



Designation: **D 4161 – 9601**

An American National Standard

## Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals<sup>1,2</sup>

This standard is issued under the fixed designation D 4161; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification covers axially unrestrained bell-and-spigot gasket joints including couplings required for machine-made “fiberglass” (glass-fiber-reinforced thermosetting-resin) pipe systems, 8 in. (200 mm) through 144 in. (3700 mm), using flexible elastomeric seals to obtain soundness. The pipe systems may be pressure (typically up to 250 psi) or nonpressure systems for water or for chemicals or gases that are not deleterious to the materials specified in this specification. This specification covers materials, dimensions, test requirements, and methods of test.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

NOTE 1—There is ~~no~~ a similar or equivalent but technically different ISO ~~s~~ Standard (ISO 8639).

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Plastic Piping Systems and Chemical Equipment.

Current edition approved July 10, 1996; 2001. Published September 1996; 2001. Originally published as D 4161 – 82. Last previous edition D 4161 – 94.

<sup>2</sup> An ISO equivalency statement was added.

\*A Summary of Changes section appears at the end of this standard.

D 883 Terminology Relating to Plastics<sup>3</sup>

D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>3</sup>

F 412 Terminology Relating to Plastic Piping Systems<sup>4</sup>

F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe<sup>4</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *General*—Definitions and abbreviations are in accordance with Terminology D 883 or Terminology F 412, and Terminology D 1600 unless otherwise indicated.

### 4. Types of Joints

4.1 This specification covers two types of axially unrestrained joints based on effecting soundness of the joint through compression of an elastomeric seal or ring:

4.1.1 ~~Bell-and-spigot-gasket~~ or coupling joint with the gasket placed in the bell in circumferential compression. ~~A single~~ An elastomeric gasket joint design featuring a continuous elastomeric ring gasket placed in an annular space provided in the bell or socket of the pipe or fitting. The spigot end of the pipe or fitting is forced into the bell, thereby compressing the gasket radially to form a positive seal.

4.1.2 ~~Bell-and-spigot-gasket~~ or coupling joint with the gasket placed on the spigot in circumferential tension: A push on joint design featuring a continuous elastomeric ring gasket placed in an annular space provided on the spigot end of the pipe or fitting. The spigot is forced into the bell of the pipe or fitting, thereby compressing the gasket radially to form a positive seal.

NOTE 2—A coupling joint of these types is a loose double-bell sleeve used to connect pipes which have spigots at both ends (see Fig. 1). All references to bells in this specification are applicable to the sleeve coupling as well as to the integral bell of a bell-and-spigot gasket joint.

### 5. Materials and Manufacture

5.1 The gasket shall be a continuous elastomeric ring of circular or other geometric cross section and shall meet the requirements of Specification F 477, unless otherwise specified in this specification. When a splice is used in the manufacture of the gasket, no more than two splices shall be made in any one gasket.

5.1.1 The chemical composition of the gasket shall be compatible with the type of environment to which it will be subjected. Selection of the gasket composition shall be in accordance with a purchaser and seller agreement.

NOTE 3—Consult the gasket manufacturer for advice as to the suitability of specific rubber compounds for the intended service and joint configurations. Items such as cold set when the joint is deflected under low-temperature conditions and maximum and minimum stretch in the gasket may be dependent upon the specific chemical compounds used.

5.2 Materials in the bell and spigot of the joint shall meet the requirements of the applicable ASTM specification for the pipe or fitting of which the joint is a part.

### 6. Requirements

6.1 *Joint Surfaces*—All surfaces of the joint upon or against which the gasket may bear shall be smooth and free of cracks,

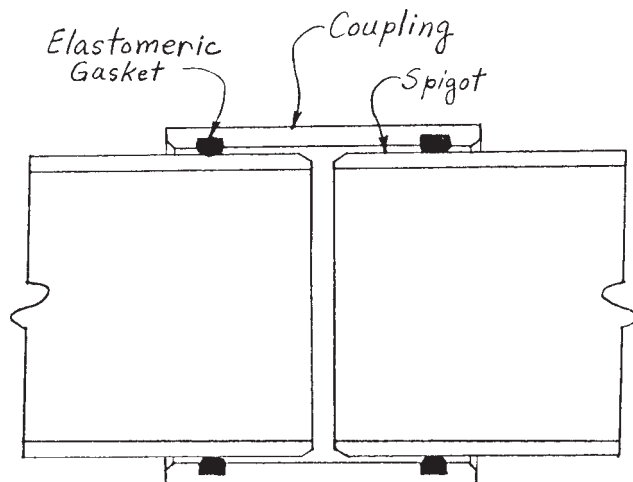


FIG. 1 Typical Coupling Joint Detail

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 08.04.

fractures, or other imperfections that would adversely affect the performance of the joint.

