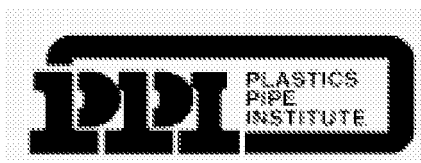


Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping TR-41/2002



1825 Connecticut Ave., NW Suite 680 Washington, DC 20009-P: 202-462-9607-F: 202-462-9779-www.plasticpipe.org

FOREWARD

This report was developed and published with the technical help and financial support of the members of the PPI (Plastics Pipe Institute, Inc.). The members have shown their interest in quality products by assisting independent standards-making and user organizations in the development of standards, and also by developing reports on an industry-wide basis to help engineers, code officials, specifying groups, and users.

The purpose of this technical report is to provide important information available to PPI on a particular aspect of polyethylene pipe saddle fusion to engineers, users, contractors, code officials, and other interested parties. More detailed information on its purpose and use is provided in the document itself.

This report has been prepared by PPI as a service of the industry. The information in this report is offered in good faith and believed to be accurate at the time of its preparation, but is offered without any warranty, expressed or implied, including **WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE**. Consult the manufacturer for more detailed information about the particular joining procedures to be used with its piping products. Any reference to or testing of a particular proprietary product should not be construed as an endorsement by PPI, which does not endorse the proprietary products or processes of any manufacturer. Industry members in fulfilling their own compliance responsibilities offer the information in this report for consideration. PPI assumes no responsibility for compliance with applicable laws and regulations.

PPI intends to revise this report from time to time, in response to comments and suggestions from users of the report. Please send suggestions of improvements to the address below. Contacting PPI directly or visiting the web site can obtain information on other publications.

The Plastics Pipe Institute, Inc.
Toll Free: (888) 314-6774
<http://www.plasticpipe.org>

October 2002

I. Introduction

In 1994, representatives of the U.S. Department of Transportation (DOT), Office of Pipeline Safety requested that the Plastics Pipe Institute assist in promoting greater uniformity in the joining procedures utilized by gas utilities in the butt and saddle fusion of polyethylene (PE) gas piping products. DOT reported that it had encountered a proliferation of similar but slightly varying joining procedures from individual PE pipe producers. The slight differences in the various procedures made it more difficult for pipeline operators to qualify persons with appropriate training and experience in the use of these procedures, and more difficult for DOT to enforce the joining requirements in 49 C.F.R. § Part 192.285 (Plastic pipe; qualifying persons making joints) of the Code of Federal Regulations.

In response to DOT's request, PPI established a task group to review the fusion procedures currently used and develop a more uniform, or "generic" joining procedure that could be qualified by pipeline operators. This joining procedure would bring greater consistency to this aspect of gas pipeline installation, facilitate the pipeline operator's efforts to qualify the procedure, reduce costs, and simplify DOT's enforcement duties.

II. Scope

The program undertaken by the PPI Task Group for the testing of representative materials under a generic set of conditions was designed to reflect the fusion conditions and parameters specified in most joining procedures recommended by pipe producers and qualified by pipeline operators. It produced a PPI Technical Report (TR-33/99) that reflects a Generic Butt Fusion Procedure that most of the Polyethylene Gas Pipe manufacturer's recommend. At the conclusion of the butt fusion phase of the program, the task group started its testing to develop a Generic Saddle Fusion Procedure that is based on common interfacial pressures and heater adapter surface temperatures. In anticipation of a change in the Maximum Allowable Operating Pressure (MAOP) and the design factor from .32 to .40, it was felt that this procedure was needed to insure safety in saddle fusion on live gas mains. It was intended to provide a technical basis for the development of a proposed generic saddle fusion procedure (see Appendix A) that can be offered to the industry for use with selected PE piping products. The procedure would be available for use by pipeline operators who would determine whether the procedure is appropriate for their use with the PE piping products they employ. Pipeline operators may consider recommendations and testing performed by others in their efforts to comply with the fusion procedure qualification requirements of 49 C.F.R. § Part 192.283 (Plastic pipe; qualifying joining procedures).

It is important to emphasize that the testing performed by the PPI Task Group was intended only to establish a technical basis for developing and proposing a generic fusion joining procedure that may be qualified and used by pipeline operators with a broad range of PE piping products. The testing was not intended to qualify the procedure for use with any particular pipe product, and PPI offers no opinion on whether the procedure is properly qualified for use with any particular PE pipe product. PE pipe producers remain solely responsible for any representations that they may make about the use of this generic procedure or any other joining procedure with their proprietary PE piping products. Pipeline operators remain solely responsible for compliance with the requirements of 49 C.F.R. § Part 192.283 (Plastic pipe; qualifying joining procedures) when qualifying any procedure for use with the products they select for their pipelines.

