LG&E
a PPL company

Louisville Gas and Electric Company
State Regulation and Rates
220 West Main Street
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Louisville, Kentucky 40232
www.lge-ku.com

Rick E. Lovekamp
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Gwen R. Pinson
Executive Director
Kentucky Public Service Commission
211 Sower Boulevard
Frankfort, Kentucky 40601

January 31, 2019

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. 3 in Case No. 2017-00119, Louisville Gas and Electric Company ("LGE") hereby notifies the Commission that the removal of all remaining mechanical couplings on the LG&E transmission system is now complete.

The following three couplings were removed from LG&E's transmission system:

1) A bolted-style mechanical coupling installed in 1959 was removed from service on March 23, 2018. The lab report analysis is attached as Exhibit A.

2) A bolted-style mechanical coupling installed in 1962 was removed from service on April 6, 2018. The lab report analysis is attached as Exhibit B.

3) A nut follower-style mechanical coupling installed in 1959 was removed from service on January 3, 2019. The lab report analysis is attached as Exhibit C. The work required to remove this last coupling was delayed due to the time it took to obtain the required permits to work in the vicinity of a railroad.

Enclosed, please find the full reports on the removal effort in the above referenced matter.

Should you require anything further, please contact me at your convenience.

Sincerely,

Rick E. Lovekamp

Enclosure

# 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:

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:

1. Contact Employee for the bolt style coupling found: Frank Rudolph E0003497
2. Date of exposure: 3/23/2018
3. Location: Kramer Ln and Beech Dr
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)
6. Soil Density test: □ Type A □Type B □Type C Note: data not collected, this field was added after coupler was removed)
7. Status: x Removed □Abandoned in place □Backfilled- left in service

## 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 showing the coupling orientation (vertical/horizontal), nearby branches, pipe, valves and fittings, other utilities or structures, etc.

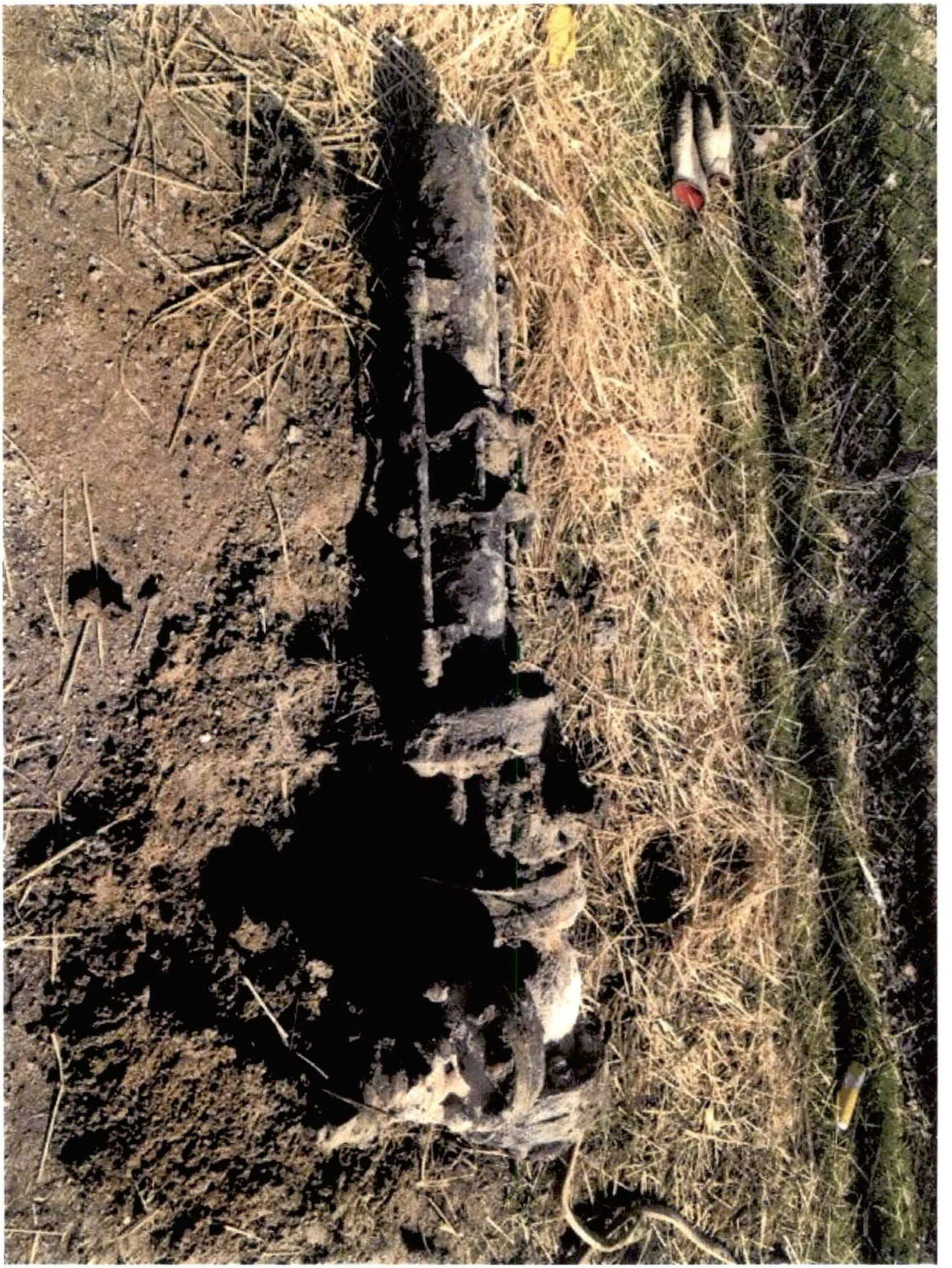
## Leak Survey:

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.

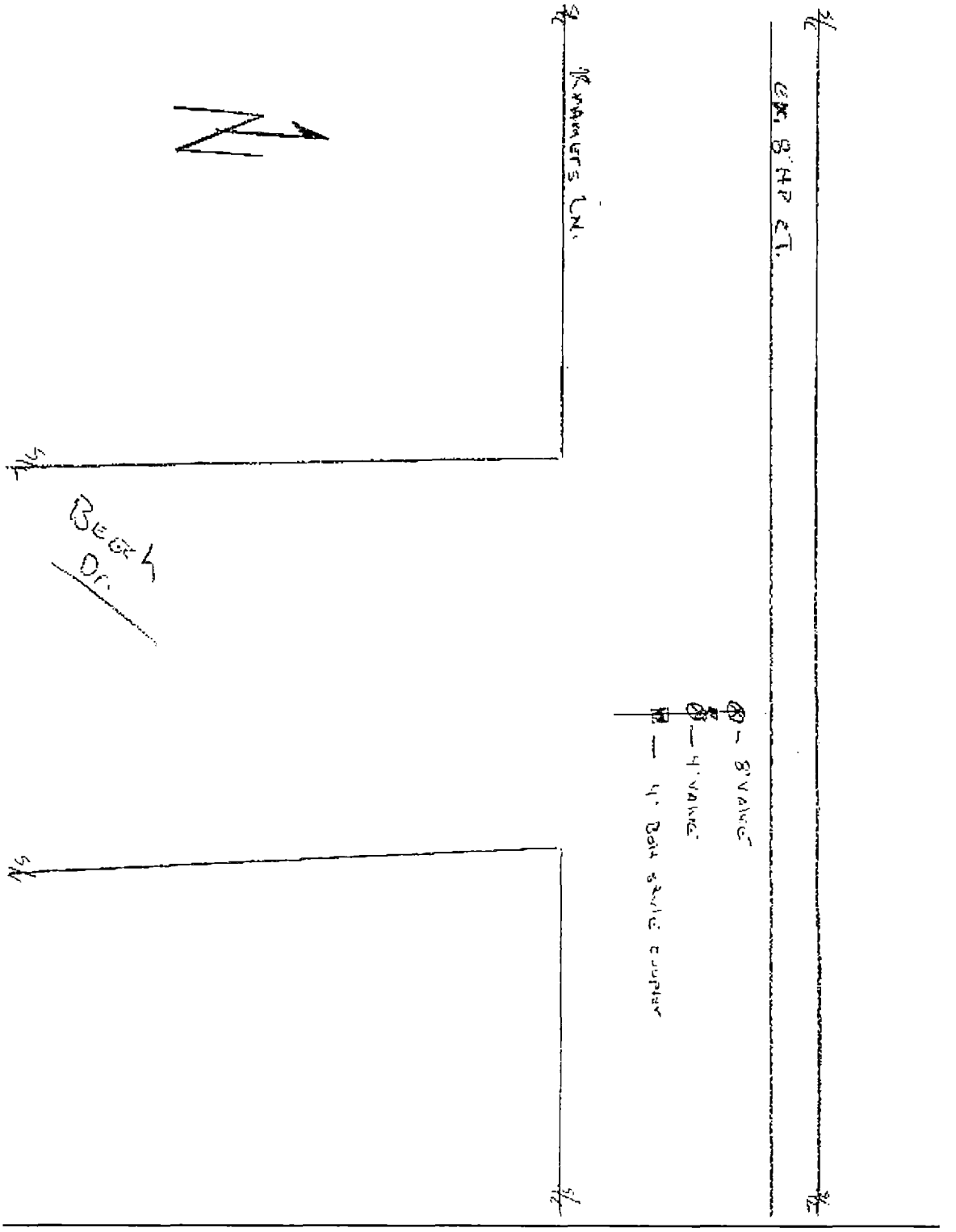
Leak Survey completed at time of backfill (circle one) yes (no)

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.

Field Pictures



Sketch

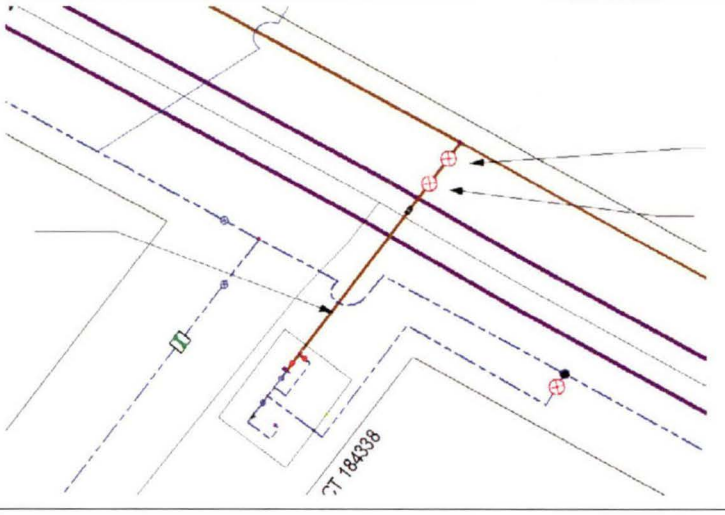


## Part B- Coupling Information

| General Information | | | Tracking #: 2018-004 |
|---|---|---|---|
| Date<br>7/3/2018 | Expense Org<br>004385 | Project<br>134829 | Task<br>LAB |
| Address/Location<br>Kramers Ln & Beech Dr | | | |
| Size<br>4- inch | Material<br>Steel | Coating<br>Coal Tar | MAOP<br>305 |
| Main/Service Number<br>184337 | Soil Type (from Part A)<br>Unavailable | Manufacturer<br>Dresser | Model<br>4-inch Style 39 |
| Pipe Connection: | Steel to Steel | Steel to Plastic | Plastic to Plastic |

| Historical Information | |
|---|---|
| Installation Date<br>6/14/1962 | Document Source<br>Main Report |
| Installation Company<br>Unknown | Document Source<br>Main Report |
| Foreman<br>F.G. Briel | Document Source<br>Main Report |
| Welder<br>Unknown | Document Source<br>Main Report |

| GIS Information |
|---|
| Sys Id (of Coupler)<br>73247224 |
| Screen Capture |



Pictures

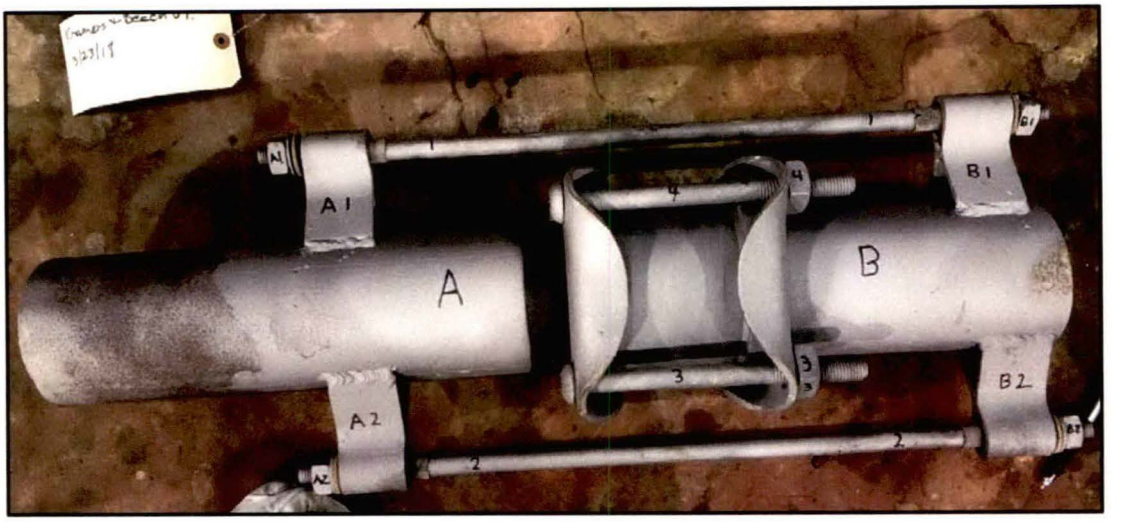



*Figure 1- Top View*

*Figure 2- Front View*


*Figure 3- Back View*

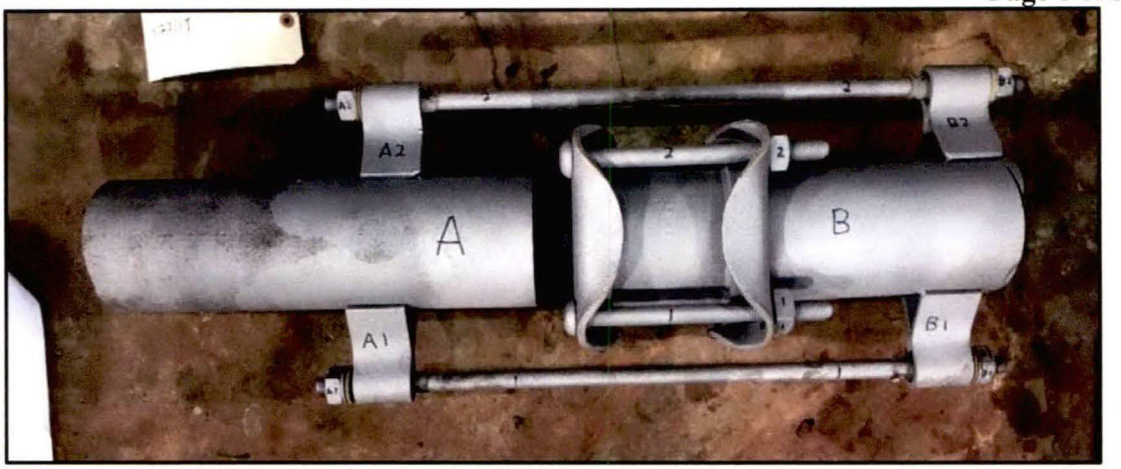



*Figure 4- Bottom View*

*Figure 5- Left Side View*

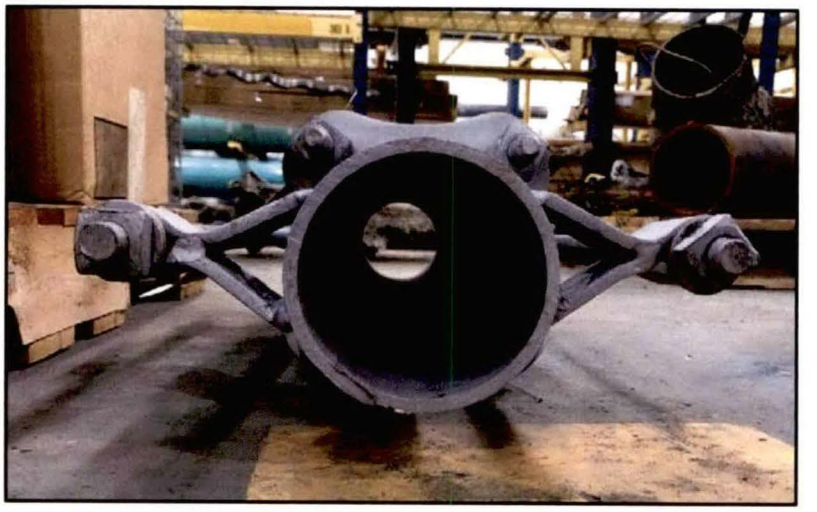


*Figure 6- Right Side View*

## Part C- Inspection of Coupling

Visual Inspection Performed by: Chad Augustine [redacted] & Elliott Bauer [redacted]

| Component Quantities | |
|---|---|
| Number of Bolts on Coupler Body | 4 |
| Number of Reinforcement Rods | 2 |
| Number of Lugs | 2 (2 each rod) |

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

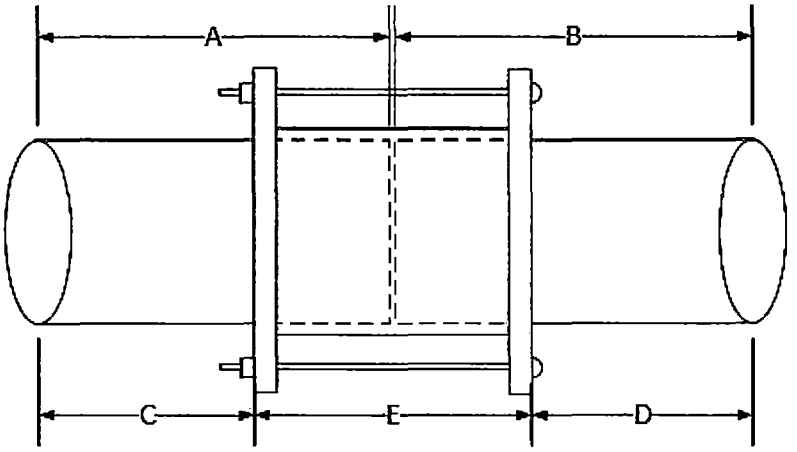
| Coupler Body | | | | |
|---|---|---|---|---|
| Length of Coupler (in.): | 6.25" | | | |
| Bolt | Washer Present | Nut present? | | |
| 1 | No | Yes | | |
| 2 | No | Yes | | |
| 3 | No | Yes | | |
| 4 | No | Yes | | |

| 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" | .627" (16mm) | Yes<br>No head on rod<br>See Figures 7 & 8 | Yes | Yes.<br>Square. | All Thread(?) |
| 2 | 24" | .644" (16mm) | Yes<br>No head on rod<br>See Figures 9 & 10 | Yes | Yes.<br>Square. | All Thread(?) |

| Lugs (Measurements) | | | | |
|---|---|---|---|---|
| Pipe Side | Lug Number | Thickness (in.) | Circumference (in) | |
| | | | Distance to next lug, clockwise | Distance to next lug, counter-clockwise |
| A | 1 | .245" | To A2 along top: 6.75" | To A2 along bottom: 7.50" |
| B | 1 | .249" | To B2 along top: 6.375" | To B2 along bottom: 8.0625" |
| A | 2 | .252" | To A1 along top: 6.75" | To A1 along bottom: 7.50" |
| B | 2 | .269" | To B1 along top: 6.375" | To B1 along bottom: 8.0625" |

| Lugs (Observations) | | | | |
|---|---|---|---|---|
| Lug | Lug | Assembly sets aligned? | Deformed? | Deflected? (angle of) |
| A1 | B1 | In line with each other, not centered on circumference of pipe | None Observed | 0° |
| A2 | B2 | In line with each other, not centered on circumference of pipe | None Observed | 0° |

| 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 exterior continuous? If no, describe |
| A | 1 | Not completely. | No, no weld on outside of bottom leg. (Figure 11) | Yes on the top leg. No exterior weld on bottom leg. | No, no weld on inside of top leg. (Figure 11) | No, the interior weld on the bottom leg is not continuous. No interior weld on top leg. |
| A | 2 | Not completely. | No, no weld on outside of bottom leg. (Figure 12) | Yes on the top leg. No exterior weld on bottom leg. | No, no weld on inside of top leg. (Figure 12) | Yes on bottom leg. No interior weld on top leg. |
| B | 1 | Not completely. | No, no weld on outside of bottom leg. (Figure 13) | Yes on the top leg. No exterior weld on bottom leg. | No, no weld on inside of top leg. (Figure 13) | Yes on bottom leg. No interior weld on top leg. |
| B | 2 | Not completely. | No, no weld on outside of bottom leg. (Figure 14) | Yes on the top leg. No exterior weld on bottom leg. | No, no weld on inside of top leg. (Figure 14) | Yes on bottom leg. No interior weld on top leg. |




| Stab Depth | | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | Stab Depth (A-C) or (B-D) |
| Pipe Side A | 18.3125" | [redacted] | 15.5625 | [redacted] | 2.75" |
| Pipe Side B | [redacted] | 11.0000" | [redacted] | 8.2500" | 2.75" |
| | | | | Sum of stab depths | 5.5" |
| | | | | Coupler Length (E) | 6.25" |
| | | | | Difference | 0.75" |

Additional Comments and General Observations

- This is an insulating coupler. Insulating washers were present on all reinforcement rods.
- Based on the location of the welds, it can be assumed that bolts 3 & 4 on the coupler body represent the top of fitting. Using this assumption, the welds of each leg on each weld are located in the top (or upper) position.

