Office of Environment, Health, Safety and Security
Operating Experience Level 3

OE-3: 2017-04 **July 2017**

Electrofusion Coupling Failures

PURPOSE

This Operating Experience Level 3 (OE-3) document provides information about recent electrofusion coupling failures and the importance of proper installation.

BACKGROUND

Electrofusion Couplings (Figure 1) are designed to connect two ends of High Density Polyethylene (HDPE) piping together where an electrofusion butt weld cannot be performed.

Figure 1: Electrofusion Coupling

In 2010, a Line–Item project was initiated to install approximately 18,000 feet of underground piping for the Safety Class water supply at Pantex Plant. Approximately two years into the project a situation arose where an electrofusion butt welding machine could not be used due to tight clearances in a narrow trench. The electrofusion couplings were presented as a solution for this situation.

DISCUSSION

In 2016, three installed electrofusion couplings failed causing unplanned interruptions to facility operations. All three couplings were installed by the same sub-contractor and had been in service around 4 years.

All three failed couplings were removed from the ground and transported to the coupling manufacturer for evaluation. The evaluation checked for alignment of the pipe, proper stab depth, and proper pipe scraping. The coupling fusion joints were also subjected to a crush test per ASTM F1055, section 9.4.2 – *Separation of the fitting from the pipe at the fusion interface constitutes a failure of the test. Some minor separation at the outer limits of the fusion heat source, up to 15 % of the fusion length, may be seen. This does not constitute a failure. Ductile failure in the pipe, fitting, or the wire insulation material is acceptable as long as the bond interface remains intact.*

It was determined that all three couplings were not properly installed due to various reasons. The main reason was poor or improper pipe preparation.

Coupling #1

- There were no alignment/stab depth marks visible on the pipe, resulting in an improperly centered coupling.
- One side of the pipe surface was scraped with a rasp or similar tool, but material was not removed from the pipe (Figure 2). The other side had been scraped with a peeler, but less than 0.003” of material was removed. The manufacturer requires at least 0.007”-0.010” of outer pipe surface to be removed in the coupling area. This will assure virgin pipe material is exposed and remove any contaminates that will affect the fusion process.

Figure 2: Coupling #1 Pipe surface was scraped.

- When the coupling assembly was bisected for destructive testing, the pipe immediately separated from the coupling (Figure 3). ASTM F1055 requires the pipe to adhere to the coupling and not separate during a crush test.
- The pipe was damaged due to evidence of the fusion joint leaking for an extend period of time.

Figure 3: Dirt and mud in an area of the pipe and coupling where fusion between the HDPE should have occurred.

- Indication the joint was fused in a bind [e.g., hammer blows on the coupling (Figure 4) and joint was not straight (Figure 5)].

Figure 4: Hammer blows to the coupling indicate that pipe ends were not aligned and force was needed to install.

Figure 5: The pipe end and couplings were not properly aligned.

Coupling #2

- There were no alignment/stab depth marks visible on the pipe causing the pipe to be severely miss-stabbed (Figure 6). This allowed the pipe end to be centered in the fusion zone which negated the performance of the cold zone during the fusion process.

Figure 6: Pipe section is severely miss-stabbed.

- One side of the pipe surface was scraped with a rasp or similar tool, but material was not removed from the pipe. The other side had been scraped with a peeler, but less than 0.002" of material (Figure 7).

Figure 7: Scraping and the evidence of the print line which is only printed on the outer surface of the HDPE.

- When the coupling assembly was bisected for destructive testing, the pipe immediately separated from the coupling.
- Indication the joint was fused in a bind.

Coupling #3

- One end of the pipe was scraped using a rasp or similar tool with multiple un-scraped sections of pipe. There was no evidence of scraping at all on the other end of the pipe. (Figure 8)

Figure 8: Scraping of pipe surface with a rasp.

- The pipe on side two was placed in a vice to perform a crush test. The pipe on side two separated beyond the 15% allowance when the pipe walls were compressed approximately 40% (Figure 9).
- Indication that the joint was fused in a bind.

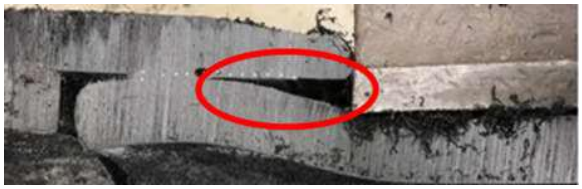

Figure 9: Results of crush test.

CONCLUSION

Electrofusion Couplings can be as strong as Butt Fusion joints if done properly. Training of installers on proper pipe end preparation and correct installation are key for a strong and reliable joint. Employing a checklist with hold points for independent verification of installation steps will ensure manufacturer requirements are being met.

RECOMMENDATIONS

Ensure the electrofusion contractor installer has been recently trained and is certified as qualified by the coupling manufacturer.

Ensure the contractor has the proper tools that have been specified by the manufacturer.

Because of the current draw when fusing 14" or greater electrofusion coupling, electrical extension cords cannot be used. Electrical extension cords may be used with smaller couplings, however ensure the appropriate size and length of

extension cord is specified/allowed by the manufacturer.

Ensure pipe ends are scored and marked to assure the depth of scraping as well as any flat spots are properly skinned to at least 0.007".

Ensure pipe ends are checked for roundness prior to installing electrofusion couplings. This will ensure a close fit between the pipe and the coupling to build up interfacial pressures for the fusion process to take place.

Ensure the pipe is restrained during and after the fusion cycle. This will restrict movement during the process and alleviate or eliminate sources of stress and strain until both the fusion and the cooling cycle are completed.

Ensure pipe ends are cut square/straight.

Use an installation checklist/procedure to ensure the process is consistently performed per manufacturer instructions.

REFERENCES

Georg Fischer Central Plastic Inspection Summary

Georg Fischer Central Plastic Large Diameter Electrofusion Coupling Training Manual #10014340 (January 2015)

ADDITIONAL SOURCES OF INFORMATION

Electrofusion Fittings and Equipment at http://www.centralplastics.com/en_US/gfcp-products2/elec-pe-fittings.html

Electrofusion Installation Procedure Manual at http://www.hdpe.ca/wp-content/uploads/2016/03/GFCP-EF-Installation-Booklet.pdf

Questions regarding this OE-3 document can be directed to Brian Rhodes, Pantex Facility Representative, at (806) 477-7561 or e-mail brian.rhodes@npo.doe.gov.

This OE-3 document requires no follow-up report or written response.

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