Designation: F 1476 – 01

An American National Standard

Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications[1]

This standard is issued under the fixed designation F 1476; 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 standard provides the performance characteristics and qualification tests required for gasketed mechanical couplings including grooved-type mechanical couplings for grooved end pipe, mechanical restraint couplings for plain end pipe and mechanical compression couplings for plain end pipe. These couplings are for use at temperatures within the recommended temperature range of their respective gaskets. Consult manufacturer for details.

1.2 The values stated in metric units (SI) are to be regarded as the standard. The values given in parentheses (inch/pound) are provided for information purposes.

1.3 Measuring and test equipment (M&TE) used in the performance of the tests described herein shall be calibrated using equipment which is traceable to the National Institute of Standards and Technology (NIST) or calibrated in accordance with the requirements detailed in BS5781 Part 1 against standards traceable to National Standards.

1.4 *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.*

1.5 As this is not a dimensional standard, nor does it contain component dimensions, the intermixing of sub-components such as gaskets and housings between manufacturers is not recommended and constitutes non-conformance with this standard.

2. Referenced Documents

2.1 *ASTM Standards:*

A 47 Specification for Ferritic Malleable Iron Castings[2]

A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless[3]

A 135 Specification for Electric-Resistance-Welded Steel Pipe[3]

A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[4]

A 183 Specification for Carbon Steel Track Bolts and Nuts[5]

A 193 Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service[3]

A 194 Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service[3]

A 325 Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength[6]

A 395 Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Eleviated Temperatures[2]

A 536 Specification for Ductile Iron Castings[2]

A 563 Specification for Carbon and Alloy Steel Nuts[6]

A 574 Specification for Alloy Steel Socket-Hand Cup Screws[6]

A 743/A743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application[2]

B 26/B26M Specification for Aluminum-Alloy Sand Castings[7]

B 88 Specification for Seamless Copper Water Tube[8]

B 580 Specification for Anodic Oxide Coatings on Aluminum[9]

B 633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel[9]

D 2000 Classification System for Rubber Products in Automotive Applications[10]

F 837 Specification for Stainless Steel Socket Head Cap Screws[6]

2.2 *ANSI, ANSI/ASQC, or ANSI/AWWA Standards:*

B 36.10—Welded and Seamless Wrought Steel Pipe[11]

B 36.19—Stainless Steel Pipe[11]

C 151/A21.51—Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids[11]

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[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

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[2] *Annual Book of ASTM Standards*, Vol 01.02.

[3] *Annual Book of ASTM Standards*, Vol 01.01.

[4] *Annual Book of ASTM Standards*, Vol 01.06.

[5] *Annual Book of ASTM Standards*, Vol 01.04.

[6] *Annual Book of ASTM Standards*, Vol 15.08.

[7] *Annual Book of ASTM Standards*, Vol 02.02.

[8] *Annual Book of ASTM Standards*, Vol 02.01.

[9] *Annual Book of ASTM Standards*, Vol 02.05.

[10] *Annual Book of ASTM Standards*, Vol 09.01.

[11] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

C 606-87—Grooved and Shouldered Joints[11]
Z 1.4 Sampling Procedures and Tables for Inspection by Attributes[11]
Z 540.1 Calibration Laboratories in Measuring Test Equipment[11]
2.3 *NFPA Standards:*
NFPA 13—Sprinkler Systems[12]
2.4 *British Standards:*
BS 1706 Method for Specifying Electro Plated Coatings of Zinc and Cadmium on Iron and Steel[13]
BS 2494 Specification for Elastomeric Seals for Joints in Pipework and Pipelines[13]
BS 5781 (IEC 550) Measurement and Calibration Systems[13]
BS 6104 Mechanical Properties of Fasteners[13]
BS 6105 (ISO 3506) Corrosion Resistant Stainless Steel Fasteners[13]

3. Terminology

3.1 *Definitions:*

3.1.1 *class*—differentiates joint characteristics such as rigid, flexible, restrained and unrestrained.

3.1.2 *failure*—any leakage or joint separation, unless otherwise determined to be due to a pipe or fitting defect.

3.1.3 *fitting*—a device used to change pipe direction, size or adapt to other joining methods. This device is used with pipe or other fittings to create a working system. Shapes such as elbows, tees, crosses, reducers and special shapes are used as needed to fulfill system design specifications.

3.1.4 *flexible*—characteristic of a joint wherein there is available limited angular and axial pipe movement.

3.1.5 *gasketed mechanical coupling* (GMC)—a device used to join pipe to pipe, pipe to fitting, or fitting to fitting wherein an elastomeric (gasket) is used to seal the joint. Coupling may or may not provide mechanical restraint of the pipe or fitting.

3.1.6 *grade*—the joint working pressure as established by tests using representative pipe or tube and the gasketed mechanical coupling (GMC). Test pipe or tube shall be:

NPS—Standard Weight Steel Pipe per ANSI B 36.10 and Specification A 53 Grade B, or Specification A 135 Grade B.

AWWA—Class 53 Ductile Iron Pipe per ANSI/AWWA C 151/A-21.51 for 3″–16″. For other sizes, consult manufacturer.

Tubing—Type K Copper Tube per Specification B 88.

Other—As agreed to by GMC manufacturer and purchaser.

3.1.7 *grooved mechanical coupling (Type I)*—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. Grooves conform to ANSI/AWWA Standard C 606 as applicable. Groove dimensions for tubing and other sizes and types of pipes shall be as specified by the manufacturer. See Fig. 1.

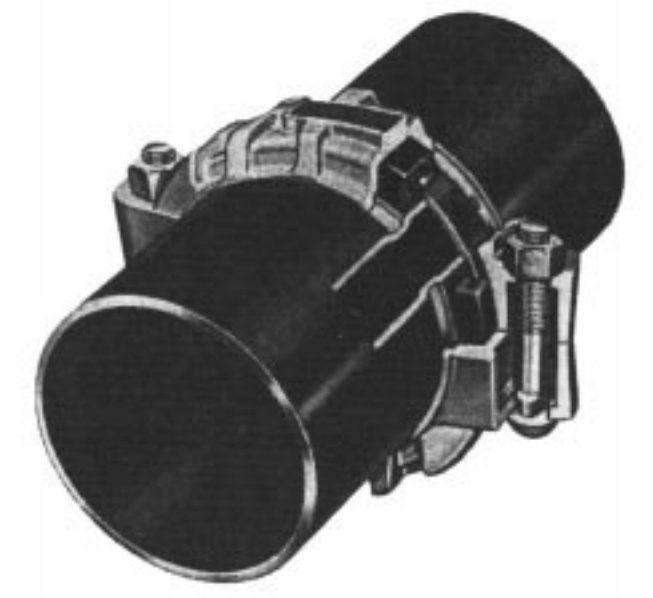

FIG. 1 Type I Typical Construction

3.1.7.1 *grooved mechanical coupling housing*—the structural parts of a grooved mechanical coupling which mechanically fit into pipe or fitting grooves providing mechanical pipe or fitting restraint and enclosure of the gasket.

3.1.8 *plain end mechanical coupling*:

3.1.8.1 *(Type II—Classes 1 and 2)*—Device consisting of gasket(s), housing(s), sleeve(s), end rings, threaded fasteners, pipe or fitting anchoring (gripping) features and seal retainers as applicable. These devices are used to create a seal and restrain plain end pipe or fittings. See Fig. 2 and Fig. 3.

3.1.8.2 *(Type II—Class 3)*—Device consisting of gasket(s), housing(s), sleeve, end rings and threaded fasteners as applicable. Tightening of the fasteners compresses the gasket(s), creating a seal on the outside of the plain end pipe. See Fig. 4.

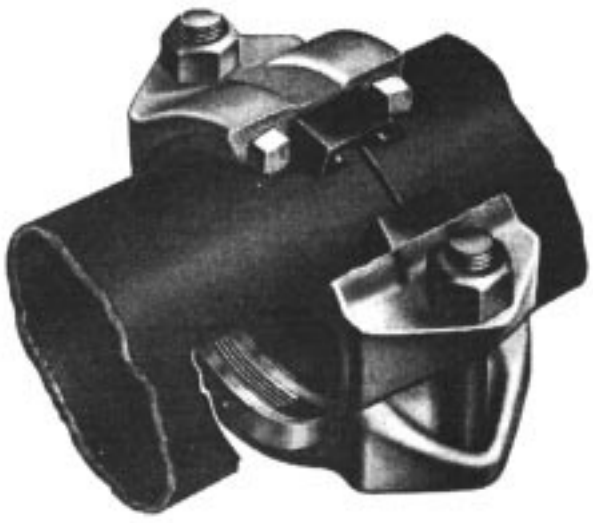

FIG. 2 Type II—Class 1 Typical Construction

[12] Available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

[13] Available from British Standards Institute, 2 Park Street, London, England W 1A2B5.

FIG. 3 Type II—Class 2 Typical Construction

3.1.9 *joint*—interface formed between pipe and pipe, pipe and fitting, or fitting and fitting where a GMC is used to seal within a specified working pressure this interface and where applicable, provide mechanical holding strength.

3.1.10 *joint pressure rating*—the working pressure for the joint on the pipe or fitting material and thickness to be used in the actual piping application.

3.1.11 *leakage*—the escape of fluid (gaseous or liquid) from any point of the specimen.

3.1.12 *penalty run*—a penalty run is performed with penalty run specimens when the original test specimen leaks or separates during testing as a result of any cause which is not related to the design of the GMC being qualified.

3.1.13 *penalty run specimens*—additional specimen(s) which are tested in the place of the original specimen(s). These additional specimen(s) are assembled using the same methods along with additional GMC's of the same type, grade, class, and configuration; and additional pipes or fittings with the same sizes, nominal wall thickness material and material condition as the original test specimen.

3.1.14 *pipe*—hollow tubular products conforming to ANSI B 36.10 and B 36.19, ANSI/AWWA C 151/A-21.51 Nominal Dimensions, or O.D. tube sizes.

3.1.15 *pressure responsive gasket*—gasket design such that application of a pressure load to the gasket enhances its sealing capabilities; that is, additional pressure results in additional force between the gasket and the surface to which it is sealing.

3.1.16 *restrained*—characteristic of the joint wherein thrust loads generated by internal pressure or external means are absorbed within the joint.

3.1.17 *rigid*—characteristic of a joint where there is essentially no available free angular or axial pipe movement.

3.1.18 *specimen*—a prepared assembly consisting of the test joint including GMC and pipes or fittings. The specimen is placed into a controlled environment and tested to determine if the joint performs to the standards established by the test.

3.1.19 *type*—differentiation of kind of pipe or fitting which gasketed mechanical couplings (GMC) are used to join (that is, grooved or plain end).

3.1.20 *unrestrained*—characteristic of a joint wherein thrust generated by internal pressure or external means is not absorbed by the joint but by other means such as pipe anchors or thrust blocks.

4. Classification

4.1 Gasketed mechanical couplings (GMC) are classified into the following design types:

4.1.1 Type I grooved mechanical couplings.

4.1.2 Type II plain end mechanical couplings.

4.2 The gasketed mechanical couplings (GMC) are classified into various grades based on successful completion of testing defined herein. Grades range from approximately 100 psi to 4000 psi and vary by GMC manufacturer. Consult GMC manufacturer for specific grades available.

4.3 The gasketed mechanical couplings (GMC) are classified by the following joint characteristics:

4.3.1 Class 1—rigid and restrained.

4.3.2 Class 2—flexible and restrained.

4.3.3 Class 3—flexible and unrestrained.

5. Ordering Information

5.1 Orders for GMC (Gasketed Mechanical Couplings) under this specification shall include the following:

5.1.1 ASTM designation, title, number and year of issue,

5.1.2 Quantity (number of gasketed mechanical couplings),

5.1.3 Size and appropriate suffix (examples: 8″ NPS, 76.1 mm OD),

5.1.4 Type (I, II),

5.1.5 Grade (consult GMC manufacturer),

5.1.6 Class (joint characteristic),

5.1.7 Housing material and finish,

5.1.8 Gasket material,

5.1.9 Bolt (stud) and nut material and finish,

5.1.10 Supplementary requirements, if any,

5.1.11 Other requirements agreed to between purchaser and GMC manufacturer.

5.2 *Optional Ordering Requirements*:

5.2.1 Certification requirements,

5.2.2 Special marking requirements.

6. Materials and Manufacture

6.1 *Type I—Grooved Mechanical Coupling*:

6.1.1 *Grooved Mechanical Coupling Housings*:

6.1.1.1 *Ferrous Materials*—Housings shall be constructed of ductile iron in accordance with Specification A 395 Grade 60–40–18 or 65–45–15, Specification A 536, Grade 65-45-12 or malleable iron in accordance with Specification A 47, Grade 32510 or 35018.

6.1.1.2 Grooved mechanical coupling housings shall be coated with the manufacturer's standard preparation and paint, or at the purchaser's option, hot-dip galvanized in accordance with Specification A 153, or other finish as agreed upon between purchaser and manufacturer.

6.1.1.3 *Aluminum Alloy Materials*—Housings shall be constructed of aluminum alloy in accordance with Specification B 26, Grade 356-T6 or A 356-T6.

FIG. 4 Type II—Class 3 Typical Construction

6.1.1.4 Finish for aluminum alloy housings shall be bare, anodized in accordance with Specification B 580 or as otherwise agreed between purchaser and manufacturer.

6.1.1.5 Iron-chromium-nickel, corrosion resistant material: Housings shall be constructed of iron-chromium-nickel alloy in accordance with Specification A 743/A 743M, Grade CF-8 or Grade CF-8M.

6.1.1.6 Finish for iron-chromium-nickel shall be bare or otherwise agreed between purchaser and manufacturer.

6.1.2 *Grooved Mechanical Coupling*—Gaskets shall be of materials suitable for the intended service. Elastomers shall comply with Classification System D 2000.