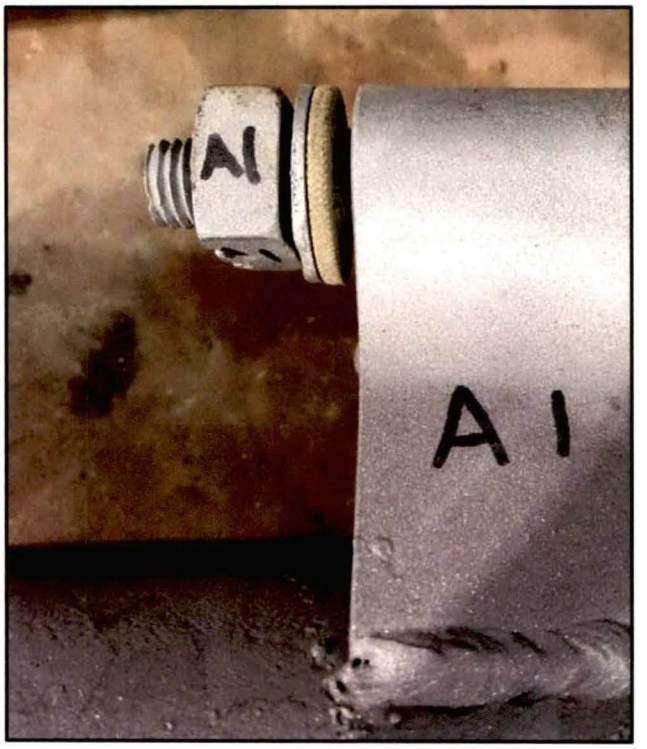



*Figure 7- Lug A1*

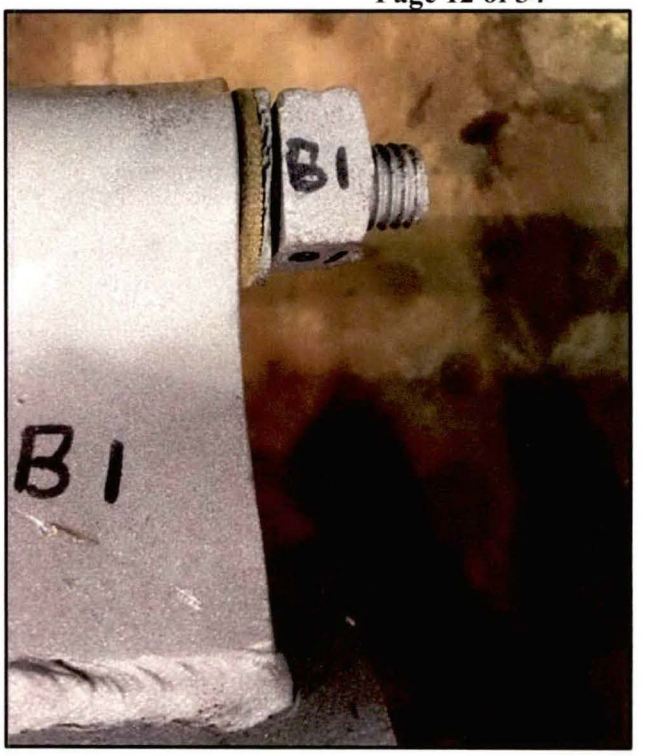



*Figure 8- Lug B1*

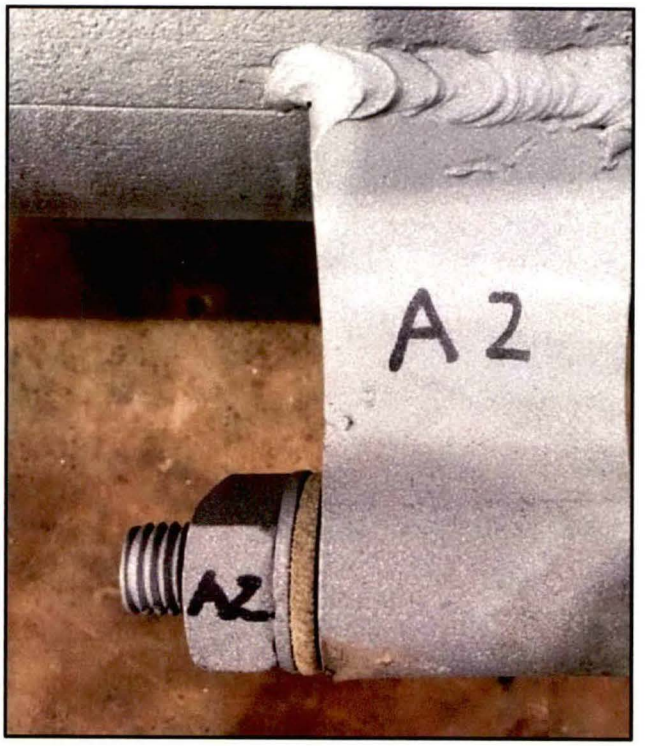



*Figure 9- Lug A2*

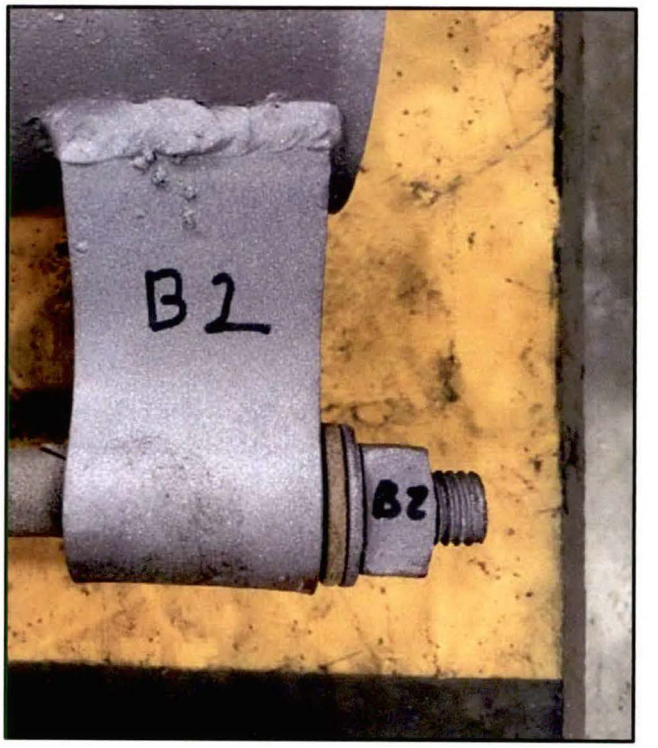



*Figure 10- Lug B2*


*Figure 11- Lug A1 Welds*

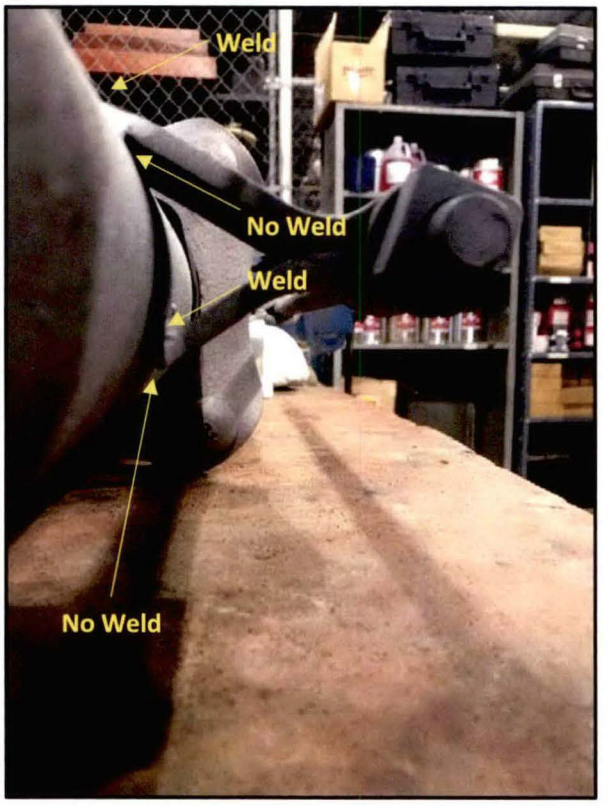



*Figure 12- Lug A2 Welds*

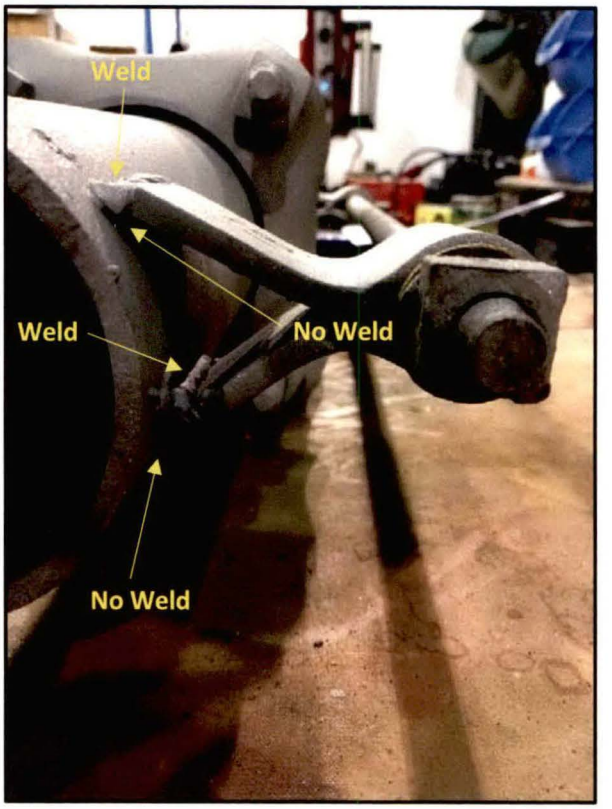



*Figure 13- Lug B1 Welds*

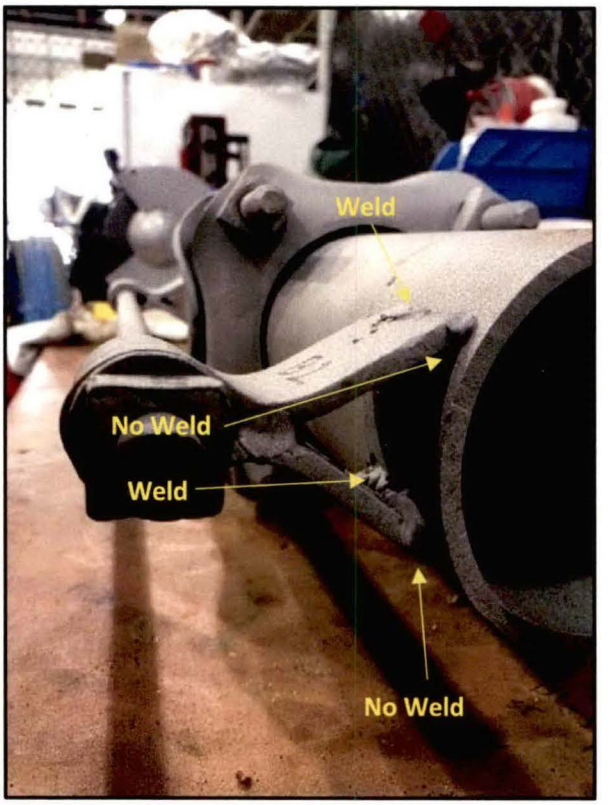



*Figure 14- Lug B2 Welds*

## Part D- Analysis of Coupling

This section is reserved for the lab report.

**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**

**August 17, 2018**

Attention: Chad Augustine

# Report No. 201801864

## Metallurgical Evaluation of Coupling and Associated Hardware

**Location: Kramers & Beech St.**

### 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 39 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 Kramers & Beech Streets. 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 A-frame lugs of the joint harnesses had been fillet welded to the pipe segments. Two rods and associated nuts with deflection rings had been affixed through the welded lugs to apply compression to the coupled joint. The coupling consisted of two followers, a middle ring and associated nonmetallic gaskets and sleeves. Four equally spaced bolts with associated nuts secured the coupling components together and against the pipe segments. The general orientation of the coupling was consistent with the supplied information for the specified Dresser Style 39. 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 of the pipe was selected as the surface with the generally better weld appearance. 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 arbitrarily identified as Rod 1, whereas the opposite was Rod 2. The four coupling bolts were arbitrarily numbered as Bolts 1 through 4 around the circumference.

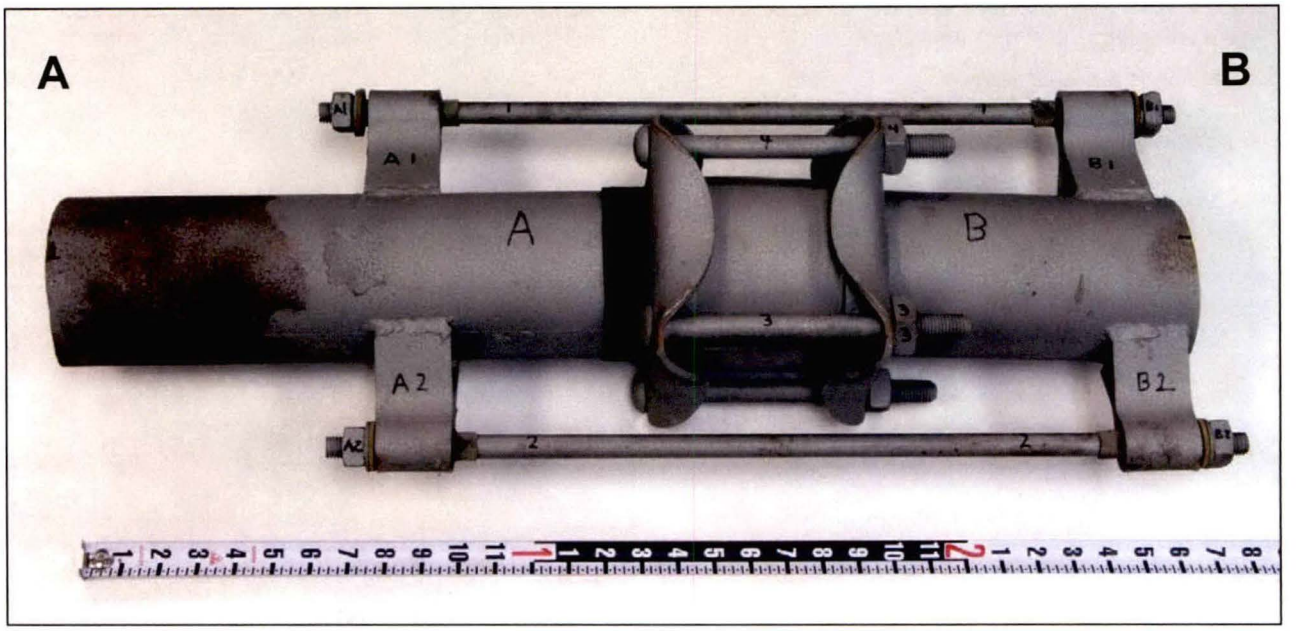



Figure 1. Photograph of the top of the submitted coupling sample. The bolt heads were all at End A, while the nuts were toward End B.

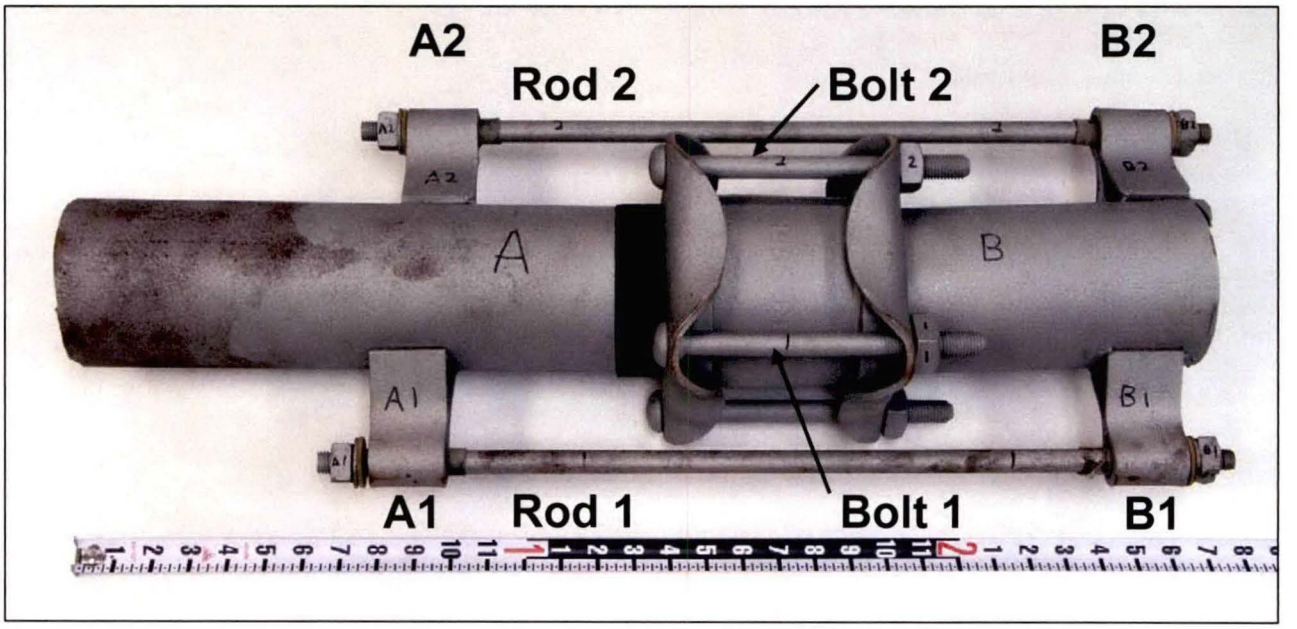



Figure 2. Photograph of the bottom of the submitted sample. Lug, rod and bolt identifications are shown.

## SECTION 1- DIMENSIONAL MEASUREMENT

The two sets of harness lugs were positioned on opposite sides of the pipe. The relative orientation of the harness lugs was 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. Both harness lugs were straight and not bent. The depth of insertion of each pipe into the coupling was also measured, both before and verified after disassembly. The dimensions are provided in Table 2. No requirements were provided for these characteristics.

## TABLE 1 – LUG SPACING DIMENSIONAL MEASUREMENTS

| Compound | Angle | Deviation from 180° | Image |
|---|---|---|---|
| Rod A1 / Rod A2 | 172° | 8° | Figure 3 |
| Rod B1 / Rod B2 | 169° | 11° | Figure 4 |

## TABLE 2 – PIPE COUPLING DIMENSIONAL MEASUREMENTS

| Component | Depth of Pipe into Coupling | Gap Between Pipes in Coupling |
|---|---|---|
| Pipe A | 2" | ~ ½" (Original sample length – 30 1/2") |
| Pipe B | 2 ¼" | |

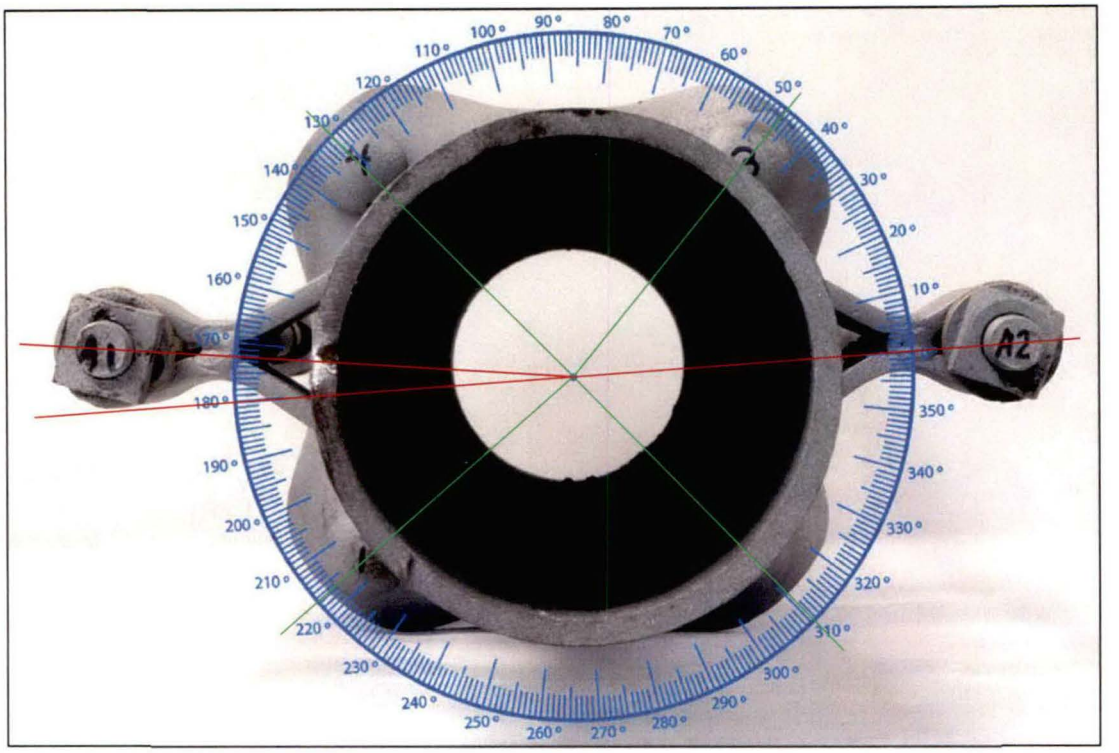



Figure 3. End facing image of the sample at End A. A superimposed protractor shows that the centers of Lugs A1 and A2 were approximately 8° from square.

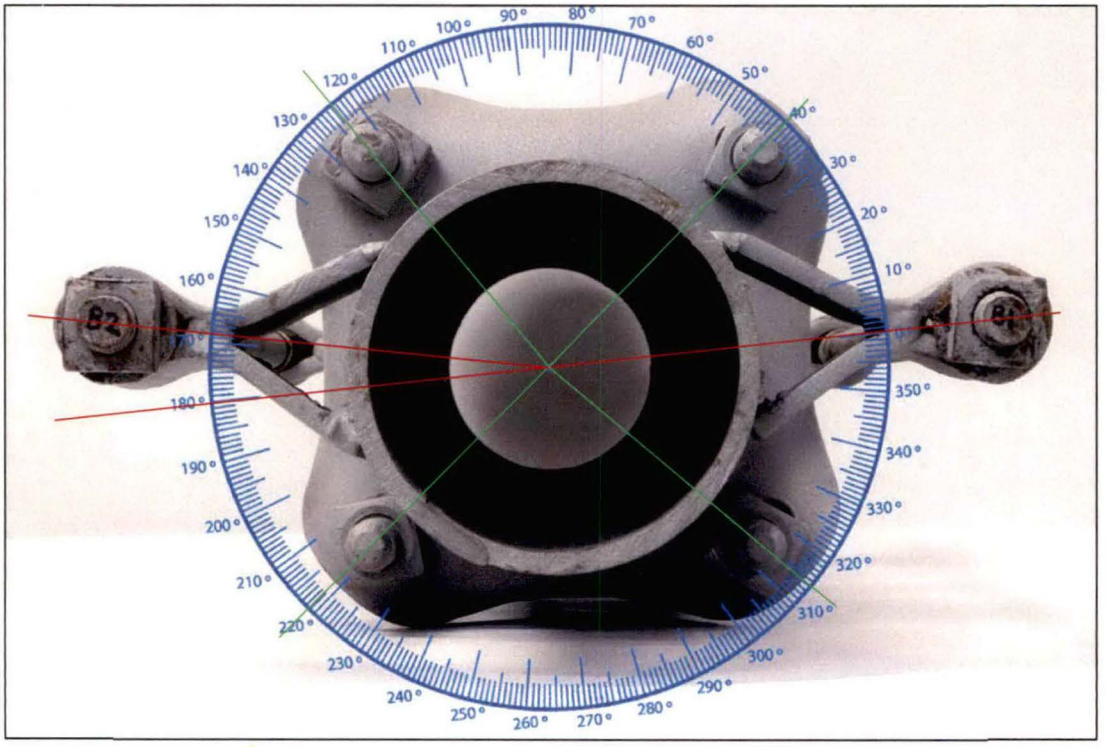



Figure 4. End facing image of the sample at End B. A superimposed protractor shows that the centers of Lugs B1 and B2 were approximately 11° from square.

## SECTION 2- VISUAL OBSERVATIONS

The lug attachment welds were regions of interest on the pipe coupling sample. Each A-frame lug contained four fillet weld locations; exterior top, exterior bottom, interior top, and interior bottom. Each weld was inspected visually using a flashlight and magnifying lens. No welding code or quality criteria were provided for weld acceptance or for the severity of corrosion alteration. 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 13. It was further noted that the welds also contained localized weld discontinuities including undercut, overlap, and spatter in addition to the incomplete fusion. Welding was only performed on the exterior top and interior bottom of each lug, consistent with the ease of welding in the field. No cracking in the welds or base metal heat affected zones (HAZ) was identified. Some superficial pitting corrosion was observed, but no significant material loss had occurred.

The harness rods and coupling bolts were also inspected for corrosion alteration. The observations are provided in Table 4. None of the fasteners, or the surrounding lugs, coupling components and pipe surfaces exhibited significant corrosion. The fasteners and the lugs were not necked down / stretched and no cracks were present. The coupling bolt heads were not marked. The coupling was disassembled during inspection and additional images of the observed features are included as Figures 14 through 18. The interior surfaces were not significantly degraded or corroded.

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 A1 | Exterior | Top | Substantial fusion |
| | | Bottom | No weld |
| | Interior | Top | No weld |
| | | Bottom | Partial weld |
| 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 | Substantial fusion |
| | | Bottom | No weld |
| | Interior | Top | No weld |
| | | Bottom | Substantial fusion |

## TABLE 4 – FASTENER VISUAL EXAMINATION RESULTS

| Component | Observations |
|---|---|
| Rod 1 | Not bent or stretched, no gross corrosion, rotated freely |
| Rod 2 | Not bent or stretched, no gross corrosion |
| Bolt 1 | Not bent or stretched, no gross corrosion |
| Bolt 2 | Not bent or stretched, no gross corrosion |
| Bolt 3 | Not bent or stretched, no gross corrosion |
| Bolt 4 | Not bent or stretched, no gross corrosion |

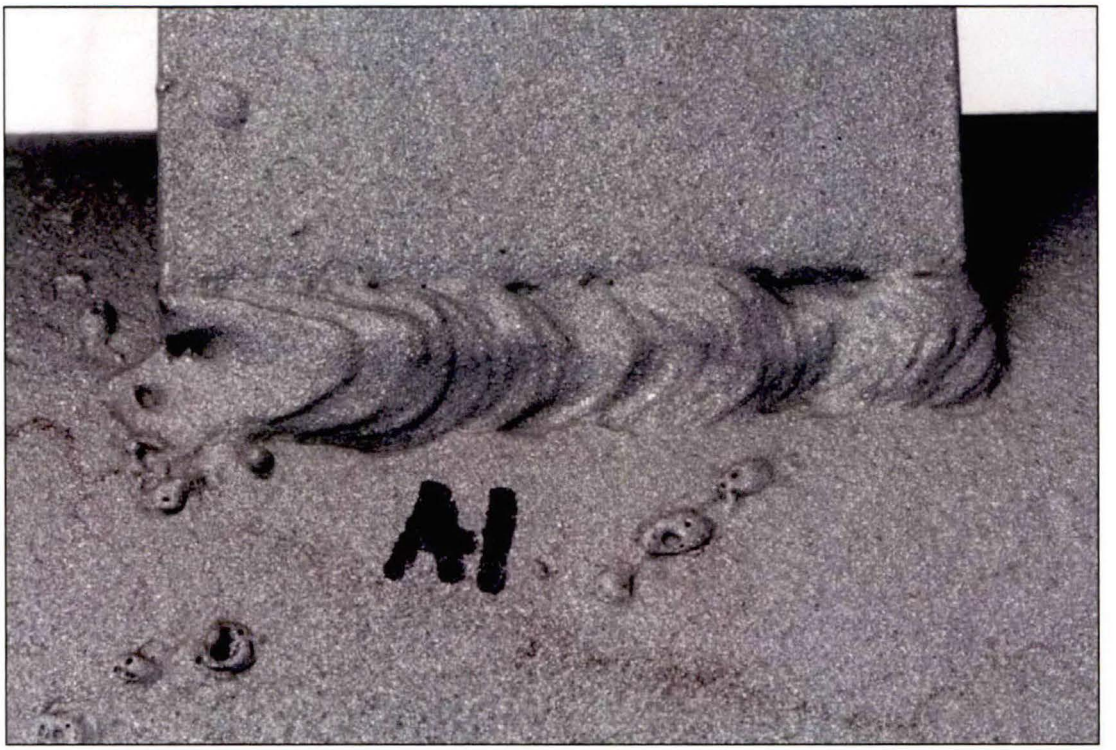



Figure 5. Image of the Lug A1 exterior top weld which exhibited substantial fusion except for some overlap, spatter and underfill.


Figure 6. Image of the Lug B1 exterior top weld which exhibited minimal porosity.

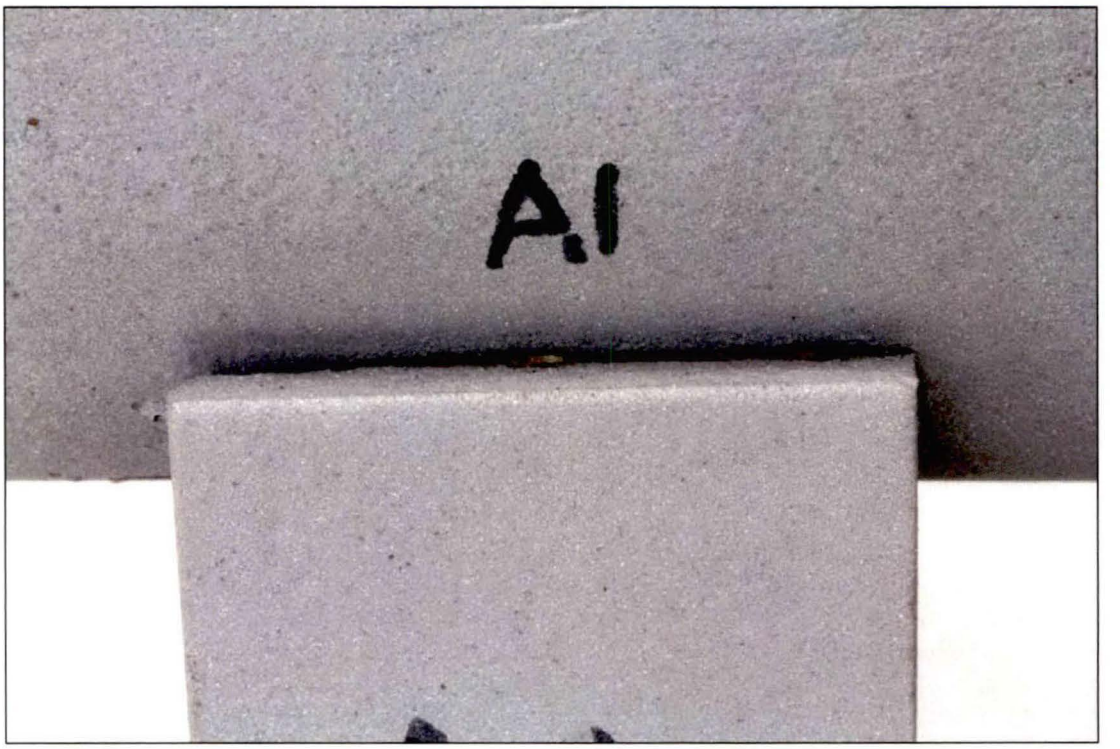



Figure 7. Image of the Lug A1 exterior bottom joint region which was not welded.