PPI hopes that the inherent value of greater uniformity will provide an incentive for manufacturers and pipeline operators to evaluate the proposed generic procedure in Appendix A as a first option for saddle fusion joining of PE piping products. Use of this procedure is not mandatory, and each PE pipe producer and pipeline operator retains the option of developing different procedures for its particular products and pipelines. However, PPI believes that its work in developing this procedure will promote the use of effective, qualified procedures for saddle fusion joining of PE pipe.

III. Testing Program to Evaluate Use of PPI-Proposed Generic Saddle Fusion Joining Procedure with Polyethylene Gas Piping Products

The PPI Task Group consisted of representatives from the following equipment, fitting, and pipe manufacturers: Performance Pipe, Rinker PolyPipe, Central Plastics, Uponor, Charter Plastics, North American Pipe, KWH Pipe, Rahn Plastics, McElroy Manufacturing, and T.D. Williamson.

The Task Group collected and examined a large number of diverse procedures now in use by gas pipeline operators or recommended by pipe producers for specific PE piping products. It then identified those conditions and fusion parameters that were common to the majority of those procedures. The Task Group proposed the following saddle fusion parameters as representative of the conditions in the individual procedures that they reviewed:

Heater Adapter Surface Temperature	500 ± 10 F
Initial Interfacial Pressure	80 PSI
Heat Soak Interfacial Pressure	0 PSI
Fusion Interfacial Pressure	40 PSI

Note: "Interfacial pressure" is the force per unit area applied between the fitting saddle base and the main pipe. Most saddle fusion equipment provides a gauge reading that is the actual force applied in pounds (Newtons). To determine the applied force for a

particular saddle fitting design, multiply the interfacial pressure by the saddle fitting base area.

From its review of the different procedures collected from PE gas pipe producers, the Task Group further developed the "generic" joining procedure set out in Appendix A, based on its assessment of the common elements in the individual procedures. It was agreed that proprietary products such as Uponor's Aldyl A MDPE products and Phillips Driscopipe's 8000 HDPE piping products (both of which have been discontinued) were sufficiently different from the remainder of the materials being discussed that they were not included in the test program. The manufacturers should be contacted for more information on particular joining procedures for those products.

Using these proposed parameter ranges and procedures, the Task Group initiated a testing program to evaluate whether a representative cross-section of marketed PE gas piping products would qualify under the qualification requirements of Part 192 when joined in accordance with this "generic" joining procedure. The evaluation was conducted using pipe and fittings from MDPE and HDPE materials deemed suitable for fuel gas applications per ASTM D 2513. These materials have a grade designation, in accordance with ASTM D3350, of PE24 and PE34, respectively.

Grade	Density (grams/cc)	Melt Index (grams/10min.)	Pipe Marking
PE24	.926/.940	.15 to .40	PE2406
PE34	.941/.955	.05 to .15	PE3408

After saddle fusion of the fittings onto pressurized gas main pipe, destructive tests were conducted in accordance with the requirements of DOT and ASTM. The results of the test program are described in the following sections. PPI's Conclusions and Recommendations, based on the Task Group's work, are noted at the end of the testing report. Test data are maintained at PPI headquarters.

Part 1 - Saddle Fusion and Testing - (Like Materials) By an independent lab.

Part 1 of this project was to evaluate the generic procedure for use in fusing PE pipe fittings to the same pipe main material (e.g., MDPE to MDPE) using different heating times. An independent lab was used to saddle fuse the samples using the proposed interfacial pressure combinations and different heating times at both 32 F and 120 F temperature conditions. The following parameters were used to make samples that were destructively tested and evaluated by the independent lab to narrow down the proposed fusion procedure and parameters for saddle fusing different fittings on ASTM D 2513 gas mains. The Task Group members supplied 2" SDR 11 pipe samples and tapping tee fittings for this saddle fusion testing. All

fusions were made on pipe mains under 0.40 design factor pressures - that is, MDPE -100 psig and HDPE -125 psig to observe any leakage or blowout problems (Note - the 73°F HDB may be used only for temperatures below 100°F; for 100°F and above, elevated temperature ratings must be used). The Task Group agreed to use these same fusion parameters for both the MDPE and HDPE (shown in Appendix A). Approximately (210) saddle fusion joints were made and evaluated by visual inspection, quick burst testing per ASTM D1599, knock off testing per ASTM F905 and Section/bend testing per ASTM D 2657. From this, the task group decided to use the same parameters shown above and ask each pipe manufacturer to do the next round of testing by varying the heating times and keeping the heater temperature and interfacial pressures the same.