6.1.3 *Grooved Mechanical Coupling—Bolting*:

6.1.3.1 *Carbon Steel Material*—Bolts shall be in accordance with Specification A 183, Grade 2, Oval Neck. Nuts shall be in accordance with Specification A 194, Grade 2. Finish shall be black or at the purchaser's option, zinc electroplated to Specification B 633.

6.1.3.2 *Corrosion Resistant Material*—Bolts shall be in accordance with Specification A 193, Grade B 8, Class 2 (AISI Type 304) or Specification A 193, Grade B 8M, Class 2 (AISI Type 316). Nuts shall be in accordance with Specification A 194 Grade 8.

6.2 *Type II—Plain End Mechanical Coupling*:

6.2.1 *Plain End Mechanical Coupling Housings or Center Sleeves*:

6.2.1.1 *Cast Ferrous Materials*—Cast housings or center sleeves shall be constructed of ductile iron in accordance with Specification A 395 Grade 60–40–18 or 65–45–15, Specification A 536, Grade 65-45-12 or malleable iron in accordance with Specification A 47, Grade 32510 or 35018.

6.2.1.2 *Steel Materials*—End rings and sleeves made from carbon or stainless steel shall be made from material with a minimum yield strength of 172 MPa (25,000 PSI).

6.2.1.3 Plain end mechanical couplings shall be coated with the manufacturer's standard preparation and paint or other finish as agreed upon between the purchaser and manufacturer. Finish for iron chromium-nickel parts shall be bare or otherwise agreed upon between purchaser and manufacturer.

6.2.2 *Plain End Mechanical Coupling*—Gaskets shall be of materials suitable for the intended service (consult manufacturer for recommendation). Elastomer shall comply with Classification System D 2000 or BS 2494.

6.2.3 *Plain End Mechanical Coupling—Bolting*:

6.2.3.1 *Carbon Steel Material*—Bolts shall be in accordance with Specification A 183, Grade 2, Oval Neck or Specification A 325—Type 2 Heavy Hex; Cap screws shall be in accordance with Specification A 574 or BS 6104; Female threaded parts, other than nuts, shall be in accordance with Specification A 183, Grade 2; Nuts, if required, shall conform to Specification A 183, Grade 2 or Specification A 563—Grade C_3 or DH_3, or as otherwise agreed by purchaser and manufacturer. Finish shall be zinc electroplated to Specification B 633 or BS 1706.

6.2.3.2 *Corrosion Resistant Material*—Bolts or threaded female parts other than nuts shall be in accordance with Specification A 193, Grade B 8, Class 2 (AISI Type 304) or Grade B 8M, Class 2 (AISI Type 316); Cap screws shall be in accordance with F 837 or BS 6105; Nuts, if required, shall be in accordance with Specification A 194, Grade 8 or as agreed upon by purchaser and manufacturer.

6.3 *Other Materials*—Where other materials are required, the material and mechanical properties of the product shall be as agreed upon by the GMC manufacturer and the purchaser.

6.4 *Material Quality*:

6.4.1 The material shall be of such quality and purity that the finished product shall have the properties and characteristics to meet the performance requirements of this standard.

6.4.2 The manufacturer is encouraged to use materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means: "Materials which have been collected or recovered from solid waste and reprocessed to become a source of raw material, as opposed to virgin raw materials." Used or rebuilt products shall not be used.

7. Other Requirements

7.1 *Testing Requirements*:

7.1.1 GMC shall be subjected to the tests described in the Annex for the purpose of qualifying the GMC design.

7.1.2 These tests shall be repeated when changes are made in the design, material, or manufacturing process that degrade the performance of the GMC. Degradation determination is to be made by the manufacturer or at agreement between the manufacturer and purchaser.

7.2 *Qualification Requirements*:

7.2.1 GMC shall be qualified using specimens of the same type, grade and class. Each type, grade, and class shall be tested in order to qualify the design. Qualification of the GMC requires successful completion of required testing. Each GMC design is only qualified for use on the pipe or fitting material and wall thickness on which it was tested.

7.2.2 All GMC's tested shall be comprised of an equal number of specimens from the smallest, most intermediate size, and largest sizes within the size range of the GMC being qualified.

7.2.3 Through reasonable interpolations between the GMC sizes tested, other sizes of GMC's within the same type, grade and class will be considered qualified if the specimens according to 7.2.2 pass the testing requirements. Extrapolation shall not be used for qualification purposes.

7.3 *Qualification Test Report*:

7.3.1 Upon completion of testing, a qualification test report shall be written and maintained on file during the life cycle of the design. A copy of this report shall be made available for inspection at the manufacturer's facility.

7.3.2 Any failure during qualification testing shall be analyzed and the failure analysis and corrective action shall be included in the qualification test report.

7.3.3 A retest as specified in Section 11 (number of tests and retests) may be allowed when failure to the original joint occurs during qualification testing. When retesting is permitted, the failure analysis and corrective action shall be included in the qualification test report specified in 7.3.1.

7.4 *Test Equipment and Inspection Facilities*:

7.4.1 Test equipment and inspection facilities shall be of sufficient accuracy and quality to permit performance of required inspections and tests.

7.4.2 *Calibration System Requirements*—The testing and inspection facilities shall maintain a calibration system for Measuring and Test Equipment (M&TE) in accordance with ANSI Z 540.1 with traceability to the National Institute of Standards and Technology (NIST), or shall maintain a calibration system in accordance with the requirements detailed in BS 5781 Part 1 against standards traceable to National Standards.

7.5 *Test Conditions*:

7.5.1 Test pressures as specified within each test shall be used.

7.5.2 Fluid used in the testing of GMC shall be water or air, as specified.

7.5.3 Unless otherwise specified herein, GMC shall be tested within the temperature range stated by the type of test being performed.

NOTE 1—When no temperature is specified within a test, the test shall be conducted at ambient conditions.

7.6 *Performance Requirements*:

7.6.1 Pass criteria for each test shall require meeting or exceeding the performance requirements specified in each test.

8. Dimensions, Mass, and Permissible Variations

8.1 *GMC Dimensions*:

8.1.1 Type I GMC dimensions shall be as specified by the manufacturer and shall provide the degree of axial and angular deflection (as applicable) specified by the manufacturer when used on pipe grooved in accordance with ANSI/AWWA C-606, as applicable, or manufacturer's recommendation(s).

8.1.2 Type II GMC dimensions shall be as specified by the manufacturer. Type II Class 2 shall provide angular deflection as specified by the manufacturer. Type II Class 3 GMC shall provide axial movement and angular deflection as specified by the manufacturer.

9. Workmanship, Finish, and Appearance

9.1 *GMC Machined Surfaces*:

9.1.1 Machined surfaces shall be free from burrs, cracks, laps, and seams which would affect the suitability for the intended service.

9.1.2 Machined surface finishes shall be as specified by the manufacturer.

9.2 *Unmachined Surfaces*:

9.2.1 Unmachined surfaces, such as forging or casting surfaces, shall be free from scale, blisters, fins, folds, seams, laps, segregations and cracks which would affect suitability for the intended service.