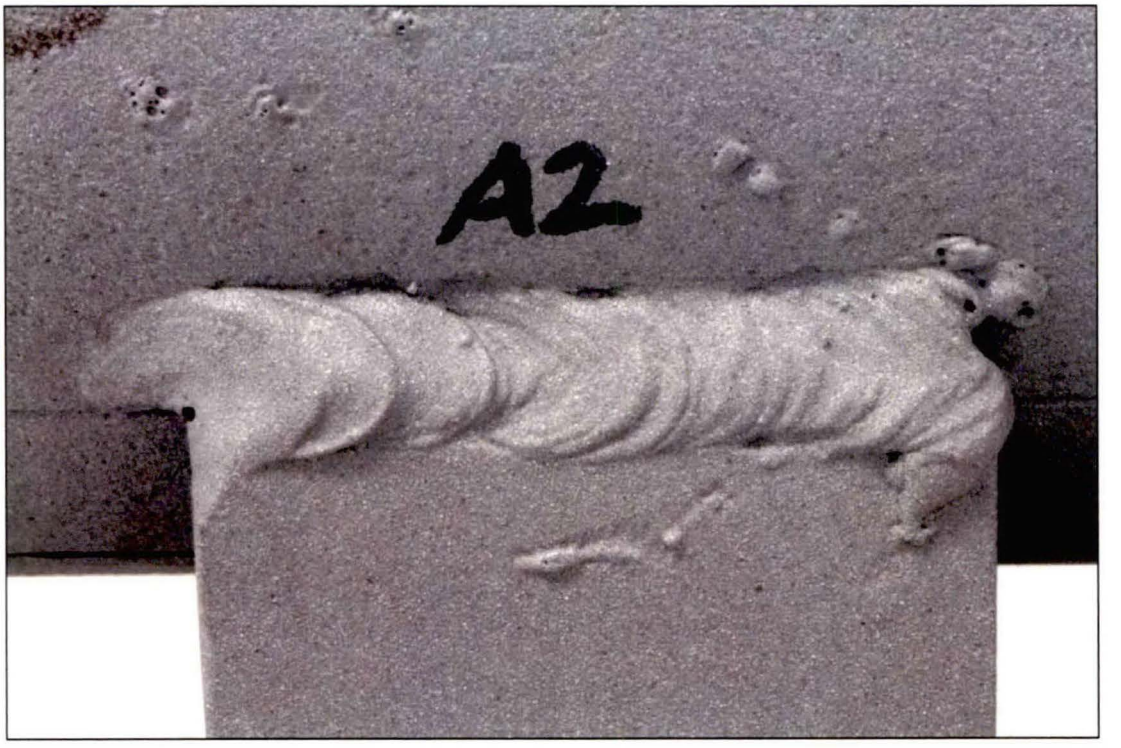



Figure 8. Image of the Lug A1 exterior top weld.

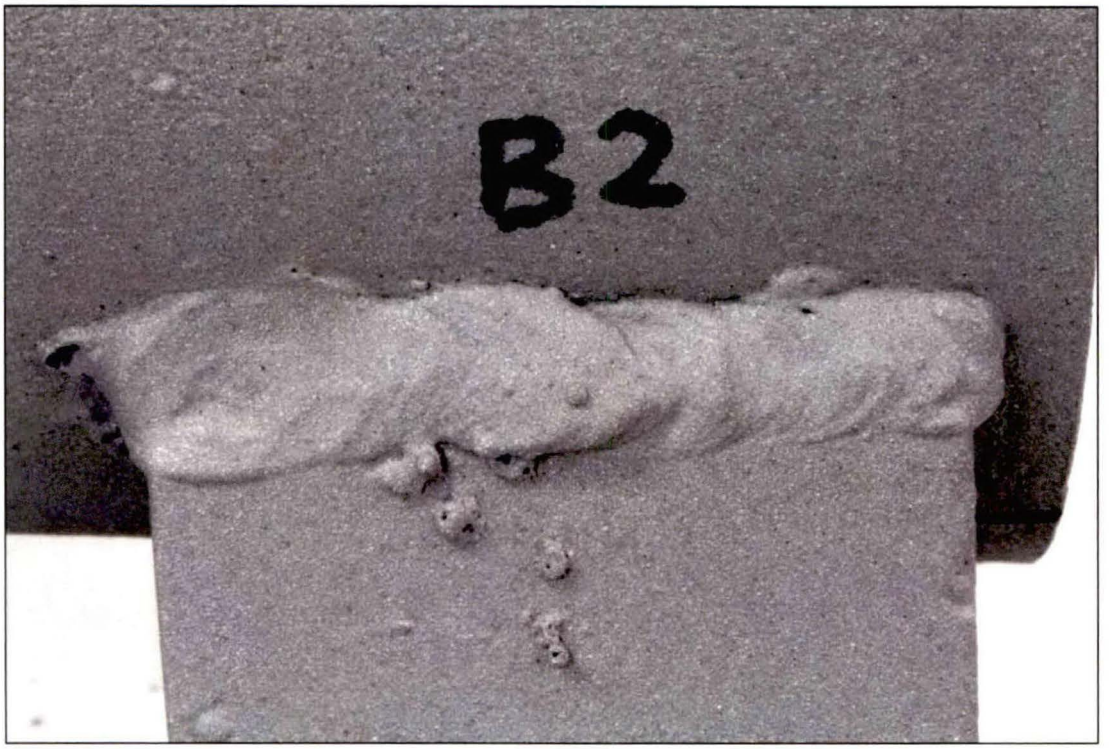



Figure 9. Image of the Lug B2 exterior top weld which exhibited substantial fusion except for some overlap and spatter.

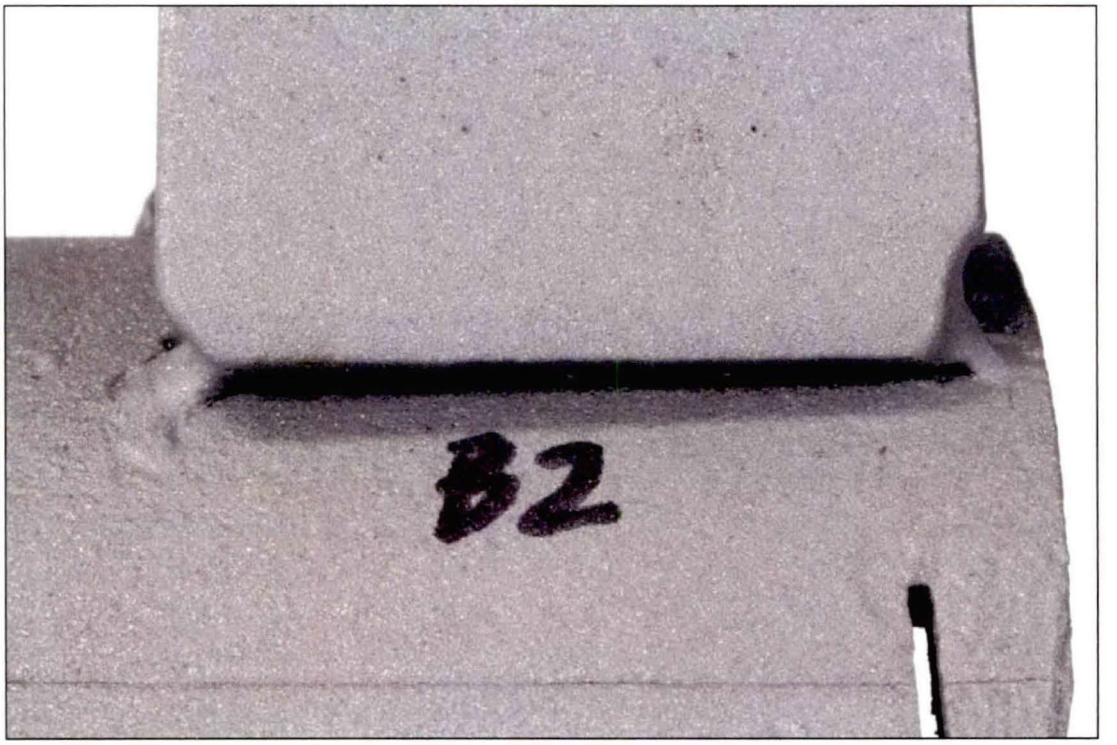



Figure 10. Image of the Lug B2 exterior bottom weld. Joining at the ends of the lug was from welding from the interior surface.

Figure 11. Image of the Lug A2 interior bottom weld which exhibited substantial fusion except for some overlap and spatter.

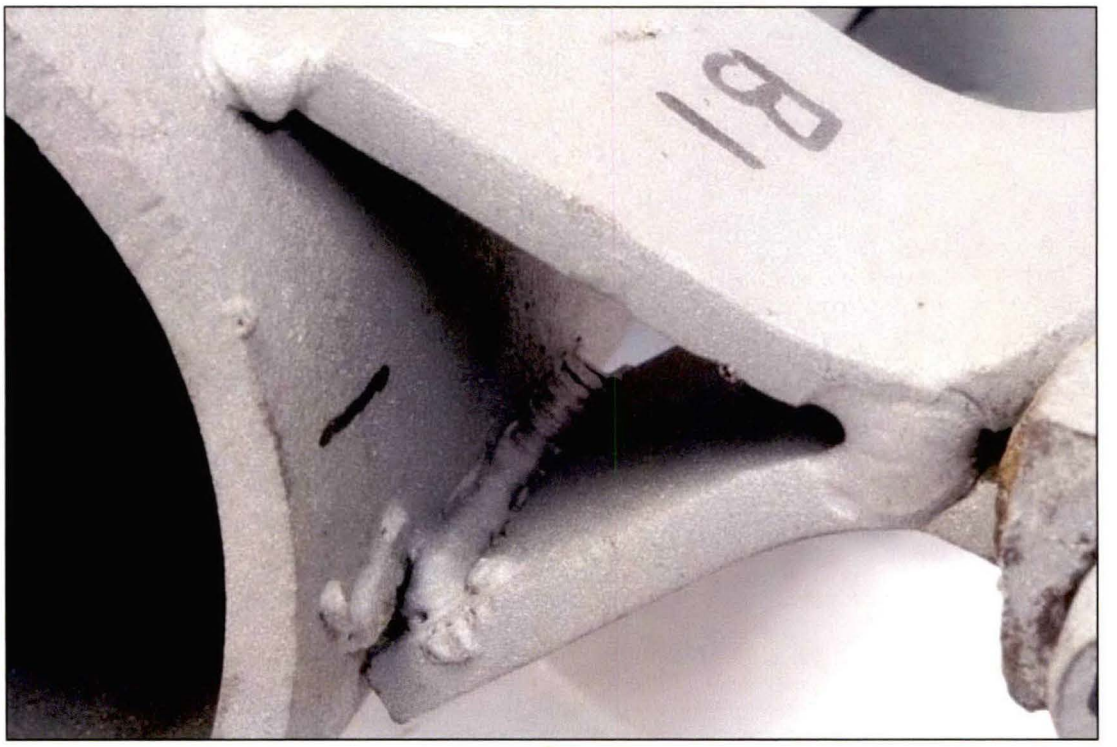



Figure 12. Image of the Lug B1 interior bottom weld which exhibited some fusion.

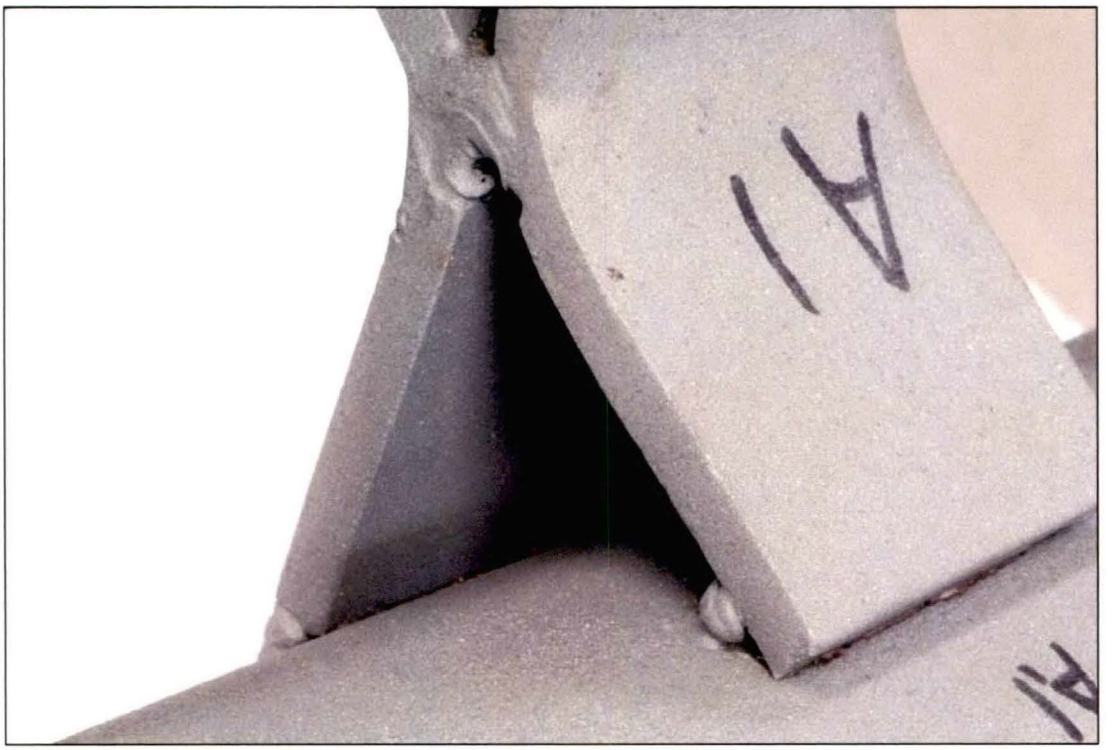



Figure 13. Image of the Lug A1 interior top weld (left) and the exterior bottom weld (right).

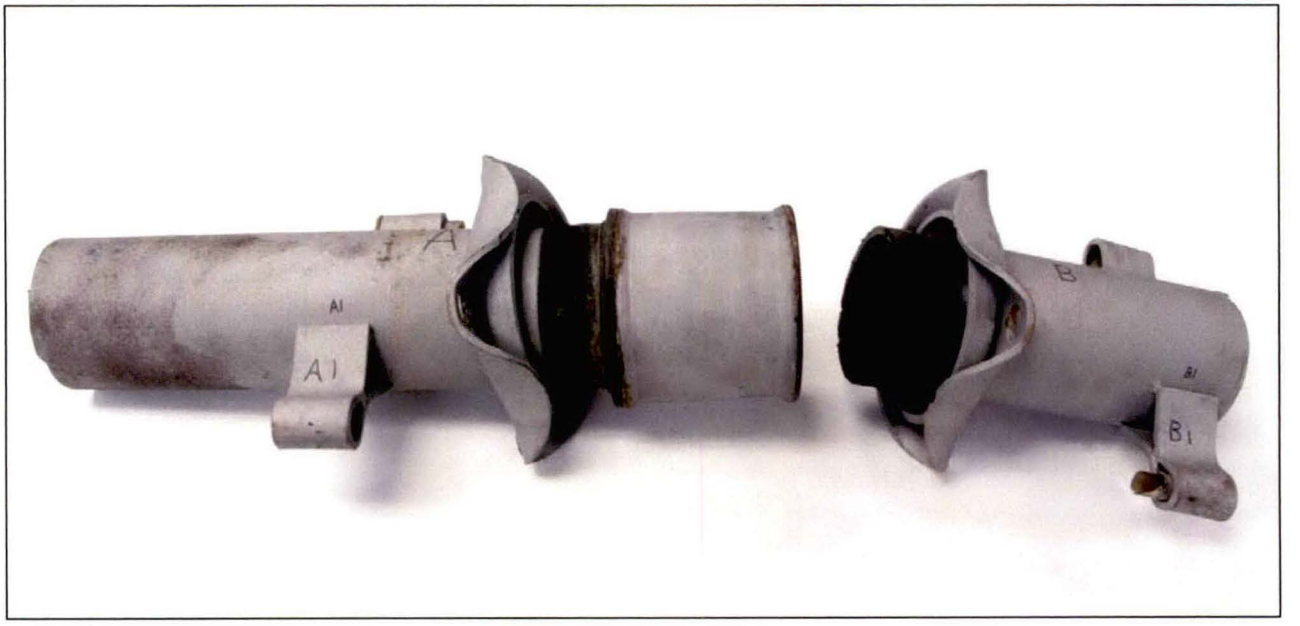



Figure 14. Photograph of the pipe sample after disassembly.

Figure 15. Photograph into the End A pipe section with the coupling attached. The green pipe separator ring was evident.

Figure 16. Photograph of the end of the End B pipe section.

Figure 17. This is an image of the black polymeric sleeve.

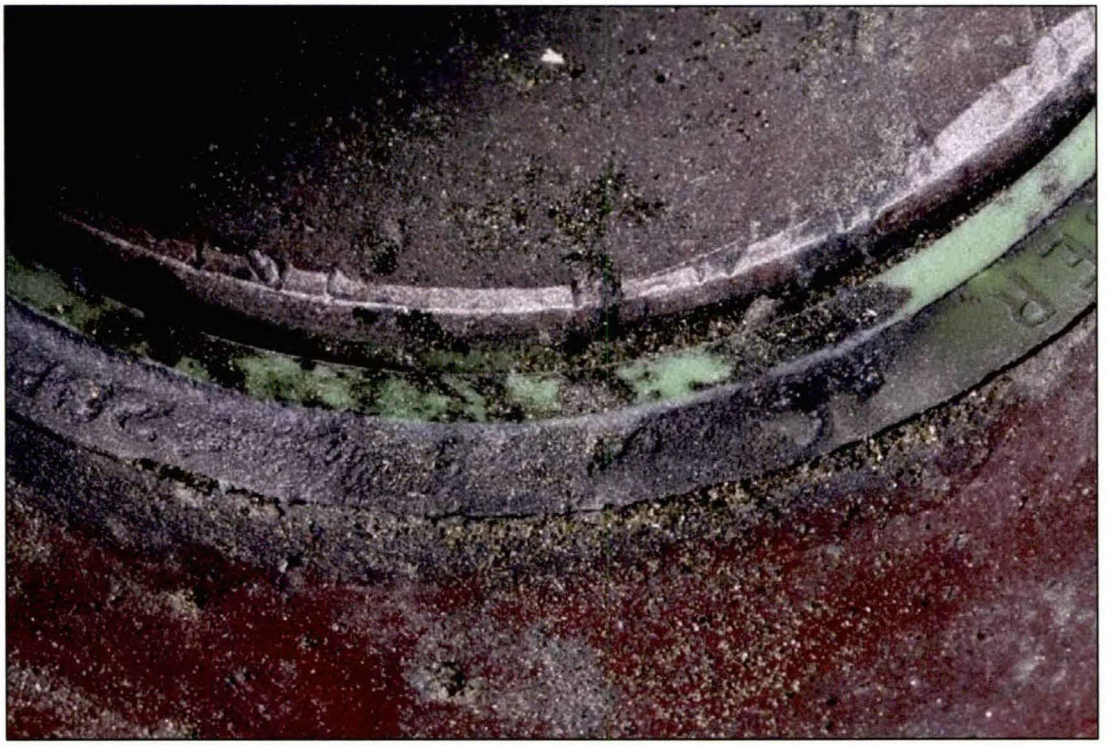


Figure 18. Photograph of the green pipe separator.

## SECTION 3- TORQUE TESTING- FOR INFORMATION ONLY

Torque testing was performed on the nuts of the rods and studs on the pipe coupling sample. A calibrated torque wrench was used to determine breakaway torque on each fastener. Prior to testing it was apparent that the Rod 1 nut was loose, suggesting no clamping force on the lugs. The breakaway torque measurements are summarized in Table 5. The rods did not have a specified torque requirement. The four coupling bolts exhibited torque values ranging from 70 to 90 ft.-lbs. Two bolt torque values were below the Dresser Style 39 coupling installation torque recommendation of 75 ft.-lbs. minimum for 5/8" fasteners.

### TABLE 5 – FASTENER TORQUE MEASUREMENT

| Component | Breakaway Torque | Observations |
|---|---|---|
| Rod 1 | < 10 ft.-lbs. | Nut spun by hand – no clamping force |
| Rod 2 | 15 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 1 | 70 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 2 | 70 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 3 | 90 ft.-lbs. | Satisfied the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 4 | 75 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |

## 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 indicated for the fasteners on the provided Dresser harness or coupling information.

### TABLE 6 – FASTENER TENSION TEST RESULTS

| Component | Ultimate Tensile Strength, ksi | 0.2% Offset Yield Strength, ksi | Elongation, % | Reduction in Area, % |
|---|---|---|---|---|
| Rod 1 | 89.0 | 52.0 | 30 | 51 |
| Rod 2 | 98.5 | 55.5 | 17 | 35 |
| Bolt 1 | 69.0 | 52.0 | 32 | 67 |
| Bolt 2 | 68.0 | 48.9 | 34 | 67 |
| Bolt 3 | 68.0 | 49.8 | 35 | 67 |
| Bolt 4 | 68.5 | 50.5 | 33 | 65 |

Specimen Dimensions; Diameter 0.35", with gage length of 1"
Percent elongation was measured using elongation-after-fracture measurements

## SECTION 5- ROCKWELL AND SUPERFICIAL HARDNESS, ASTM E18-17

Small sections of the four lugs were excised for hardness testing. Rockwell hardness testing was performed on the lugs after 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 | 87 | 90 | 89 | 89 | 89 |
| Lug A2 | 87 | 88 | 87 | 87 | 87 |
| Lug B1 | 88 | 88 | 88 | 89 | 88 |
| Lug B2 | 87 | 87 | 87 | 87 | 87 |

## SECTION 6- LIQUID DYE PENETRANT EXAMINATION

The two separated ends of the disassembled coupling were sent to a third party NDE laboratory for inspection. The primary inspector recommended dye penetrant examination rather than the magnetic particle inspection technique. Inspection was performed in accordance with the acceptance criteria of API 1104 "Welding of Pipelines and Related Facilities". The inspection results are provided as an appendix. Two representative welds are shown in Figures 19 and 20 with the dye penetrant test media remaining.

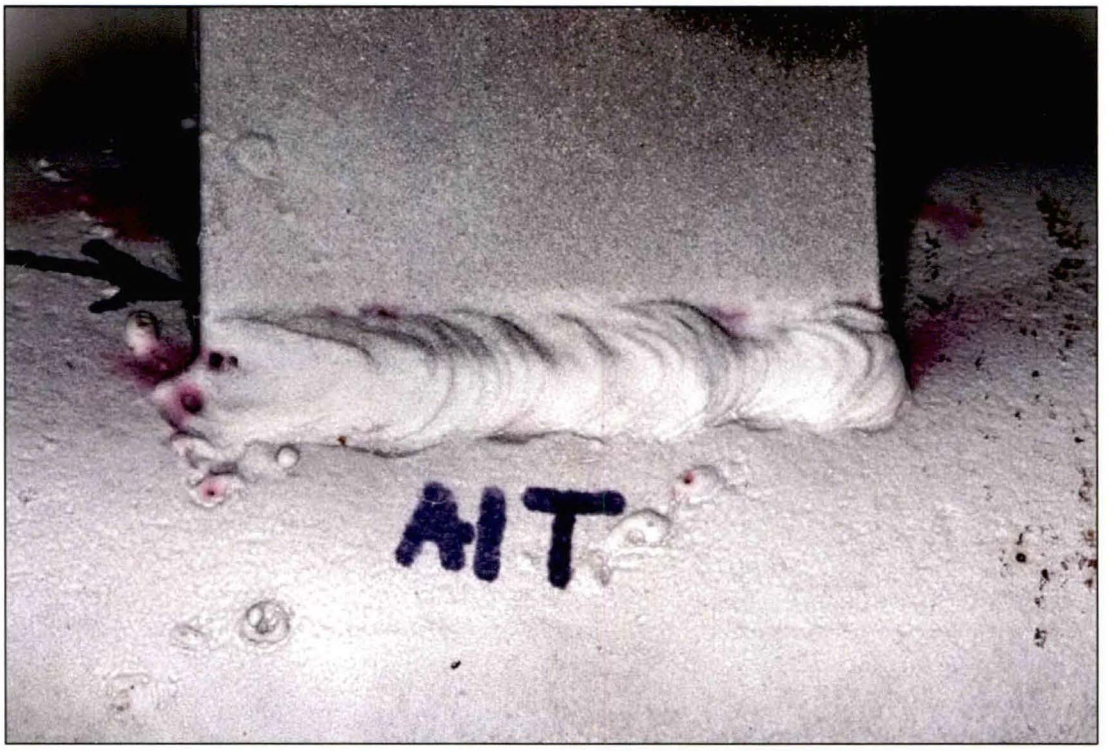



Figure 19. Image of the Lug A1 exterior top weld after dye penetrant media had been used during inspection.

Figure 20. Image of the Lug B1 interior bottom weld after dye penetrant media had been used during inspection.

Testing Cert # 1140.03 & 1140.04

Respectfully submitted

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

Concurrence

Remmel O. Taylor
Senior Metallurgist / Failure Analyst

All procedures were performed in accordance with the IMR Quality Manual, current revision, and related procedures; and the PWA MCL Manual F 23 and related procedures. The information contained in this test report represents only the material tested and may not be reproduced, except in full, without the written approval of IMR Test Labs ("IMR"). IMR maintains a quality system in compliance with the ISO/IEC 17025 and is accredited by the American Association for Laboratory Accreditation (A2LA), certificates #1140.03 and #1140.04. IMR will perform all testing in good faith using the proper procedures, trained personnel, and equipment to accomplish the testing required. IMR's liability to the customer or any third party is limited at all times to the amount charged for the services provided. All samples will be retained for a minimum of 6 months and may be destroyed thereafter unless otherwise specified by the customer. The recording of false, fictitious, or fraudulent statements or entries on this document may be punished as a felony under federal statutes. IMR Test Labs is a GEAE S-400 approved lab (Supplier Code T9334).

