

GENERIC BUTT FUSION JOINING PROCEDURE FOR FIELD JOINING OF POLYAMIDE-12 (PA12) PIPE

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Foreword

This report was developed and published with the technical help and financial support of the members of the PPI (Plastics Pipe Institute). 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 Polyamide-12 (PA12) pipe butt 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.

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The Plastics Pipe Institute, Inc.

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1.0 INTRODUCTION

To promote the safe joining of plastic piping materials, Title 49 CFR Part 192 prescribes certain requirements for developing and qualifying approved joining procedures that must be in place at each utility for use with their plastic piping materials. Specifically,

- Each joint must be made in accordance with written procedures that have been proven by test or experience to produce strong leak tight joints – CFR Part 192, §192.273
- Written procedures for various types of joints must be qualified by subjecting them to various required tests – CFR Part 192, §192.283
- All persons making joints must be qualified under the operators written procedures - CFR Part 192, §192.285
- Gas system operators must ensure that all persons who make or inspect joints are qualified - CFR Part 192, §192.285 and §192.287

Polyamide-12 (PA12) piping is approved for use in piping systems under the jurisdiction of CFR Title 49 Part 192 by reference of ASTM F2785-12 in Appendix B(I.). Thus, this PPI technical report provides a uniform joining procedure bringing 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.

2.0 SCOPE

In order to ensure compliance to CFR Part 192 requirements, the PA12 suppliers (Evonik Degussa and UBE Industries) have performed comprehensive testing and evaluation to establish the technical basis for generic heat fusion procedures specific to PA12 piping systems. The PA12 grades used in the test program were classified as PA42316 per ASTM F2785. The specific intent of the testing was to address the following key considerations:

- Establishing the optimum set of butt heat fusion joining parameters which lead to strong joints that can effectively perform over the intended service life;
- Verifying the ability to make strong joints over a range of pipe sizes;
- Verifying the compatibility of cross-fusion using PA12 pipe from the various manufacturers.

In order to address each of these key considerations, extensive sample fabrication and testing was performed at leading independent research institutes and McElroy manufacturing. The comprehensive results of the testing confirm the ability to make strong heat fusion joints using a range of heat fusion parameters. Annex A describes the testing program used to establish the recommended fusion condition ranges.

3.0 TESTING PROGRAM TO VALIDATE PA12 BUTT FUSION CONDITIONS

The following report presents a summary of the sample fabrications details, testing protocols, and results of the research to establish the parameter range for butt fusion of PA12 pipe. Two separate testing programs were executed; one at the Gas Technology Institute in the United States, and a second program at *Sueddeutsches Kunststoff Zentrum* (SKZ) Welding Institute in Germany. Based on these results, a generic PA12 heat fusion procedure has been established for the industry. ***It is important to note that these procedures are being presented as guidelines to help assist gas utility companies in developing and/or qualifying their own procedures for use with PA12 piping systems.*** Moreover, these procedures have also been integrated within ISO 16486 Part 2 requirements for PA12 piping systems. Additional work is on-going to integrate these procedures within ASTM and other industry accepted standards and specifications for use in the United States.

3.1. Testing Programs

Gas Technology Institute (GTI) Program

In order to comply with the relevant requirements contained within 49 CFR Part 192 requirements, the PA12 suppliers with the support of the Gas Technology Institute and McElroy Manufacturing performed comprehensive testing to establish and validate a suitable range of generic heat fusion parameters. From the onset, it was noted that previous experience with other thermoplastic materials, specifically polyethylene and polyamide 11 materials, indicates that there is a wide range for key heat fusion parameters which can influence the strength and integrity of the butt heat fusion joint.

In general, there are numerous variables which can impact the overall strength and integrity of a butt heat fusion joint, including surface preparation, heater plate temperature, interfacial pressures, and overall heating and cooling times. In order to aid the industry in developing a uniform and standardized heat fusion procedure for PE materials, the Plastics Pipe Institute, during the mid-1990's, performed extensive testing to develop a range of suitable heat fusion parameters and procedure. This procedure was issued as PPI TR-33 guidelines.

As a first step in the development of the PA12 heat fusion procedure, several PA12 heat fusion joints were made in accordance to PPI TR-33 guidelines for PE materials with the exception of using a higher heater plate

temperature of 500° F. The higher heater plate temperature was specified given the higher melt point for the PA12 materials as compared to PE materials. The remaining parameters were kept the same as compared to PPI TR-33 guidelines.

Subsequently, for the PA12 materials, the following parameters were evaluated using both 2-inch IPS SDR 11 and 6-inch IPS SDR 11 PA12 pipe sizes from three of the four (3/4) PA12 suppliers including Evonik-Degussa, UBE Industries, and EMS Grivory.

- Heater Plate Temperature: 500°F ± 10°F
- Interfacial Pressure Range: 60 – 90 psi

All of the fusions were performed using the visual melt bead width guidance provided under PPI TR-33 guidelines.

Six specimens (like to like, e.g. Evonik pipe to Evonik pipe) were made using the upper and lower bound limits for interfacial pressure ranges and heating times with the appropriate heat fusion equipment settings as follows:

Condition 1:

- Minimum heating time / Minimum interfacial Pressure (60 sec / 60 psi)

Condition 2:

- Minimum heating time / Maximum interfacial pressure (60 sec / 90 psi)

Condition 3:

- Maximum heating time / Minimum interfacial pressure (90 sec / 60 psi)

Condition 4:

- Maximum heating time / Maximum interfacial pressure (90 sec / 90 psi)

The specimens were then tested according to the requirements contained within 49 CFR Part 192.283. Specifically, 49 CFR Part 192.283 requires either the burst pressure testing or long term sustained pressure testing and tensile strength determinations. For the PA12 butt heat fusion joints, all three tests were performed. The results were consistent with expectations – strong joints can be effectively made using these conditions. The results of the burst pressure testing and tensile strength testing demonstrated that the PA12 heat fusion joint has similar properties as compared to PA12 un-fused pipe.

Moreover, results of long term sustained pressure testing at 80° C, and 290 psig demonstrated that there were no failures for test times of at least 1000 hours. Representative test results are summarized in Table 1 below: