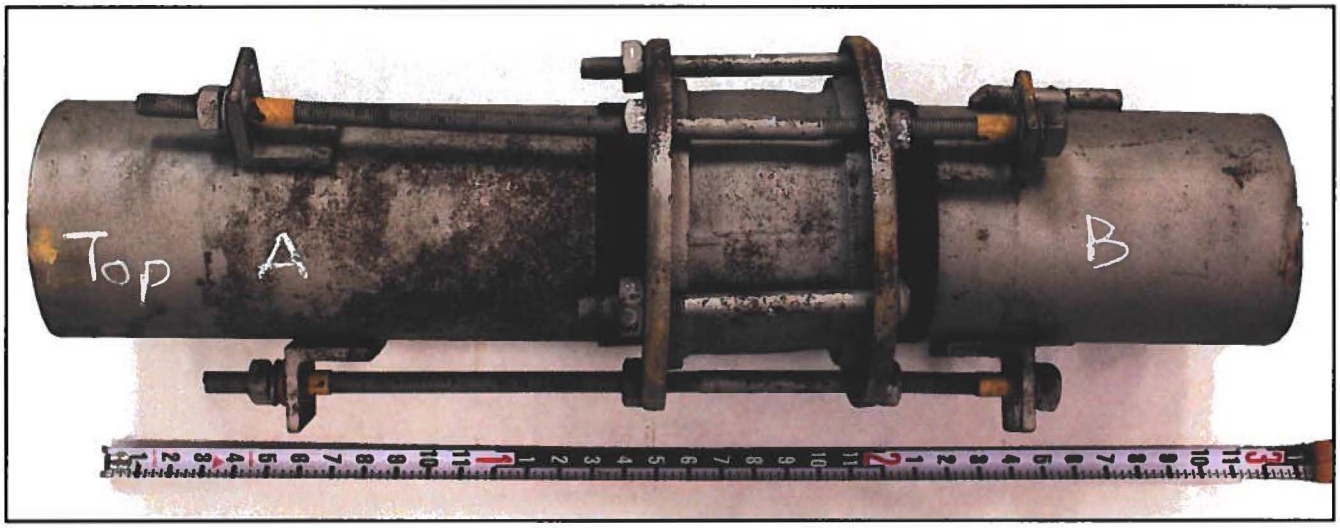


Figure 1. Photograph of the top of the submitted coupling sample.

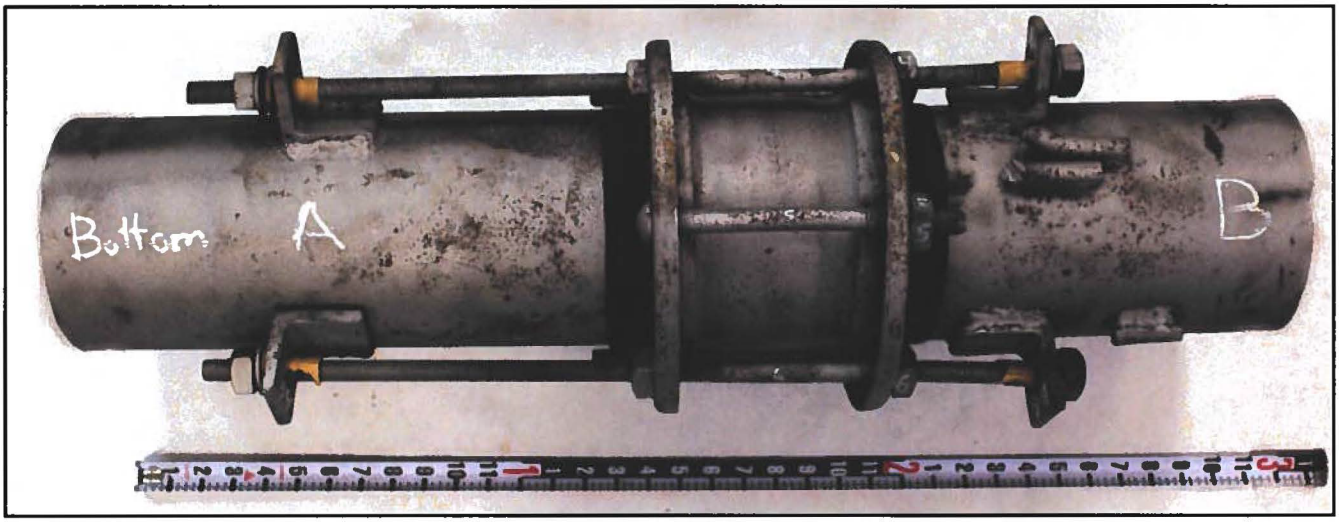


Figure 2. Photograph of the bottom of the submitted sample.

SECTION 1- DIMENSIONAL MEASUREMENT

The three sets of harness lugs were positioned around the pipe. The relative orientations of the harness lugs were measured by photographing the assembly from the ends and applying a protractor overlay for angle measurement. The obtained measurements are shown in Figures 3 and 4 with the data summarized in Table 1. The depth of insertion of the pipe segments into the coupling was also measured and the dimensions are provided in Table 2. No requirements were provided for these characteristics.

TABLE 1 – LUG SPACING DIMENSIONAL MEASUREMENTS

Component	Angle	Deviation from 120°	Image
Rod A2 / Rod A4	133°	13°	Figure 3
Rod A2 / Rod A6	118°	2°	Figure 3
Rod B4 / Rod B6	130°	10°	Figure 4
Rod B4 / Rod B2	118°	2°	Figure 4

TABLE 2 – PIPE COUPLING DIMENSIONAL MEASUREMENTS

Component	Depth of Pipe into Coupling	Gap Between Pipes in Coupling
Pipe A	4"	1/2" (Original sample length – 35.5")
Pipe B	4"	

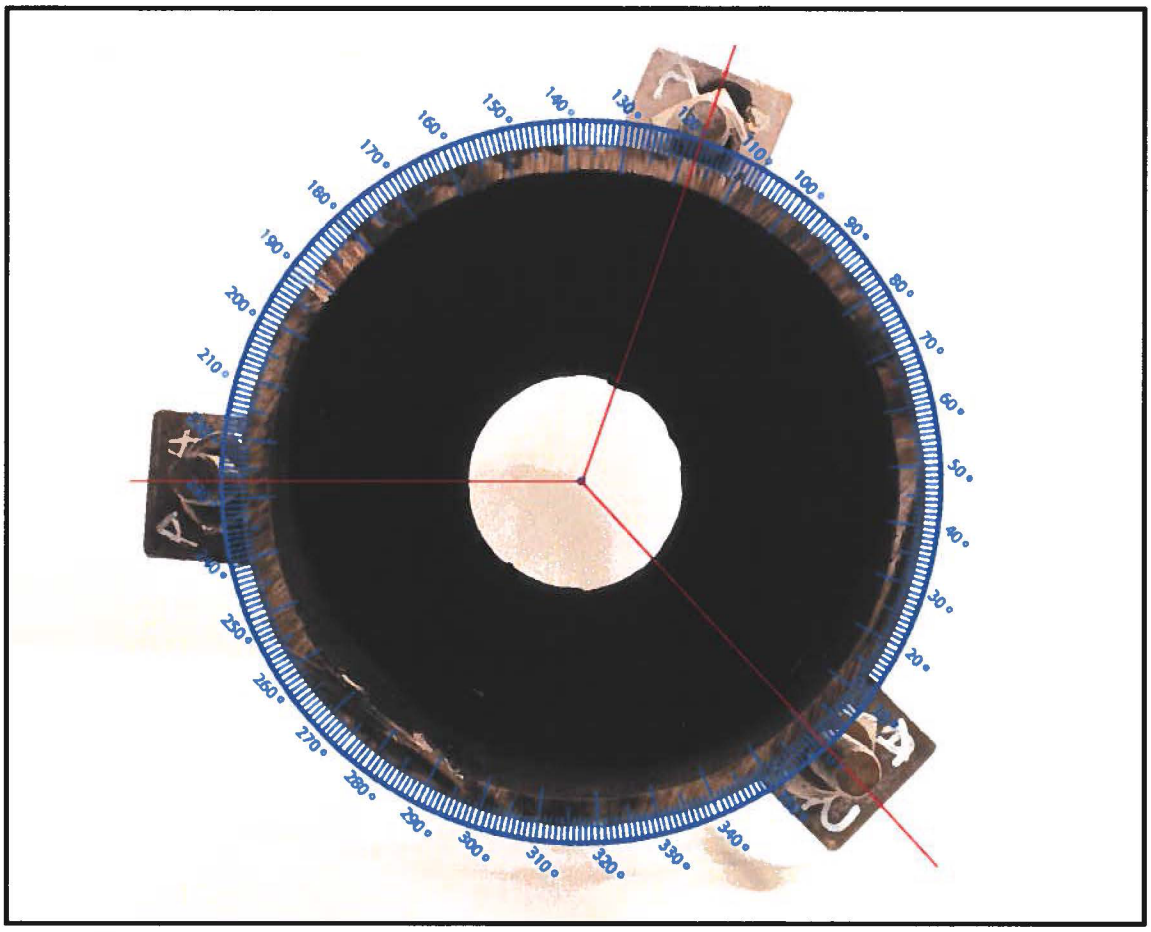


Figure 3. End facing image of the sample at End A with a superimposed protractor.

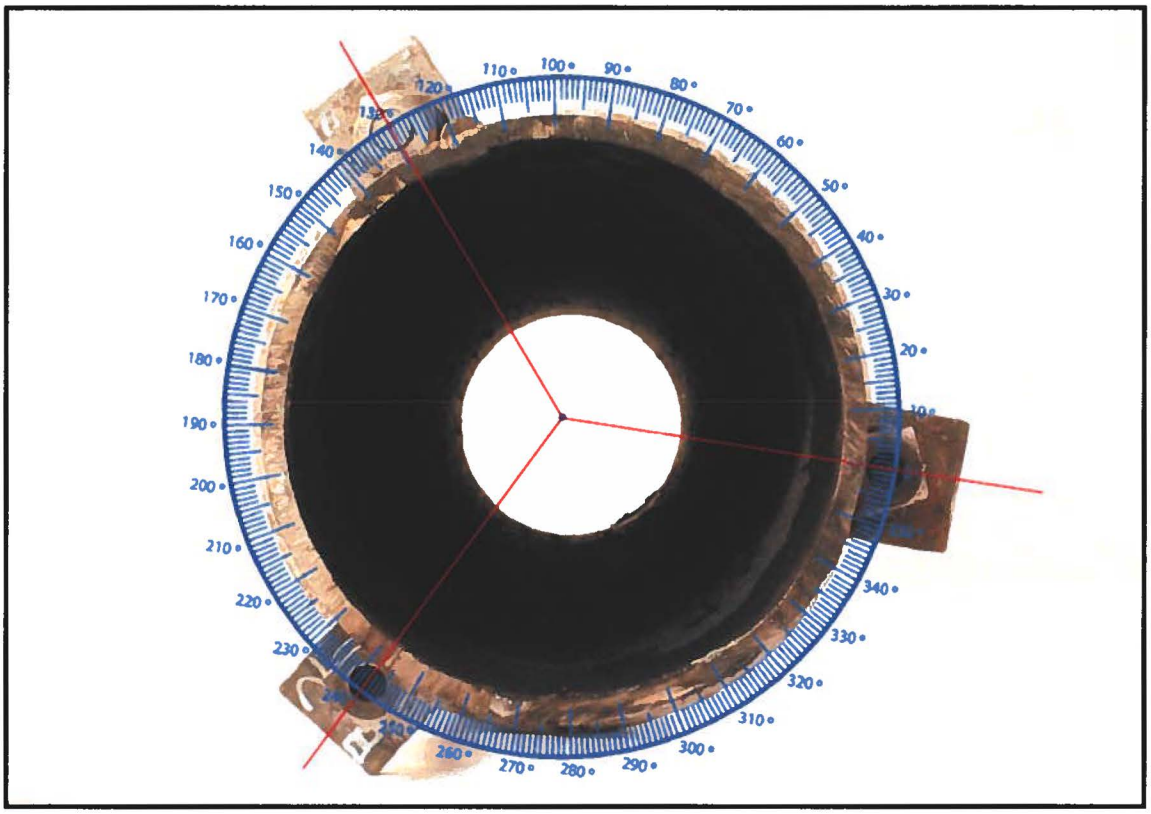


Figure 4. End facing image of the sample at End B with a superimposed protractor.

SECTION 2- VISUAL OBSERVATIONS

The lug attachment welds were regions of interest on the pipe coupling sample. Each lug contained two fillet weld locations; exterior top and exterior bottom. Each weld that was present was inspected visually using a flashlight and magnifying lens. It was indicated that welding was performed in accordance with API 1104. General weld inspection was performed initially, followed by visual inspection by an outside NDE company. For comparison purposes, the welds were rated as substantial fusion, partial fusion, and minimal fusion. The summarized weld fusion and corrosion observations are provided in Table 3. Representative weld regions are shown in Figures 5 through 14. The welds contained localized weld discontinuities including undercut, overlap, porosity, arc burn and spatter. No cracking in the welds or base metal heat affected zones (HAZ) was visually identified. Some superficial corrosion of the coupling and associated hardware was observed, but no significant material loss had occurred.

The coupling and harness rods were also inspected for corrosion alteration. No significant corrosion was identified. The observations for the rods and bolts are provided in Table 4. No corrosion cracking was evident. The rods were not necked down or stretched.

The elastomeric components of the coupling consisted of a pipe separator, insulating sleeve, and two gaskets. Inspection revealed that they appeared to be intact and not degraded.

TABLE 3 – LUG WELD VISUAL EXAMINATION RESULTS

Component	Location	Weld	Observations
Lug A2	Exterior	Top	No Weld
		Bottom	Substantial fusion
Lug A4	Exterior	Top	No Weld
		Bottom	Substantial fusion
Lug A6	Exterior	Top	Substantial fusion
		Bottom	No Weld
Lug B2	Exterior	Top	No Weld
		Bottom	Substantial fusion
Lug B4	Exterior	Top	No Weld
		Bottom	Substantial fusion
Lug B6	Exterior	Top	Substantial fusion
		Bottom	Substantial fusion

TABLE 4 – FASTENER VISUAL EXAMINATION RESULTS

Component	Observations
Rod 2	Not bent or stretched, no substantial corrosion pitting
Rod 4	Not bent or stretched, no substantial corrosion pitting
Rod 6	Not bent or stretched, no substantial corrosion pitting
Bolt 1	Not bent or stretched, no substantial corrosion pitting
Bolt 3	Not bent or stretched, no substantial corrosion pitting
Bolt 5	Bent but not stretched, no substantial corrosion pitting

Figure 5. Image of the Lug A4 exterior bottom weld which exhibited substantial fusion except for some arc burn, porosity and spatter.

Figure 6. Image of the Lug A4 exterior top weld which exhibited no fusion.