## APPENDIX – NONDESTRUCTIVE INSPECTION RECORD

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

# NDE PENETRANT REPORT

Client: IMR
Project: 201801864A/B
Item Description: 4" support clips
Part No: See below
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 | |
| Material Thickness | | Dimensions | N/A |
| Weld Length/OD | | Additional Info | |
| Surface Condition | | Surface Condition | |

PRECLEAN: Method Spray/wipe Material SKC-S Aerosol
Batch No. 15M15K Drying Time 10 minutes

PENETRANT: Material SKL-WP2 Batch No. 17H13K
Application brush Dwell Time 25 minutes

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

EXCESS PENETRANT REMOVAL: Material towel/wipe Batch No.
Method Drying Time

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

POSTCLEAN: Material SKC-S Aerosol Batch No. 15M15K
Method Spray/wipe

No. of Parts Accepted 4 Serial No.'s
No. of Parts Rejected 6 Serial No.'s

OTHER INFORMATION:

A1B-No weld
A1B1-Rejected porosity/crack
A1T-Accepted
A1T1-Rejected
A2T-Accepted
A2T1-No weld
A2B1-Rejected

B1T-Accepted
B1T1-Rejected crack
B1B1-Rejected Lack of fusion
B1B-No weld
B2T-Accepted
B2T1-No weld
B2B1-Rejected Lack of fusion

INSPECTED BY:

DATE: 8/10/18

Legend

A1B- Lug **A1**, Bottom Weld

A1BI- Lug **A1**, Bottom Inside Weld

A1T- Lug **A1**, Top Weld

A1TI- Lug **A1**, Top Inside Weld

A2T- Lug **A2**, Top Weld

A2TI- Lug **A2**, Top Inside Weld

A2BI- Lug **A2**, Bottom Inside Weld

B1T- Lug **B1**, Top Weld

B1TI- Lug **B1**, Top Inside Weld

B1BI- Lug **B1**, Bottom Inside Weld

B1B- Lug **B1**, Bottom Weld

B2T- Lug **B2**, Top Weld

B2TI- Lug **B2**, Top Inside Weld

B2BI- Lug **B2**, Bottom Inside Weld

# 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:

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:

1. Contact Employee for the bolt style coupling found:
2. Date of exposure: 04/06/2018
3. Location: 5252 Cane Run Rd (Cane Run Generating Station
4. Size of coupling (based on pipe size if not exposed enough to determine):
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 (Note: data not collected, this field was added after coupler was removed)
7. Status: x Removed □Abandoned in place □Backfilled- left in service

## 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 showing the coupling orientation (vertical/horizontal), nearby branches, pipe, valves and fittings, other utilities or structures, etc.

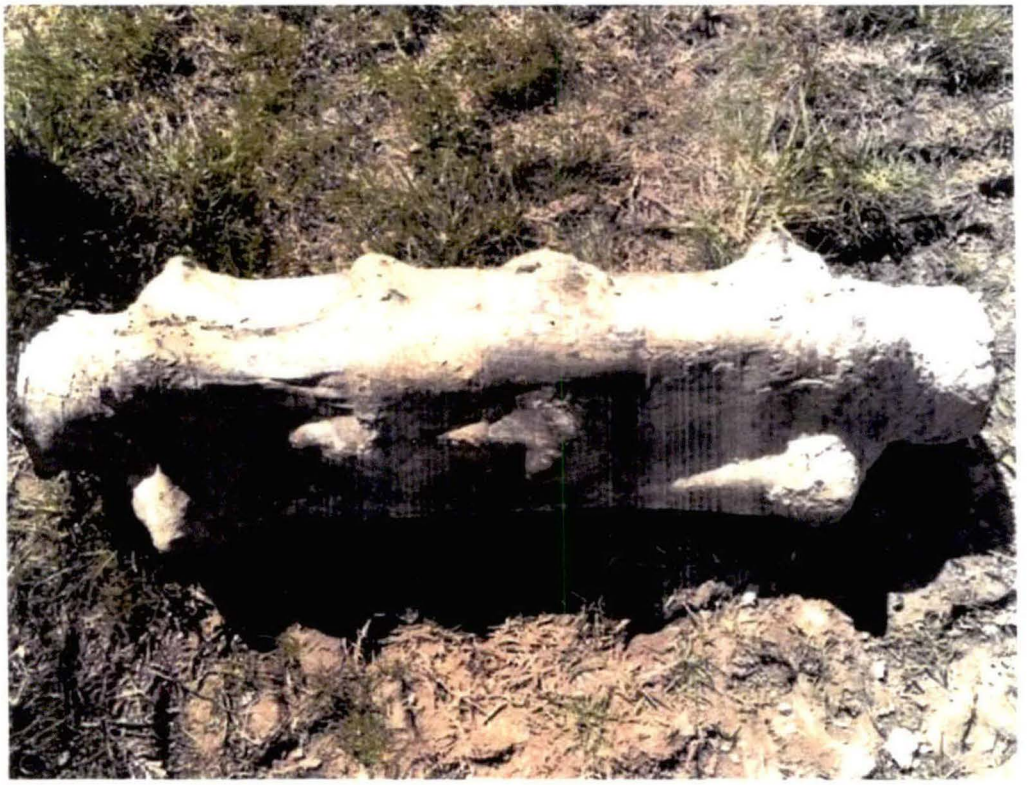
## Leak Survey:

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.

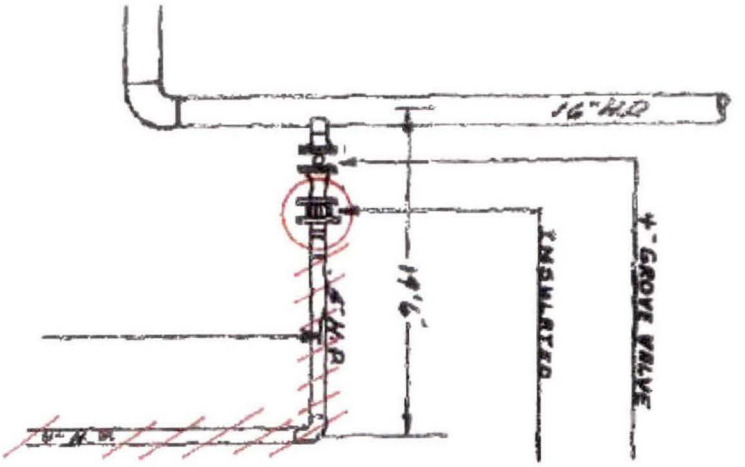
Leak Survey completed at time of backfill (circle one) yes no

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.

Field Pictures



Sketch

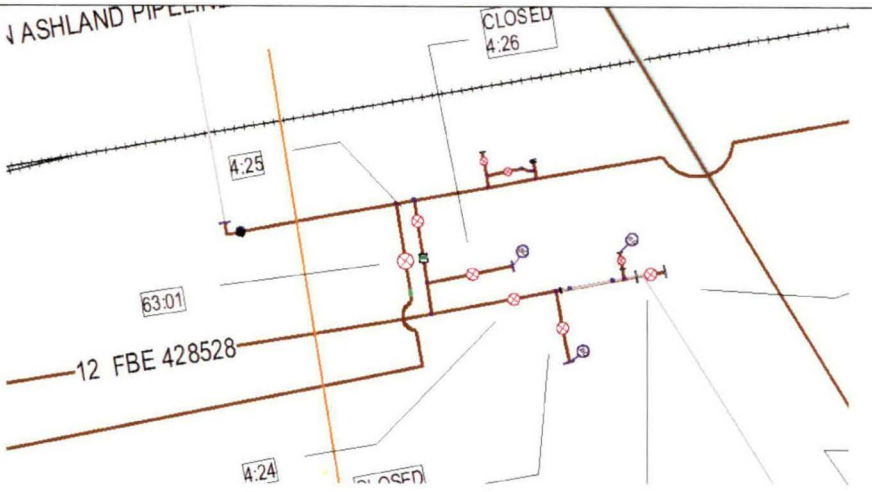


## Part B- Coupling Information

| General Information | | | Tracking #: 2018-005 |
|---|---|---|---|
| Date<br>7/3/2018 | Expense Org<br>004385 | Project<br>134829 | Task<br>LAB |
| Address/Location<br>5252 Can Run Rd (Cane Run Power Plant) | | | |
| Size<br>4-inch | Material<br>Steel | Coating<br>Wax Tape | MAOP<br>305 |
| Main/Service Number<br>160878 | Soil Type (from Part A)<br>Unavailable | Manufacturer<br>Dresser | Model<br>4-inch Style 39 |
| Pipe Connection: | Steel to Steel (circled) | Steel to Plastic | Plastic to Plastic |

| Historical Information | |
|---|---|
| Installation Date<br>4/8/1959 | Document Source<br>Main Report |
| Installation Company<br>Mims Pipeline | Document Source<br>Main Report |
| Foreman<br>R.E. Mingus | Document Source<br>Main Report |
| Welder<br>Unknown | Document Source<br>Main Report |

| GIS Information |
|---|
| Sys Id (of Coupler)<br>11926543 |
| Screen Capture |



Pictures

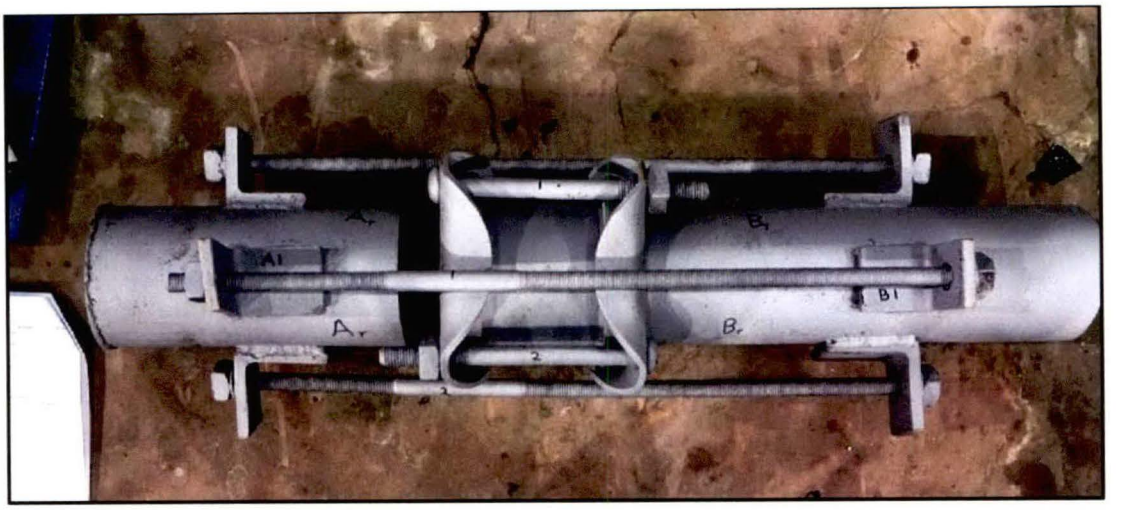



*Figure 1- Top View*


*Figure 2- Front View*

*Figure 3- Back View*

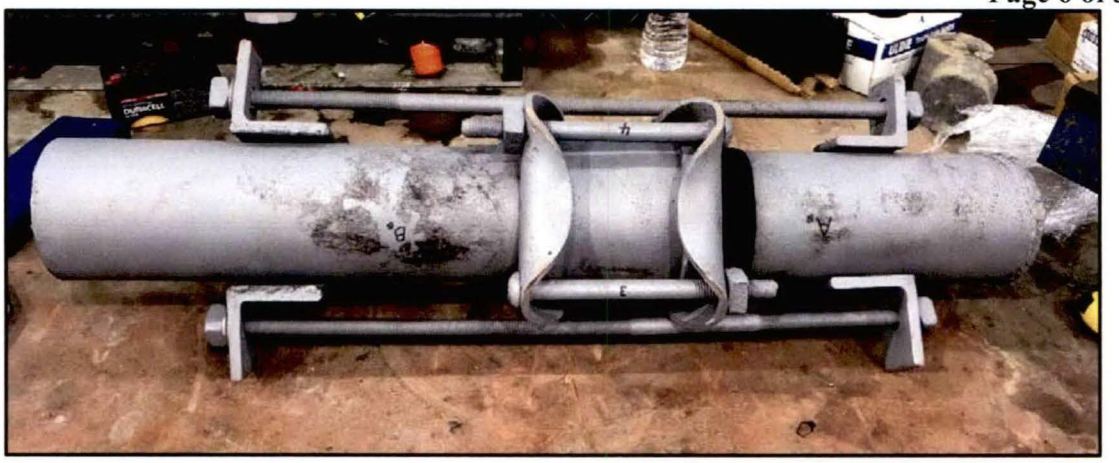


*Figure 4- Bottom View*

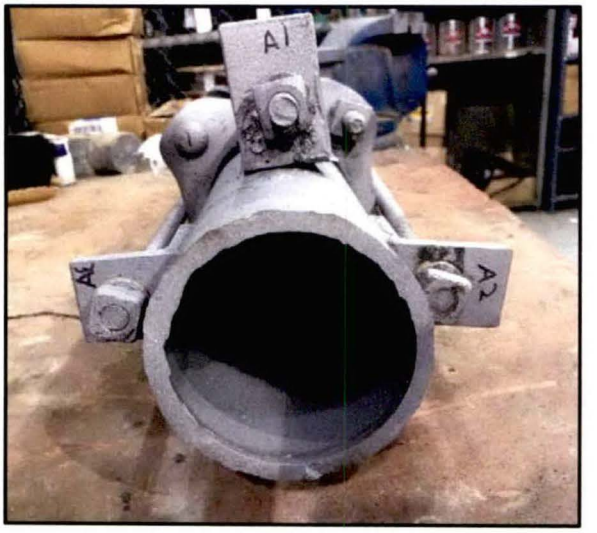



*Figure 5- Left Side*


*Figure 6- Right Side*

## Part C- Inspection of Coupling

Visual Inspection Performed by: Chad Augustine [redacted] & Elliott Bauer [redacted]

| Component Quantities | |
|---|---|
| Number of Bolts on Coupler Body | 4 |
| Number of Reinforcement Rods | 3 |
| Number of Lugs | 6 (2 each) |

| Corrosion | | | | | | |
|---|---|---|---|---|---|---|
| | Pipe A | Pipe B | Coupler Body | Bolts | Rods | Lugs |
| General External Corrosion Present? | No | No | No | No | No | No |
| Localized Corrosion Present? | No | No | No | No | Possible[1,2] | No |
| Pit Depths | N/A | N/A | N/A | N/A | >.03 $mm^2$ | N/A |
| Internal Corrosion? | No | No | | | | |

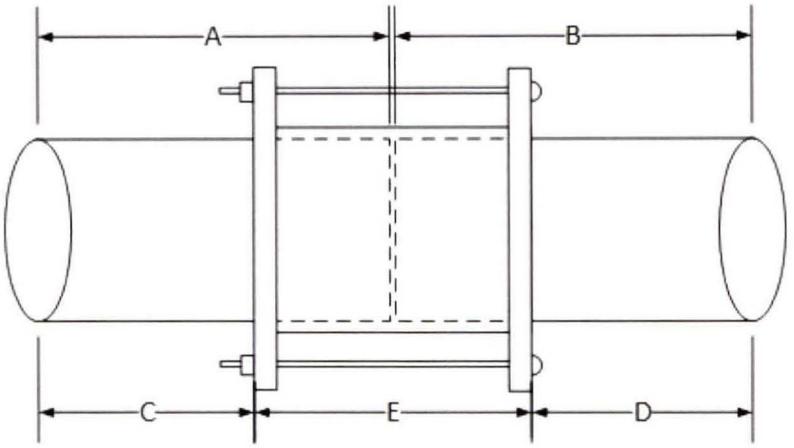
| Coupler Body | | | | |
|---|---|---|---|---|
| Length of Coupler (in.): | 6.5625 in | | | |
| Bolt | Washer Present? | Nut present? | | |
| 1 | No, no washer either side | Yes | | |
| 2 | No, no washer either side | Yes | | |
| 3 | No, no washer either side | Yes | | |
| 4 | No, no washer either side | Yes | | |

| 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" | .629" | Yes | Yes | Yes[3] Square | All Thread? (no head) |
| 2 | 24" | .631" | Yes | Yes | Yes Square | All Thread? (no head) |
| 3 | 24" | .645" | Yes | Yes | Yes Square | All Thread? (no head) |

| Lugs (Measurements) | | | | |
|---|---|---|---|---|
| Pipe Side | Lug Number | Thickness (in.) | Circumference (in) | |
| | | | Distance to next lug, clockwise | Distance to next lug, counter-clockwise |
| A | 1 | .485" | To A2: 3.1875" | To A3: 4.375" |
| A | 2 | .481" | To A1: 3.1875"' | To A3: 6.375" |
| A | 3 | .481" | To A1: 4.375" | To A2: 6.375" |
| B | 1 | .478 | To B2: 3.4375" | To B3: 4.250" |
| B | 2 | .477" | To B1: 3.4375" | To B3: 6.6875" |
| B | 3 | .477" | To B1: 4.250" | To B2: 6.6875" |

| Lugs (Observations) | | | | |
|---|---|---|---|---|
| Lug | Lug | Assembly sets aligned? | Deformed? | Deflected? (angle of) |
| A1 | B1 | Yes | Yes. The rods are bowed over the coupler body. See Figures 1, 2, 3, & 4. | 0° |
| A2 | B2 | Yes | Yes. The rods are bowed over the coupler body. See Figures 1, 2, 3, & 4. | 0° |
| A3 | B3 | Yes | Yes. The rods are bowed over the coupler body. See Figures 1, 2, 3, & 4. | 0° |

| Lugs (Weld Quality) | | | | | | |
|---|---|---|---|---|---|---|
| Pipe Side | Lug Number | Any part detached from pipe? | Welded on all three sides of exterior? If no, describe | Are welds on exterior continuous? If no, describe | Welded on all three sides of interior? If no, describe | Are welds on interior continuous? If no, describe |
| A | 1 | Yes | No, all have one weld.[4] | Yes | Not Applicable[5] | Not Applicable[5] |
| A | 2 | Yes | No, all have one weld.[4] | Yes | Not Applicable[5] | Not Applicable[5] |
| A | 3 | Yes | No, all have one weld.[4] | Yes | Not Applicable[5] | Not Applicable[5] |
| B | 1 | Yes | No, all have one weld.[4] | Yes | Not Applicable[5] | Not Applicable[5] |
| B | 2 | Yes | No, all have one weld.[4] | Yes | Not Applicable[5] | Not Applicable[5] |
| B | 3 | Yes | No, all have one weld.[4] | Yes | Not Applicable[5] | Not Applicable[5] |




| Stab Depth | | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | Stab Depth (A-C) or (B-D) |
| Pipe Side A | 13.5" | | 10.5625" | | 2.9375" |
| Pipe Side B | | 17.9375" | | 14.5" | 3.4375" |
| | Sum of stab depths (should be closely equal to measurement E) | | | | 6.375" |
| | | | | Coupler Length (E) | 6.5625" |
| | | | | Difference | 0.1875" |

Additional Comments and General Observations

[1] Possible corrosion on rod 1. The rod is in contact with the coupler brackets. It is unknown if the indications on the rod and bracket are corrosion or metal loss due to rod and bracket rubbing against each other. See Figure 7.

[2] Severe corrosion on nut A1. It is greater than .03. The pit gage would not lay flat against the nut in order to get an accurate measurement. See Figure 8.

[3] Does not have an insulating washer.

[4] The lugs do not conform to the curvature of the pipe and cannot make complete contact. See Figures 9 & 10.

[5] The lugs are solid flat surfaces with no interior. See Figure 11.

*Figure 7- Rod 1 Metal Loss*

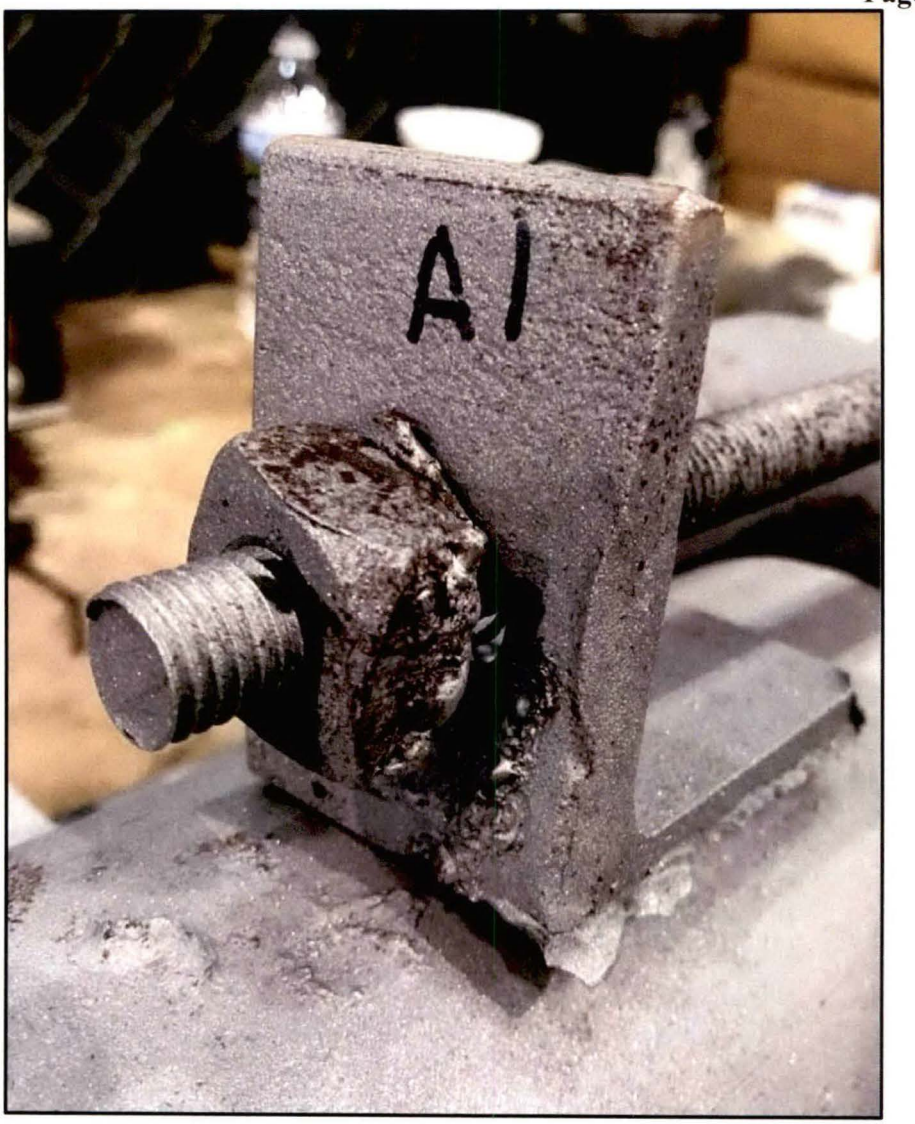



*Figure 8- Nut A1 & Lug A1 Metal Loss*


*Figure 9- Side View of Lug*


*Figure 10- Front View of Lug*

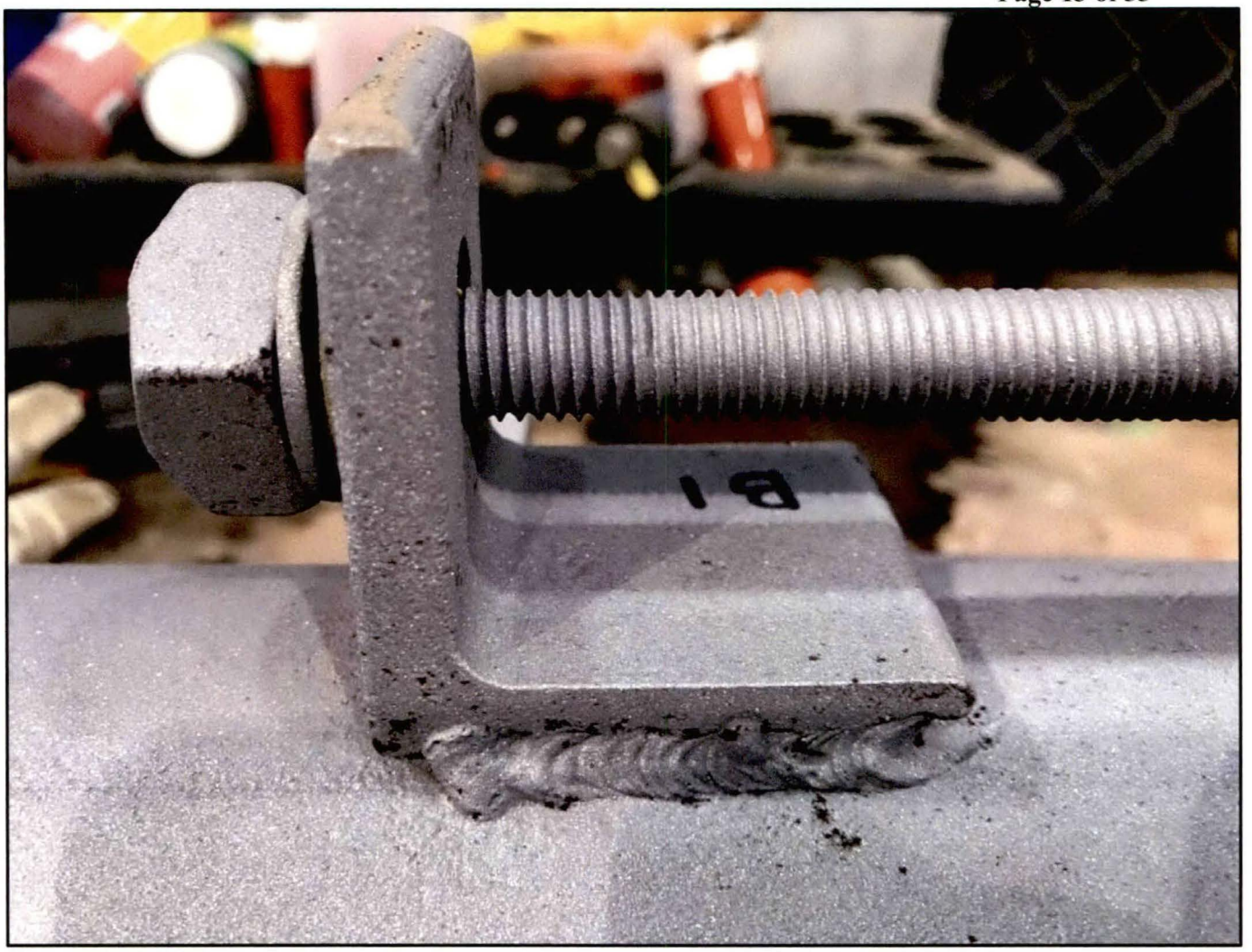



*Figure 11- Front View of Lug*

## Part D- Analysis of Coupling

This section is reserved for the lab report.