10. Sampling

10.1 *In-process Inspection Sampling of GMC Products*:

10.1.1 Inspection samples of GMC being manufactured or processed shall be selected in accordance with ANSI/ASQC Z 1.4. Level of inspection and acceptable quality level (AQL) shall be in accordance with the GMC manufacturer's quality assurance procedures. Other inspection or sampling plans may be used upon mutual agreement between the manufacturer and the purchaser.

10.2 *Lot Acceptance*:

10.2.1 Lot acceptance shall be based upon meeting the sampling and pass/fail requirements of ANSI/ASQC Z 1.4. Other inspection or sampling plans may be used upon mutual agreement between the manufacturer and the purchaser.

11. Number of Tests and Retest, for Qualification Testing

11.1 *Number of Test Specimens*:

11.1.1 Each test shall be performed on specimens as denoted in Table A1.1.

11.2 *Replacement of Test Specimens*:

11.2.1 When untested specimens are rejected as a result of inferior workmanship or materials, or assembly, the specimens shall be dispositioned in accordance with the manufacturer's quality assurance procedures.

11.2.1.1 New test specimens of the same type, grade, and class, and pipe or fittings of the same O.D. size and wall thickness shall be prepared in accordance with Section 12.

11.3 *Penalty Runs*:

11.3.1 In the event of not passing a test, the manufacturer shall proceed with one of the following options:

11.3.1.1 If the leak or separation is determined to be design related, the manufacturer shall redesign the GMC and start all tests from the beginning.

11.3.1.2 If the leak or separation is determined to be unrelated to the design, the test specimen shall be rerun. A replacement test specimen shall be prepared in accordance with the requirement specified in 11.2.

11.3.1.3 If the leak or separation cannot be shown to be either design related or non-design related, the manufacturer shall test three (3) additional penalty specimens. The requirements specified in 11.3.2 shall apply.

11.3.2 Penalty run specimens shall be prepared when GMC has failed any of the tests specified in the Annex.

11.3.2.1 The GMC's used for penalty run(s) shall be of the same type, grade, and class as the failed GMC being replaced.

11.3.2.2 The pipe or fitting used in penalty runs shall be of the same material, O.D., and wall thicknesses as the pipe or fitting being replaced.

11.3.2.3 Preparation of the penalty run specimens shall be in accordance with Section 12.

11.3.2.4 Penalty run specimens shall be identified in accordance with 12.3 and 11.3.2.5.

11.3.2.5 In addition to the part number and test specimen number, a designator shall be placed after the test specimen number which allows the specimen to be identified as a penalty run specimen. The method used to identify penalty run specimens shall be at the manufacturer's option.

12. Specimen Preparation

12.1 *Specimen Preparation and Installation*:

12.1.1 Specimen preparation and installation on appropriate testing apparatus shall be in accordance with the manufacturer's recommended procedures.

12.2 *Assembly of Specimens*:

12.2.1 GMC qualified under the requirements of this specification shall be tested and qualified as a completed assembly; that is, joint.

12.2.2 The intermixing of sub-components of the same type, grade, and class, but of different brands or trade name, constitutes non-compliance with this standard.

12.2.3 Test specimens used in testing shall be assembled using a GMC of a single type, grade and class.

12.2.4 The wall thickness and O.D. size of the pipe or fitting shall be as specified for the GMC joint being qualified.

12.3 *Identification of Test Specimens*:

12.3.1 Each test specimen shall be identified with a unique number to provide traceability back to the test records.

12.3.2 Identification of test specimens shall be permanent. In those cases where size or design does not permit permanent markings, tagging or bagging may be used.

12.3.2.1 When, as a result of testing, a test specimen is sectioned into two (2) or more pieces, each piece shall be marked with the original unique identification number.

12.4 Test specimens may be disposed of following approval of the qualification test report by the GMC manufacturer.

13. Test Methods

13.1 Standard Qualification Tests for GMC shall be as specified in the Annex. The following tests described herein are required for GMC qualification as applicable to the type, grade and class.

Name of Test	Annex
Performance Tests for GMC	Annex A1
Examination of Specimen	Annex A2
Pneumatic Proof Test	Annex A3
Vacuum Test	Annex A4
Hydrostatic Proof Test	Annex A5
Flexibility Test	Annex A6
Hydrostatic Burst Test	Annex A7
Rigidity Test	Annex A8
Bending Moment Proof Test	Annex A9
Bending Moment Ultimate Test	Annex A10

13.2 *Certification of Test Results*:

13.2.1 When specified in the purchase order or the contract, the purchaser shall be furnished certification that samples representing the GMC have been tested as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the results shall be available for inspection at the manufacturer's facility.

13.3 *In-Process Material Tests*—In-Process Material Tests shall be performed in accordance with manufacturer's standard in-process test procedures.

14. Inspection

14.1 *Terms of Inspection:*

14.1.1 Inspection of GMC shall be in accordance with manufacturer's standard inspection procedure or as agreed upon between the purchaser and the manufacturer or supplier as part of the purchase contract.

14.2 *Raw Material Inspection*:

14.2.1 Raw material shall be inspected for compliance with its material specification. A certificate of compliance or mill certificate shall be obtained from the material supplier, as applicable.

14.3 *Quality Conformance Inspection*:

14.3.1 GMC samples shall be visually and dimensionally examined to verify compliance with the manufacturer's appropriate drawings.

14.4 *Process Control Inspection*:

14.4.1 GMC shall be inspected throughout the entire manufacturing and processing cycle. Methods of inspection shall be in compliance with manufacturer's quality assurance procedures.

14.5 *Inspection Records*:

14.5.1 Inspection records shall be maintained by the manufacturer. The length of time on file shall be in accordance with the manufacturer's quality assurance procedures.

15. Certification

15.1 *Certification of Testing* (see 13.2).

15.2 *Certification of Material*.

15.2.1 A certificate of compliance shall be obtained from the material supplier, when applicable. This certificate shall state that applicable requirements for the raw material have been met. As a minimum, the material specification shall specify the chemical and mechanical requirements of the material, as applicable.

16. Product Marking

16.1 *Product Marking*:

16.1.1 Each GMC shall be marked with the manufacturer's name or trademark, size, and markings traceable to the type, grade and class. When shape or size does not permit inclusion of all required markings, the information may be omitted in the reverse order presented.

16.2 *Additional Markings*:

16.2.1 When specified in the contract or purchase order, additional markings other than those specified shall be applied, provided purchaser and supplier have agreed upon such prior to issuance of the contract or purchase order.

17. Packaging

17.1 The GMC shall be boxed, crated, wrapped and otherwise protected during shipment and storage in accordance with manufacturer's standard practice. Care shall be taken to properly protect the GMC from distortion and other damage during shipment and storage. GMC's may be shipped assembled; or bolts and gaskets may be packaged separately in suitable containers to withstand handling and storage.

18. Keywords

18.1 coupling; flexible; gasketed; grooved; plain end; rigid

ANNEXES

(Mandatory Information)

A1. PERFORMANCE TESTS FOR GMC

A1.1 Scope

A1.1.1 This section lists the tests to be used in the qualification of GMC. In addition, statements that apply to all tests are specified to minimize redundancy.

A1.1.2 The values stated in acceptable metric units are to be regarded as standard. The values given in parentheses (inch/pound) are provided for information purposes only.