6.2 *Joint Geometry*—The design of the joint shall include a means to retain the gasket and prevent it from being unintentionally displaced, either during assembly of the joint or during operation of the completed pipe system.

6.3 *Dimensions and Tolerances*—The provisions of 6.3.1, 6.3.2, 6.3.3, and 6.3.4 6.3.1.1 apply only to a joining system utilizing a gasket of circular cross section retained in a rectangular groove. Manufacturers may submit to the purchaser detailed designs for joints utilizing gaskets or grooves, or both, of other geometric shape or for joints not meeting the criteria of 6.3.1, 6.3.2, 6.3.3, and 6.3.4. 6.3.1. Joints not meeting the requirements of these sections shall meet the test requirements of Section 7; such joints shall be acceptable, provided the design is approved by the purchaser prior to manufacture and provided the test pipe complies with the specified test requirements. Test results may be extended to other diameters with the same joint configuration, gasket shape and gasket composition provided substantially similar gasket compressions and gasket hardness are maintained. Gasket dimensions may be increased or decreased provided joint geometry is also appropriately proportioned so that critical relationships like gasket confinement are equal or superior to the tested joint. Design submissions shall include joint geometry, tolerances, gasket characteristics, proposed plant tests, and such other information as required by the purchaser to evaluate the joint design for field performance.

#### 6.3.1 *Joints Using Circular Gasket Cross Sections:*

6.3.1.1 The volume of the annular space provided for the gasket, with the engaged joint at normal joint closure in concentric position, and neglecting ellipticity of the bell and spigot, shall not be less than the design volume of the gasket furnished. For a rectangular gasket groove, the cross-sectional area of annular space shall be calculated for minimum bell inside diameter, maximum spigot outside diameter, minimum width of groove at surface of spigot, and minimum depth of groove. The volume of the annular space shall be calculated at the centerline of the groove and considering the centroid of the cross-sectional area to be at the midpoint between the surface of the groove on which the gasket is seated and the surface of the bell, if the groove is on the spigot, or the surface of the spigot, if the groove is in the bell.

6.3.1.2 When the design volume of the gasket is less than 75 % of the volume of the annular space in which the gasket is confined, the dimensions and tolerances of the gasket, bell, and spigot shall be such that, when the outer surface of the spigot and the inner surface of the bell come into contact at some point in their periphery, the deformation in the gasket shall not exceed 40 % at the point of contact nor be less than 15 % at any point. If the design volume of the gasket is 75 % or more of the volume of the annular space, the deformation of the gasket, as prescribed above, shall not exceed 50 % nor be less than 15 %. The cross-sectional area of annular space shall be calculated for average bell diameter, average spigot diameter, average width of groove at surface of spigot, and average depth of groove. The volume of the annular space shall be calculated at the centerline of the groove and considering the centroid of the cross-sectional area to be at the midpoint between the surface of the groove on which the gasket is seated and the surface of the bell, if the groove is on the spigot, or the surface of the spigot, if the groove is in the bell.

NOTE 4—It is recognized that a relationship exists between the water-tightness of a joint, the gasket deformation, and the ratio of gasket volume to space volume. For high-pressure applications, it may be necessary to provide a very high-volume ratio to obtain a sound joint. Some manufacturers also have developed satisfactory joints with very little gasket deformation, but meet the requirements of Section 6 by utilizing a very high-volume ratio.

6.3.2-1.3 When determining the maximum percent deformation of the gasket, the minimum depth of groove and the stretched gasket diameter shall be used and calculations made at the centerline of the groove. When determining the minimum percent deformation of the gasket, the maximum bell diameter, the minimum spigot diameter, the maximum depth of groove, and the stretched gasket diameter shall be used and calculations made at the centerline of the groove. For gasket deformation calculations, if the gasket is placed on the spigot in circumferential tension, the stretched gasket diameter shall be determined as being the design diameter of the gasket divided by the square root of  $(1 + x)$  where  $x$  equals the design percent of gasket stretch divided by 100. If the gasket is placed in the bell in circumferential compression, the design diameter of the gasket shall be used.