**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**

**August 17, 2018**

Attention: Chad Augustine

# Report No. 201801863

# Metallurgical Evaluation of Coupling and Associated Hardware

# Location: 5252 Cane Run Road

## 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 39 Insulating Coupling. Three joint harnesses were also affixed to the pipe section using angle iron lugs. Copies of the installation information for the coupling and harnesses were provided for a prior investigation. It was reported that the coupling had been installed in the field at 5252 Cane Run Road. The coupled pipe section was subsequently excavated after a 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. Six cut angle iron lugs of the joint harnesses had been fillet welded to the pipe segments. Three threaded rods and associated nuts with deflection rings had been affixed through the welded lugs to apply compression to the coupled joint. The coupling consisted of two followers, a middle ring and associated nonmetallic gaskets and sleeves. Four equally spaced bolts with associated nuts secured the coupling components together and against the pipe segments. The general orientation of the coupling was consistent with the supplied information for the specified Dresser Style 39. 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 of the pipe was selected as the surface with the middle harness and generally better weld appearance. Lugs A1, A2 and A3 were welded to Pipe A, and Lugs B1, B2 and B3 were welded to Pipe B. The rod between lugs A1 and B1 was Rod 1, between A2 and B2 was Rod 2 and the between Lugs A3 and B3 was Rod 3. The four coupling bolts were arbitrarily numbered as Bolts 1 through 4 around the circumference.


Figure 1. Photograph of the top of the submitted coupling sample. Three attachment rods were affixed with angle iron lugs. Lugs A1 and B1 are identified.

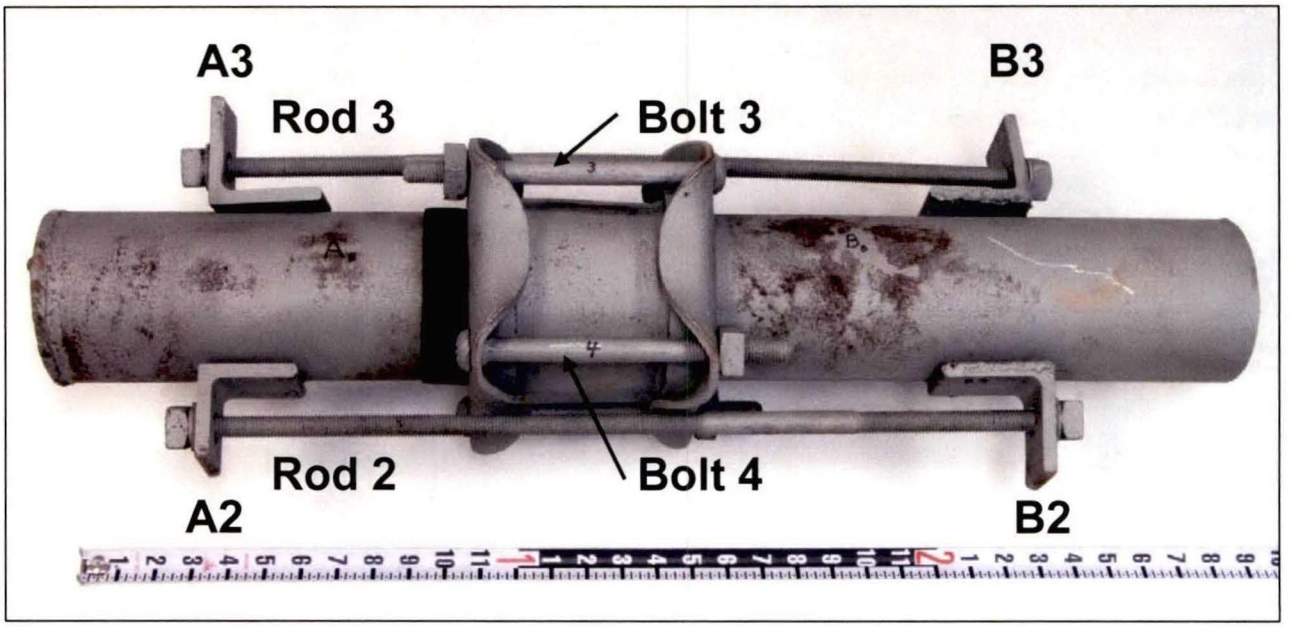



Figure 2. Photograph of the bottom of the submitted sample. Lug, rod and bolt identifications are shown.

## SECTION 1- DIMENSIONAL MEASUREMENT

The three sets of harness lugs were positioned on opposite sides of 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 harness lugs were straight and not bent. The depth of insertion of each pipe into the coupling was also measured, both before and verified after disassembly. The dimensions are provided in Table 2. No requirements were provided for these characteristics.

### TABLE 1 – LUG SPACING DIMENSIONAL MEASUREMENTS

| Compound | Angle | Image |
|---|---|---|
| Rod A1 / Rod A2 | 96° | Figure 3 |
| Rod A1 / Rod A3 | 100° | Figure 3 |
| Rod A2 / Rod A3 | 196° | Figure 3 |
| Rod B1 / Rod B2 | 84° | Figure 4 |
| Rod B1 / Rod B3 | 102° | Figure 4 |
| Rod B2 / Rod B3 | 186° | Figure 4 |

### TABLE 2 – PIPE COUPLING DIMENSIONAL MEASUREMENTS

| Component | Depth of Pipe into Coupling | Gap Between Pipes in Coupling |
|---|---|---|
| Pipe A | 2 1/2" | ~ ½" (Total sample length = 31 3/4") |
| Pipe B | 2" | |

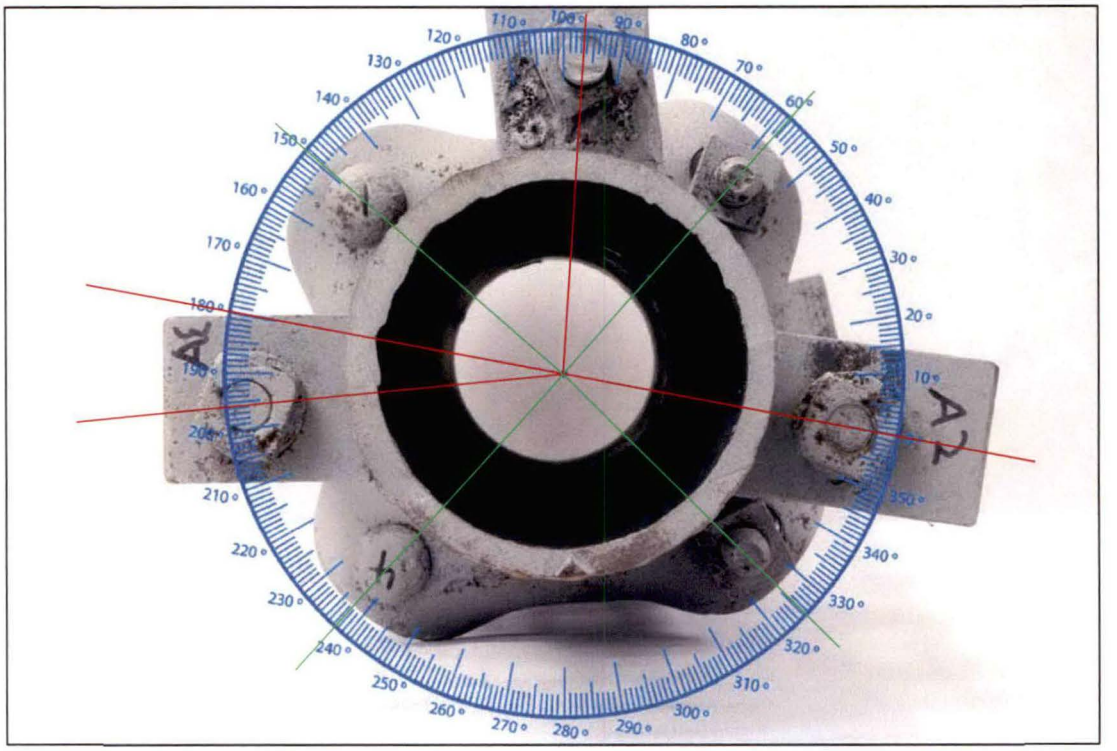



Figure 3. End facing image of the sample at End A. A superimposed protractor shows the angles between the centers of Lugs A1, A2 and A3.

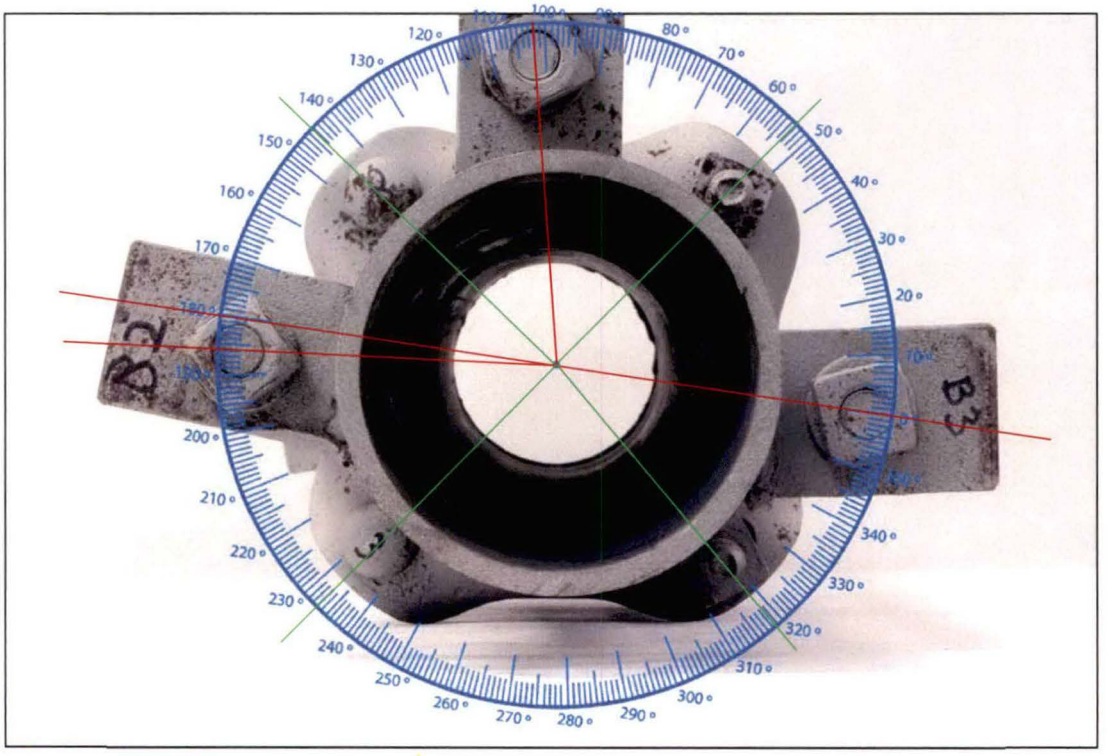



Figure 4. End facing image of the sample at End B. A superimposed protractor shows the angles between the centers of Lugs B1, B2 and B3.

## SECTION 2- VISUAL OBSERVATIONS

The lug attachment welds were another region of interest on the coupling sample. Each of the six lugs contained two fillet weld locations. Lugs A1 and B1 had welds on the left and right whereas Lugs A2, B2, A3 and B3 had top and bottom weld joints. Each weld was inspected visually using a flashlight and magnifying lens. 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 13. The bases of the lugs were flat so they did not conform to the curvature of the pipe surface. As a result, only one side of each lug could be welded. The non-welded sides of some lugs contained welding evidence but no fusion. It was noted that the completed welds contained localized weld discontinuities including undercut, overlap, and spatter in addition to the incomplete fusion. No cracking in the welds or base metal heat affected zones (HAZ) was visually identified. Some superficial pitting corrosion was observed, but no significant material loss had occurred.

The harness rods and coupling bolts were also inspected for corrosion alteration. The observations are provided in Table 4. None of the fasteners, or the surrounding lugs, coupling components and pipe surfaces exhibited significant corrosion. The fasteners and the lugs were not necked down / stretched and no cracks were present. The coupling was disassembled during inspection and additional images of the observed features are included as Figures 14 through 18. The interior surfaces were not significantly degraded or corroded.

The elastomeric components of the coupling consisted of a pipe separator, insulating sleeve, and gaskets. Inspection revealed that they appeared to be intact and not degraded. Some debris was evident within the assembled components but corrosion was minimal.

## TABLE 3 – LUG WELD VISUAL EXAMINATION RESULTS

| Component | Location | Weld | Observations |
|---|---|---|---|
| Lug A1 | Exterior | Right | No fusion |
| | | Left | Substantial fusion |
| Lug A2 | Exterior | Top | Substantial fusion |
| | | Bottom | No weld |
| Lug A3 | Exterior | Top | Substantial fusion |
| | | Bottom | No weld |
| Lug B1 | Exterior | Right | No weld |
| | | Left | Substantial fusion |
| Lug B2 | Exterior | Top | Substantial fusion |
| | | Bottom | No fusion |
| Lug B3 | Exterior | Top | Substantial fusion |
| | | Bottom | No fusion |

## TABLE 4 – FASTENER VISUAL EXAMINATION RESULTS

| Component | Observations |
|---|---|
| Rod 1 | Not bent or stretched, no gross corrosion, nut rotated freely |
| Rod 2 | Not bent or stretched, no gross corrosion |
| Rod 3 | Not bent or stretched, no gross corrosion |
| Bolt 1 | Not bent or stretched, no gross corrosion |
| Bolt 2 | Not bent or stretched, no gross corrosion |
| Bolt 3 | Not bent or stretched, no gross corrosion |
| Bolt 4 | Not bent or stretched, no gross corrosion |


Figure 5. Image of the Lug A1 left weld which exhibited substantial fusion. Some porosity was apparent.


Figure 6. Image of the Lug B1 left weld which exhibited substantial fusion.


Figure 7. Image of the Lug A2 top weld. This weld exhibited some incomplete fusion.

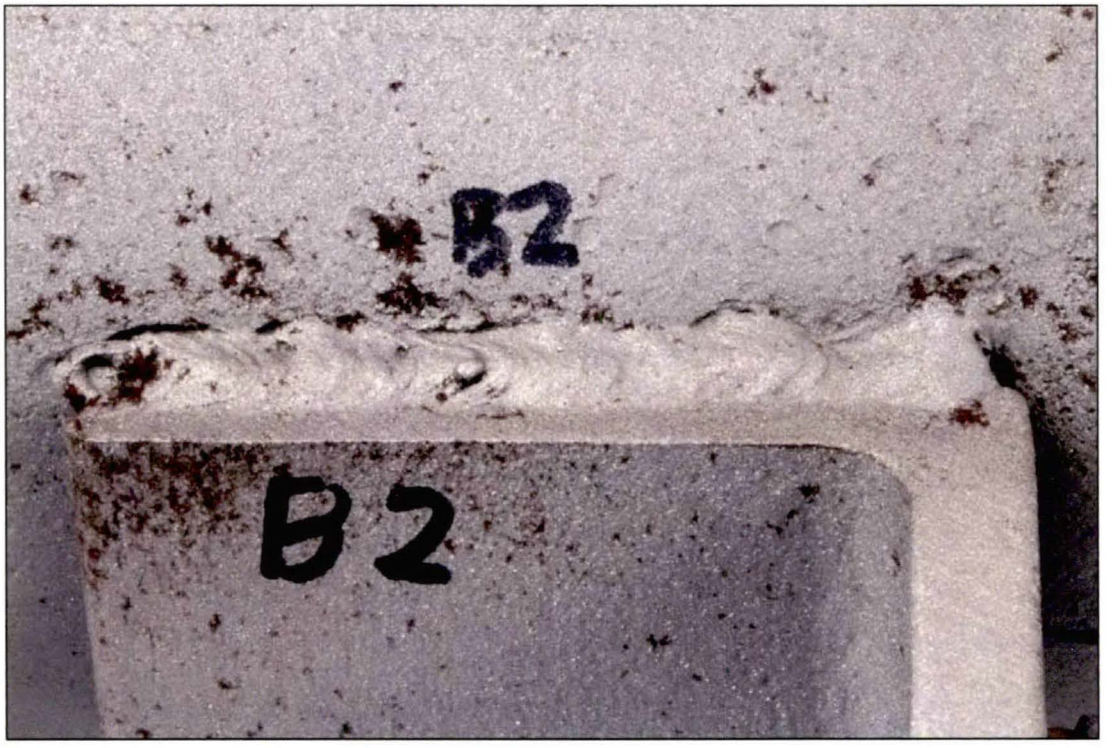



Figure 8. Image of the Lug B2 top weld region. This weld exhibited substantial fusion.

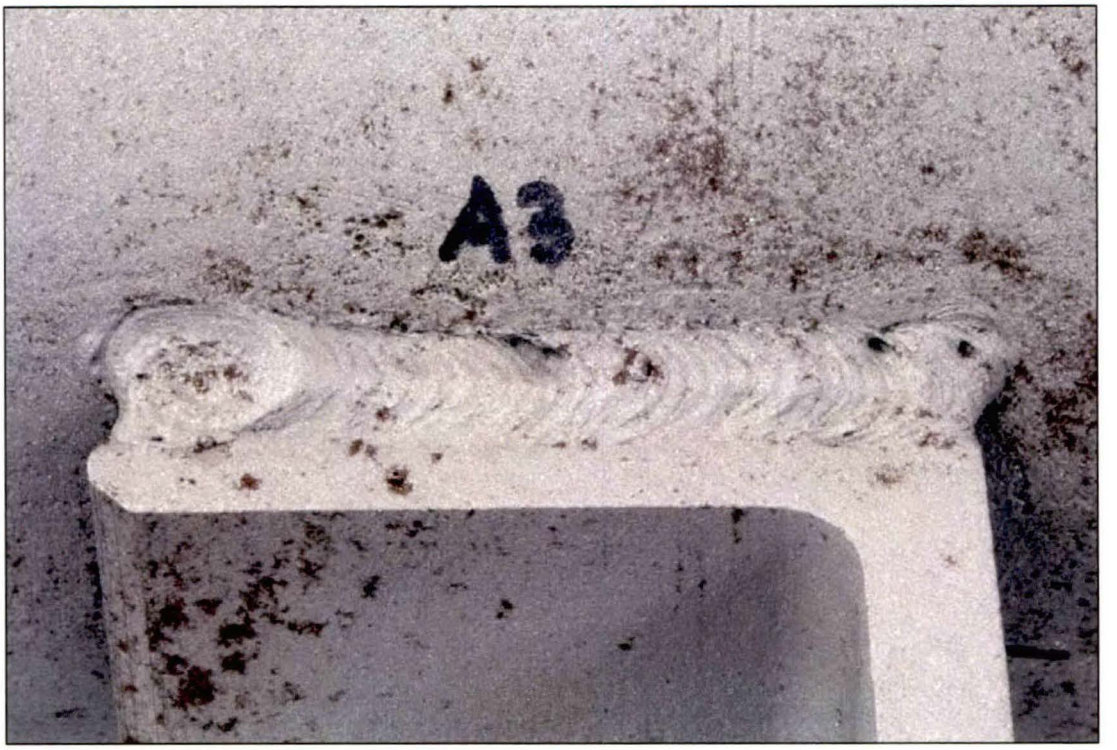



Figure 9. Image of the Lug A3 top weld with some porosity.


Figure 10. Image of the Lug B3 top weld showing spatter and porosity.

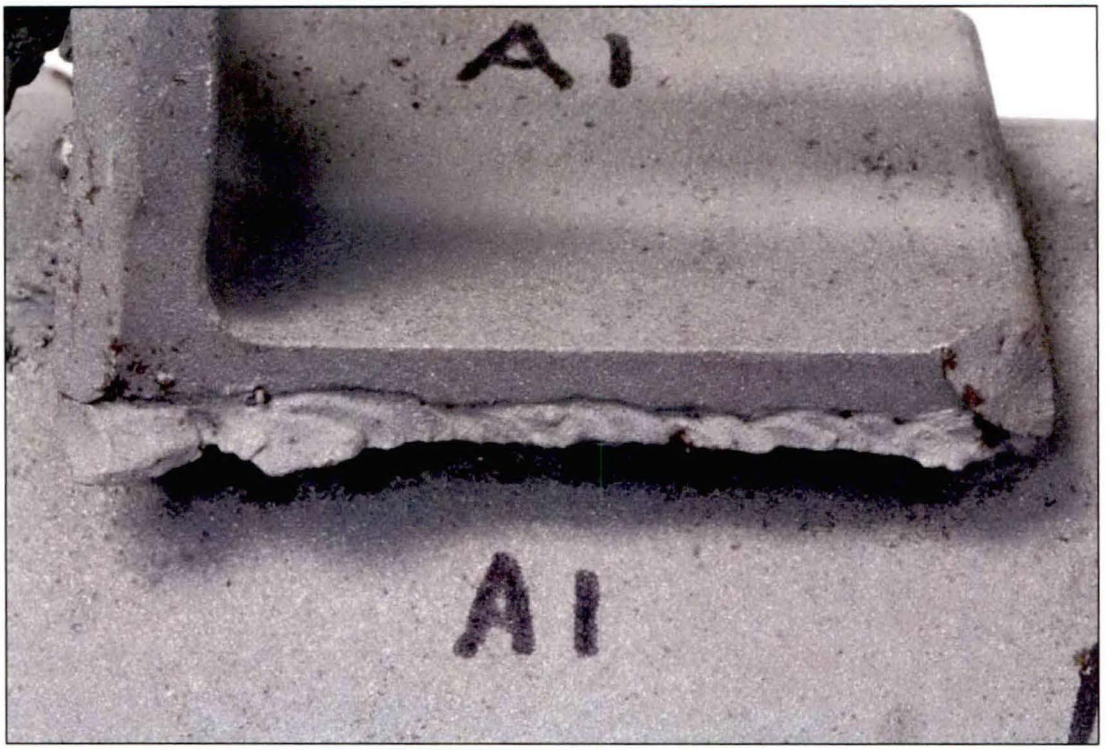



Figure 11. Image of the Lug A1 right side weld which was not fused. Due to the flat lug base configuration, one side of each lug was not properly welded.

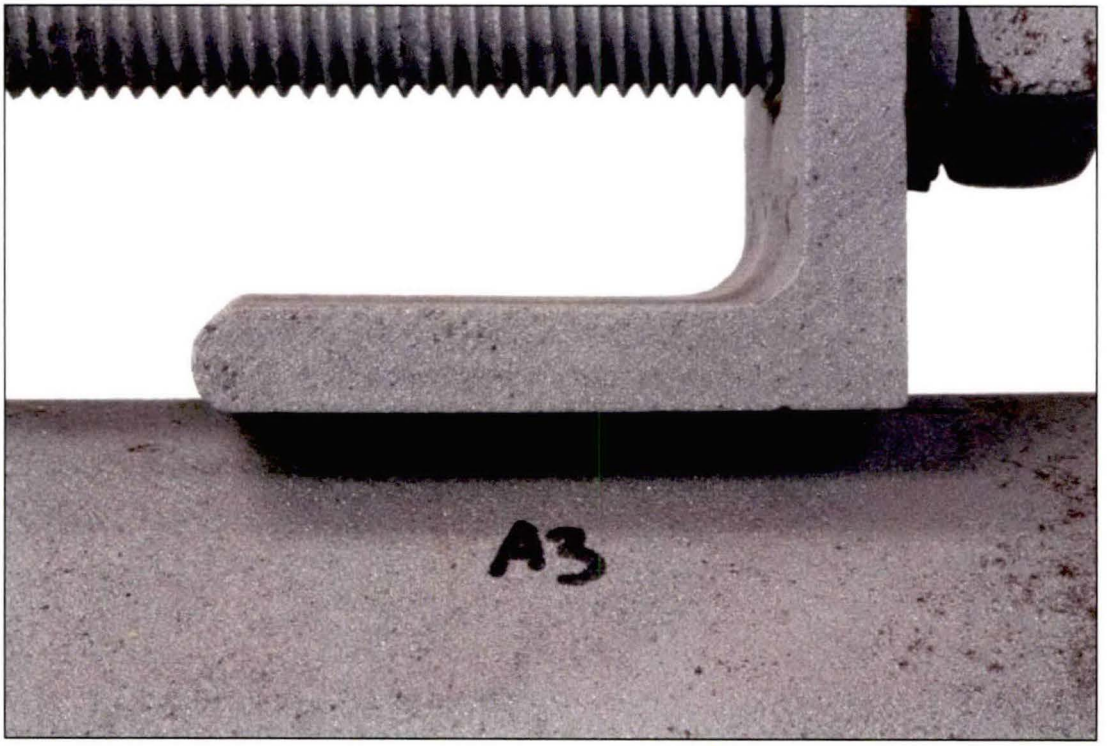



Figure 12. Image of the Lug A3 bottom weld.

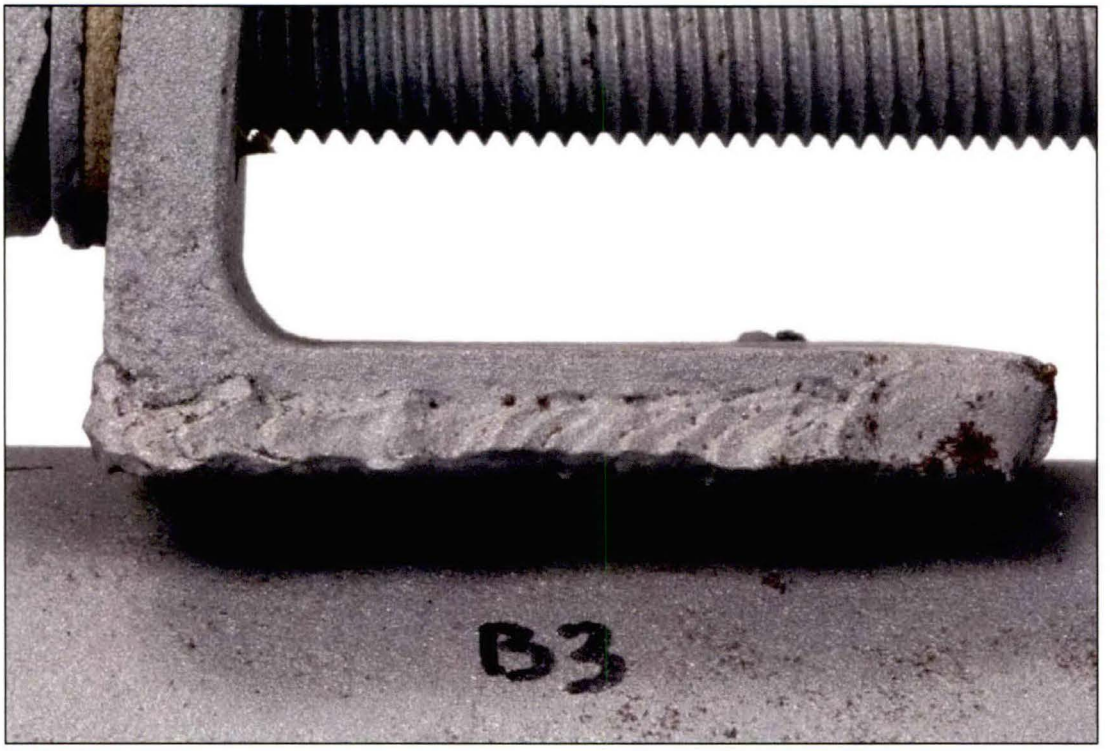



Figure 13. Image of the Lug B3 bottom weld with no fusion.