A1.1.3 *The tests required to qualify GMC may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems 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 regulations/limitations prior to use.*

A1.1.4 The test procedures appear in the following order:

Procedure	Section
Examination of Specimen	Annex A2
Pneumatic Proof Test	Annex A3
Vacuum Test	Annex A4
Hydrostatic Proof Test	Annex A5
Flexibility Test	Annex A6
Hydrostatic Burst Test	Annex A7
Rigidity Test	Annex A8
Bending Moment Proof Test	Annex A9
Bending Moment Ultimate Test	Annex A10

A1.1.5 The sections listed below are from the main body of this standard and apply to the test specimens used in the performance of the tests listed in A1.1.4.

Title	Section
Scope	1
Referenced Documents	2
Terminology	3
Classification	4
Materials and Manufacture	6
Other Requirements	7
Workmanship, Finish, and Appearance	9
Number of Tests and Retest	11
Specimen Preparation	12
Test Methods or Analytical Methods	13
Inspection	14
Certification	15

A1.2 Significance and Use

A1.2.1 *List of All Tests Required to Qualify GMC* (Except additional tests specified by customer)—A1.1.4 provides a listing of all standard tests specified. The requirements for each standard test shall be as specified in Annex A2 through Annex A10.

A1.2.2 *General Information*—All of the general information which applies to the tests described shall be as specified in A1.3.

A1.3 *General Testing Requirements:*

A1.3.1 Table A1.1 provides information on the tests that shall be performed and the number of specimens for each test.

A1.3.2 Ambient temperature tests shall be performed at 24°C ± 5°C (75°F ± 10°F).

A1.3.3 Tests may be performed by the manufacturer or by a test facility designated by the manufacturer. In all cases, the testing apparatus used to test GMC shall be calibrated in accordance with the requirements specified in 7.4.2.

A1.3.4 Pipe or fitting shall be prepared and installed in accordance with the manufacturer's recommendations.

TABLE A1.1 Testing Requirements

NOTE—As far as practical, specimens may be used for more than one test.

Description of Test	Number of Specimens	Applicability of Test
Section A 2—Examination of Specimens	All	Type I & II—Class 1, 2, 3
Section A 3—Pneumatic Proof Test	5	Type I & II—Class 1, 2, 3
Section A 4—Vacuum Proof Test	5	Type I & II—Class 1, 2, 3
Section A 5—Hydrostatic Proof Test	5	Type I & II—Class 1, 2, 3
Section A 6—Flexibility Proof Test	5	Type I & II—Class 2 and 3
Section —Hydrostatic Burst Test	5	Type I & II—Class 1, 2, 3
Section A 8—Rigidity Proof Test	5	Type I & II—Class 1
Section A 9—Bending Moment Proof Test	5	Type I—Class 1, 2 and Type II Class 1
Section A 10—Bending Moment Ultimate Test	5	Type I—Class 1, 2 and Type II Class 1

A1.3.5 When pressure testing with water, test specimens shall be purged of air prior to pressurizing.

A1.3.6 End caps, adapters, and plugs used to block off a pipe or fitting end shall be of design(s) designated by the manufacturer. The end caps, adapters, and plugs shall be constructed to preclude their failure during testing.

A1.3.7 Failure of any test specimen which is related to separation or leakage at the end cap, adapter or pipe/fitting shall be recorded in the test report, but shall not be considered a failure of the GMC pipe or fitting combination being tested. Replacement test specimens shall be prepared in accordance with Section 12.

A1.3.8 Failure of any test specimen at the GMC pipe or fitting joint being proof tested constitutes failure of the GMC design.

A1.3.9 GMC shall be assembled in accordance with manufacturer's recommended procedures.

A1.3.10 Qualification of GMC shall be based upon a successful passing of the tests described in Annex A2 through Annex A10. The flexibility test (see Annex A6) does not apply to Class 1 GMC's, the rigidity test (see Annex A8) does not apply to Class 2 and 3 GMC's and the bending moment proof test (see Annex A9) does not apply to Type II Class 2 or 3 GMC's.

A1.4 Precision and Bias

A1.4.1 No statement is made about either the precision or bias of Section A1 "Performance Tests for GMC" since this section contains general information only.

A2. EXAMINATION OF SPECIMEN

A2.1 Scope

A2.1.1 This procedure covers the inspection and examination of test specimens prepared in accordance with the requirements specified in Section 12.

A2.2 Significance and Use

A2.2.1 GMC's are comprised of couplings which are attached to or onto pipes or fittings using a variety of methods. In order to ascertain the integrity of each GMC type covered, it becomes important to subject all types of GMC to essentially the same tests. When the same tests are used, the assembly of some of the test specimens may become critical to the results of the test performed. The usefulness of this procedure lies in the examination of GMC test specimens to ensure that resulting assemblies duplicate appropriate stresses for all types of GMC qualified using the tests specified herein.

A2.3 Procedure

A2.3.1 GMC test specimens shall be assembled in accordance with the manufacturer's assembly procedures.

A2.3.2 The materials used to assemble the test specimens shall be in accordance with Section 12. The pipe or fitting dimensions may vary (tolerances), as allowed by the manufacturer.

A2.3.3 Quality and workmanship of the test specimens shall be in accordance with the requirements specified in Section 9.

A2.3.4 End caps or adapters used to close off pipe or fitting ends shall be at the discretion of the manufacturer or designated testing facility (see A1.3.6).

A2.3.5 During visual examination of the test specimens, any unusual findings in accordance with the requirements specified in Section 14 shall be recorded.

A2.3.6 The following information shall be recorded in the test report (or form) at the time of examination: Date examined, GMC specimen number, pipe or fitting material and finish, measured pipe or fitting O.D. and wall thickness.

A2.4 Precision and Bias

A2.4.1 Precision is based upon the accuracy of the GMC dimensions in accordance with applicable drawings. The pipe or fitting used in conjunction with GMC shall be in accordance with specification(s) recommended by the manufacturer. There may be bias for the examination of specimen based upon the human elements involved in the visual inspection and measurement methods used.

A3. PNEUMATIC PROOF TESTING

A3.1 Scope

A3.1.1 This section covers pneumatic proof testing of GMC test specimens.

A3.2 Significance and Use

A3.2.1 This test is the initial test of all GMC specimens prepared for qualification. The test is performed by internally pressurizing the test specimen(s) using dry air or nitrogen (N_2). A pressure of .55 MPa (80 psi) is applied. If the specimen shows no evidence of leakage, the specimen has successfully passed the test. This test is useful in determining if the GMC pipe or fitting connection has been assembled correctly, if the gasket is seated and installed correctly, and if the GMC design performs as proposed at this pressure.

A3.3 Procedure of Test

A3.3.1 The test specimen shall be placed in an appropriate chamber and secured in place in accordance with the manufacturer's recommended procedures. Classes 1 and 2 shall not be longitudinally restrained. Class 3 shall be longitudinally restrained.

A3.3.2 The chamber shall be equipped with calibrated pressure gages (see A1.3.3) to permit visual readings of the actual internal pressure being applied.