6.3.3-1.4 The taper on all sealing surfaces of the bell and spigot on which the elastomeric gasket may bear after closure of the joint and at any degree of partial closure, except within the gasket groove, shall form an angle of not more than  $2^\circ$  with the longitudinal axis of the pipe. If the joint design does not incorporate a mechanical locking feature, the joint shall be designed and manufactured in such a way that at the position of normal joint closure, the parallel surfaces upon which the gasket may bear after closure will extend not less than 0.75 in. (20 mm) away from the edges of the gasket groove.

#### 6.3.4-1.5 *Circular Gaskets:*

6.3.4-1.5.1 In a joint in which the gasket is placed in the bell in circumferential compression, the circumferential length of the gasket shall be such that, when inserted into the gasket groove, the amount of circumferential compression will be less than 4 %. In larger pipe diameters, an adhesive may be required to hold the gasket in place prior to installation.

6.3.4-1.5.2 In an elastomeric joint in which the gasket is placed on the spigot in circumferential tension, the circumferential length of the gasket shall be such that, when installed in the gasket groove, the amount of stretch shall not exceed 30 %.

6.3.4-1.5.3 Compute the amount of compression or stretch by comparing the circumferential length of the centroid of the relaxed gasket with the circumferential length of the centroid of the compressed or stretched gasket after installation in the bell or on the spigot.

6.3.4-1.5.4 Each gasket shall be manufactured to provide the volume of elastomer required by the pipe manufacturer's joint design, with a tolerance of  $\pm 1$  % for gaskets of 1.0-in. (25-mm) diameter and larger. The allowable percentage tolerance shall vary

linearly between  $\pm 3\%$  and  $\pm 1\%$  for gasket diameters between 0.5 and 1.0 in. (13 and 25 mm).

6.3.5.2 The tolerances permitted in the construction of the joint shall be those stated in the pipe manufacturer’s design as approved.

6.4.3.3 Drawings—The manufacturer shall furnish drawings of the joint and gasket, including dimensions and tolerances, if requested by the purchaser.

**7. Laboratory Performance Requirements**

7.1 General:

7.1.1 The gasket shall be the sole element depended upon to make the joint leakproof. The assembled joints shall pass the performance tests listed in this section. The tests shall be performed with components selected to provide minimum compression in the gasket. The internal hydrostatic pressures required in 7.2 and 7.3 shall be two times the rated pressure, if the pipe is manufactured for pressure service, or 29 psi (200 kPa), if the pipe is manufactured for nonpressure service.

7.1.2 Laboratory hydrostatic pressure tests on joints shall be made on an assembly of two sections of pipe properly connected in accordance with the joint design. Suitable bulkheads may be provided within the pipe adjacent to and on either side of the joint, or the outer ends of the two jointed pipe sections may be bulkheaded. Restraints may be provided at the joint to resist transverse thrust. No coatings, fillings, or packings shall be placed prior to the hydrostatic tests.

7.2 Pipes in Angularly Deflected Position—Using a pipe and joint system as described in 7.1.2, the test sections shall be deflected angularly, as shown in Fig. 2, and subjected to the appropriate internal hydrostatic test pressure for 10 min without leakage. The angle defined by the joint openings given in Fig. 2 is the angle between the axis of the two joined pipes.

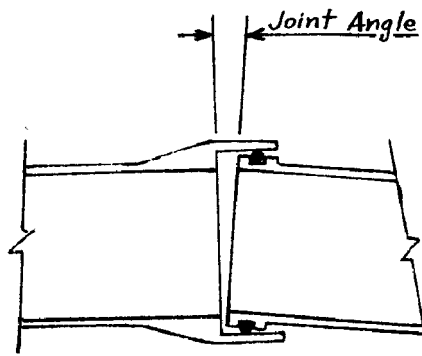
7.2.1 Joints intended for use of pressures greater than 250 psi may have lower allowable angular deflections than those given in Fig. 2 by manufacturer purchaser agreement. The joints shall be tested at the manufacturers maximum allowed angular deflection.

7.2.2 Determine the joint opening by scribing a circumferential index mark on the outside of the pipe a sufficient distance from the spigot end to be visible when the pipe is joined. Measure the maximum and minimum distance from the end of the bell to the mark. The difference equals the joint opening. Fig. 2 illustrates a typical joint in closed and deflected positions and the index mark.