Figure 14. Photograph showing some superficial rust on the coupling surface where a rod had been in close proximity.

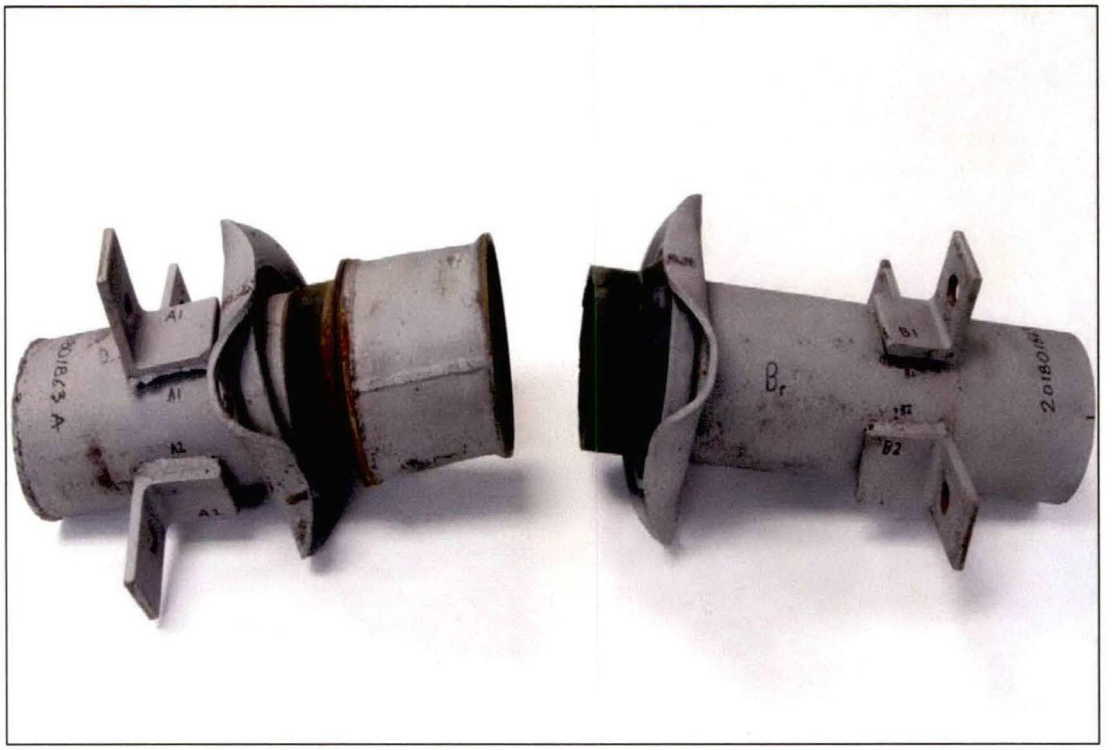



Figure 15. Photograph of the A (left) and B (right) sides of the coupled pipe after disassembly.

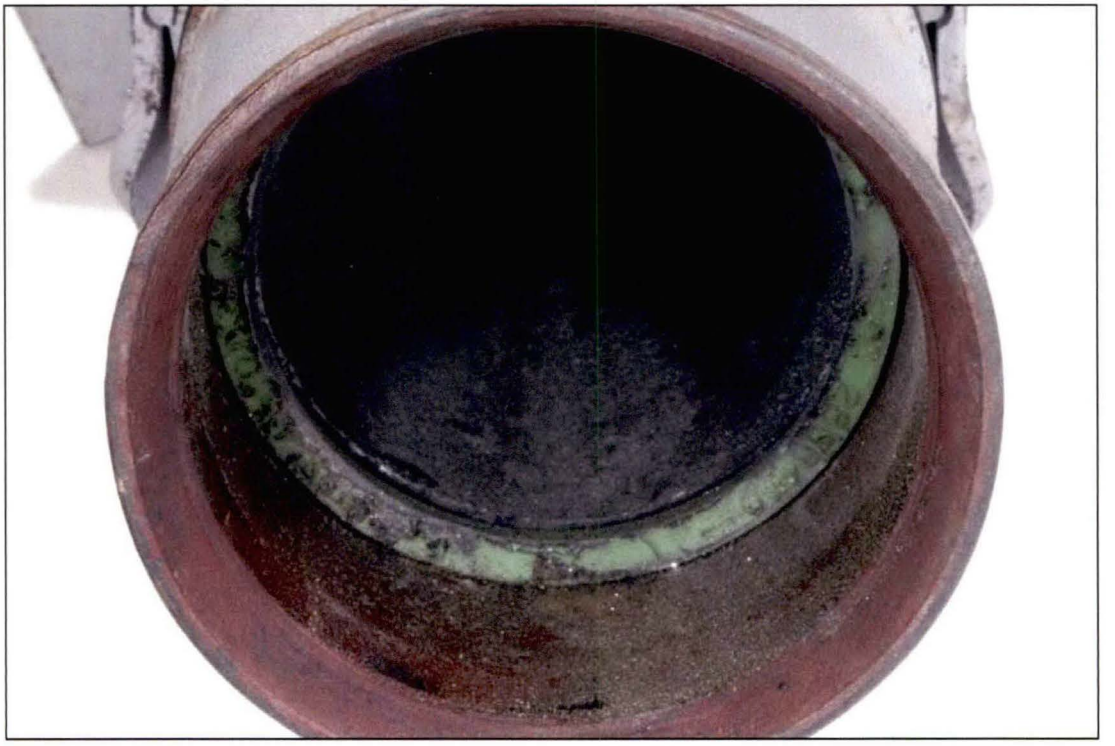


Figure 16. The interior of the coupling region contained a green colored pipe separator.

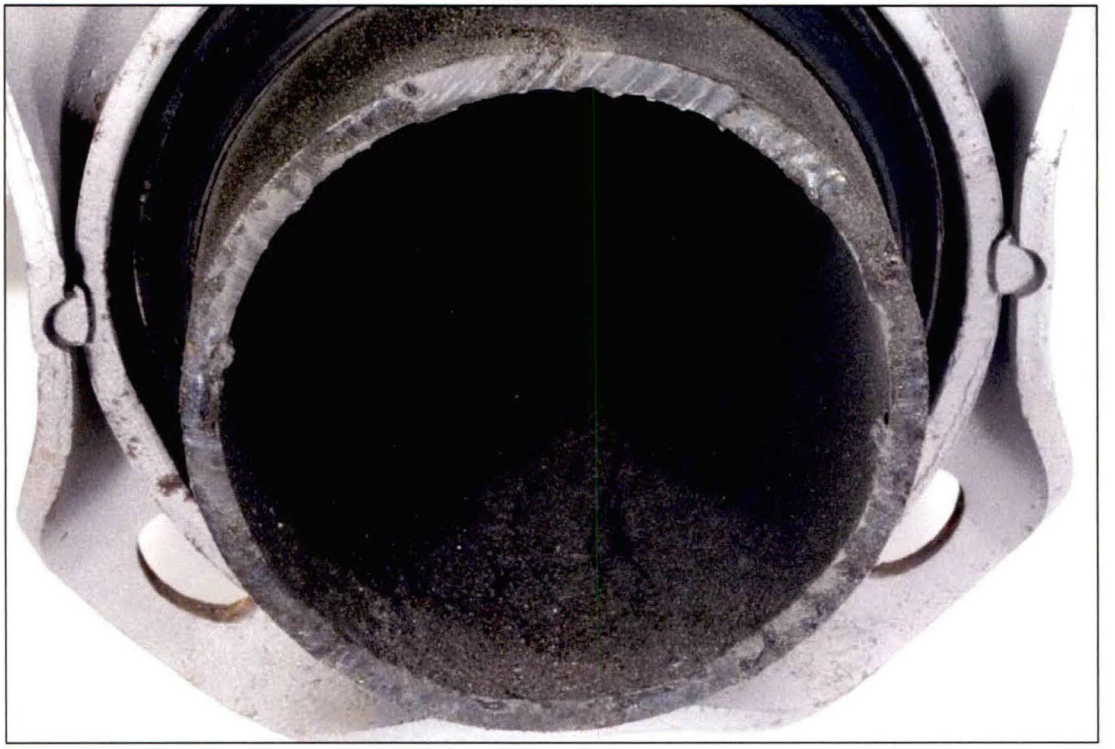


Figure 17. The bore of pipe end B is shown.

Figure 18. Image of the sleeve on the exterior of the pipe. Some debris was also present.

## SECTION 3- TORQUE TESTING- FOR INFORMATION ONLY

Torque testing was performed on the nuts on the rods, and the studs on the pipe samples. A calibrated torque wrench was used to determine breakaway torque on each fastener. Prior to testing it was apparent that one harness rod was loose, suggesting no clamping force on the lugs. The breakaway torque measurements are summarized in Table 5. The rods did not have a specified torque requirement. The four coupling bolts exhibited torque values ranging from 65 to 100 ft.-lbs. One value was below the Dresser Style 39 coupling installation torque recommendation of 75 ft.-lbs. minimum for 5/8" fasteners.

### TABLE 5 – FASTENER TORQUE MEASUREMENT

| Component | Breakaway Torque | Observations |
|---|---|---|
| Rod 1 | < 10 ft.-lbs. | Nut spun by hand – no clamping force |
| Rod 2 | 20 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |
| Rod 3 | 20 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 1 | 90 ft.-lbs. | Satisfied the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 2 | 90 ft.-lbs. | Satisfied the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 3 | 100 ft.-lbs. | Satisfied the 75 ft.-lbs. recommended for 5/8" fasteners |
| Bolt 4 | 65 ft.-lbs. | Less than the 75 ft.-lbs. recommended for 5/8" fasteners |

## SECTION 4- TENSILE TESTING, ASTM A370-17A

Tensile testing was performed on round specimens that were removed from the three 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 indicated for the fasteners on the provided Dresser harness or coupling information.

## TABLE 6 – FASTENER TENSION TEST RESULTS

| Component | Ultimate Tensile Strength, ksi | 0.2% Offset Yield Strength, ksi | Elongation, % | Reduction in Area, % |
|---|---|---|---|---|
| Rod 1 | 138 | 123 | 21 | 65 |
| Rod 2 | 131 | 116 | 22 | 86 |
| Rod 3 | 129 | 113 | 23 | 67 |
| Bolt 1 | 67.5 | 39.6 | 34 | 56 |
| Bolt 2 | 66.0 | 40.2 | 36 | 62 |
| Bolt 3 | 63.5 | 33.9 | 36 | 62 |
| Bolt 4 | 64.5 | 33.6 | 36 | 60 |

Specimen Dimensions; Diameter 0.35", with gage lengths of 1"
Percent elongation was measured using elongation-after-fracture measurements

## SECTION 5- ROCKWELL AND SUPERFICIAL HARDNESS, ASTM E18-17

Small sections of the six lugs were excised for hardness testing. Rockwell hardness testing was performed on the angle iron lugs after 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 | 76 | 77 | 75 | 77 | 76 |
| Lug A2 | 72 | 71 | 72 | 73 | 72 |
| Lug A3 | 72 | 71 | 73 | 70 | 72 |
| Lug B1 | 73 | 73 | 76 | 72 | 74 |
| Lug B2 | 72 | 73 | 71 | 71 | 72 |
| Lug B3 | 71 | 71 | 70 | 71 | 71 |

## SECTION 6- LIQUID DYE PENETRANT EXAMINATION

The two separated ends of the disassembled coupling were sent to a third party NDE laboratory for inspection. The primary inspector recommended dye penetrant examination rather than the magnetic particle inspection technique. Inspection was performed in accordance with the acceptance criteria of API 1104 "Welding of Pipelines and Related Facilities". The inspection results are provided as an

appendix. Two representative welds are shown in Figures 19 and 20 with the dye penetrant test media remaining.

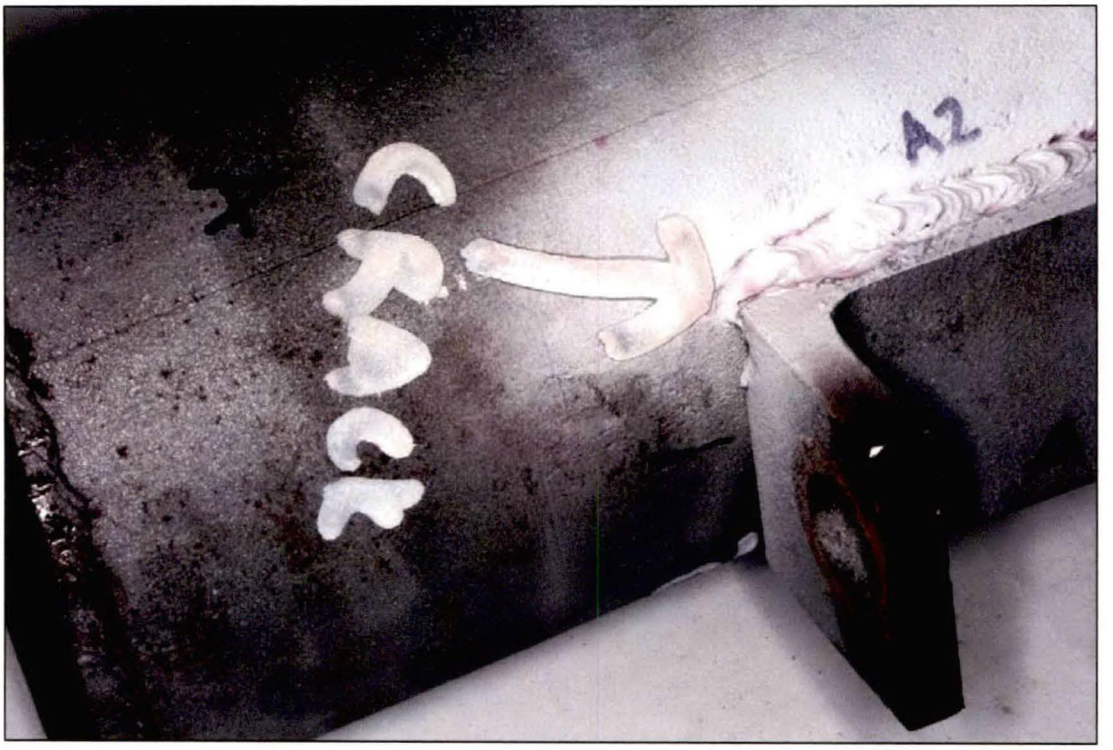



Figure 19. Image of the Lug A2 top weld which exhibited a crack that was detected during dye penetrant inspection.

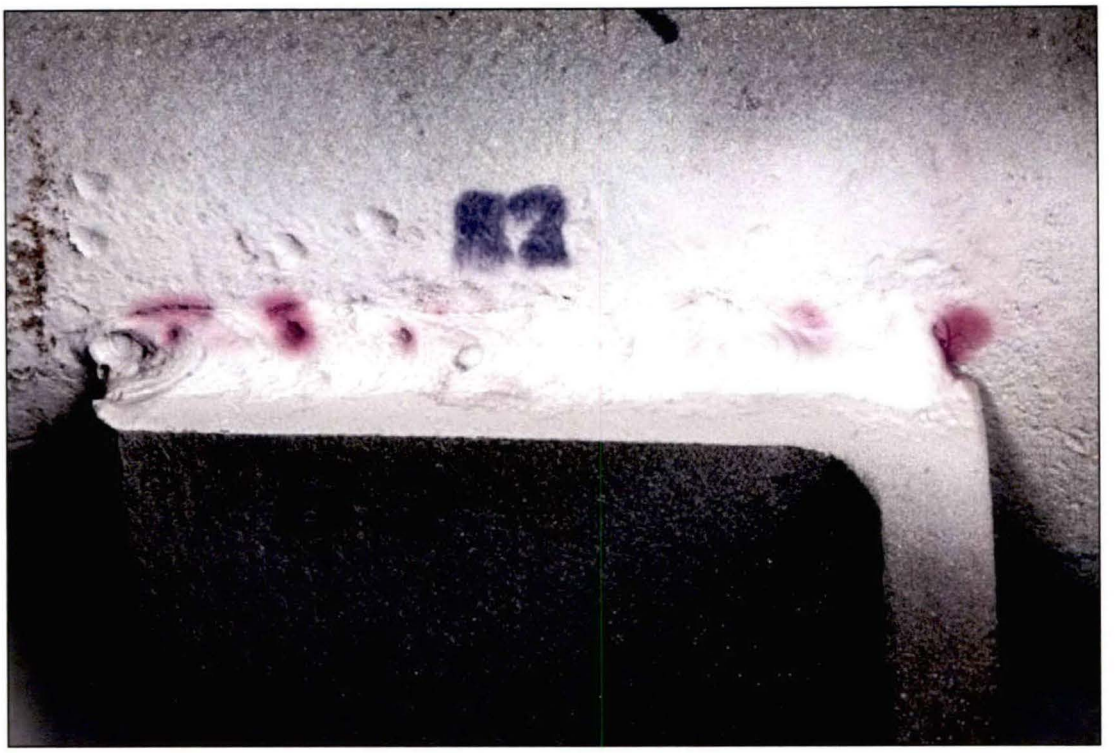



Figure 20. Image of the Lug B2 top weld which exhibited numerous pores.

Respectfully submitted

Brett A. Miller

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

Concurrence

Remmel O. Taylor

Remmel O. Taylor
Senior Metallurgist / Failure Analyst

All procedures were performed in accordance with the IMR Quality Manual, current revision, and related procedures; and the PWA MCL Manual F 23 and related procedures. The information contained in this test report represents only the material tested and may not be reproduced, except in full, without the written approval of IMR Test Labs ("IMR"). IMR maintains a quality system in compliance with the ISO/IEC 17025 and is accredited by the American Association for Laboratory Accreditation (A2LA), certificates #1140.03 and #1140.04. IMR will perform all testing in good faith using the proper procedures, trained personnel, and equipment to accomplish the testing required. IMR's liability to the customer or any third party is limited at all times to the amount charged for the services provided. All samples will be retained for a minimum of 6 months and may be destroyed thereafter unless otherwise specified by the customer. The recording of false, fictitious, or fraudulent statements or entries on this document may be punished as a felony under federal statutes. IMR Test Labs is a GEAE S-400 approved lab (Supplier Code T9334).

## APPENDIX – NONDESTRUCTIVE TESTING RECORD

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

### NDE PENETRANT REPORT

Client: IMR
Project: 201801863A/B
Item Description: Support clips
Part No: See below
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 Spray/wipe Material SKC-S Aerosol
Batch No. 15M15K Drying Time 10 Minutes

PENETRANT: Material SKL-WP2 Batch No. 17H13K
Application brush Dwell Time 25 Minutes

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

EXCESS PENETRANT REMOVAL: Material towel/wipe Batch No.
Method Drying Time

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

POSTCLEAN: Material SKC-S Aerosol Batch No. 15M15K
Method Spray/wipe

No. of Parts Accepted 1 Serial No.'s
No. of Parts Rejected 5 Serial No.'s

OTHER INFORMATION:

A1L- Rejected porosity
A1R- No weld
A2- Rejected crack
A3- Rejected porosity
A3- No weld
B1R- No weld
B1L- Accepted
B2- Rejected porosity
B2- No weld
B3- Rejected porosity
B3- No weld

INSPECTED BY: [signature] II

DATE: 8/10/18

Legend

A1L- Lug **A1**, **L**eft Weld

A1R- Lug **A1**, **R**ight Weld

A2- Lug **A2**

A3- Lug **A3**

B1R- Lug **B1**, **R**ight Weld

B1L- Lug **B1**, **L**eft Weld

B2- Lug **B2**

B3- Lug **B3**

# 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:

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:

1. Contact Employee for the bolt style coupling found: Found via records research in TIMP
2. Date of exposure: 1/3/2019
3. Location: Dixie Beach Regulator Station
4. Size of coupling (based on pipe size if not exposed enough to determine): 2 inch
5. Type of soil (circle one): Sandy Clay Gravel Topsoil Other (take picture and describe)
6. Soil Density test: X Type A □Type B □Type C
7. Status: X Removed □Abandoned in place □Backfilled- left in service
8. Discovered How?: □ Leak on Coupler □Other Maintenance Excavation X Facility Replacement
   □Facility Retirement X Other Records

## 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 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.

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.

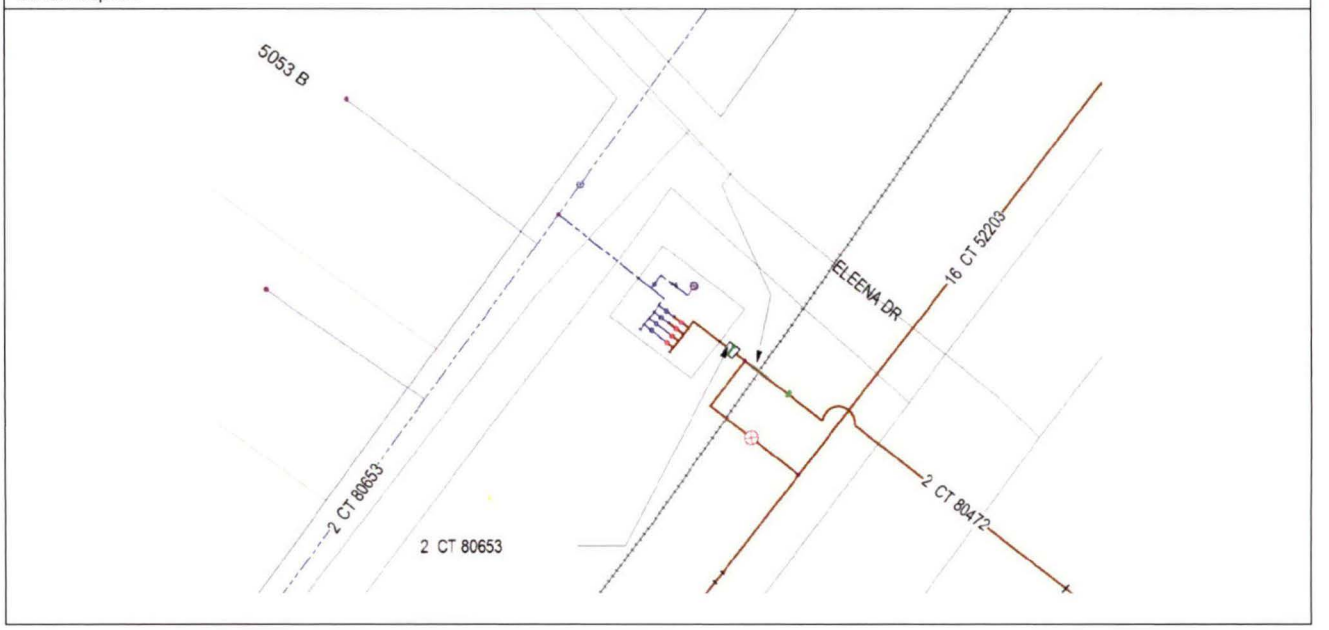
Field Pictures

## Part B- Coupling Information

| General Information | | | Tracking #: 2019-001 |
|---|---|---|---|
| PO Number<br>1019768 | Expense Org<br>4385 | Project<br>134829 | Task<br>LAB |
| Address/Location<br>16402 Dixie Beach Rd | | | |
| Size<br>2 inch | Material<br>Steel | Coating<br>Grease Wrap | MAOP<br>305 psig |
| Main/Service Number<br>80472 | Soil Type (from Part A)<br>Clay | Manufacturer<br>Dresser | Model<br>Style 90 |
| Pipe Connection: | Steel to Steel | Steel to Plastic | Plastic to Plastic |

| Historical Information | |
|---|---|
| Installation Date<br>8/7/1959 | Document Source<br>Main Report |
| Installation Company<br>Unknown | Document Source<br>Main Report |
| Foreman<br>Unknown | Document Source<br>Main Report |
| Welder<br>Unknown | Document Source<br>Main Report |