A3.3.3 The test shall be performed by one of the following methods.

Method 1

The test joint shall be completely submerged in water (H_2O) prior to beginning the test. Uppermost portion of GMC shall be no more than one foot below the surface of the water.

Method 2

Where submersion under water is impractical, leak detection using a soap type leak detecting fluid may be substituted.

A3.3.4 The pneumatic proof test shall be performed at ambient (see A1.3.2) temperature.

A3.3.5 Nitrogen (N_2) or dry air shall be used to internally pressurize the test specimens to .55 MPa ± .03 MPa (80 psi [±4.3 psi]). A stabilization period shall be allowed to remove surface bubbles. The test period following stabilization shall be five minutes. There shall be no evidence of leakage during the test period. If leakage occurs during the test period, the test shall be discontinued and the affected specimens shall have failed the test. The test report shall be filled out noting the reason for discontinuing the test (see A1.3.7 and A1.3.8 for further information).

A3.3.6 If there is no evidence of leakage during the test period, the test specimens shall have passed the pneumatic proof test. If specimens do not pass this test, proceed per Section 11.

A3.4 Precision and Bias

A3.4.1 The precision of this test is the calibrated accuracy of the pressure gages. The gage(s) used to measure the internal pressures applied shall be calibrated to ±1 % throughout the range shown on the gage(s). There shall be no bias for Annex A3. Pneumatic Proof Testing, as the allowable test pressure tolerances of ±.03 MPa (4.3 psi) are well above the range of accuracy required to attain accurate readings.

A4. VACUUM PROOF TEST

A4.1 Scope

A4.1.1 This section covers Vacuum Proof Test of GMC test specimens.

A4.2 Significance and Use

A4.2.1 This test is performed by drawing an internal vacuum in the GMC test specimen, isolating the GMC by closing shut off valves and checking for loss of vacuum. The vacuum is internally applied to the assembled specimen to determine if it can maintain specified vacuum. If the specimen shows no loss of vacuum after 5 minutes, it shall pass the test.

A4.3 Procedure of Test

A4.3.1 The test specimen shall be placed in an appropriate test area and secured in place in accordance with the manufacturer's recommended practice. Classes 1 and 2 shall not be longitudinally restrained. Class 3 shall be longitudinally restrained.

A4.3.2 The test set up shall be equipped with a calibrated vacuum gage(s) to permit visual readings of the actual vacuum being applied.

A4.3.3 The Vacuum Proof Test shall be performed at ambient temperature (see A1.3.2).

A4.3.4 An internal vacuum shall be drawn on the test specimen using a suitable vacuum pump. The test specimen shall be drawn down to 635 mm (25 in.) of mercury [Hg] vacuum ±5 % and then isolated using appropriate isolation valves. Following a stabilization period, the vacuum of 635 mm (25 in.) Hg shall be re-established, if necessary, and monitored for 5 min. There shall be no evidence of loss of vacuum. If leakage (loss of vacuum) occurs during the 5-minute time test period, the specimen shall fail the test. Proceed per Section 11.

A4.3.5 If there is no evidence of loss of vacuum during the 5-minute test period, the test specimen shall pass the vacuum test.

A4.4 Precision and Bias

A4.4.1 The precision of this test shall be the calibrated accuracy of the vacuum gages. The gage(s) used to measure the vacuum applied shall be calibrated to ±1 % or better throughout the range shown on the gage(s). There shall be no bias for A4 Vacuum Test, as the allowable vacuum tolerances of ±5 % are well above the range of accuracy required to attain accurate readings.

A5. HYDROSTATIC PROOF TESTING

A5.1 Scope

A5.1.1 This section covers hydrostatic proof testing of GMC test specimens.

A5.2 Significance and Use

A5.2.1 This test is performed by internally pressurizing the test specimens using water. The initial pressure applied, .690 MPa (100 psi), tests the assembled specimen to determine if it can retain fluid without wetting of the external surface or leakage at the GMC joint. If there is no leakage, the pressure is gradually increased to 150 % of the proposed rated pressure of the pipe or fitting GMC joint. This elevated pressure level tests the ability of the specimens to hold fluid without wetting of the surface, and not to leak or fail structurally. Holding time for this pressure test shall be 10 min.

A5.2.2 If the specimen still shows no evidence of leakage after this test, the specimens shall pass the test. This test is useful in determining the integrity of the fitting joint to hold fluid at an elevated pressure without any wetting of the surface or leakage. After successful completion of this test, the test specimens are ready for additional testing (see Table Test Sequence).

A5.3 Procedure of Test

A5.3.1 Test specimens shall be installed onto an appropriate testing apparatus, filled with water and purged of all air.

A5.3.2 The test specimens shall be placed in a burst chamber and secured into place in accordance with the manufacturer's recommended procedures. Class 1 and 2 GMC shall be tested with no longitudinal restraint provided by the test operator. Class 3 GMC shall be longitudinally restrained.

A5.3.3 The chamber shall be equipped with calibrated pressure gages (see A1.3.3) to permit visual readings of actual internal pressure being applied.

A5.3.4 The hydrostatic proof test shall be performed at ambient temperature (see A1.3.2).

A5.3.5 The test specimens shall be initially pressurized to .690 MPa (100 psi) ± .03 MPa (4.3 psi) for a total period of 5 min. There shall be no evidence of wetting of the surface or leakage during this 5-min period. If wetting of the surface or leakage occurs, the test shall be discontinued and the affected specimens shall fail the test. Proceed per Section 11.

A5.3.6 If there is no evidence of leakage after the initial 5 min period, the internal pressure shall be gradually increased at a rate not to exceed 138 MPa/min (20 000 psi/min) to 150 % ± 5 % of the proposed rated pressure of the pipe or fitting GMC joint. This pressure shall be maintained for an additional period of 10 min. There shall be no evidence of wetting of the external surface or leakage during this 10-min period. If wetting of the surface or leakage occurs, the test shall be discontinued and the affected specimens shall fail the test. Proceed per Section 11.

A5.3.7 If there is no evidence of wetting of the external surface or leakage within the fitting area or joint during both pressurized periods, the test specimens shall pass the hydrostatic proof test.

A5.4 Precision and Bias

A5.4.1 The precision of this test shall be the calibrated accuracy of the pressure gages. The gages used to measure the pressures applied shall be calibrated to ±1 % or better throughout the range shown on the gages. There shall be no bias for A5 hydrostatic proof test, as the allowable tolerances (±5 %) are well above the range of accuracy required to attain accurate readings during both pressurized periods.

A6. FLEXIBILITY PROOF TEST

A6.1 Scope

A6.1.1 This section covers flexibility proof testing of Types I & II Class 2 and Type II Class 3 GMC.

A6.2 Significance and Use

A6.2.1 The significance of this test is to verify the axial pipe and angular pipe movement available with Types I & II Class 2 and Type II Class 3 couplings.

A6.2.1.1 *Type I Class 2*—The test for axial movement is performed by assembling the GMC with the pipe or fitting ends fully inboard and then pressurized to extend the joint to its furthest extended position. The test for angular movement is performed by applying bending moment from Table A6.1 (see Note 2) to the joint and measuring the resultant angular deflection.