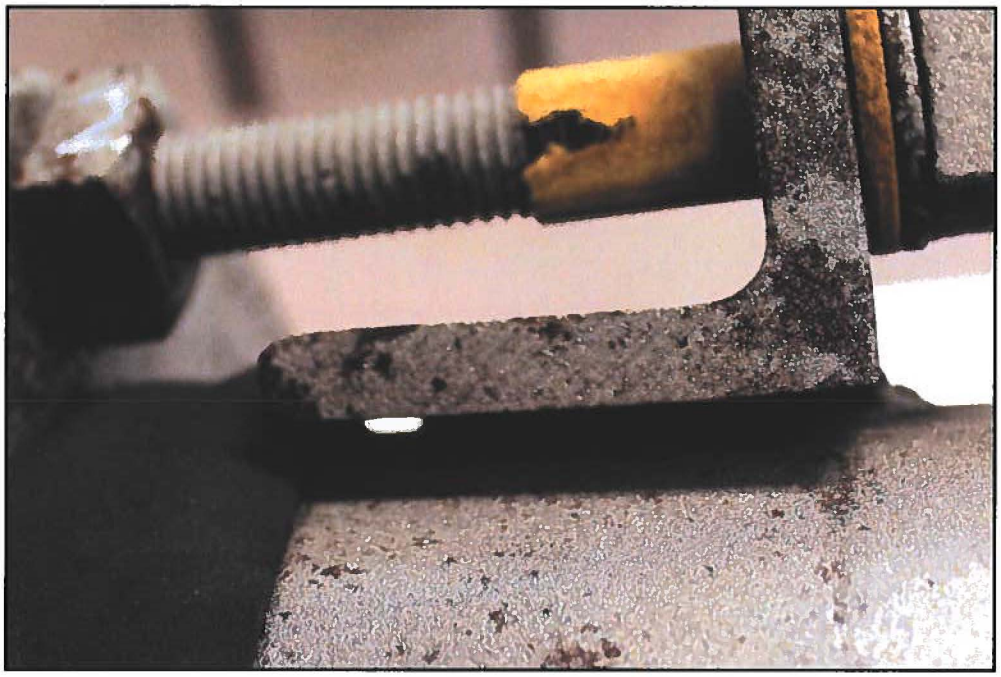


Figure 7. Image of the Lug B2 exterior top weld which exhibited no fusion.

Figure 8. Image of the Lug B2 exterior bottom weld which exhibited substantial fusion except for some arc burn, spatter, porosity and undercut.

Figure 9. Image of the Lug B6 exterior top weld which exhibited substantial fusion except for some arc burn, porosity, spatter and undercut.

Figure 10. Image of the Lug B6 exterior bottom weld which exhibited substantial fusion except for some arc burn, porosity, spatter and undercut.

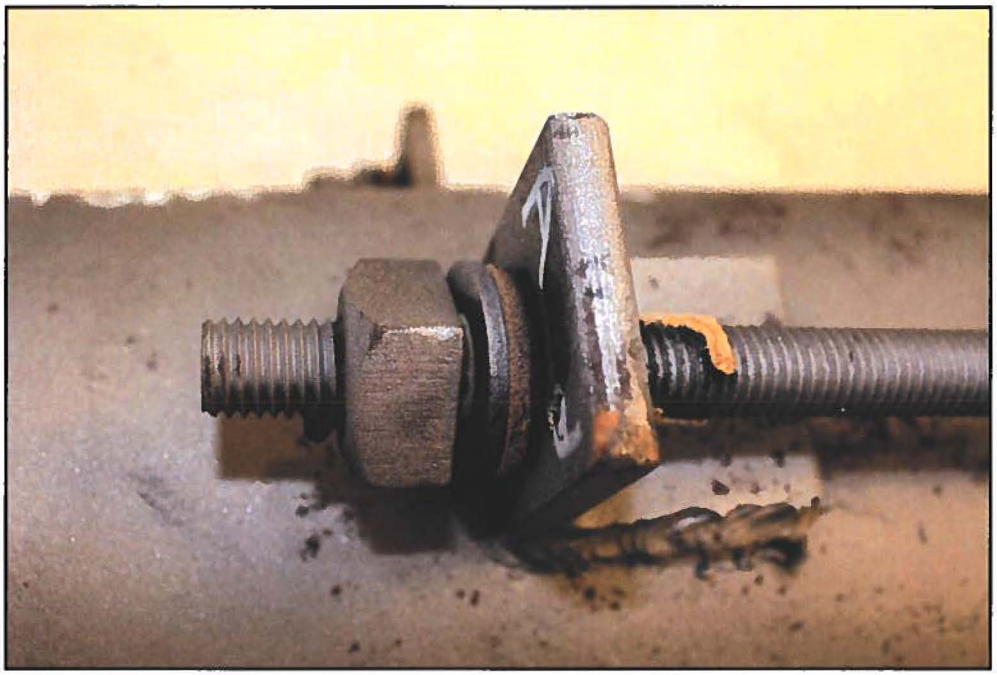


Figure 11. Image of the Lug A6 fastener assembly which was loose.

Figure 12. Image of the remainders of additional rods, which had been welded then cut off, present on Side B of the assembly.

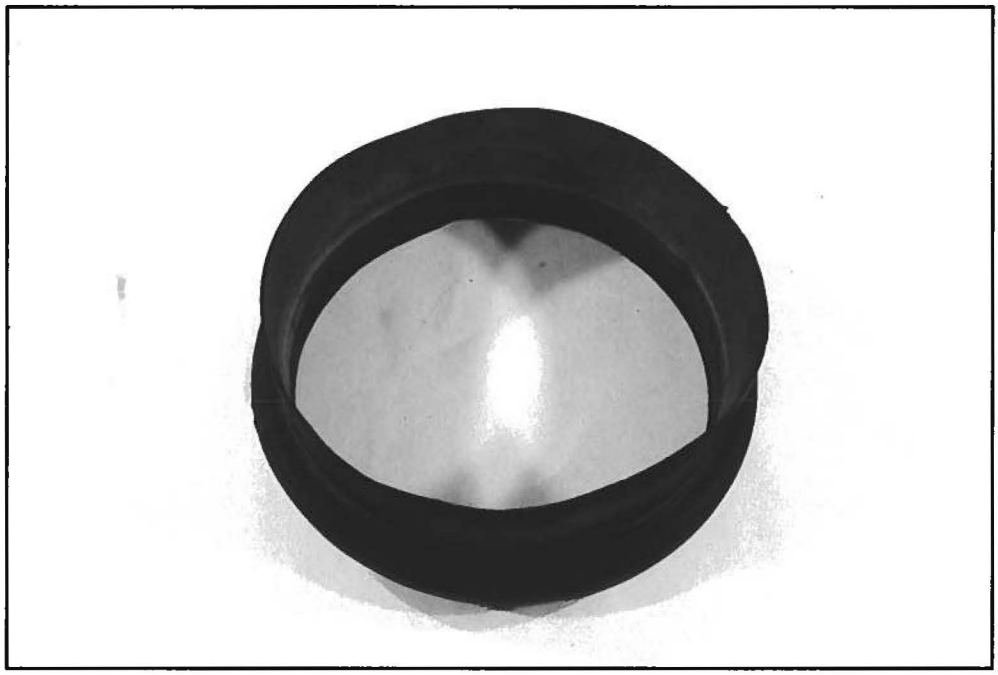


Figure 13. Image of the Side A gasket which was mostly intact and separated entirely from its housing upon disassembly of the coupling.

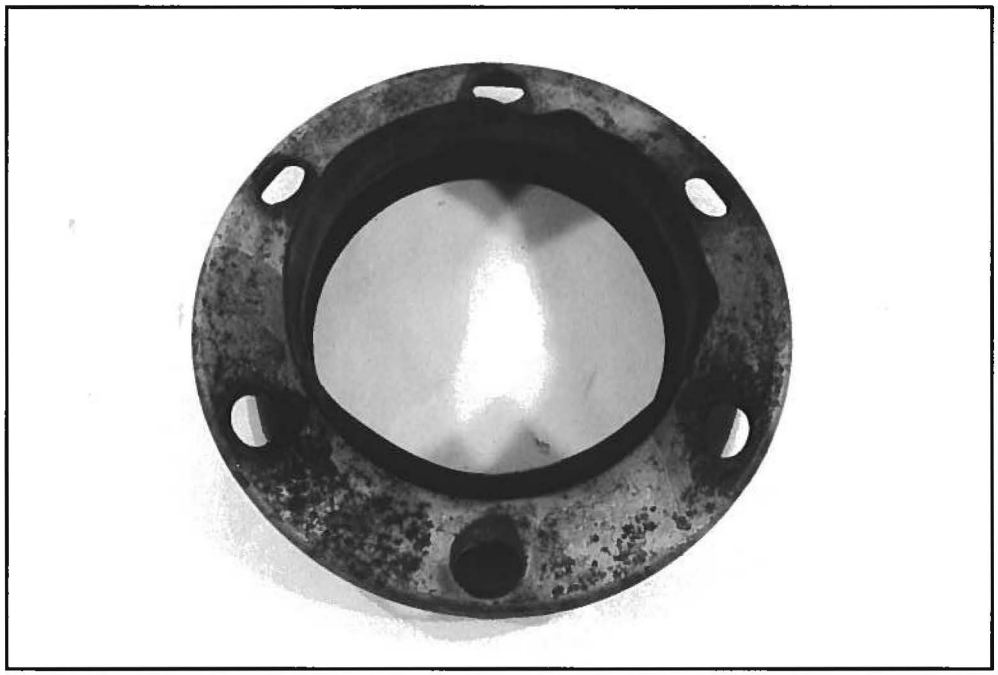


Figure 14. Image of Side B gasket which was mostly intact but remained attached to its housing.

SECTION 3- TORQUE TESTING- FOR INFORMATION ONLY

Torque testing was performed on the nuts of the rods and bolts on the pipe coupling sample. A calibrated torque wrench was used to determine breakaway torque on each fastener. The breakaway torque measurements are summarized in Table 5. Rod fasteners did not have a specified torque requirement. The designation "Inner" signifies the rod nut at the coupling face. The six coupling bolts exhibited torque values ranging from 30 to 100 ft.-lbs. Bolt 1 and Rod 6 Inner torque values were below the Dresser Style 38 coupling installation torque recommendation of 75 ft.-lbs. minimum for 5/8" fasteners.

TABLE 5 – FASTENER TORQUE MEASUREMENT

Component	Breakaway Torque	Observations
Rod 2 Inner	100 ft.-lbs.	Satisfied the recommended torque
Rod 2 Outer	70 ft.-lbs.	Did not satisfy the recommended torque
Rod 4 Inner	80 ft.-lbs.	Satisfied the recommended torque
Rod 4 Outer	40 ft.-lbs.	Did not satisfy the recommended torque
Rod 6 Inner	30 ft.-lbs.	Did not satisfy the recommended torque
Rod 6 Outer	30 ft.-lbs.	Did not satisfy the recommended torque
Bolt 1	40 ft.-lbs.	Did not satisfy the recommended torque
Bolt 3	100 ft.-lbs.	Satisfied the recommended torque
Bolt 5	100 ft.-lbs.	Satisfied the recommended torque

SECTION 4- TENSILE TESTING, ASTM A370-17A

Tensile testing was performed on round specimens that were removed from the three harness rods and the three coupling bolts. The tensile mechanical properties of the fasteners were measured and the results are summarized in Table 6. No mechanical property requirements were provided for the fasteners.

TABLE 6 – FASTENER TENSION TEST RESULTS

Component	Ultimate Tensile Strength, ksi	0.2% Offset Yield Strength, ksi	Elongation, %③	Reduction in Area, %
Rod 2①	145	127	21	63
Rod 4①	136	119	24	67
Rod 6②	127	106	21④	68
Bolt 1①	84.0	42.3	33	57
Bolt 3①	70.0	39.4	38	64
Bolt 5①	74.0	38.7	31	45

① Specimen Dimensions; Diameter 0.25" with gage length of 1.00"
② Specimen Dimensions; Diameter 0.24" with gage length of 0.96"
③ Percent elongation was measured using elongation-after-fracture measurements
④ Specimen fractured outside the middle half of the marked gauge

SECTION 5- ROCKWELL HARDNESS, ASTM E18-17

Small sections of the six lugs were excised for hardness testing. Rockwell hardness testing was performed on sectioned segments of the lugs after the removal of surface roughness by sanding. The obtained results are provided in Table 7 and are suggestive of a moderate strength level. No requirements were provided for comparison.

TABLE 7 – LUG HARDNESS TEST RESULTS – ROCKWELL B – HRBW

Results	Reading 1	Reading 2	Reading 3	Reading 4	Average
Lug A2	72	70	71	72	71
Lug A4	72	72	71	70	71
Lug A6	73	70	73	74	73
Lug B2	70	72	69	74	71
Lug B4	72	72	77	66	72
Lug B6	75	80	71	72	75

SECTION 6- NONDESTRUCTIVE EXAMINATION

The two separated ends of the disassembled coupling were sent to a third party NDE laboratory for inspection. Visual, magnetic particle and liquid dye penetrant inspection were performed on the lug attachment welds. Inspection was performed in accordance with the acceptance criteria of API 1104 "Welding of Pipelines and Related Facilities". The inspection results are provided as Appendix A and Appendix B. Two representative welds are shown in Figures 15 and 16 with the dye penetrant test media remaining.