NOTE 5—This test is a laboratory performance test of joint integrity and is not indicative of allowable angular deflections in field installations. In actual installations, deflections greater than the manufacturer’s recommended maximum should be avoided, and elbows, bends, or special fittings should be used in such cases.

7.3 Pipes in Laterally Offset Position (Shear Loading)—Using a pipe and joint system as described in 7.1.2, the test sections shall be deflected while the pipe units are in a horizontal position, as shown in Fig. 3, by applying a perpendicular load. The load shall be 100 lb/in. (17.5 kN/m) in diameter. The load shall be uniformly applied over an arc of not more than 120° along a longitudinal distance equal to one pipe diameter or 12 in. (300 mm), whichever is the smaller, at the unsupported spigot end of the pipe immediately adjacent to the bell of the assembled joint. The pipe in the test shall be supported on adequate blocks placed immediately behind or on the bells, as indicated in Fig. 3. Bands may be required to secure the pipe to the blocks. There shall be no leakage when the appropriate internal hydrostatic test pressure is applied for 10 min after application of the load.

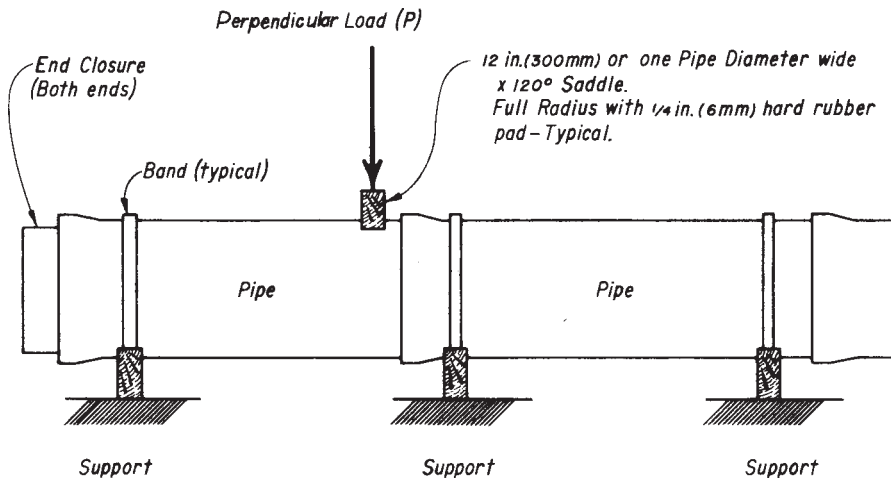
7.4 Vacuum or External Pressure Test—The assembled joint shall withstand an external pressure of 11.6-psi (80-kPa) gage or an internal vacuum of -11.6-psi (-80-kPa) gage while in the angularly deflected position, as in 7.2, and in the laterally offset



NOTE 1—Joint opening shall not exceed the maximum unstressed limit permitted by dimensional clearance between spigot and bell.

Pipe Size	Joint Angle
≤ 20 in.	3°
>20 in. ≤ 33 in.	2°
>33 in. ≤ 60 in.	1°
> 60 in.	1/2°

FIG. 2 Typical Bell-and-Spigot Gasket Joint Detail



NOTE 1—The load shall be applied perpendicular to the axis of the pipe. It may be applied vertically, as shown in this figure, or at any other circumferential orientation.

FIG. 3 Shear Loading-Test Setup

position, as in 7.3. Allow the pressure to stabilize for 30 min, then seal off for a minimum of 10 min. The maximum permissible pressure increase inside of the pipe during the seal-off period shall be 0.1 psi (0.7 kPa). Some grades of pipe may not have the capability in the pipe wall of withstanding the above vacuum or external pressure. In such cases, the joint design may be considered as meeting these criteria if a pipe and joint system, incorporating a geometrically identical joint and heavier-walled pipe, meets the criteria satisfactorily.

## 8. Retesting

8.1 If any failure occurs during performance of the tests specified in Section 7, the joint may be retested to establish conformity in accordance with agreement between the purchaser and the manufacturer.

## 9. Keywords

9.1 angular deflection; bell and spigot; coupling; elastomeric seals; flexible gasket; glass-fiber-reinforced; pipe joints; specification; thermosetting resin

## SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standards since the last issue (D 4161-96) that may impact the use of this standard.

- (1) Modified ISO equivalence statement.
- (2) Revised numbering of 6.3 to clarify. (Only applies to circular gaskets.)
- (3) Added 7.2.1 relating to high pressure points.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).