A6.2.1.2 *Type II Class 2*—The test for angular movement is performed by filling and pressurizing the GMC with water to the proposed working pressure, then deflecting the joint to the test angle. The test angle shall be the maximum deflection angle specified by the manufacturer. No leakage shall be allowed during or after this deflection. No permanent damage shall occur to the GMC.

A6.2.1.3 *Type II Class 3*—The test for axial movement shall be performed by assembling the GMC in accordance with the manufacturer's instructions. The joint shall then be pressurized

TABLE A6.1 Bending Moments for Flexibility (Note 2) Rigidity (Note 3) and Proof Test Pipe Schedule

NOTE 1—For sizes and wall thicknesses not listed.
METHOD FOR CALCULATING TEST MOMENT
M = F (L)
F = Weight of Pipe + Weight of Water
L = (½) (Hanger Spacing)
EX: For 2" Schedule 40 steel pipe with NFPA Hanger Spacing where L = 7½ ft
F = 3.653 (15) + 40.27 (15) (.036) Where 3.653 is the pounds per foot of 2" Schedule 40 pipe, 40.27 is the cubic inches of water per foot of 2" Schedule 40 pipe, .036 is the pounds per cubic inch of water, 15 is total length of pipe in feet.
F = 54.796 + 21.746 = 76.542 pounds
M = F (L); M = (76.542) (7½); M = 574 FT-LBS for Rigidity and Proof Test
Moment = 2M = 1148 FT-LBS for Ultimate Test
NOTE 2—Use 10 % of Moments listed for flexibility tests.
NOTE 3—Use 25 % of Moments listed for rigidity tests.
NOTE 4—Values in table are for NFPA 13 Hanger Spacing.

Schedules	STEEL NPS								AWWA	
	5		10		30		40		Class 53	D.I.
Nominal Size	N.M.	(Lb.-Ft.)	N.M.	(Lb.-Ft.)	N.M.	(Lb.-Ft.)	N.M.	(Lb.-Ft.)	N.M.	(Lb.-Ft.)
1½	358	264	464	342	. . .	. . .	549	405	. . .	. . .
2	507	374	644	475	. . .	. . .	780	575	. . .	. . .
2½	759	560	899	663	. . .	. . .	1200	885	. . .	. . .
3	1039	767	1492	893	. . .	. . .	1645	1213	2240	1652
4	1572	1159	1797	1325	. . .	. . .	2471	1823	3000	2213
5	2454	1810	2639	1946	. . .	. . .	3551	2619	. . .	. . .
6	3286	2424	3512	2590	. . .	. . .	4803	3543	5262	3881
8	5179	3820	6114	4509	7146	5271	7663	5652	8176	6030
10	8024	5918	8817	6503	10540	7774	11379	8393	11516	8494
12	. . .	. . .	. . .	. . .	14262	10519	15558	11475	15467	11408
14	. . .	. . .	. . .	. . .	17435	12859	18609	13725	19962	14738
16	. . .	. . .	. . .	. . .	21614	15942	24299	17922	24847	18326

to its proposed working pressure, while allowing the pipe to move longitudinally to the maximum allowable movement specified by the manufacturer. No leakage shall be allowed during or after this movement. The test for angular movement shall be performed by assembling the GMC at the test angle and pressurizing to the proposed working pressure. Deflection angles shall be as recommended by the manufacturer.

A6.3 Procedure of Test

A6.3.1 *Type I Class 2*—Pipe shall be grooved (roll or cut as applicable) in accordance with ANSI C 606 as applicable or maufacturer's recommendation(s) and a line scribed 1 in. from each groove away from pipe end. The GMC shall be assembled with the pipe ends touching or as fully inboard as the GMC permits. The distance between the two scribe lines shall be measured and recorded. The specimen shall not be longitudinally restrained. The specimen shall be filled with water and pressurized to .69 MPa (100 psi) or 25 % of GMC proposed rating, whichever is larger. The new distance between the scribe lines shall be measured and recorded. The difference between the two scribe line measurements is the measured axial movement. The test for angular movement consists of applying a small bending moment per Table A6.1 (see Note 2) to the same assembled specimen from above with no internal pressure and measure the total deflected angle achieved. The angle shall be measured using an inclinometer or by measuring the deflection and distance between the support points and calculating the angle.

A6.3.2 *Type II Class 2*—Prepare the pipe in accordance with the coupling manufacturer's recommendations. The test for angular movement shall be performed by assembling the GMC onto the pipe, filling and pressurizing with water to the proposed working pressure, and deflecting the joint to the test angle. The test angle shall be the maximum deflection angle specified by the manufacturer. No damage to the GMC or leakage shall be allowed during the test. Holding time for this test shall be no less than 10 min. The deflection angle shall be measured using an inclinometer or by measuring the deflection and distance between the support points and calculating the angle.

A6.3.3 *Type II Class 3*—The pipe shall be prepared in accordance with the coupling manufacturer's recommendations. The GMC shall be assembled with pipes at their most in-board position. A line shall be scribed 1″ from the outside of the coupling on each pipe. The distance between the two scribed lines shall be measured and recorded. The specimen shall be pressurized and filled with water to its working pressure. The restraint on the pipe shall be adjusted to provide 10 mm (⅜ in.) of total longitudinal movement for 254 mm (10 in.) and larger pipe. Smaller size shall be tested in accordance with manufacturer's published limits. No leakages shall be allowed during this test. Movement shall be determined by measuring between the two scribed lines and subtracting the original line spacing. The test for angular movement shall be performed by assembling the GMC with the pipe in the deflected position, and filling and pressurizing with water to the working pressure. The deflection angles shall be the maximum deflection angle specified by the manufacturer. No leakage shall be allowed when the GMC is pressurized. The

deflection angle shall be measured using an inclinometer or by measuring the deflection and distance between the support points and calculating the angle. Holding time at pressure for axial and angular test shall be no less than 10 min for each test.

A6.3.4 The flexibility proof test shall be performed at ambient temperature (see A1.3.2).

A6.4 Precision and Bias

A6.4.1 The precision of this test shall be the calibration accuracy of the measuring equipment. The calipers used to measure the movement shall be calibrated to .03 mm (.001 in.) throughout its range. The inclinometer shall be zeroed prior to each reading. The accuracy of the readings is dependent solely on the ability to read the scales typically ±1°. There may be bias for the examination of the movement based upon the human elements involved in the visual inspection used.

A7. HYDROSTATIC BURST TEST

A7.1 Scope

A7.1.1 This section covers the test requirements for burst testing.

A7.2 Significance and Use

A7.2.1 This test verifies the mechanical integrity of the pipe or fitting and GMC to withstand, without leakage or burst, a minimum pressure equal to three times the proposed rated pressure of the pipe or fitting and GMC, which form a joint. To successfully pass this test, the pipe or fitting and GMC shall not leak or burst.

A7.3 Procedure of Test

A7.3.1 Test specimens shall be filled with water prior to installation onto the appropriate testing apparatus and purged of entrapped air.

A7.3.2 The test specimens shall be placed in a burst chamber. Class 1 and 2 GMC shall not be longitudinally restrained.