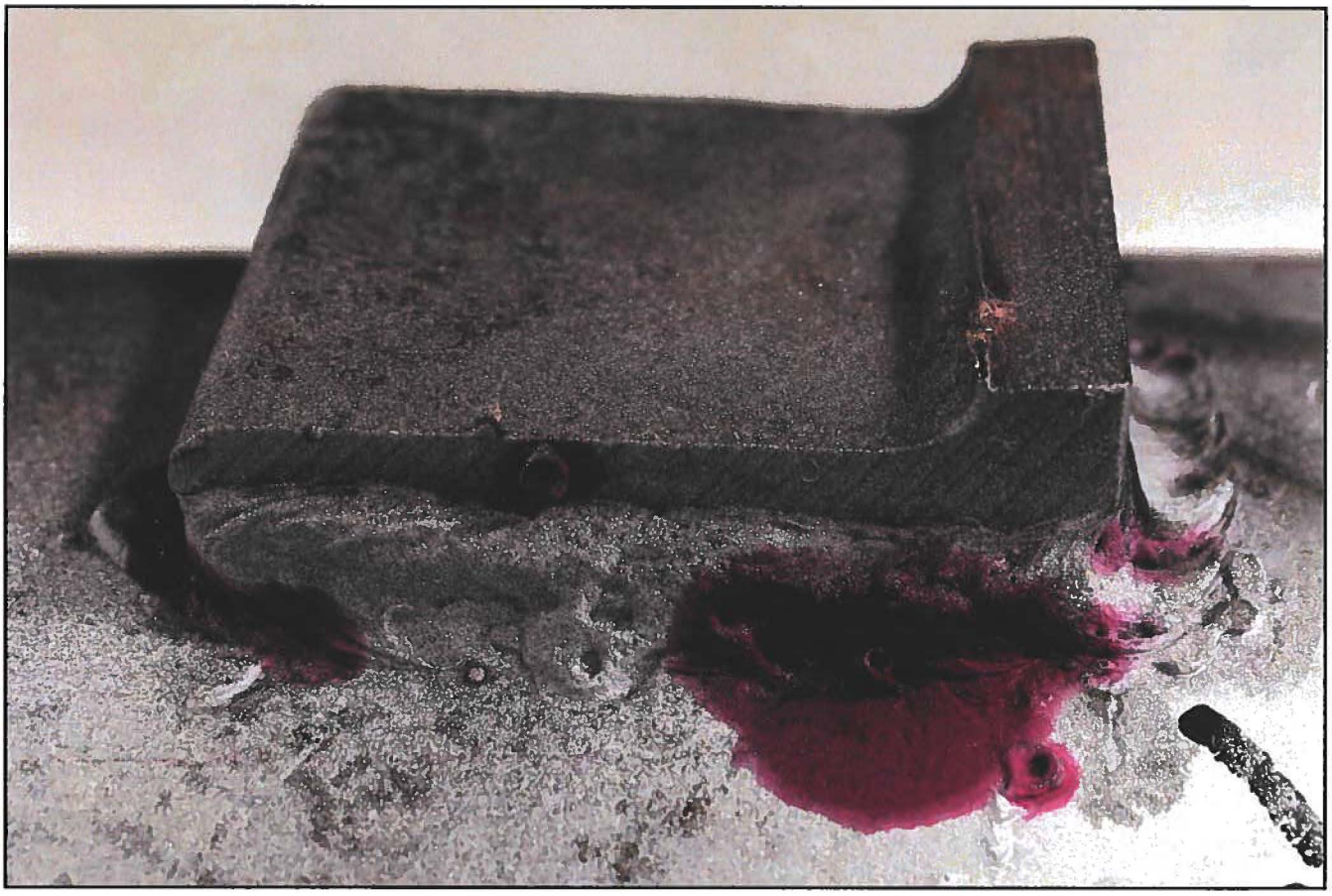


Figure 15. Image of the Lug A2 exterior top welds after dye penetrant media had been used during inspection.

Figure 16. Image of the Lug B2 exterior top welds after dye penetrant media had been used during inspection.

Respectfully submitted

Brian Kelly
Failure Analyst

Concurrence

Brett A. Miller, P.E. FASM
Technical Director

APPENDIX A – MAGNETIC PARTICLE INSPECTION RECORD

HAYES TESTING LABORATORY, INC.
Phone 502-266-9729
2521 Holloway Rd.
Louisville, Kentucky 40299

MAGNETIC PARTICLE INSPECTION REPORT

Customer Name: IMR Date of Work: 10/26/19

Purchase Order #: 6014FA Job #: 201902215

1. Identification:
Item(s) Inspected A1-3 / B1-8 Description 6" coupling

Location of Item: HTL Part No. _____

2. Technique - [✓] Dry Powder [] Wet Fluorescent [] Non-Fluorescent

3. Equipment - []Coil []Prods [✓] Yoke []Clamps 4. Current Type []AC [✓] DC

5. AMP Turns

6. Inspection Procedure HTL-MT

7. Inspection Specifications API 1104

8. Type of Indication Found:

1.Crack 2.Linear Surface 3.Linear Subsurface 4.Undercut
5.Non- Relevant 6. NONE

RESULTS: See below

9. Sketch/Description

A1 - CRACK, LOF, Porosity
A2 - CRACK, LOF
A3 - LOF, Porosity

B1 - LOF
B2 - OK
B3 - LOF
B4 - LOF, Porosity
B5 - LOF
B6 - LOF, Porosity
B7 - LOF, Cluster porosity
B8 - LOF, Porosity

10. Inspection Performed by Hayes Testing Laboratory, Inc. personnel:

Signature _____
Level II Technician

APPENDIX B – PENETRANT INSPECTION RECORD

HAYES TESTING LABORATORY, INC.
Phone 502-266-9729
2521 Holloway Rd.
Louisville, Kentucky 40299

NDE PENETRANT REPORT

Client: IMR
Project: 20190221S / 6004FA
Item Description: 6" Coupling
Part No: A1-3 B1-8
Drawing No:
Spec. 1104
Acceptance Class API
Procedure HTL-PT

WELD		OTHER TEST ITEMS	
Weld Joint		Material	
Weld Process		Processing	
Base Material	N/A	Material	N/A
Material Thickness		Dimensions	
Weld Length/OD		Additional Info	
Surface Condition		Surface Condition	

PRECLEAN: Method Wipe — Material SKC-S Aerosol
Batch No. 19G08K — Drying Time 10 Min.

PENETRANT: Material SKL-WP2 — Batch No. 17H13K
Application Brush — Dwell Time 20 MIN

EMULSIFICATION: Material N/A — Batch No. N/A
Application N/A — Emulsification Time

EXCESS PENETRANT REMOVAL: Material SKC-S — Batch No. 19G08K
Method Wipe — Drying Time 10 Min

DEVELOPER: Material SKD-S2 — Batch No. 14F04K
Method Spray — Drying Time 10 Min — Developing Time 10 Min.

POSTCLEAN: Material SKC-S Aerosol — Batch No. 19G08K
Method Wipe / Spray

No. of Parts Accepted 1 — Serial No.'s
No. of Parts Rejected 10 — Serial No.'s

OTHER INFORMATION:

A1- CRACK, LOF, Porosity
A2- CRACK, LOF
A3- LOF

B1- LOF
B2- OK
B3- LOF
B4- LOF

B5- LOF
B6- LOF, Porosity
B7- LOF, Porosity
B8- LOF

INSPECTED BY: JH II — DATE: 10/26/19

Tracking #: YYYY-###
(Assigned by DIMP group)

Checklist for Exposed Bolt-Style Coupling (pressures > 3 psig)

This form will be completed when LG&E or LG&E contractors expose a bolt-style coupling in a system where the pressure is > 3 psig (medium and high pressure distribution and transmission) and the coupling will be backfilled. The purpose of the form is to provide Operations, Engineering and Gas Regulatory personnel with information about the bolt style coupling installation.

Precautions:

1. Stop excavation upon discovering the bolt-style coupling in the excavation
2. Set-up a perimeter around the excavation to keep the public away from the excavation

General Information:

Called gas trouble and spoke with Brittany @ 1:45 pm

1. Contact Employee for the bolt style coupling found: Roger Groves
2. Date of exposure: 6-12-19
3. Location: 830 South 13TH ST
4. Size of coupling (based on pipe size if not exposed enough to determine): 4"
5. Type of soil (circle one): (Sandy) Clay Gravel Topsoil Other (take picture and describe)

Pictures:

1. Take at least two pictures of the coupling. The pictures should be from different angles (additional pictures can be taken).
2. Email pictures to supervisor. Ensure pictures are attached to this form:

Sketch: Provide a sketch on the backside of the form showing the coupling orientation (vertical/horizontal), nearby branches, pipe, valves and fittings, other utilities or structures, etc.

Leak Survey:

1. Use an instrument designed to detect natural gas to check for the presence of natural gas after backfilling the excavation. Include readings in the above sketch in relation to the coupling. If the contact employee is not leak survey qualified they should contact:
   a. Their supervisor to call Gas Regulatory to complete the survey after the excavation is backfilled. Call [redacted].
   b. If Gas Regulatory is not available contact Gas Dispatch to have the survey assigned to a Gas Trouble Technician.

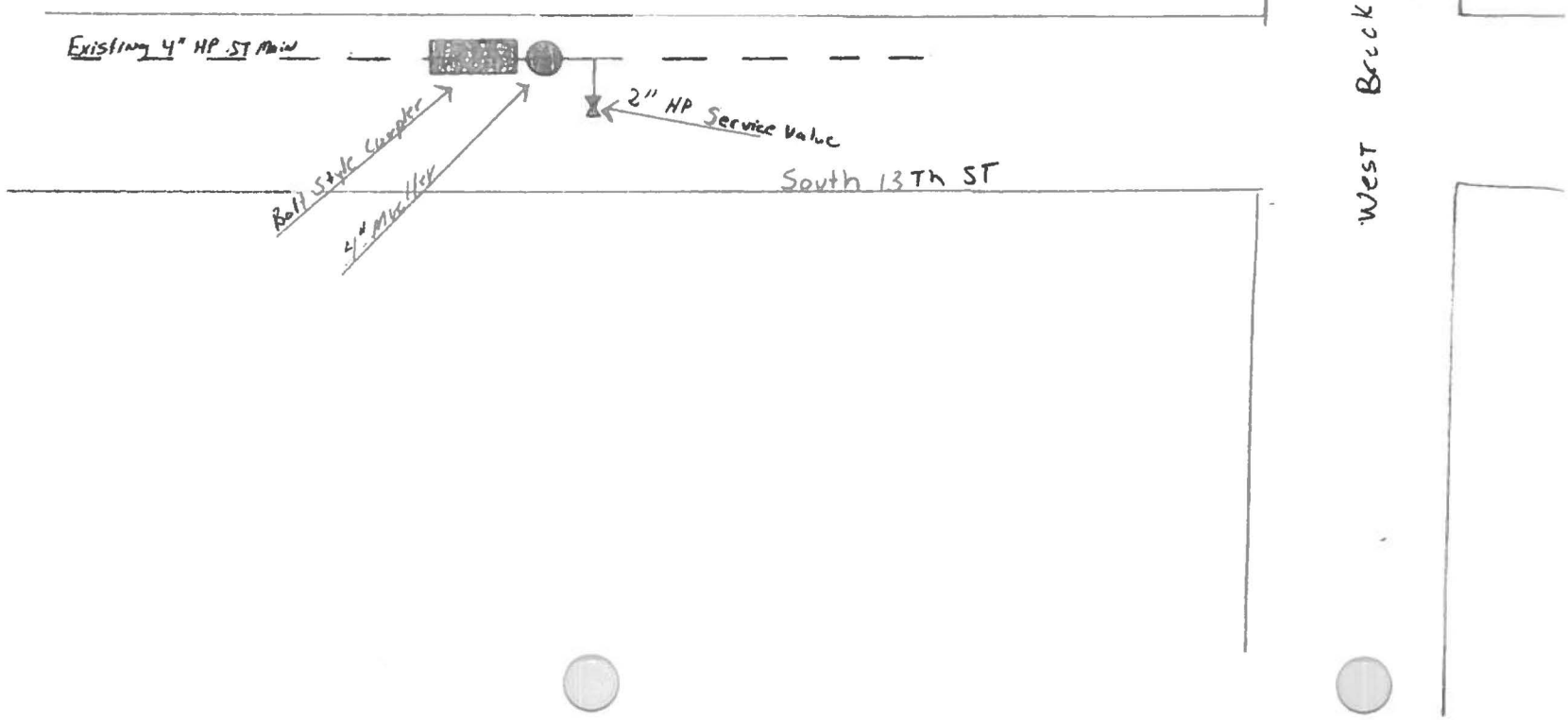
EJB 1/7/2020

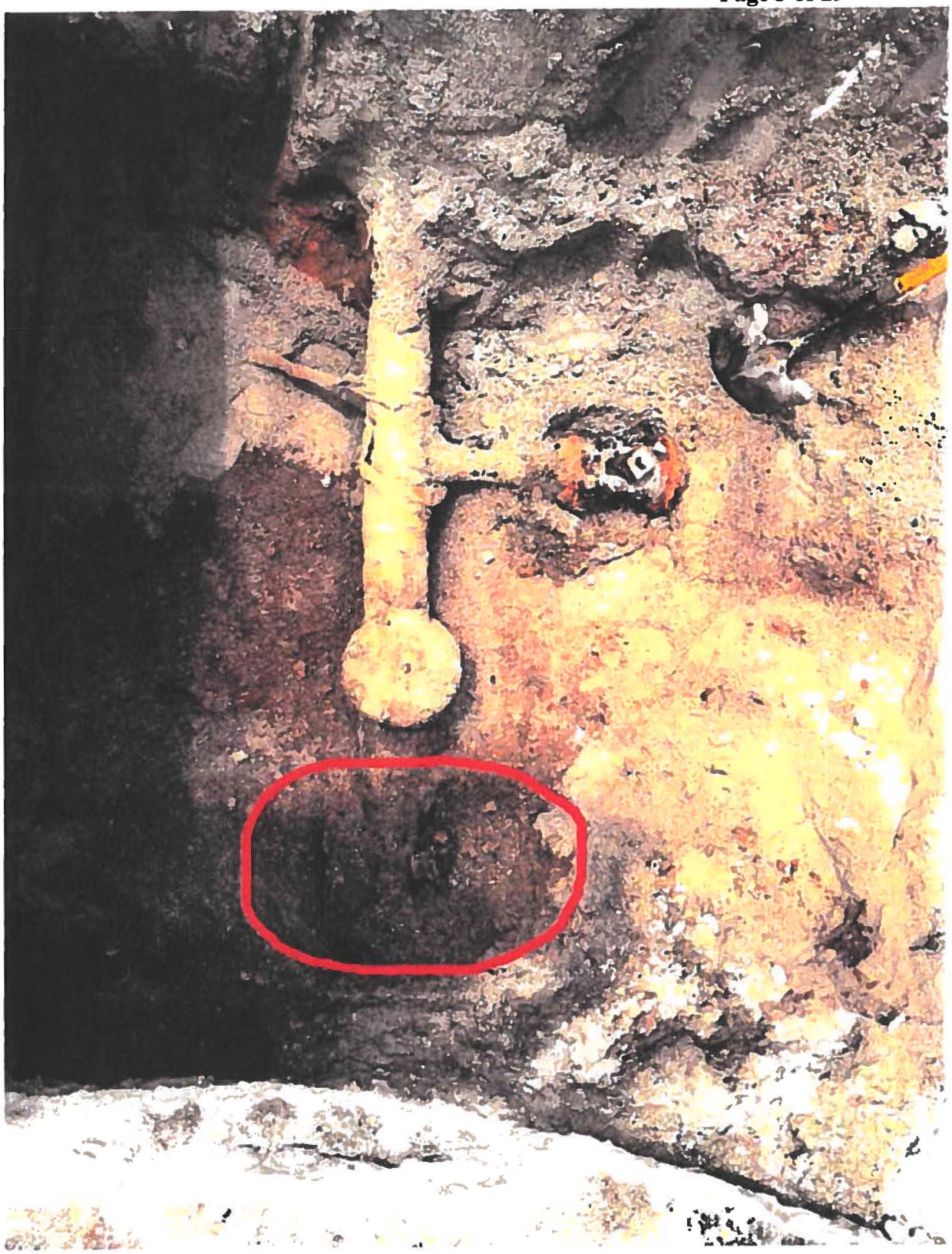
Leak Survey completed at time of backfill (circle one) (yes) no

Include completed form in the main report and email a scanned copy of the completed form (back and front) to the Distribution Integrity Management (DIM) group.