Part 2 - Saddle Fusion and Testing - (Like Materials) By Pipe Manufacturers

Part 2 of this project was to evaluate the proposed generic saddle fusion procedure on

2"IPS main pipe and larger using the same parameters as in Part 1 but varying the heating times. Each pipe manufacturer saddle fused tapping tees onto 2" IPS straight and coiled 2" IPS DR11 main pipe using both serrated and smooth heater adapters at 73°F. All fusions were made on pipe mains under 0.40 design factor pressures (that is, MDPE -100 psig and HDPE -125 psig at 73°F) to observe any leakage or blowout problems. The Task Group agreed to use these same fusion parameters for both the MDPE and HDPE (shown in Appendix A). Again, the saddle fusion joints were made and evaluated by visual inspection, quick burst testing per ASTM D1599, knock off testing per ASTM F905 and Section/bend testing per ASTM D 2657. The results were very encouraging the fusion parameters and heating times were narrowed as shown below:

Heater Adapter Surface Temperature	500 ± 10 F
Initial Interfacial Pressure	60 PSI
Heat Soak Interfacial Pressure	0 PSI
Fusion Interfacial Pressure	30 PSI
Total Heating Times	20,30 and 40 seconds

(Note: Total heating times include the time required for initial heating and heat soak. During initial heating, the main is observed and when an indication of melt is visible on the crown of the main, the pressure is reduced for the heat soak time. Typically, initial heating takes from 3 to 5 seconds.)

Part 3 - Saddle Fusion and Testing - 2" IPS DR11 (Like Materials)

Part 3 of this project was to evaluate the proposed generic saddle fusion procedure on

2"IPS and larger main pipes using the same parameters from Part 2 and varying the heating times. Each pipe manufacturer saddle fused tapping tees onto 2" IPS straight and coiled 2" IPS DR11 main pipe using both serrated and smooth heater adapters at 73°F. All fusions were made on pipe mains under 0.40 design factor pressures (that is, MDPE -100 psig and HDPE -125 psig at 73°F) to observe any leakage or blowout problems. The Task Group agreed to use these same fusion parameters for both the MDPE and HDPE (shown in Appendix A). Again, the saddle fusion joints were made and evaluated by visual inspection, quick burst testing per ASTM D1599, knock off testing per ASTM F905 and Section/bend testing per ASTM D 2657. The task group member reported no failures using a 25-35 second total heating time, 60 psi Initial Heat interfacial pressure and 30 psi Fusion Interfacial Pressure. The Task Group therefore decided to do cross fusion testing of HDPE fittings on MDPE mains and different manufacturer's fittings on other manufacturer's pipe. A test matrix was developed for (186) samples to be made and tested as in earlier parts.

Heater Adapter Surface Temperature	500 ± 10 F
Pre-Heat Interfacial Pressure	60 PSI
Soak Interfacial Pressure	0 PSI
Fusion Interfacial Pressure	30 PSI
Heating time	25-35 seconds

Part 4 - Saddle Fusion and Testing - (Unlike Materials)

Part 4 of this project was to evaluate the proposed generic saddle fusion parameters shown in Part 3 above and the generic saddle fusion procedure shown in Appendix A on different combinations of "standard" tapping tee fittings and pipe manufacturer's pipe (brands and material types). Each pipe manufacturer saddle fused "standard" tapping tees onto 2" IPS DR11 straight and 2" IPS DR11 coiled main pipe using both serrated and smooth heater adapters at 73°F. All fusions were made on pipe mains under 0.40 design factor pressures (that is, MDPE -100 psig and HDPE -125 psig at 73°F) to observe any leakage or blowout problems. The Task Group agreed to use these same fusion parameters for both the MDPE and HDPE (shown in Appendix A). Again, the saddle fusion joints were made and evaluated by visual inspection, quick burst testing per ASTM D1599, knock off testing per ASTM F905 and Section/bend testing per ASTM D 2657. Approximately (186) samples were made and tested with no blowouts, failures or unsatisfactory results under any of the DOT or ASTM test conditions.

IV. Conclusions and Recommendations

The results of this study indicate that there is a single fusion procedure, with defined ranges of acceptable heater adapter surface temperature, heating times and interfacial pressures, that can be used for saddle fusing most of the PE fittings and