| GIS Information |
|---|
| Sys Id (of Coupler)<br>73249338 |
| Screen Capture |



## Pictures

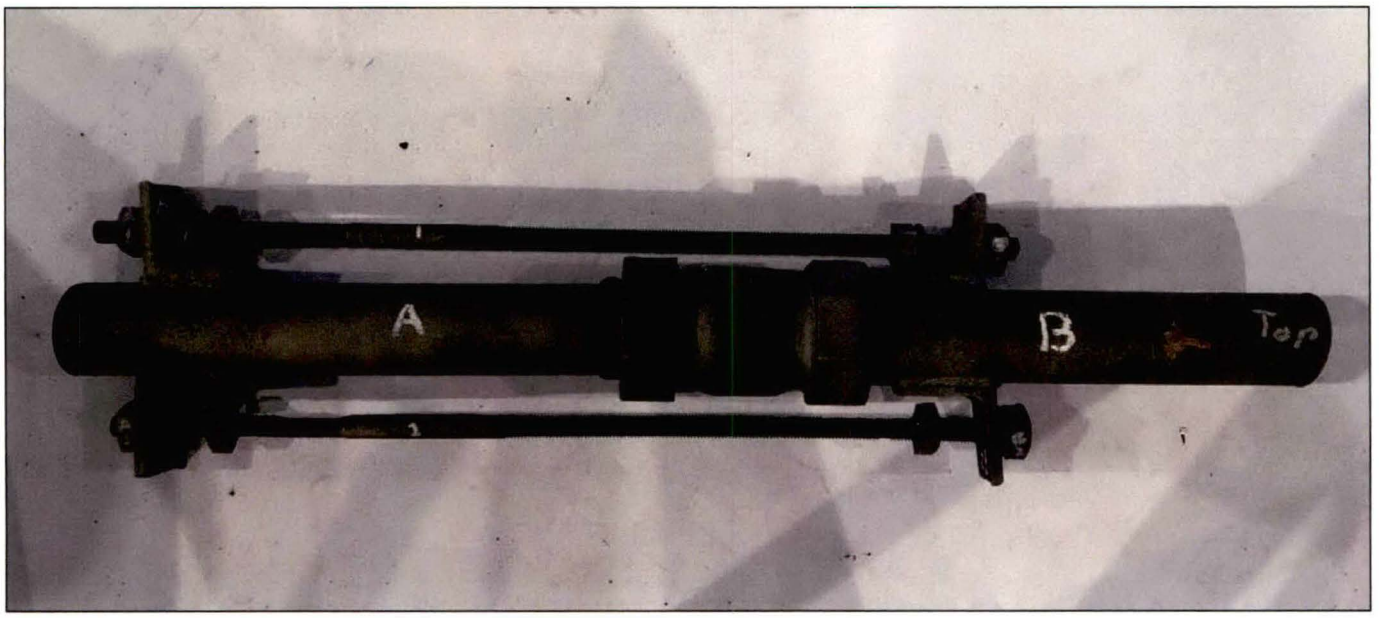



*Figure 1- Top View*

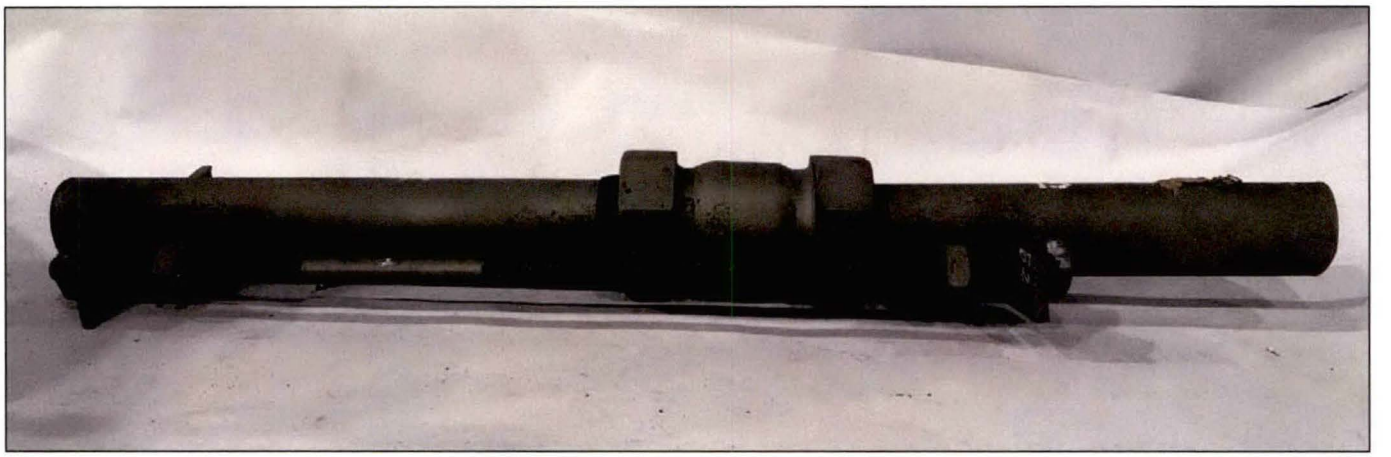


*Figure 2- Front View*

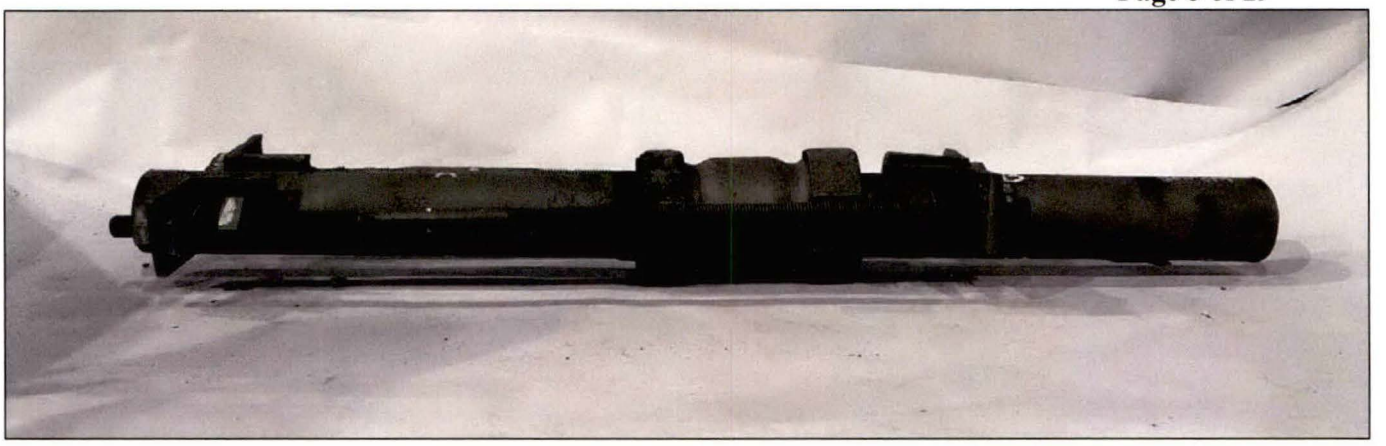


*Figure 3- Back View*

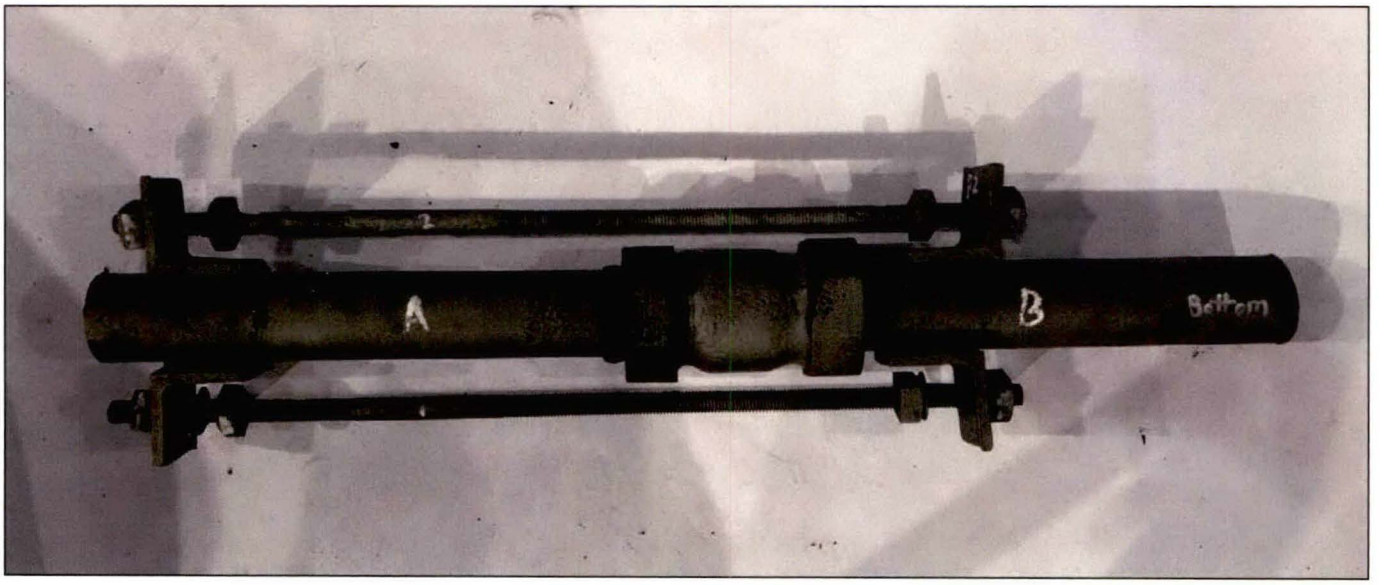



*Figure 4- Bottom View*

*Figure 5- Left Side View*

*Figure 6- Right Side View*

## Part C- Visual Inspection of Coupling

Visual Inspection Performed by: Chad Augustine [redacted] Date: 1/4/2019

**Table 1- Component Quantities**

| | |
|---|---|
| Number of Bolts on Coupler Body | 0[1] |
| Number of Reinforcement Rods | 2 |
| Number of Lugs | 4 (2 each rod) |

[1] This is not a bolted style coupling, it is a compression nut follower style. See figure(s) 1-6.

**Table 2- Corrosion**

| | Pipe A | Pipe B | Coupler Body | Bolts | Rods | Lugs | Nuts |
|---|---|---|---|---|---|---|---|
| General External Corrosion Present? | Yes, minor | Yes, minor | Yes, minor | Not Applicable | Yes, minor | Yes, minor | Yes, minor |
| Localized Corrosion Present? | No | No | No | Not Applicable | No | No | No |
| Pit Depths | 0.040" | 0.040" | Note[3] | Not Applicable | 0.080" | Note[3] | Note[3] |
| Internal Corrosion? | | | | | | | |

[3] Could not measure with a pit gage card because there was not enough clearance for the card.

*Figure 7- Corrosion Rod 2*

*Figure 8- Corrosion Pipe A*

*Figure 9- Corrosion Coupling Body*

**Table 3- Coupler Body**

| Bolt | Washer Present | Nut present? |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

Not Applicable.

This coupling is not a bolted style.

**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 | 24.25 | 0.6230 | Yes[4] | Yes | Yes, square | Appears to be kit provided |
| 2 | 24.00 | 0.6230 | Yes[4] | Yes | Yes, square | Appears to be kit provided |

[4] There is no head for the bolt. A nut is serving as the head.

## 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.)

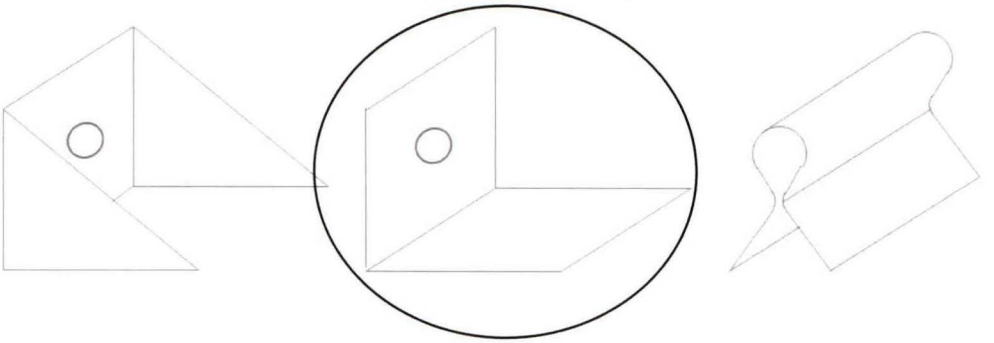


**Table 5- Lugs (Measurements)**

| Pipe Side | Lug Number | Thickness (in.) | Circumference (in) | |
|---|---|---|---|---|
| | | | Distance to next lug, clockwise | Distance to next lug, counter-clockwise |
| A | 1 | 0.3740 | Top: 2.500[5] | Bottom: 7.000[5] |
| A | 2 | 0.3580 | Top: 2.500[5] | Bottom: 7.000[5] |
| B | 1 | 0.3540 | Top: 2.750[5] | Bottom: 6.750[5] |
| B | 2 | 0.3745 | Top: 2.750[5] | Bottom: 6.750[5] |

[5] Since the lugs are not flush along the curvature of the pipe, only one side of the lug was welded to the pipe. There is no other point of reference to measure from lug to lug so the weld were used.

**Table 6- Lugs (Observations)**

| Lug | Lug | Assembly sets aligned? | Deformed? | Deflected? (angle of) |
|---|---|---|---|---|
| A1 | B1 | Yes | No | 2° |
| A2 | B2 | Yes | No | 1° |

**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 | Yes[6] | No[6] | Yes | Not Applicable | Not Applicable |
| A | 2 | Yes[6] | No[6] | Yes[7] | Not Applicable | Not Applicable |
| B | 1 | Yes[6] | No[6] | Yes | Not Applicable | Not Applicable |
| B | 2 | Yes[6] | No[6] | Yes | Not Applicable | Not Applicable |

[6] The lugs are not flush along the curvature of the pipe, so only one side of the lug was welded to the pipe. See Figures 10 & 11.

[7] Major porosity. See figure 12.

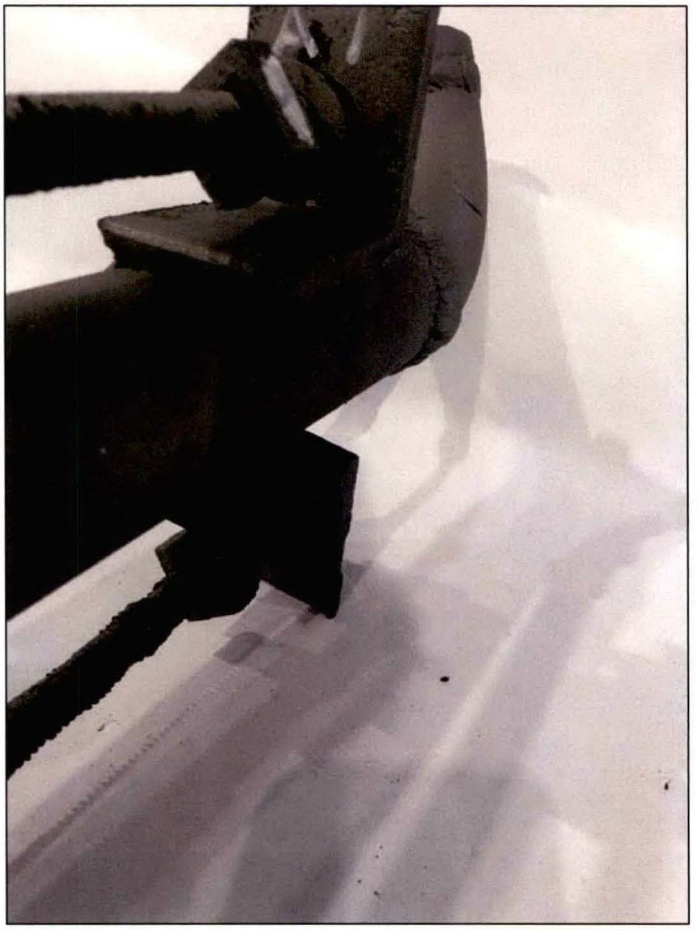


*Figure 10- Lugs*

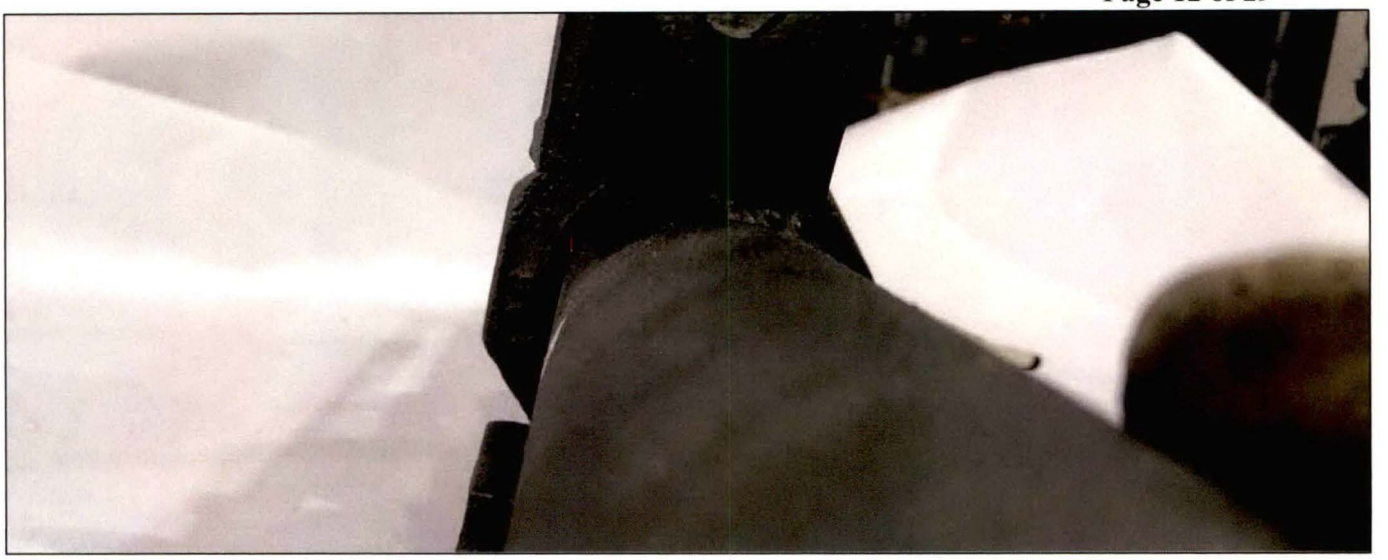


*Figure 11- Lug*

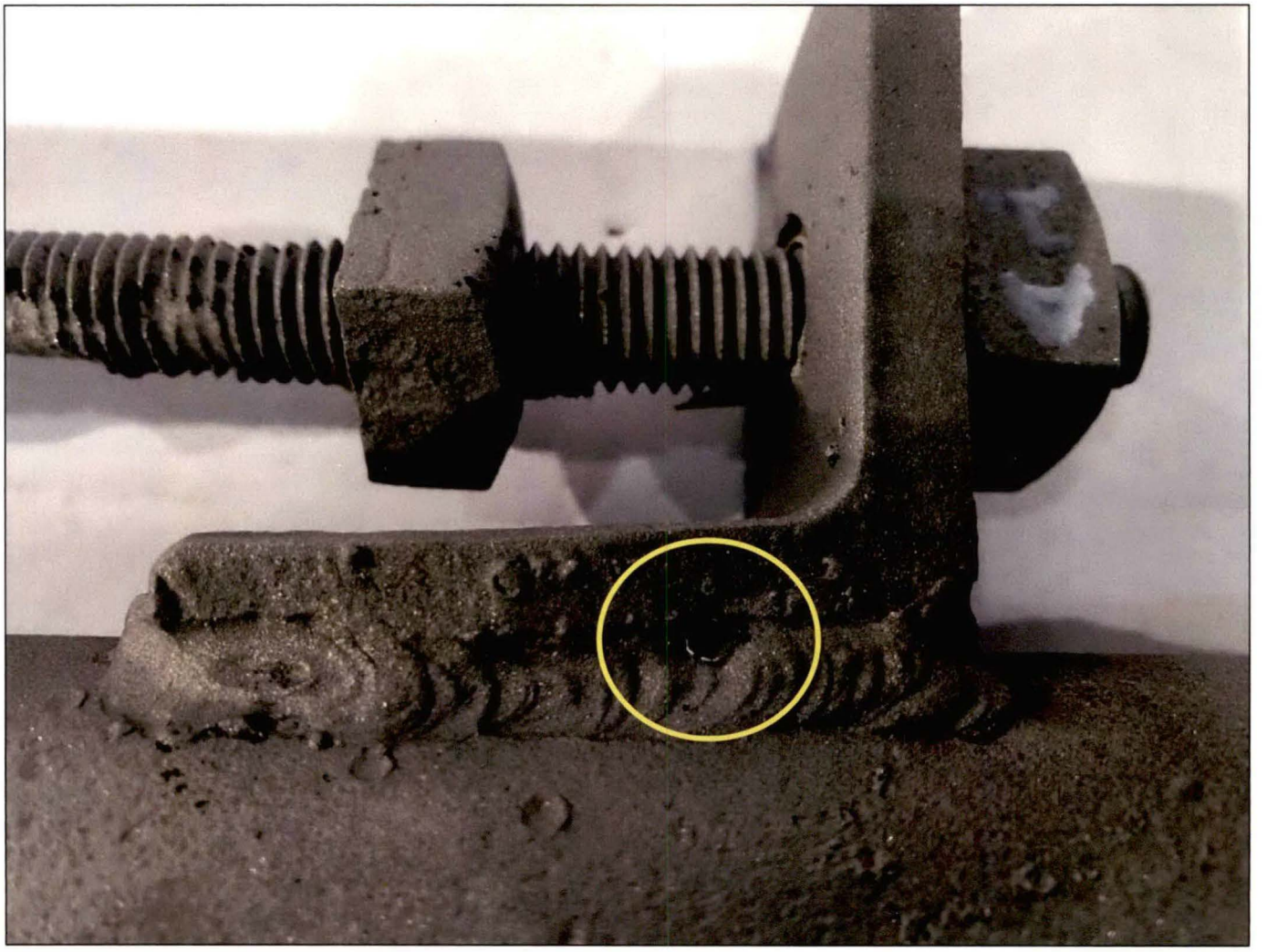


*Figure 12- Porosity in weld*

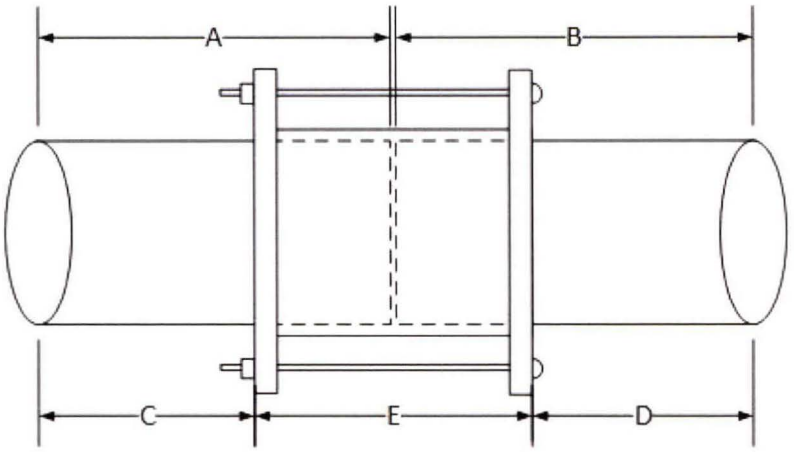



**Table 8- Stab Depth**

| | A | B | C | D | **Stab Depth** (A-C) or (B-D) |
|---|---|---|---|---|---|
| Pipe Side A | 16.6875 | | 13.9375 | | 2.7500 |
| Pipe Side B | | 14.8125 | | 11.4375 | 3.3750 |
| | Sum of stab depths (should be closely equal to measurement E) | | | | 6.1250 |
| | Coupler Length (E) | | | | 6.3125 |
| | Difference | | | | -0.1875 |

Additional Comments and General Observations

Pictures indicate manufacturer and style of coupling.

*Figure 13- Manufacturer*

*Figure 14- Style*

## Part D- Analysis of Coupling

This section is reserved for the lab report.

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

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

**January 14, 2019**

Attention: Chad Augustine

# Report No. 201900016

## Metallurgical Evaluation of Coupling and Associated Hardware

**Location: 16402 Dixie Beach Road**

### DESCRIPTION AND PURPOSE

A natural gas pipe section including a coupling was submitted for metallurgical evaluation. The section was a 2" pipe with an integral coupling without attachment bolts. Two joint harnesses were also affixed to the pipe section. It was reported that the coupling had been installed in the field at 16402 Dixie Beach Road. 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 coupling consisted of a steel coupling with and 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 and bottom of the coupling section were marked. 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.

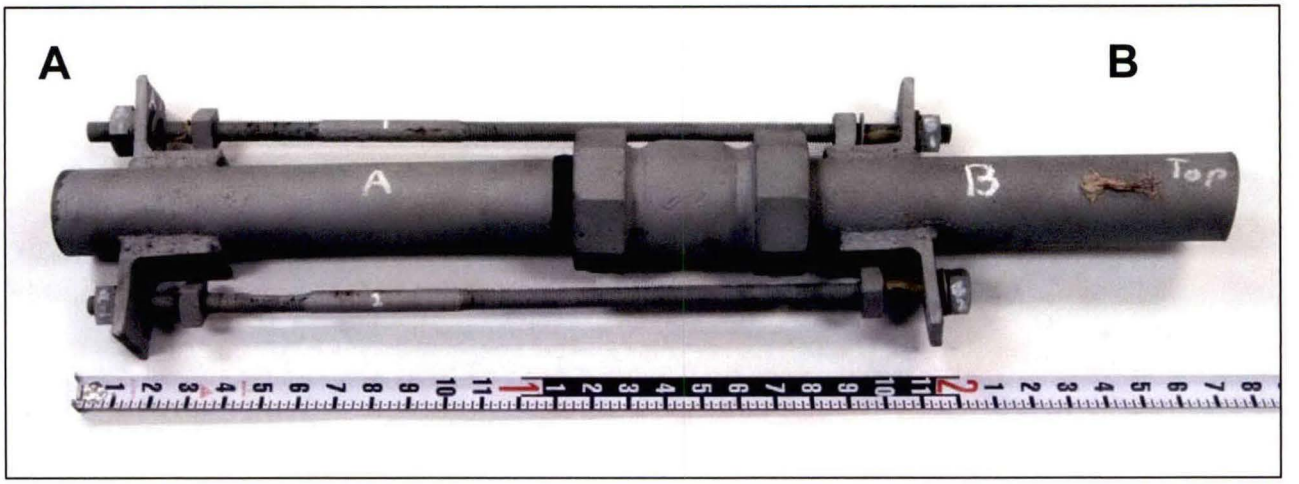


Figure 1. Photograph of the top of the submitted coupling sample.

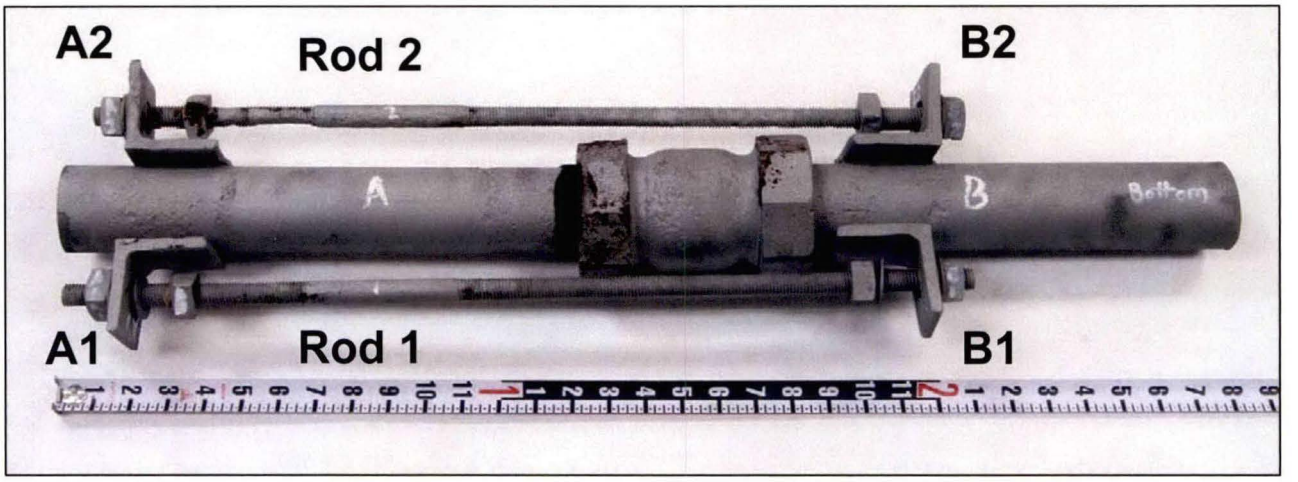


Figure 2. Photograph of the bottom of the submitted sample. Lug and rod identifications are shown.