830 South
13TH ST.

4" Bolt coupler
458' N of CENT/L of West Brackenridge Street
15' E of CENT/L of South 13TH Street





Sent from my iPhone

Sent from my iPhone

Part B- Coupling Information

General Information			Tracking #: 2019-014
PO Number 1033457	Expense Org 4610	Project 158276	Task COUPLER
Address/Location 830 S. 13th St, Louisville, KY 40210 (Greyhound Bus)			
Size 4 inch	Material Steel	Coating Coal Tar	MAOP
Main/Service Number 245118	Soil Type (from Part A) Sandy	Manufacturer Dresser[1]	Model Style 38[1]
Pipe Connection:	Steel to Steel	Steel to Plastic	Plastic to Plastic

[1] No markings on the couplings. Appears to be a Dresser Style 38.

Historical Information	
Installation Date Unknown	Document Source No documentation of coupling
Installation Company Unknown	Document Source No documentation of coupling
Foreman Unknown	Document Source No documentation of coupling
Welder Unknown	Document Source No documentation of coupling

GIS Information
Sys Id (of Coupler) Not in GIS
Screen Capture

Pictures

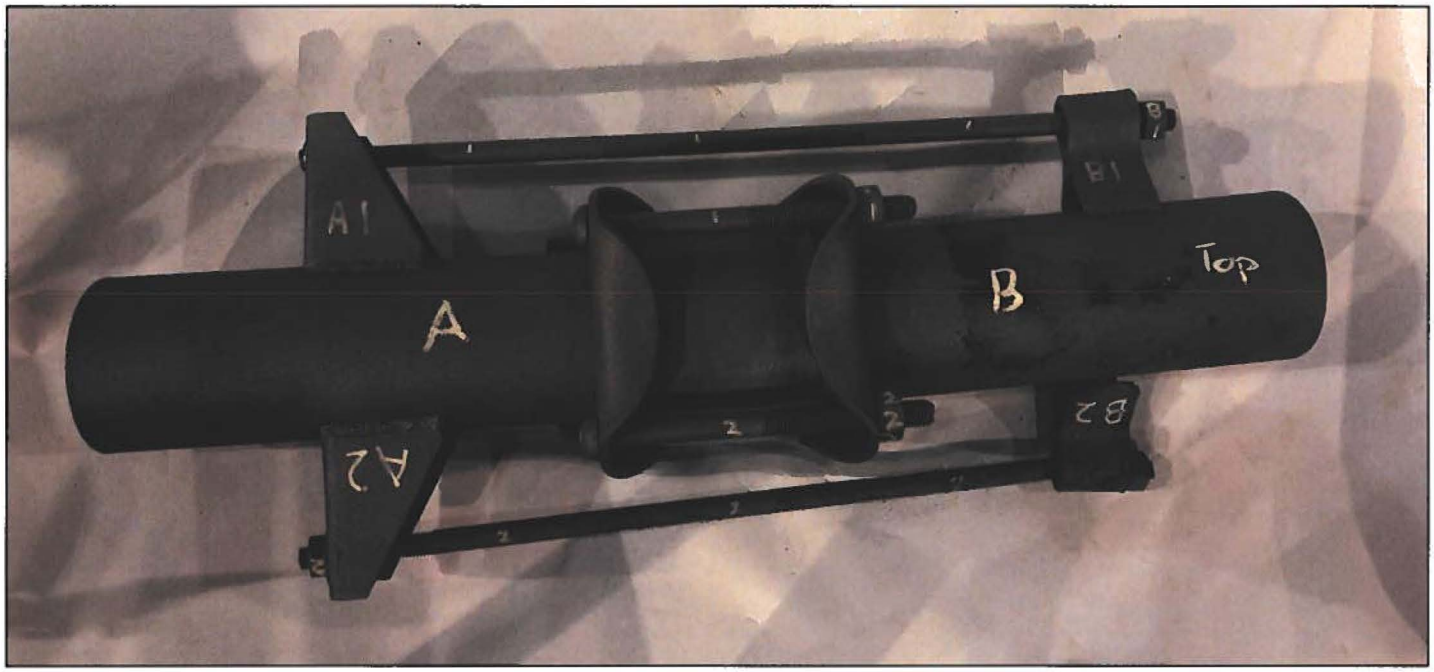


Figure 1- Top View

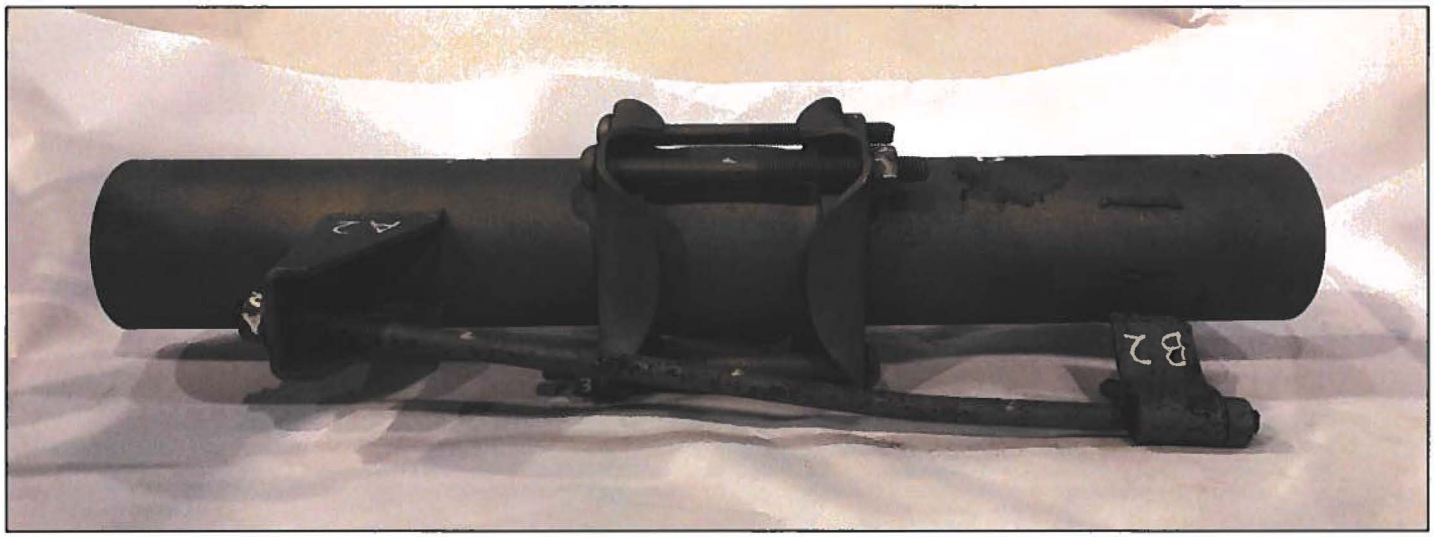


Figure 2- Front View

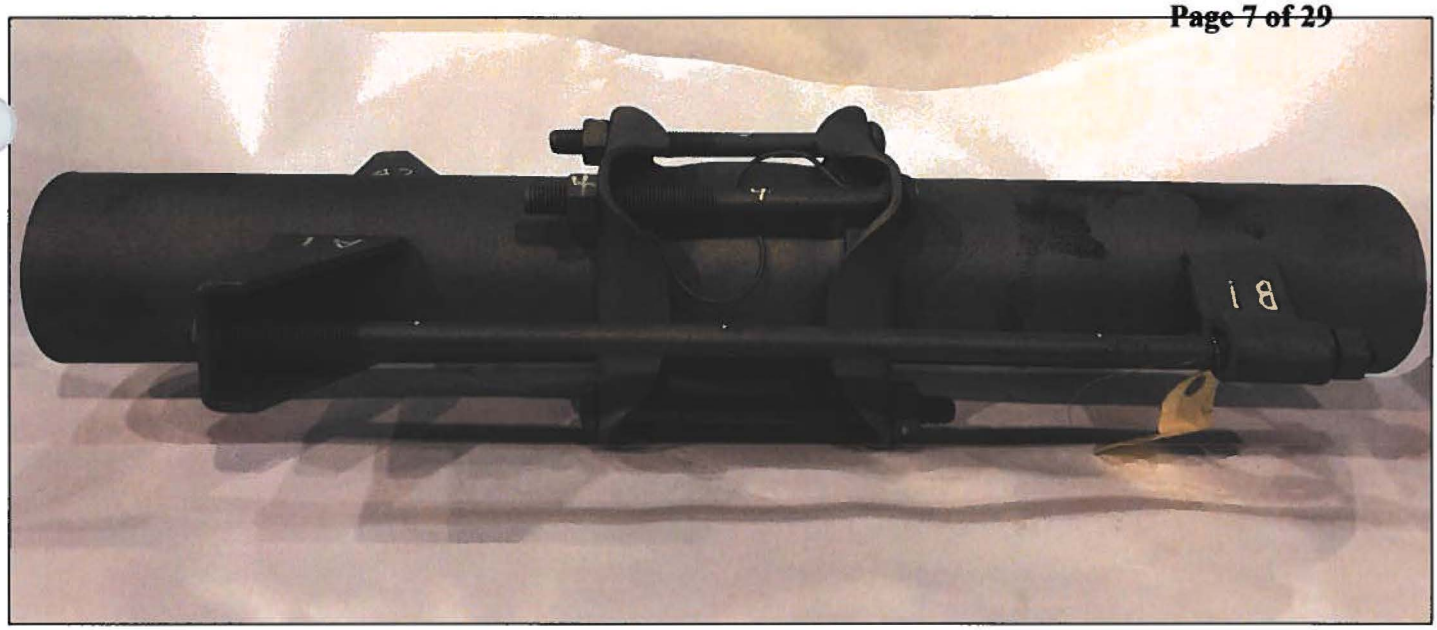


Figure 3- Back View

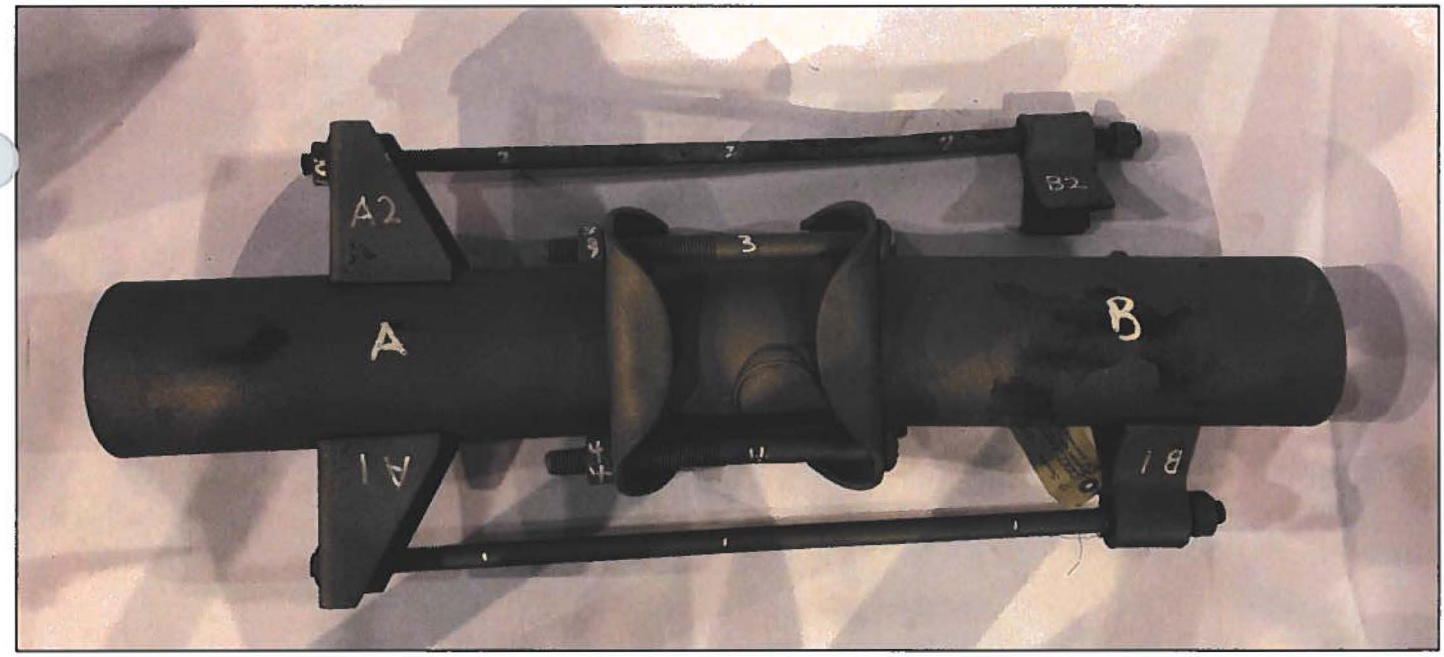


Figure 4- Bottom View

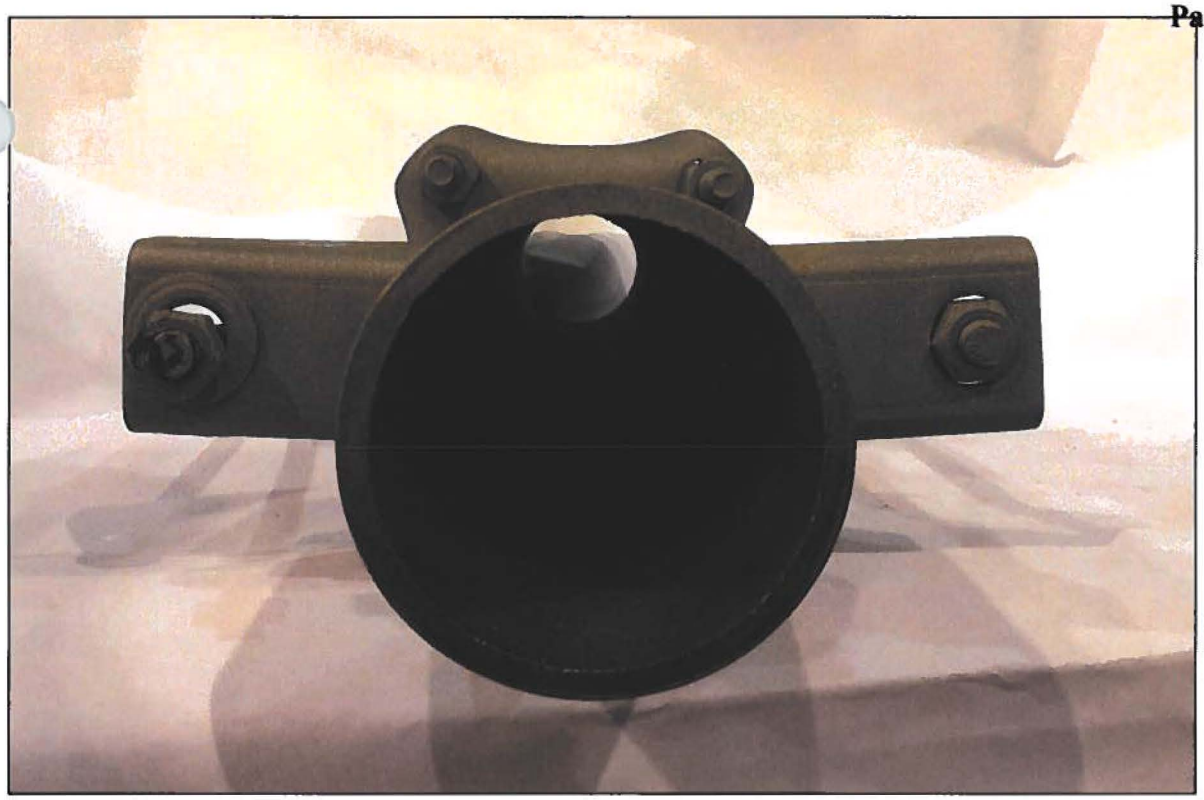


Figure 5- Left Side View

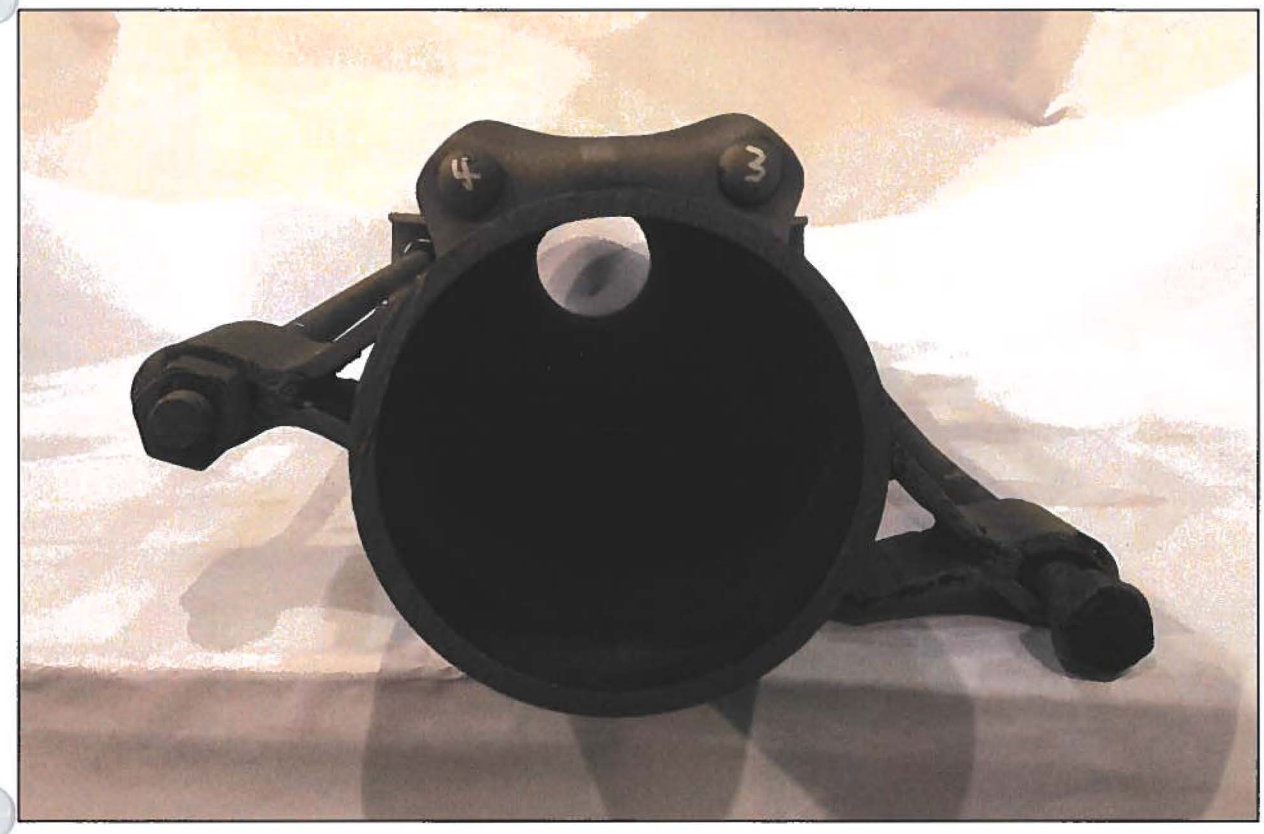


Figure 6- Right Side View

Part C- Visual Inspection of Coupling

Visual Inspection Performed by: C. Augustine ([redacted]) Date: 6/24/2019

Table 1- Component Quantities

Number of Bolts on Coupler Body	4
Number of Reinforcement Rods	2
Number of Lugs	4 (2 each rod)[2]

[2] Different types of lugs. See Section "Type of Lug" and Figures 1-6.

Table 2- Corrosion

	Pipe A	Pipe B	Coupler Body	Bolts	Rods	Lugs	Nuts
