

MECHANICAL COUPLINGS FOR JOINING POLYETHYLENE PIPE

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Foreword

This technical note was developed and published with the technical help and financial support of the members of the Plastics Pipe Institute (PPI). These members have shown their commitment to developing and improving quality products by assisting standards development organizations in the development of standards, and also by developing design aids and reports to help engineers, code officials, specifying groups, contractors and users.

The purpose of this technical report is to provide a guide on mechanical fittings for use with HDPE pipe. It is intended for engineers, users, contractors, code officials, and other interested parties.

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PPI intends to revise this technical note within five years, or sooner if required, from the date of its publication, in response to comments and suggestions from users of the document. Please send suggestions for improvements to the address below. Information on other publications can be obtained by contacting PPI directly or visiting our website.

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1.0 INTRODUCTION & SCOPE

The purpose of this document is to illustrate the common designs of mechanical fittings used to join HDPE pipe. Although not exhaustive, included are fittings for gas distribution, oil & gas gathering, and municipal water applications.

This document does not address flanges, lateral or fused connections. This document also does not specifically address industrial, plumbing, heating, geothermal, or ice melt system applications; however, these fittings may be useful in some of these applications.

This document is intended to be informative and general in nature.

- **Always consult with the manufacturer when selecting a particular design and model of fitting to ensure it is appropriate for the application and operating conditions.**
- **Always follow the fitting manufacturer's instructions when installing fittings and follow recommendations for the use of stiffeners.**
- **Always be aware of any specific regulatory requirements that may apply.**

This document relates only to fittings designed for use with outside diameter controlled pipe.

The user should also be aware that some fittings may encroach on the pipe inside diameter (e.g., inserts, OD compression) so this should be kept in mind when selecting fittings for piping systems that may be pigged in the future.

2.0 DOCUMENT STRUCTURE

Section 3.0 provides information that is common to the mechanical fittings industry in general, such as terminology and generically the designs of mechanical fittings.

Sections 4.0 through 6.0 provide additional guidance by end-use application, including industry specific requirements, regulations, and terminology. Specifically, the following sections cover:

- **Section 4.0 – Gas Distribution**
- **Section 5.0 – Oil and Gas Gathering**
- **Section 6.0 – Municipal Water**

3.0 GENERAL

3.1. Definitions

Standard industry terms are as defined in ASTM F412.¹

Nominal Pipe Size (NPS) referred to in this text may refer to Iron Pipe Size (IPS), Ductile Iron Pipe Size (DIPS), Copper Tube Size (CTS) or other commonly used standards that define pipe sizes for PE pipe.

3.1.1. Fitting Categories and Types

Fitting *Categories* and *Types*, as shown in Table 1 through Table 3, classify fitting designs on the degree of pipe restraint provided by the fitting design. *Categories* are taken from the gas industry (ASTM D2513²) or the water industry (ASTM F3536³), and may be used in other industries. *Types* are taken from ASTM F1476⁴ *Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications*. Some industries also simply refer to restrained or unrestrained fittings.

Table 1: Fitting Category Definitions used in Gas

Categories	Definition (Source ASTM D2513 for Gas)
Category 1	A mechanical joint design that provides a seal plus a resistance to a force on the pipe end equal to or greater than that which will cause a permanent deformation of the pipe. Note: US Federal Code for gas requires Category 1 fittings and references the definitions as incorporated into the specific fitting standards and may vary slightly.

¹ ASTM F412 *Standard Terminology Relating to Plastic Piping Systems*, ASTM International, West Conshohocken, PA.

² ASTM D2513 *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*, ASTM International, West Conshohocken, PA.

³ ASTM F3536 *Standard Specification for PE and PP Mechanical Fittings for use on NPS 3 or Smaller Cold-water Service Polyethylene (PE) or Crosslinked Polyethylene (PEX) Pipe or Tubing*, ASTM International, West Conshohocken, PA.

⁴ ASTM F1476 *Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications*, ASTM International, West Conshohocken, PA.

Table 2: Fitting Category Definitions used in Water Industry for Small Diameter Fittings (NPS 3 and smaller)

Categories	Definition (Source ASTM F3536 for Water)
Category 1	A mechanical joint design that provides a seal plus a resistance to a force on the pipe end equal to or greater than that which will cause a permanent deformation of the pipe.
Category 2	A mechanical joint design that provides a seal only. A mechanical joint designed for this category excludes any provisions in the design or installation of the joint to resist any axial pullout forces; therefore, tensile tests are not required.
Category 3	A mechanical joint design that provides a seal plus a pipe restraint rating equivalent to the anticipated thermal stresses occurring in a pipeline. This category has a manufacturer's rated pipe end restraint less than the value required to yield the pipe as outlined in Category 1.

Table 3: Fitting & Connection Types Used in the Water Industry

Types/Classes	Description (Source ASTM F1476)
Type 1 Grooved Mechanical Couplings	A device which consists of two or more housings, closure members such as sets of bolts and nuts or pins, and a pressure-responsive gasket. It is used to mechanically join and seal grooved pipe or fitting, forming a joint.
Type 2 Plain End mechanical Couplings	Device consisting of gasket(s), housing(s), sleeve(s), end rings, threaded fasteners, pipe or fitting anchoring (gripping) features and seal retainers, as applicable.
Type 2 Class 1 – Rigid & Restrained	A connection where there is essentially no angular or axial pipe movement. Also the connection wherein thrust loads generated by internal pressure or external means are absorbed within the joint connection.
Type 2 Class 2 – Flexible & Restrained	A connection where there is available limited angular and axial pipe movement. Also the connection wherein thrust loads generated by internal pressure or external means are absorbed within the joint connection.
Type 2 Class 3 – Flexible and Unrestrained	A connection where tightening of the fasteners compresses the gasket(s), creating a seal on the outside of the plain end pipe.

3.2. Designs of Mechanical Couplings and Connections

The following subsections outline several of the common designs of mechanical couplers for HDPE pipe. The list is not exhaustive and specific designs, features and capabilities will vary by manufacturer. Different applications will have varied requirements and all designs of a type of fitting may not be intended for all applications. Always consult with the fitting manufacturer when selecting a particular design and model of fitting to ensure it is appropriate for the application and operating conditions.

3.2.1. Bolt Tightening Designs

In this fitting design, the pipe is inserted into the fitting body that includes an external seal and grip ring, as illustrated in Figure 1.

Bolt and compression segment orientations can vary. Figure 2 illustrates a product wherein the bolts are oriented parallel to the axis of inserted pipe. Figure 3 and Figure 4 illustrate product wherein the bolts are oriented perpendicular to the axis of inserted pipe. In both cases, gripping rings, if present, and sealing elements are radially compressed as the bolts are tightened. The tightening of nuts and bolts may be required to a specified torque, refer to manufacturer's installation instructions.

These fittings may be made of steel, ductile iron, or brass. Sizes for water & wastewater range typically from NPS 2 and larger. Sizes for gas applications range from NPS ¼ and larger.

Fittings of this design may be of any Category or Type and may require insert stiffeners.



Figure 1 - Example of a bolt tightening design of fitting installed on PE pipe (Image courtesy of Georg Fischer Piping Systems)



Figure 2 - A bolt tightening design of fitting with axial bolts (Image courtesy of Georg Fischer Piping Systems)



Figure 3 - A bolt tightening design of fitting with perpendicular bolts (Courtesy of Victaulic)



Figure 4 - Bolt tightening designs of fitting with perpendicular bolts. Unrestrained: Left & Center; Restrained: Right. (Courtesy of Hamilton Kent)