## SECTION 1- DIMENSIONAL MEASUREMENT

The two sets of harness lugs were positioned on opposite sides of 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. Both 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 | 199° | 19° | Figure 3 |
| Rod B1 / Rod B2 | 210° | 30° | Figure 4 |

## TABLE 2 – PIPE COUPLING DIMENSIONAL MEASUREMENTS

| Component | Depth of Pipe into Coupling | Gap Between Pipes in Coupling |
|---|---|---|
| Pipe A | 2 3/4 | ~ 3/8" (Original sample length – 36") |
| Pipe B | 3 3/8" | |

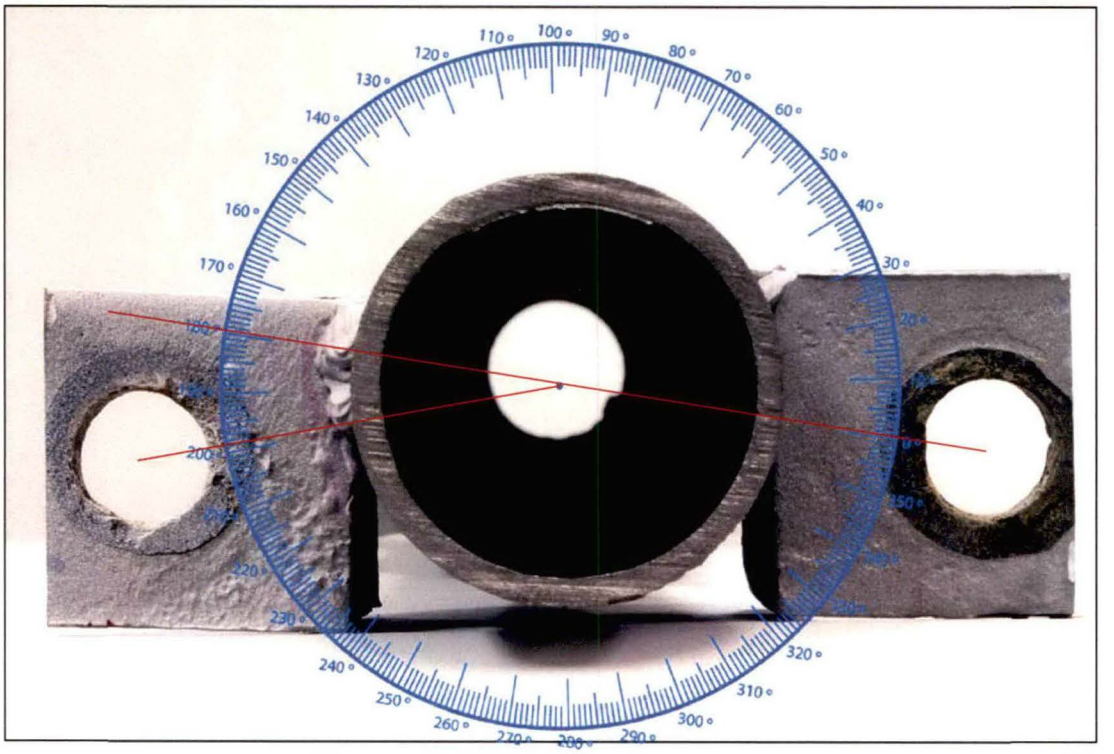

Figure 3. End facing image of the sample at End B. A superimposed protractor shows that the centers of Lugs A1 and A2 were approximately 19° from square.

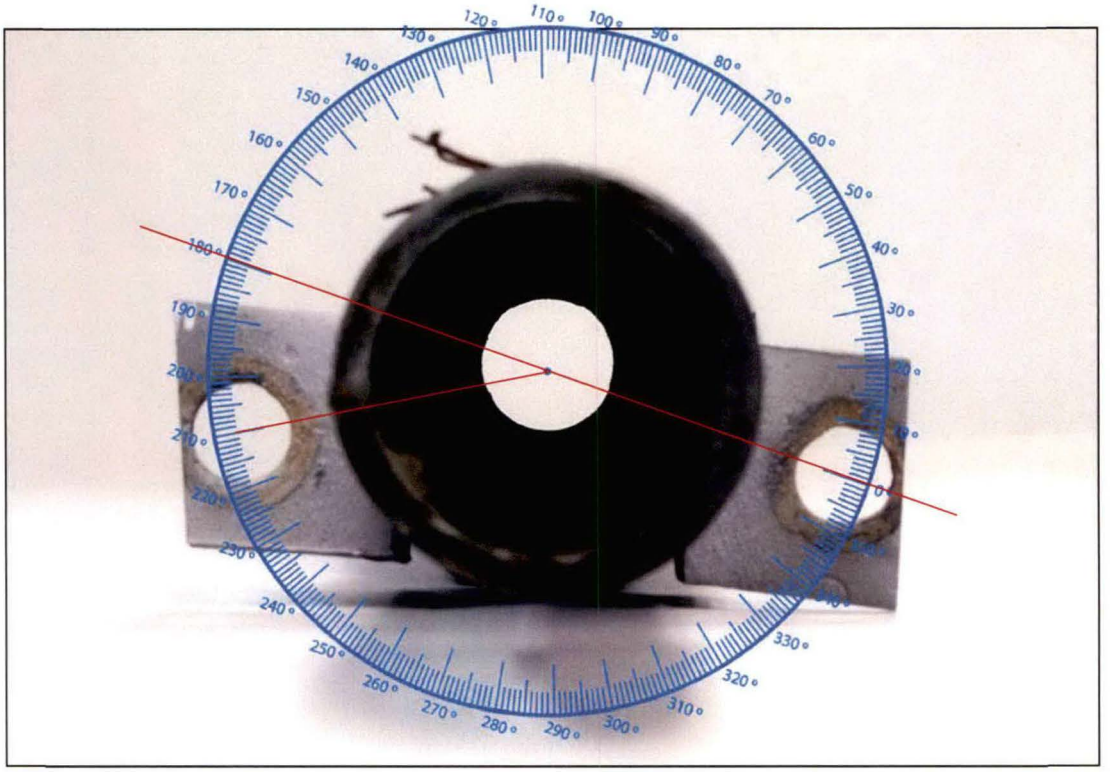


Figure 4. End facing image of the sample at End B. A superimposed protractor shows that the centers of Lugs B1 and B2 were approximately 30° from square.

## 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 5 through 10. No welding had been performed on the bottom exterior, bottom interior, or top interior locations of the lug joints. The lugs were not contoured to the diameter of the pipe so only one tangential location could be welded. It was further noted that the welds contained localized weld discontinuities including undercut, overlap, and spatter in addition to incomplete fusion. No cracking in the welds or base metal heat affected zones (HAZ) was visually identified. 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. Figure 11 shows the rusting damage to the coupling after the prior sandblasting. The observations for the rods are provided

in Table 4. The rods exhibited substantial corrosion and the worst region is shown in Figure 12. 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 | No weld |
| Lug A2 | Exterior | Top | Substantial fusion |
| | | Bottom | No weld |
| | Interior | Top | No weld |
| | | Bottom | No weld |
| Lug B1 | Exterior | Top | Substantial fusion |
| | | Bottom | No weld |
| | Interior | Top | No weld |
| | | Bottom | No weld |
| Lug B2 | Exterior | Top | Substantial fusion |
| | | Bottom | No weld |
| | Interior | Top | No weld |
| | | Bottom | No weld |

## TABLE 4 – FASTENER VISUAL EXAMINATION RESULTS

| Component | Observations |
|---|---|
| Rod 1 | Not bent or stretched, substantial corrosion pitting |
| Rod 2 | Not bent or stretched, substantial corrosion pitting |

Figure 5. Image of the Lug A1 exterior top weld which exhibited substantial fusion except for some underfill, and undercut.

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

Figure 7. Image of the Lug B1 exterior top weld which exhibited substantial fusion except for some underfill, undercut and spatter.

Figure 8. Image of the Lug B2 exterior top weld which exhibited substantial fusion except for some underfill, undercut and spatter.

Figure 9. Image of the underside of Lugs A1 and A2 showing that no welding had been performed.

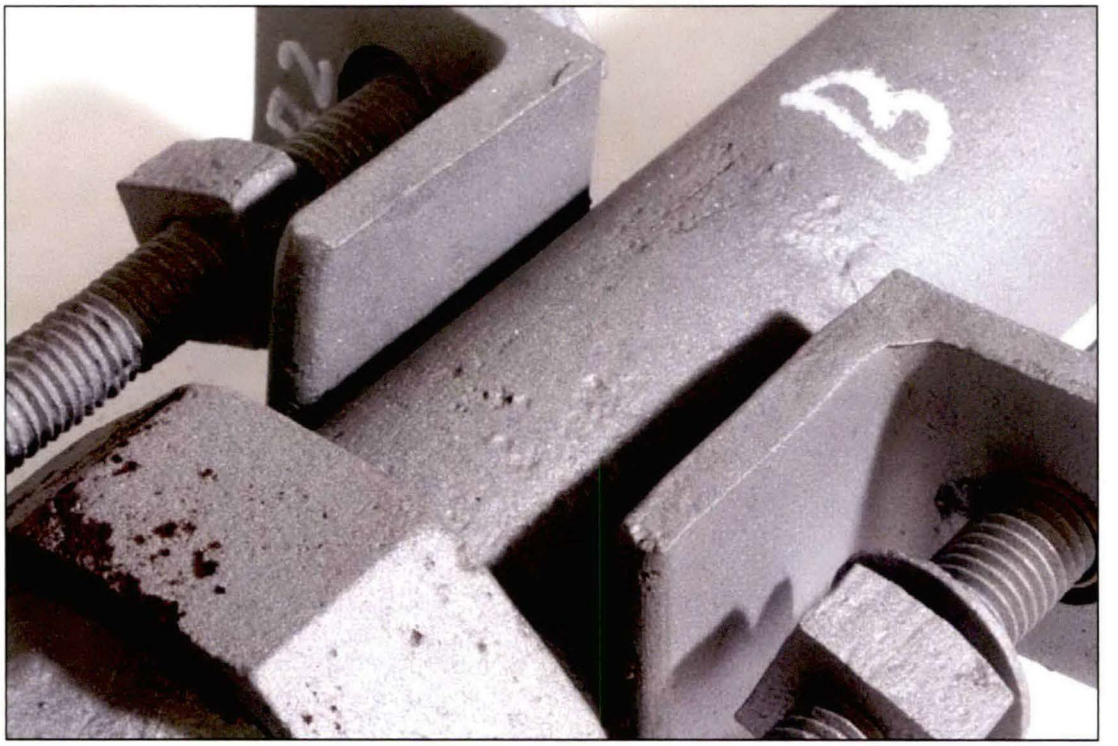


Figure 10. Image of the underside of Lugs B1 and B2 showing that no welding had been performed.

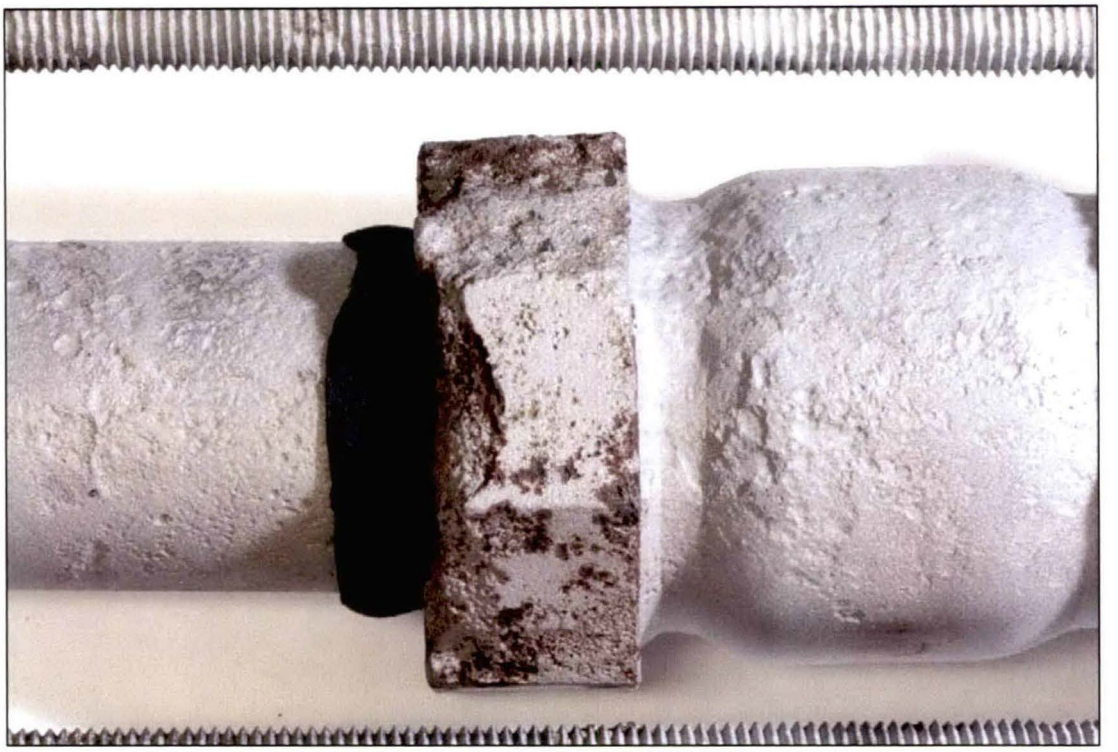

Figure 11. Photograph of a corroded region on the bottom of the coupling.

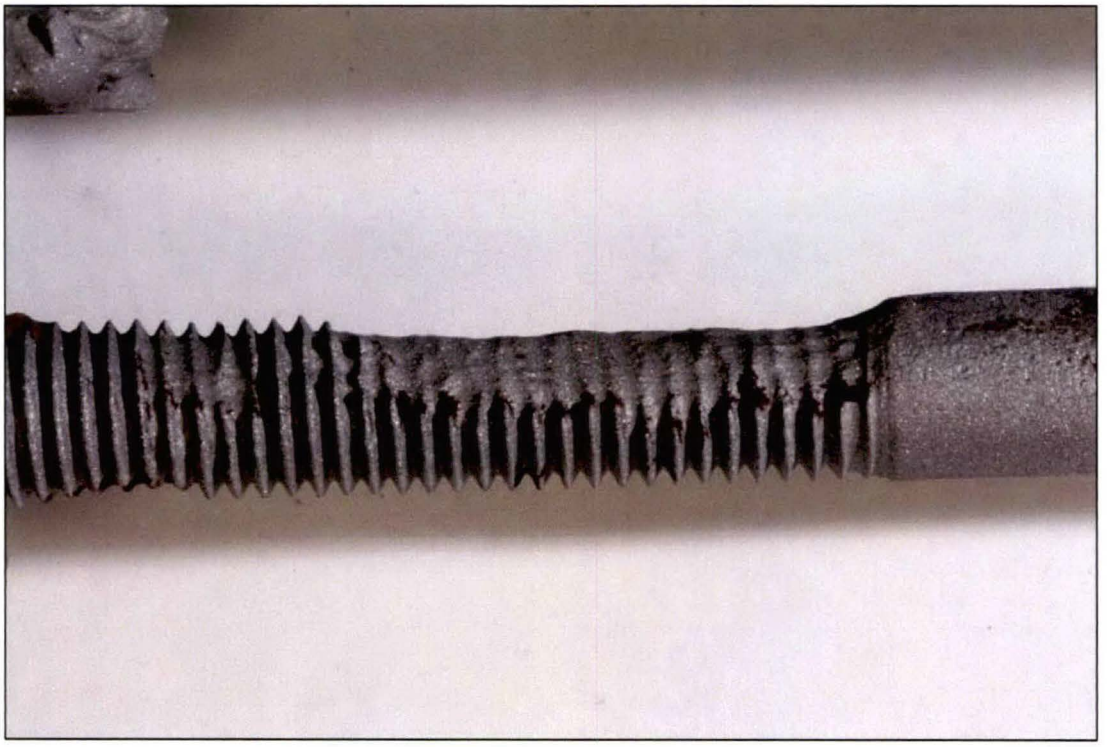

Figure 12. Photograph of the worst corrosion on one of the rods.

## SECTION 3- TORQUE TESTING- FOR INFORMATION ONLY

Torque testing was performed on the nuts of the rods 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. The rod fasteners did not have a specified torque requirement.

### TABLE 5 – FASTENER TORQUE MEASUREMENT

| Component | Breakaway Torque | Observations |
|---|---|---|
| Rod 1 | 40 ft.-lbs. | No requirement provided |
| Rod 2 | 55 ft.-lbs. | No requirement provided |

## 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 | 114 | 66.0 | 22 | 51 |
| Rod 2 | 106 | 62.0 | 26 | 56 |

Specimen Dimensions; Diameter 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 | 75 | 75 | 76 | 76 | 76 |
| Lug A2 | 73 | 73 | 74 | 74 | 74 |
| Lug B1 | 73 | 73 | 74 | 76 | 74 |
| Lug B2 | 74 | 76 | 76 | 75 | 75 |

## SECTION 6- NONDESTRUCTIVE EXAMINATION

The two separated ends of the disassembled coupling were sent to a third party NDE laboratory for inspection. Visual 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 Appendices A and B. Two representative welds are shown in Figures 13 and 14 with the dye penetrant test media remaining.

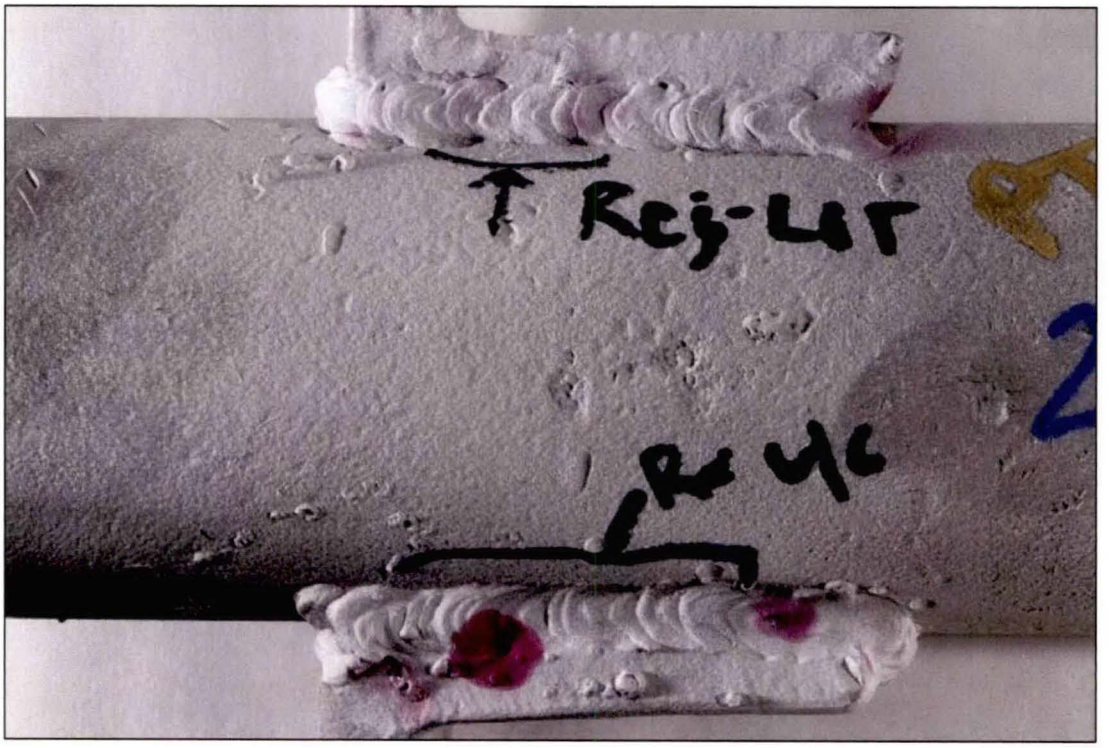


Figure 13. Image of the Lug A1 and A2 exterior top welds after dye penetrant media had been used during inspection.

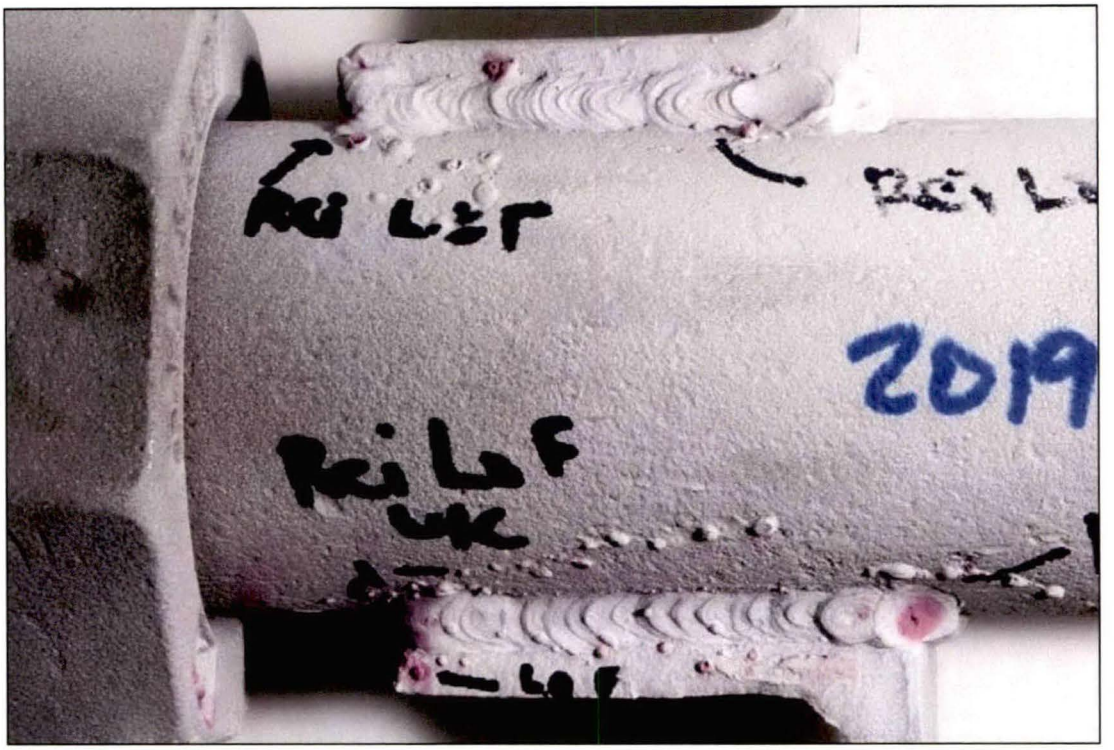


Figure 14. Image of the Lug B1 and B2 exterior top welds after dye penetrant media had been used during inspection.

Respectfully submitted

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

Concurrence

Phillip Swartzentruber, Ph.D., E.I.T.
Failure Analyst

## APPENDIX A – VISUAL INSPECTION RECORD

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

# VISUAL INSPECTION REPORT

**Customer:** IMR-Test Labs **Date:** 1-9-19

**Location of Work:** Louisville, Ky **Purchase Order #:** 5579T

**********

On 1-9-19 personel of Hayes Testing Conducted a Visual and dye penetrant inspection for IMR On job # 201900016.

Inspection was performed on steel gas coupling wher lugs are welded to API-1104. Results are listed below.

Section 201900016 A Rejected for Undercut, porosity Lack of Fusion Visually

Section 201900016 B Rejected for Lack of fusion, porosity, and undercut.

please see attached for penetrant results.

If you have any questions regarding this report please feel free to contact me at anytime

Respectfully Submitted,

**Results interpreted to CODE:** API-1104

**INSPECTOR:** [signature] **Level or CWI #:** II

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## APPENDIX C – PENETRANT INSPECTION RECORD

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

### NDE PENETRANT REPORT

Client: IMR
Item Description: 2" coupling
Drawing No:
Acceptance Class API

Project: 201900016
Part No: See below
Spec. 1104
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 Spray/wipe Material SKC-S Aerosol
Batch No. 15M15K Drying Time 10 MINUTES

PENETRANT: Material SKL-WP2 Batch No. 17H13K
Application brush Dwell Time 25 Minutes

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

EXCESS PENETRANT REMOVAL: Material towel/wipe Batch No.
Method Drying Time

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

POSTCLEAN: Material SKC-S Aerosol Batch No. 15M15K
Method Spray/wipe

No. of Parts Accepted 1 Serial No.'s
No. of Parts Rejected 3 Serial No.'s

OTHER INFORMATION:

201900016 A - PT 1 Rejected surface porosity PT2 Acceptable
201900016 B - PT 3&4 Rejected porosity, Lack of fusion

| INSPECTED BY: | DATE: |
|---|---|
| | 1/9/19 |

a PPL company

Gwen R. Pinson
Executive Director
Kentucky Public Service Commission
211 Sower Boulevard
Frankfort, Kentucky 40601

**Louisville Gas and Electric Company**
State Regulation and Rates
220 West Main Street
PO Box 32010
Louisville, Kentucky 40232
www.lge-ku.com

Rick E. Lovekamp
Manager Regulatory Strategy/Policy
T 502-627-3780
rick.lovekamp@lge-ku.com

January 31, 2019

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. 3 in Case No. 2017-00119, Louisville Gas and Electric Company ("LGE") hereby notifies the Commission that the removal of all remaining mechanical couplings on the LG&E transmission system is now complete.

The following three couplings were removed from LG&E's transmission system:

1) A bolted-style mechanical coupling installed in 1959 was removed from service on March 23, 2018. The lab report analysis is attached as Exhibit A.

2) A bolted-style mechanical coupling installed in 1962 was removed from service on April 6, 2018. The lab report analysis is attached as Exhibit B.

3) A nut follower-style mechanical coupling installed in 1959 was removed from service on January 3, 2019. The lab report analysis is attached as Exhibit C. The work required to remove this last coupling was delayed due to the time it took to obtain the required permits to work in the vicinity of a railroad.

Enclosed, please find the full reports on the removal effort in the above referenced matter.

Should you require anything further, please contact me at your convenience.

Gwen R. Pinson
January 31, 2019

Sincerely,

Rick E. Lovekamp

Enclosure