General External Corrosion Present?	No	No	No	Yes, bolt 3. Slight Corrosion	Yes, rod 2. Moderate Corrosion	Lug B2. Moderate Corrosion[3]	But B2. Moderate Corrosion
Localized Corrosion Present?	No	No	No	No	No	No	No
Pit Depths	Not Applicable	Not Applicable	Not Applicable	Pits too small for measurement	0.03"	Not able to measure with a handheld pit gage.	Not able to measure with a handheld pit gage.
Internal Corrosion?	No	No					

[3] Lug B1 has a wall loss but appears to be a damage rather than corrosion.

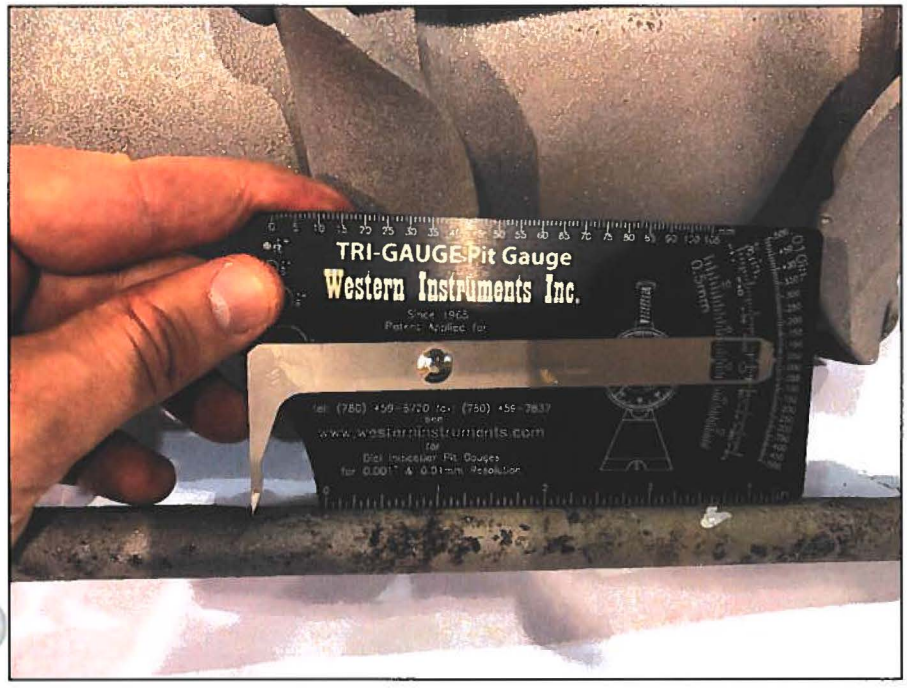


Figure 7- Corrosion, Rod 2

Figure 8- Corrosion, Lug B2

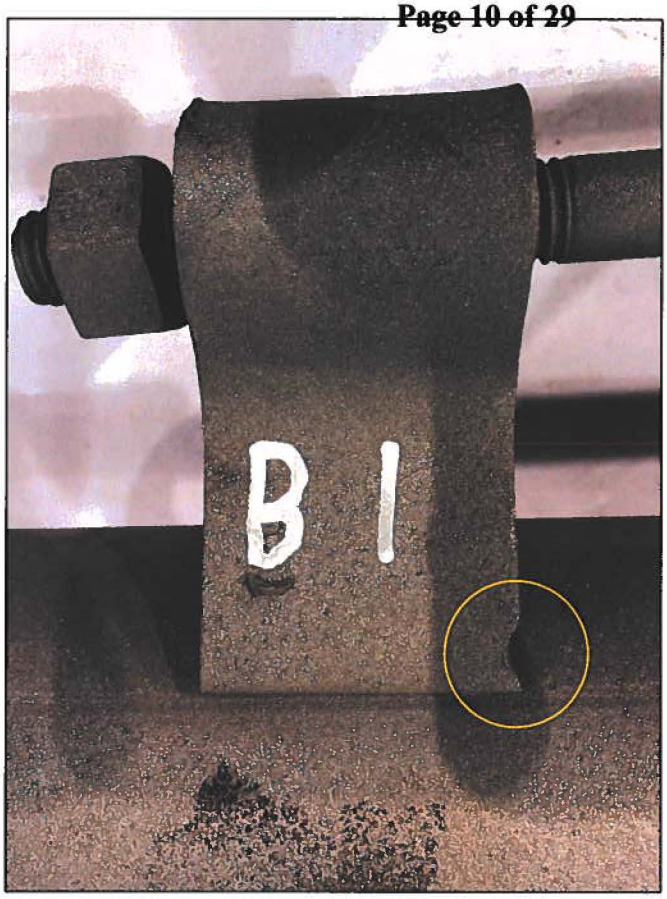


Figure 9- Damage, Lug B1

Table 3- Coupler Body

Bolt	Washer Present	Nut present?
1	No	Yes
2	No	Yes
3	No	Yes
4	No	Yes

Table 4- Reinforcement Rods

Rod	Length (in.)	Diameter (in.)	Washer present at head of bolt?	Washer present at end of bolt?	Nut Present? Type?	Type of rod?
1	24	0.6370	No[4]	No	Yes, hexagonal	Kit provided
2	24	0.6150	Yes, on lug A2	No	Yes, hexagonal	Kit provided

[4] The nut is jammed into the hole of the lug. See Additional Comments Section.

Figure 10- Jammed nut, exterior view

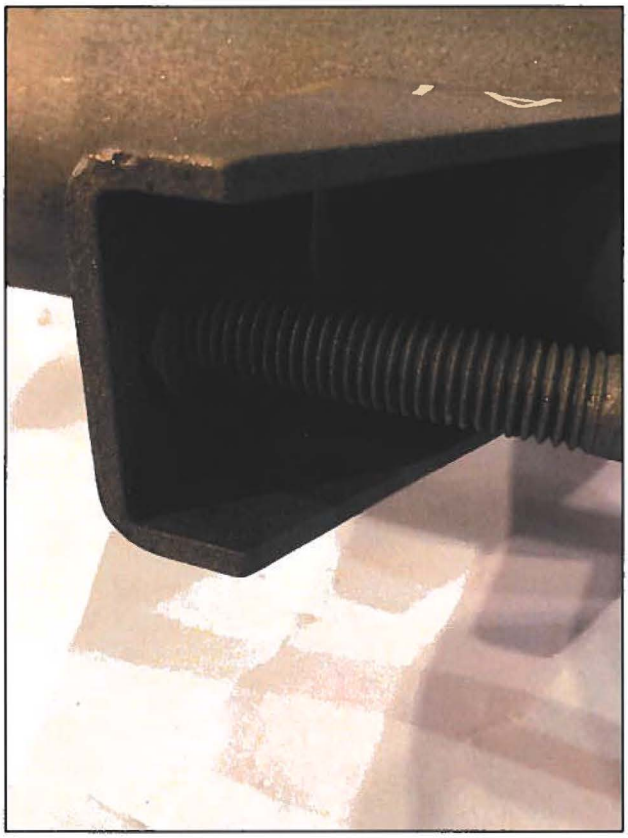


Figure 11- Jammed Nut, interior view

Type of Lug

(Please indicate the shape of the lug by circling one below. If the lug shape is different than any preset shape below, sketch the shape.)

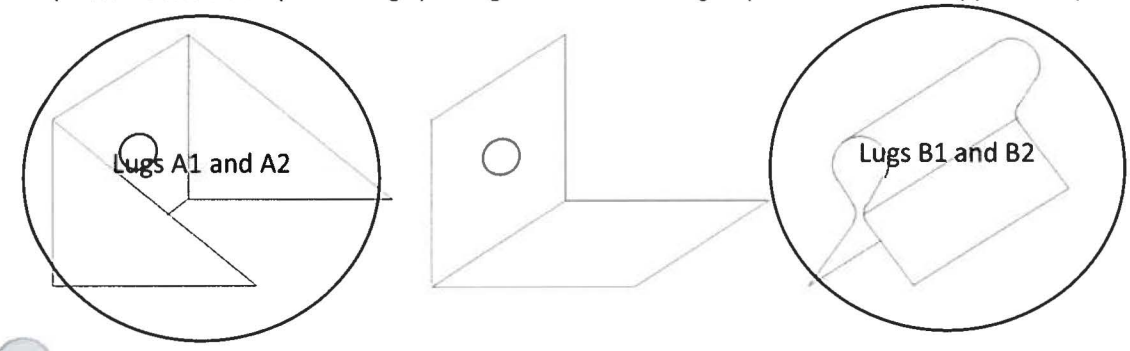


Table 5- Lugs (Measurements)

Pipe Side	Lug Number	Thickness (in.)	Circumference (in)	
			Distance to next lug, clockwise	Distance to next lug, counter-clockwise
A	1	0.2140	8.5	9.25
A	2	0.2330	9.25	8.5
B	1	0.2535	Not Applicable[5]	Not Applicable[5]
B	2	0.2405	Not Applicable[5]	Not Applicable[5]

[5] Lug B2 is broken off the pipe. Measurements cannot be taken.

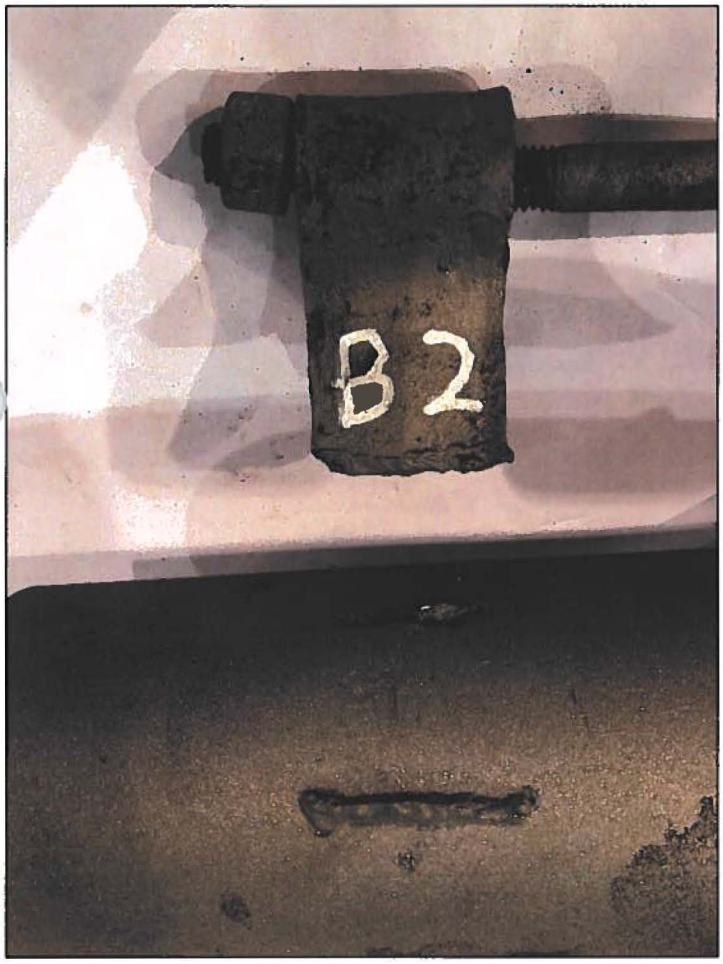


Figure 12- Detached lug, B2

Table 6- Lugs (Observations)

Lug	Lug	Assembly sets aligned?	Deformed?	Deflected? (angle of)
A1	B1	Yes[6]	No	No
A2	B2	Not Applicable[7]	Not Applicable[7]	Not Applicable[7]

[6] Lugs are different styles. The height from the pipe is different. See Additional Comments Section.

[7] Lug B2 is broken off the pipe. Measurements cannot be taken.

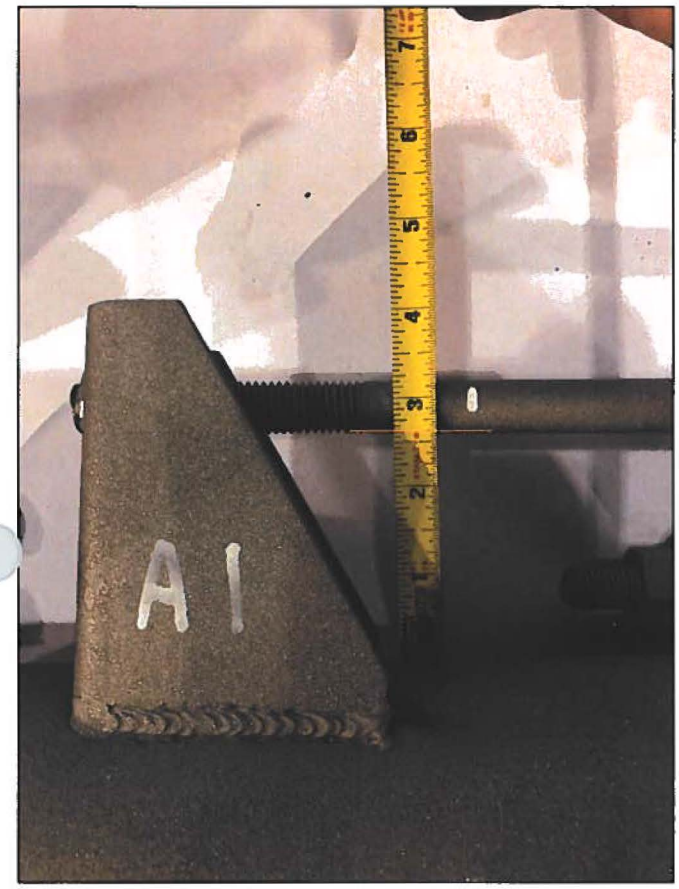


Figure 13- Lug A1, 2-5/8 inches from pipe

Figure 14- Lug B1, 2-3/16 inches from pipe

Table 7- Lugs (Weld Quality)

Pipe Side	Lug Number	Any part detached from pipe?	Welded on all sides of exterior? If no, describe	Are welds on exterior continuous? If no, describe	Welded on all sides of interior? If no, describe	Are welds on interior continuous? If no, describe
A	1	No	No weld on bottom exterior or back exterior	Yes	No weld top interior or back interior	Yes
A	2	No	No weld on bottom exterior or back exterior	No, slight imperfection	No weld top interior or back interior	Yes
B	1	No	No weld on bottom exterior	Yes	No weld on top interior	Yes
B	2	Yes, completely detached (See Figure 12)	No weld on bottom exterior	Unknown, weld broken	No weld on top interior	Unknown, weld broken

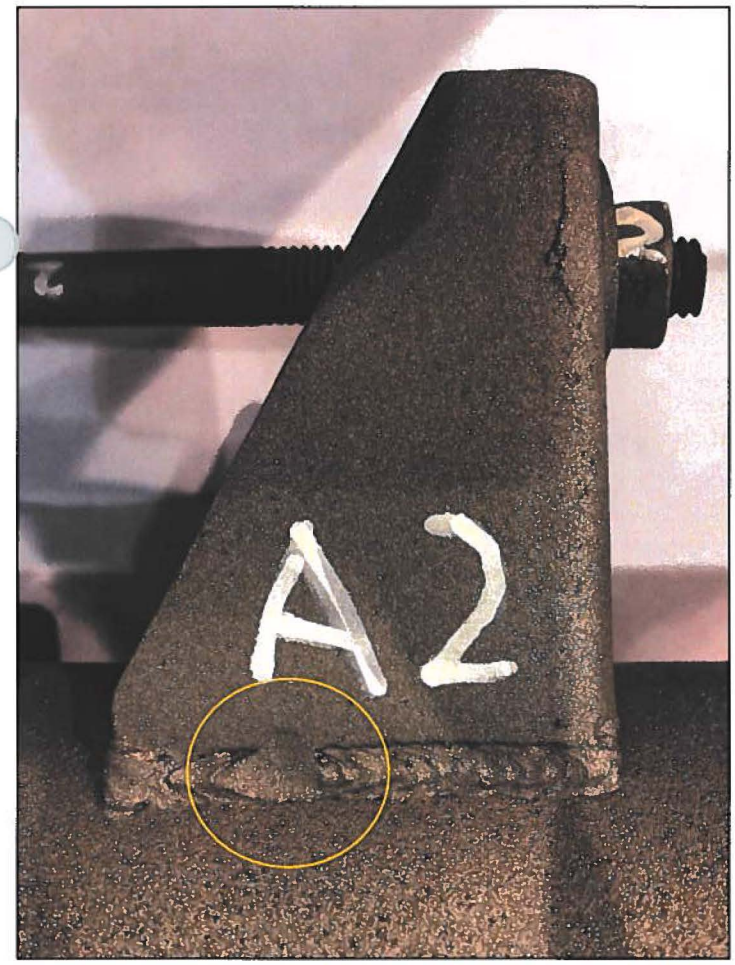


Figure 15- Lug A2, Slight weld imperfection

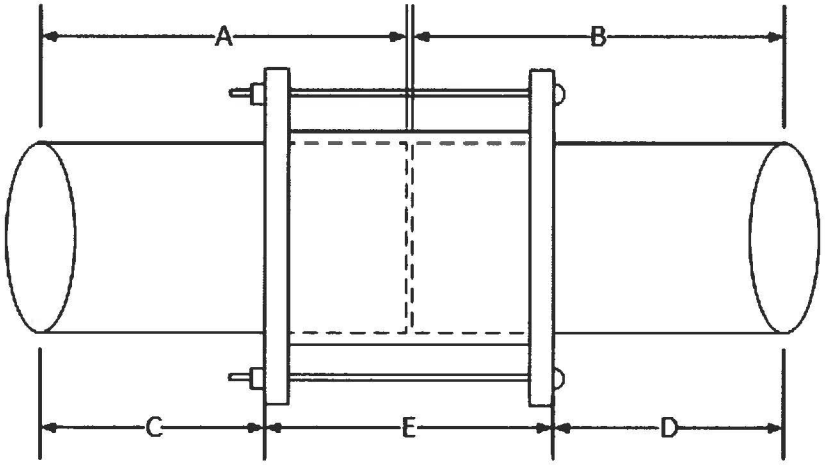


Table 8- Stab Depth

	A	B	C	D	Stab Depth (A-C) or (B-D)
Pipe Side A	15.9375		12.6875		3.2500
Pipe Side B		15.1250		11.8125	3.3125
	Sum of stab depths (should be closely equal to measurement E)				6.5625
	Coupler Length (E)				6.8125
	Difference				-0.2500

Additional Comments and General Observations

Different Lug Style

Different lug styles were used on a shared reinforcement rod. The lugs cause the reinforcement rod to have different distances from the pipe.

Jammed Nut

It was observed that the nut on reinforcement rod 1 was jammed into the hole of lug A1. An attempt was made during the inspection to remove the nut from the hole but it could not be removed with a moderate human push. It could most likely be removed from the hole with a strong human push or with the assistance of hand tools. The purpose of the observation is to show that without a washer, the nut could go through the hole. The jammed nut in lug 1 could have easily become dislodged by gas pressure. Since a lug on rod 2 had already become detached from the pipe, neither rod was serving as proper reinforcement for the coupling.

IMR TEST LABS
A Curtiss-Wright Business Unit
www.imrlouisville.com

4510 Robards Lane
Louisville, KY 40218
T: 1.502.810.9007 | F: 1.502.810.0380

LG&E - Kentucky Utilities
6900 Enterprise Drive
Louisville, KY 40214

July 11, 2019

Attention: Chad Augustine

Report No. 201901367

Metallurgical Evaluation of 4" Coupling and Associated Hardware

Location: 830 S. 13th Street, Louisville, KY 40210

DESCRIPTION AND PURPOSE

A natural gas pipe section including a coupling was submitted for metallurgical evaluation. The section was a 4" pipe with a Dresser Style 38 Insulating Coupling. Two joint harnesses were also affixed to the pipe section. Copies of the installation information for the coupling and harnesses were previously provided for this investigation. It was reported that the coupling had been installed in the field at 830 S. 13th Street. The installation date was not known. The pipe section was subsequently excavated after substantial service duration without failure. It was requested that the general dimensions, weld quality, corrosion condition and mechanical properties of the coupling components be determined as directed.

RESULTS

The submitted pipe section with the coupling is shown in Figures 1 and 2. Four lugs of the joint harnesses had been fillet welded to the pipe segments. Two rods and associated nuts had been affixed through the welded lugs to apply compression to the coupled joint. The assembly consisted of a steel coupling with an interior nonmetallic gasket / sleeve. Prior to receipt, the ends of the pipe segment were labelled as Ends A and B, as shown in Figures 1 and 2. The top surface of the coupling section was identified. Lugs A1 and A2 were welded to Pipe A, and Lugs B1 and B2 were welded to Pipe B. The rod between Lugs A1 and B1 was identified as Rod 1, whereas the opposite was Rod 2.

Lug B2 was not attached to pipe section B at the time of receipt. It appeared that both attachment welds were present but had fractured. Additionally, a washer was missing on Lug A1 causing the nut of Rod 1 to be pulled partially through the opening in the lug during installation.

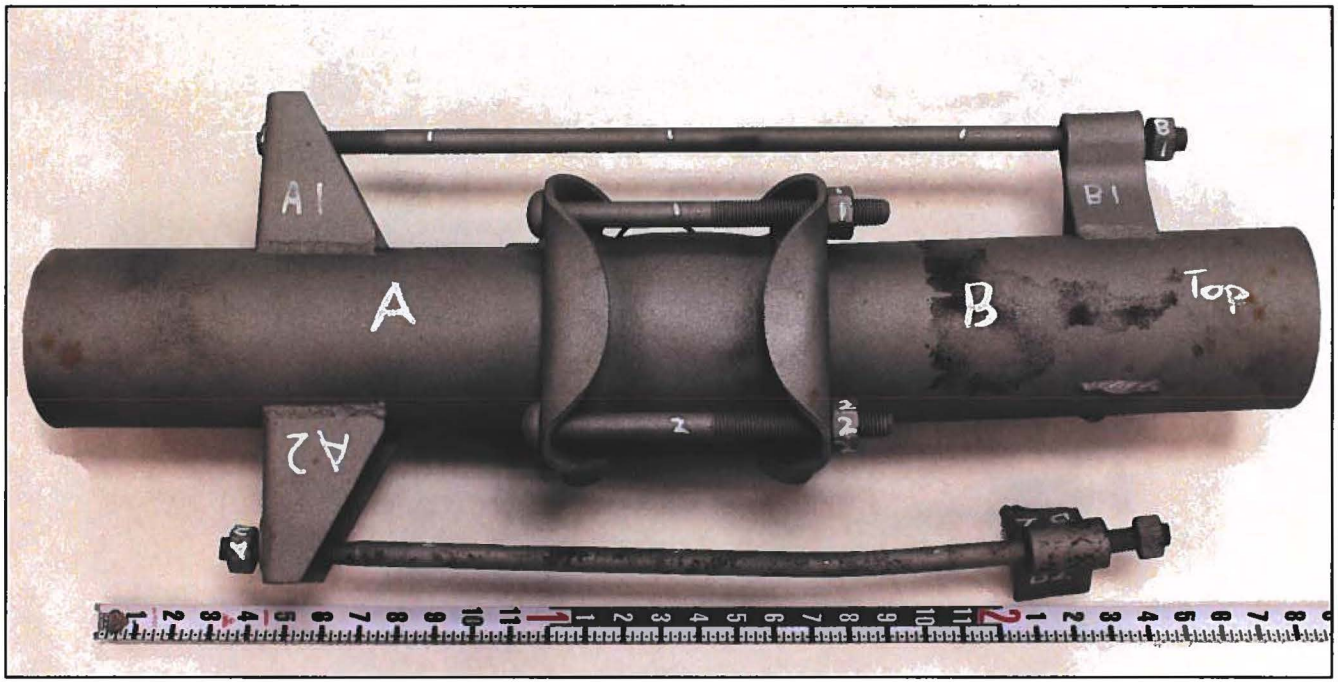


Figure 1. Photograph of the top of the submitted coupling. Lug and rod identifications are shown.

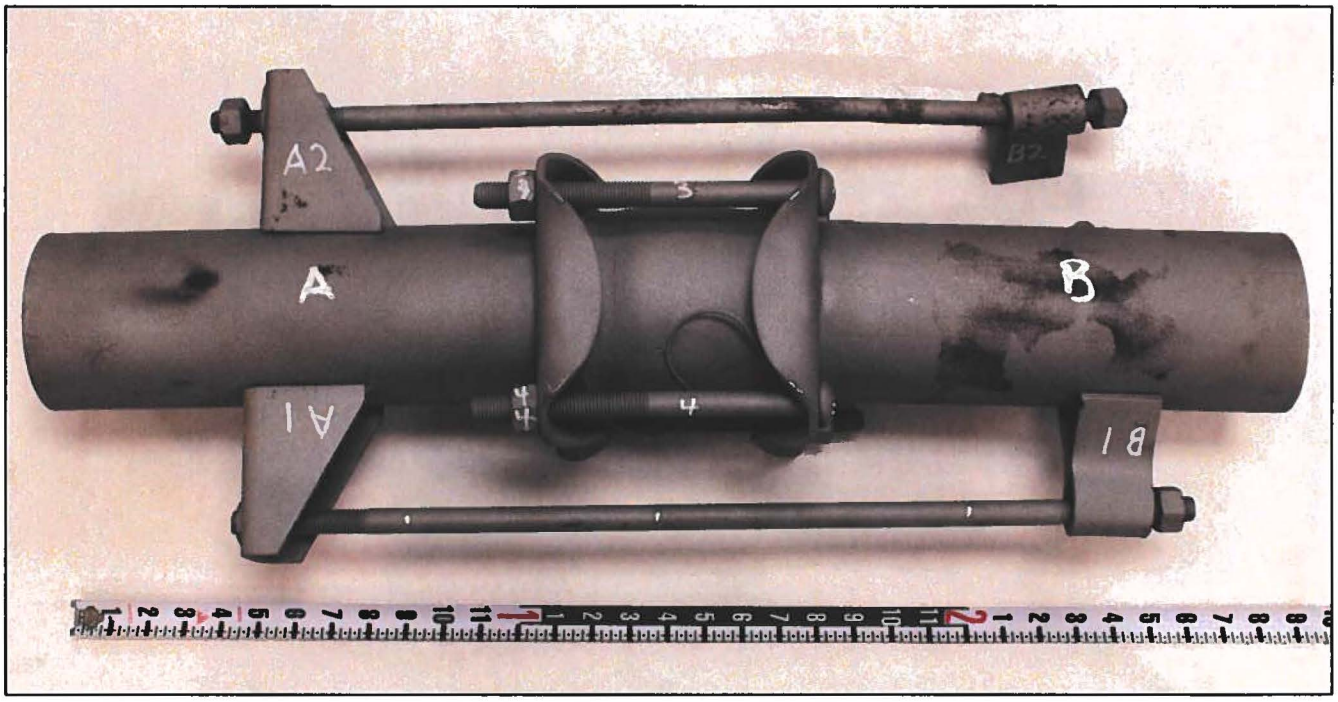


Figure 2. Photograph of the bottom of the submitted coupling. Lug and rod identifications are shown.

SECTION 1- DIMENSIONAL MEASUREMENT

The sets of harness lugs were positioned on opposite sides of the pipe. The relative orientation of the remaining harness lugs on pipe section A were measured by photographing the assembly from the end and applying a protractor overlay for angle measurement. Pipe section B could not be measured since the lug had separated. The obtained measurements are shown in Figure 3 with the data summarized in Table 1. The intact harness lugs were straight and not bent. The depth of insertion of the pipe segments into the coupling was also measured and the dimensions are provided in Table 2. No requirements were provided for these characteristics.

TABLE 1 – LUG SPACING DIMENSIONAL MEASUREMENTS

Component	Angle	Deviation from 180°	Image
Rod A1 / Rod A2	175°	5°	Figure 3
Rod B1 / Rod B2	----- ①	----- ①	N/A

① - Could not be measured since Lug B2 was separated

TABLE 2 – PIPE COUPLING DIMENSIONAL MEASUREMENTS

Component	Depth of Pipe into Coupling	Gap Between Pipes in Coupling
Pipe A	3.75"	~ 0.5" (Original sample length – 31.5")
Pipe B	3.25"	

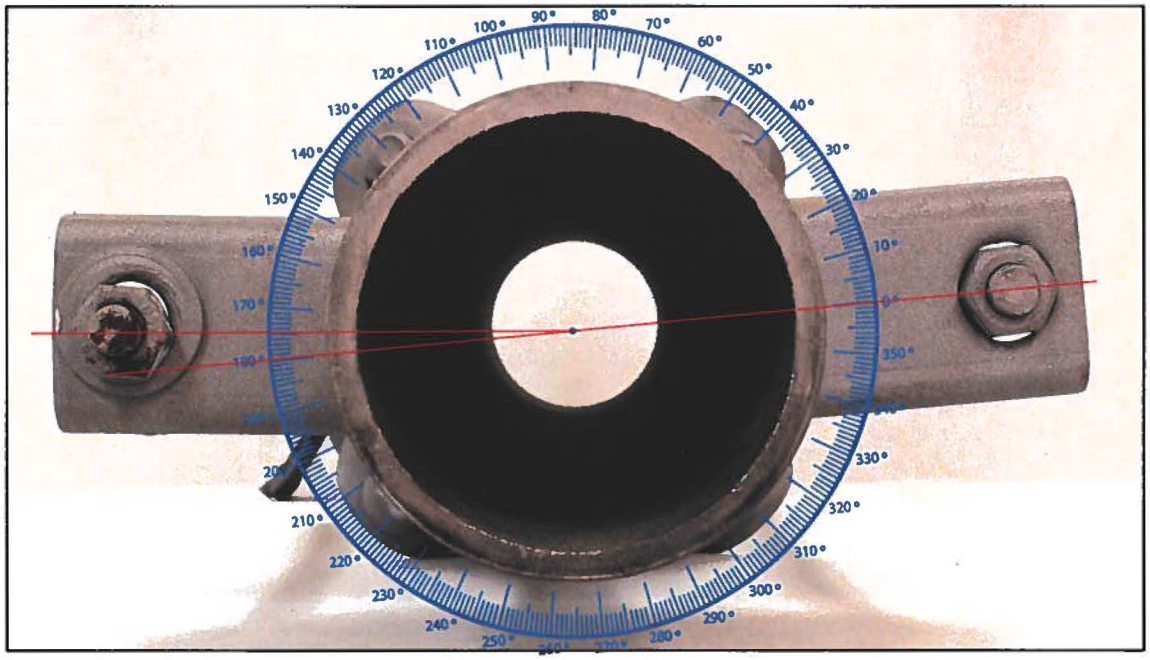


Figure 3. End facing image of the sample at End A. A superimposed protractor shows that the centers of Lugs A1 and A2 were approximately 5° from square.

SECTION 2- VISUAL OBSERVATIONS

The lug attachment welds were regions of interest on the pipe coupling sample. Each lug contained four fillet weld locations; exterior top, exterior bottom, interior top, and interior bottom. Each weld that was present was inspected visually using a flashlight and magnifying lens. It was indicated that welding was performed in accordance with API 1104. General weld inspection was performed initially, followed by visual inspection by an outside NDE company. For comparison purposes, the welds were rated as substantial fusion, partial fusion, and minimal fusion. The summarized weld fusion and corrosion observations are provided in Table 3. Representative weld regions are shown in Figures 4 through 11. It was further noted that the welds contained localized weld discontinuities including arc strikes, porosity, undercut, overlap, and spatter in addition to incomplete fusion. No cracking in the welds or base metal heat affected zones (HAZ) was visually identified except for Lug B2 which was fractured. Some superficial pitting corrosion of the welds was observed, but no significant material loss had occurred.

The coupling and harness rods were also inspected for corrosion alteration. The observations for the rods are provided in Table 4. The rods exhibited negligible corrosion damage. No corrosion cracking was evident. The rods were not necked down or stretched.

TABLE 3 – LUG WELD VISUAL EXAMINATION RESULTS

Component	Location	Weld	Observations
Lug A1	Exterior	Top	Substantial fusion
		Bottom	No weld
	Interior	Top	No weld
		Bottom	Substantial fusion
Lug A2	Exterior	Top	Substantial fusion
		Bottom	No weld
	Interior	Top	No weld
		Bottom	Substantial Fusion
Lug B1	Exterior	Top	Substantial fusion
		Bottom	No weld
	Interior	Top	No weld
		Bottom	Substantial fusion
Lug B2	Exterior	Top	Fractured
		Bottom	No weld
	Interior	Top	No weld
		Bottom	Fractured

TABLE 4 – FASTENER VISUAL EXAMINATION RESULTS

Component	Observations
Rod 1	Not bent or stretched, no gross corrosion pitting
Rod 2	Bent, unattached at Lug B2
Bolt 1	Not bent or stretched, no gross corrosion pitting
Bolt 2	Not bent or stretched, no gross corrosion pitting
Bolt 3	Not bent or stretched, no gross corrosion pitting
Bolt 4	Not bent or stretched, no gross corrosion pitting

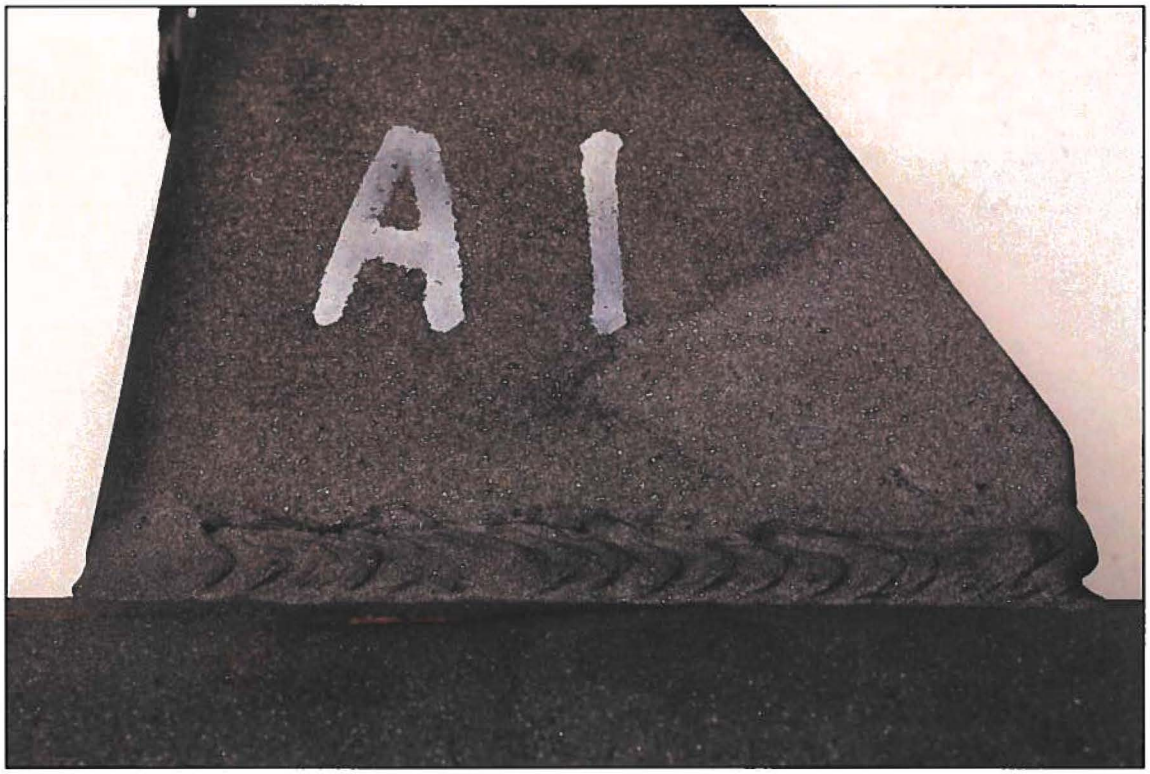


Figure 4. Image of the Lug A1 exterior top weld which exhibited substantial fusion except for some overlap, spatter and porosity.

Figure 5. Image of the Lug B1 exterior top weld which exhibited substantial fusion except for some overlap, spatter, arc strike and porosity.

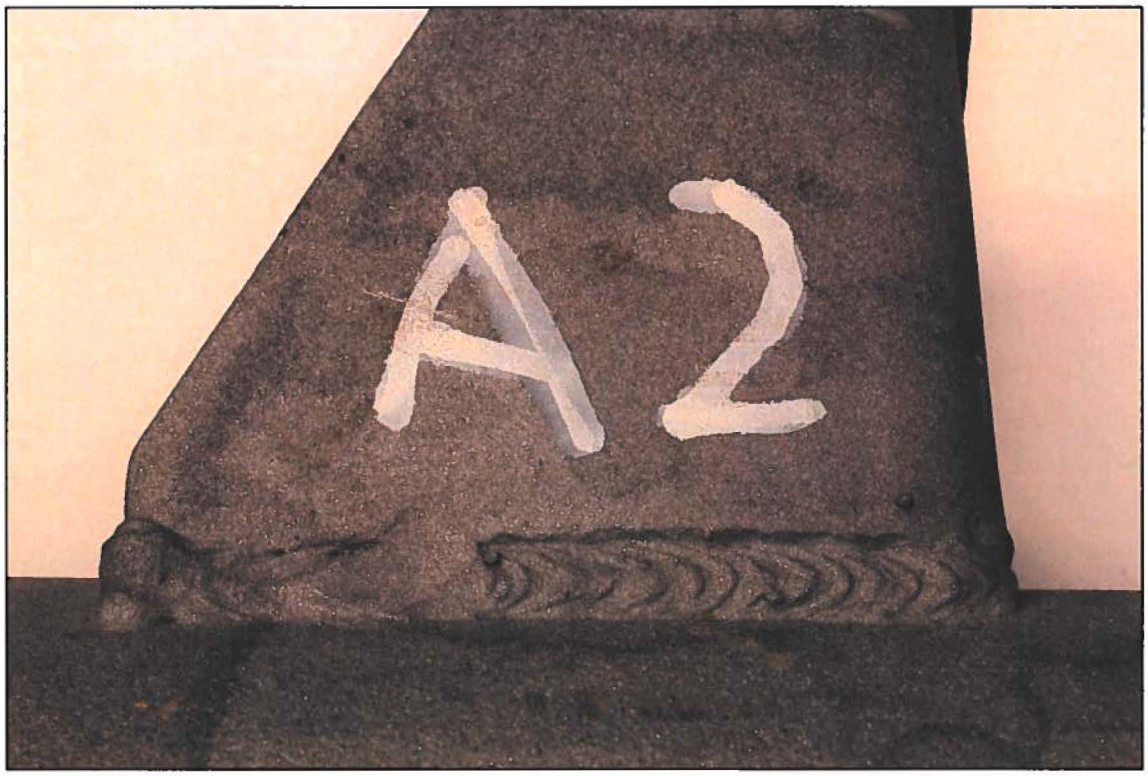


Figure 6. Image of the Lug A2 exterior top weld which exhibited substantial fusion except for some undercut, porosity and spatter.

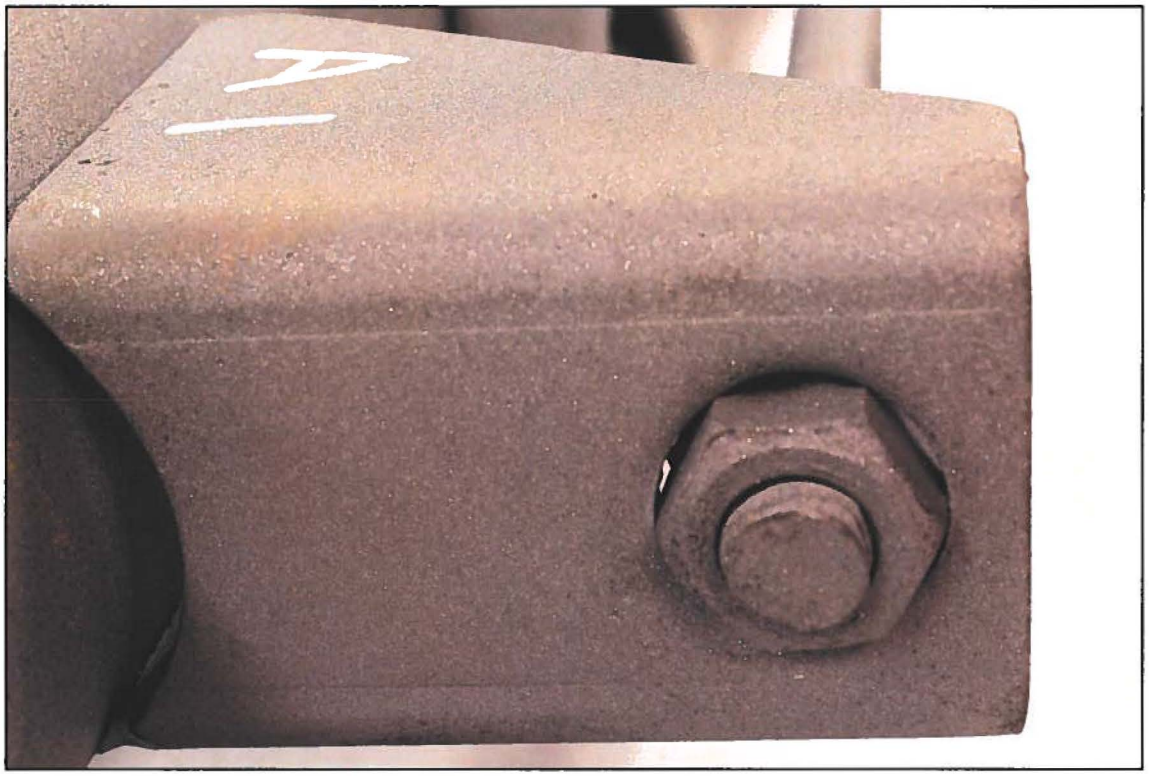


Figure 7. Photograph showing the nut of Rod 1 embedded into the opening of Lug A1.

Figure 8. Image of the Lug A1 interior bottom weld.

Figure 9. Image of the Lug B1 exterior top and interior bottom welds.

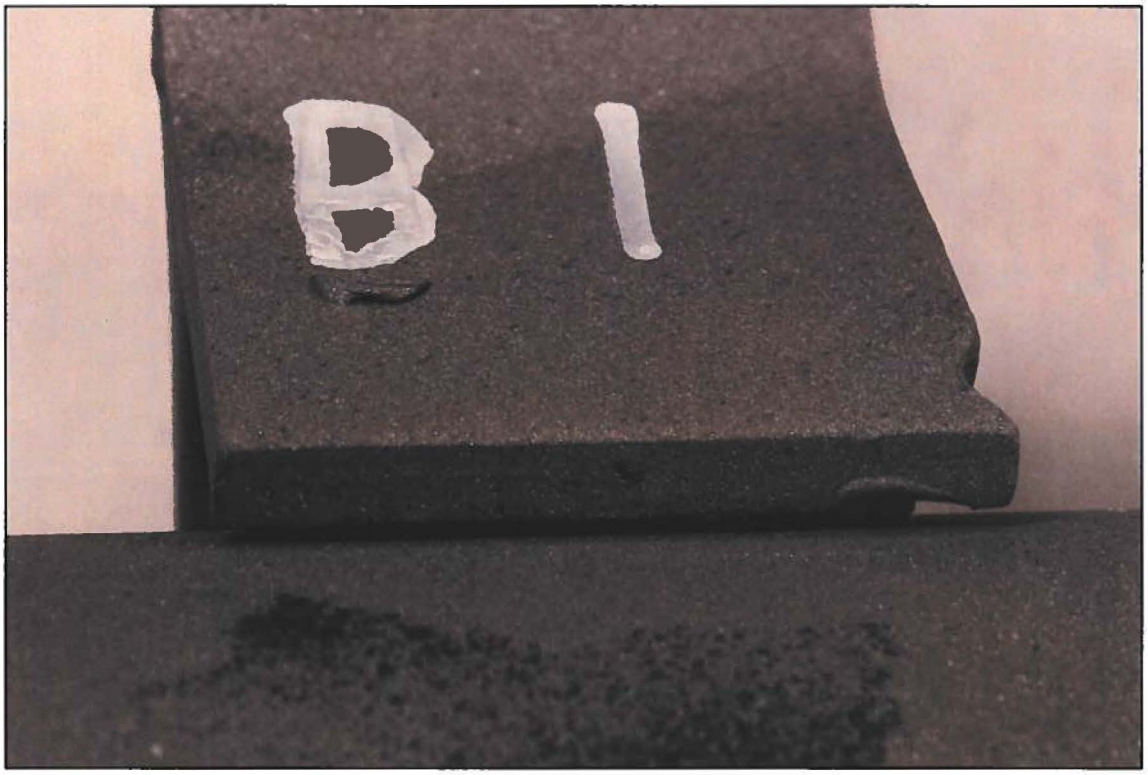


Figure 10. The exterior bottom location of Lug B1 was not welded.

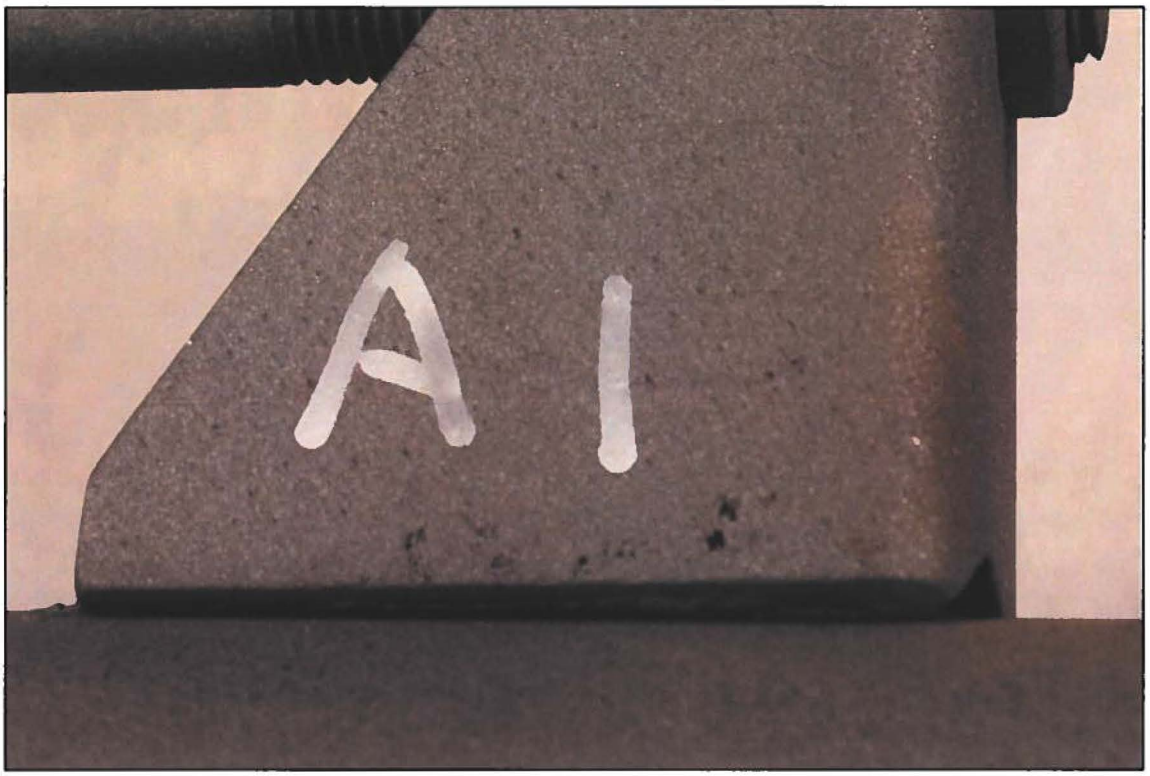


Figure 11. The exterior bottom location of Lug A1 was not welded.

SECTION 3- TORQUE TESTING- FOR INFORMATION ONLY

Torque testing was performed on the nuts of the rods and bolts on the pipe coupling sample. A calibrated torque wrench was used to determine breakaway torque on each fastener. The breakaway torque measurements are summarized in Table 5. Rod fasteners did not have a specified torque requirement. The four coupling bolts exhibited torque values ranging from 35 to 55 ft.-lbs. This result was below the Dresser Style 38 coupling installation torque recommendation of 75 ft.-lbs. minimum for 5/8" fasteners.

TABLE 5 – FASTENER TORQUE MEASUREMENT

Component	Breakaway Torque	Observations
Rod 1	N/A	Embedded Bolt
Rod 2	N/A	Loose due to lug fracture
Bolt 1	35 ft.-lbs.	Did not satisfy the 75 ft.-lbs. minimum recommended torque
Bolt 2	40 ft.-lbs.	Did not satisfy the 75 ft.-lbs. minimum recommended torque
Bolt 3	55 ft.-lbs.	Did not satisfy the 75 ft.-lbs. minimum recommended torque
Bolt 4	50 ft.-lbs.	Did not satisfy the 75 ft.-lbs. minimum recommended torque

SECTION 4- TENSILE TESTING, ASTM A370-17A

Tensile testing was performed on round specimens that were removed from the two harness rods and the four coupling bolts. The tensile mechanical properties of the fasteners were measured and the results are summarized in Table 6. No mechanical property requirements were provided for the fasteners.

TABLE 6 – FASTENER TENSION TEST RESULTS

Component	Ultimate Tensile Strength, ksi	0.2% Offset Yield Strength, ksi	Elongation, %	Reduction in Area, %
Rod 1	98.5	58.0	27	51
Rod 2	100	55.0	26	47
Bolt 1	80.0	56.5	28	59
Bolt 2	83.0	49.8	29	58
Bolt 3	84.0	48.1	32	60
Bolt 4	81.5	45.4	32	60

Specimen Dimensions: Diameter of 0.35" with gage length of 1.4"
Percent elongation was measured using elongation-after-fracture measurements

SECTION 5- ROCKWELL HARDNESS, ASTM E18-17

Small sections of the four lugs were excised for hardness testing. Rockwell hardness testing was performed on sectioned segments of the lugs after the removal of surface roughness by sanding. The obtained results are provided in Table 7 and are suggestive of a moderate strength level. No requirements were provided for comparison.

TABLE 7 – LUG HARDNESS TEST RESULTS – ROCKWELL B – HRBW

Results	Reading 1	Reading 2	Reading 3	Reading 4	Average
Lug A1	65	65	64	62	64
Lug A2	66	68	69	71	68
Lug B1	88	87	87	88	87
Lug B2	75	75	82	84	79

SECTION 6- NONDESTRUCTIVE EXAMINATION

The two separated ends of the disassembled coupling were sent to a third party NDE laboratory for inspection. Visual and magnetic particle were performed on the lug attachment welds. Inspection was performed in accordance with the acceptance criteria of API 1104 "Welding of Pipelines and Related Facilities". The inspection results are provided as Appendices A and B.

ACCREDITED
Testing Cert # 1140.03 & 1140.04

Accredited Nadcap™ Materials Testing Lab

Respectfully submitted

Brian Kelly
Failure Analyst

Concurrence

Brett A. Miller, P.E. FASM
Technical Director

APPENDIX A – VISUAL INSPECTION RECORD

HAYES TESTING LABORATORY, INC.
Phone 502-266-9729
2821 Holloway Rd.
Louisville, Kentucky 40299

VISUAL INSPECTION REPORT

Customer: IMR Test Labs **Date:** 7-9-19

Location of Work: Louisville, Ky (HTL) **Purchase Order #:** 58707

On 7-9-19 personnel of Hayes Testing conducted a Visual and magnetic particle inspection for IMR on two pipe segment couplers marks A & B. Job# 201901367.

Inspections performed where welds affixing the lugs to pipe segments in accordance with API-1104. Results as follows.

Pipe Segment A Lug A2 - Lack of fusion to lug side Rejected
Pipe Segment A Lug A1 - Undercut to lug side and pinhole Rejected
Pipe Segment B Lug B1 - Undercut to pipe side and lack of fusion on inboard lug weld rejected.

Please see attached for magnetic particle inspection results

If you have any question regarding these inspections or report feel free to contact me at any time.

Respectfully Submitted

Daniel J Hayes

Results Interpreted to CODE: API-1104

INSPECTOR: Daniel J Hayes II **Level or CWI #:** II

Your Independent Laboratory For Complete Non-Destructive Testing

IMR Metallurgical Services • 4510 Robards Lane • Louisville, KY 40218

APPENDIX B – MAGNETIC PARTICLE INSPECTION RECORD

HAYES TESTING LABORATORY, INC.
Phone 502 266 9729
2621 Holloway Rd.
Louisville, Kentucky 40299

MAGNETIC PARTICLE INSPECTION REPORT

Customer Name: IMR Test Labs Date of Work: 7-9-19

Purchase Order #: 5870T Job #: 20190367

1. Identification:
Item(s) Inspected 2 Description Coupler pipe Segments A+B

Location of Item: Lug Aff'd to Pipe welds Part No. A, B

2. Technique - [] Dry Powder [] Wet Fluorescent [] Non-Fluorescent

3. Equipment - [] Coil [] Prods [] Yoke [] Clamps 4. Current Type [] AC [] DC

5. AMP Turns

6. Inspection Procedure HTL MT

7. Inspection Specifications API-1104

8. Type of Indication Found:

(1) Crack (2) Linear Surface 3. Linear Subsurface (4) Undercut
5. Non- Relevant 6. NONE

RESULTS: 2 pipe segments A+B inspected where lug welds Aff'd to pipe. See Below for results

9. Sketch/Description

Pipe Segment A - Lug A1 Reject Undercut & Cross Crack

Pipe Segment A - Lug A2 Reject Lack of Fusion

pipe Segment B Lug B1 NO indications noted.

10. Inspection Performed by Hayes Testing Laboratory, Inc. personnel:

Signature: [signature]
Level II Technician

Independent Laboratory For Complete Non-Destructive Testing