A7.3.3 The chamber shall be equipped with calibrated pressure gages (see A1.3.3) to permit visual readings of actual pressure being applied.

A7.3.4 The hydrostatic burst test shall be performed at ambient temperature (see A1.3.2).

A7.3.5 Class 1 test specimens shall be subjected to a gradual increase of pressure at a rate not to exceed 138 MPa/min to three times the proposed rated pressure of the specimen assembly. If leakage or burst occurs below three times the proposed rated pressure of the specimen assembly, the test shall be discontinued and the affected test specimens shall fail the test for the proposed rating. The test report shall be filled out noting the reason for discontinuing the test. See A1.3.4 or A1.3.5 for further information. If there is no evidence of leakage or burst when three times the proposed rated pressure of the specimen assembly is attained, the pressure shall be gradually increased until burst occurs. The test specimens have passed the hydrostatic burst test when three times the proposed rated pressure of the specimen assembly has been attained. Pressure attained at the time of burst shall be recorded in the Qualification Test Results.

A7.3.6 For Class 2 and Class 3 GMC's, the specimen shall be mounted in a test fixture such that the joint is held fixed at its maximum angular deflected position (determined from the test in Annex A6). This test specimen shall then be subjected to a gradual increase of pressure at a rate not to exceed 138 MPa/min (20 000 psi/min) to three times the proposed rated pressure of the specimen assembly. If leakage or burst occurs before three times the proposed rated pressure of the specimen assembly, the test shall be discontinued and the affected test specimens shall fail the test for the proposed rating. If there is no evidence of leakage or burst when three times the proposed rated pressure of the specimen assembly is attained, the pressure shall be gradually increased until burst occurs. The test specimens have passed the hydrostatic burst test when three times the proposed rated pressure of the specimen assembly has been attained. Pressure attained at the time of burst shall be recorded in the Qualification Test results.

A7.4 Precision and Bias

A7.4.1 The precision of this test shall be the calibrated accuracy of the pressure gages. The gages used to measure the pressures applied shall be calibrated to ±1 % or better throughout the range shown on the gages. There may be bias in this test if the pipe or fitting selected bursts below three times its proposed rated pressure. If this occurs, the test specimens may be replaced in accordance with A1.3.7. There also may be bias based upon the human elements involved in the visual inspection used.

A8. RIGIDITY PROOF TEST

A8.1 Scope

A8.1.1 This section covers rigidity proof testing of Class 1 GMC specimens.

A8.2 Significance and Use

A8.2.1 The significance of this test is to demonstrate the suitability of the GMC for use when the piping system is supported as a rigid system. The test is performed by applying a moment to the specimen equal to the maximum moment generated by the pipe when filled with water and supported at the maximum allowable hanger spacing (see Table A6.1, Note 3). The GMC is to be pressurized with water to its rated pressure during application of the bending moments. The GMC shall pass this test if the included angle of the pipe sections adjacent to the GMC does not change by more than angle Θ with the test moment applied at the GMC, and there is no evidence of leakage. Θ shall be calculated as follows: Θ = 60′ (minutes) − [2′ (minutes) × (nominal pipe size in inches)].

A8.3 Procedure of Test

A8.3.1 The test shall be conducted with a specimen using test pipe not less than .38 m (15 in.) in length. The support points for the pipe shall be not less than .305 m (12 in.) from the GMC. The test load may be applied directly to the GMC or to the pipe adjacent to the GMC with appropriate load adjustment. The joint shall be internally pressurized to the proposed rated pressure (±5 %) of the GMC pipe or fitting (specimen), whichever is lower. The initial included angle shall be measured and recorded. Do not apply any bending moment while measuring the initial angle. The bending moment listed in Table A6.1 shall be applied (see Note 3) to the joint. The final included angle shall then be measured and recorded. The deflection angle shall be determined either by measuring the movement of the GMC and calculating the angle or by direct measurement. The test shall be conducted at ambient temperature (see A1.3.2). If there is no evidence of leakage and the included angle has not changed more than angle Θ, the GMC shall pass the test. Θ shall be calculated as follows: Θ° = 60′ (minutes) − [2′ (minutes) × (nominal pipe size in inches)]. The deflection angle e shall be defined as the difference between the initial and final included angles above.

A8.4 Precision and Bias

A8.4.1 The precision of this test shall be the calibrated accuracy of the pressure gages and the accuracy of the reading of the inclinometer or dial gage. The gages used to measure the pressure applied shall be calibrated to ±1 % or better throughout the range used for the test. The inclinometer shall be zeroed prior to each reading. Therefore, the accuracy of the readings is dependent solely on the ability to read the scales, typically ±1 %. There may be bias for the visual reading of the inclinometer or dial gage based upon the human elements involved in the visual reading of the meter(s).

A9. BENDING MOMENT PROOF TEST

A9.1 Scope

A9.1.1 This section covers the bending moment proof test for Type I Class 1 and 2 and Type II Class 1 GMC specimens.

A9.2 Significance and Use

A9.2.1 This test verifies the ability of the GMC to resist a bending moment equal to the bending moment generated by the pipe when filled with water, supported at one side of the GMC by a hanger and with the next hanger broken on the maximum allowable hanger spacing. The GMC is to be pressurized to its proposed rated pressure ±5 % during the test. The GMC shall have passed this test if it withstands this moment without failing and no evidence of leakage is observed.

A9.3 Procedure for Test

A9.3.1 The test shall be conducted with a specimen using test pipe at least .38 meters (15 inches) in length. The support points for the pipe shall be a minimum of .305 meters (12 inches) from the GMC. The test load may be applied directly to the GMC or on the pipe adjacent to the GMC. In either case, the applied load shall be such that the test moment acts at the GMC. The joint shall be pressurized to the proposed rated pressure (±5 %) of the specimen. The moment (see Table A6.1) shall be applied to the joint and held for not less than one minute. The test shall be conducted at ambient temperature (see A1.3.2). If the GMC withstands this moment and shows no evidence of leakage, it shall pass this test.

A9.4 Precision and Bias

A9.4.1 The precision of this test shall be the calibrated accuracy of the pressure gages. The gages used to measure the pressure applied to the specimen and to the bending moment apparatus, as applicable, shall be calibrated to ±1 % or better throughout the range used for the test. There is no bias for this test because the allowable tolerance of ±5 % is well above the range of accuracy required to attain accurate readings.

A10. BENDING MOMENT ULTIMATE TEST

A10.1 Scope

A10.1.1 This section covers the bending moment ultimate test for Type I Class 1 and 2 and Type II Class I GMC specimens.

A10.2 Significance and Use

A10.2.1 This test verifies the safety factors available in the GMC when tested with the bending moment from Annex A8 and Annex A9. This test is performed by pressurizing the specimen to its proposed rated pressure and then applying a bending moment to cause failure. The pressure is maintained at the proposed rated pressure throughout the test. The test is conducted at ambient temperature (see A1.3.2). A specimen that withstands two times the bending moment for Annex A9 without failure has passed this test.

A10.3 Procedure for Test

A10.3.1 The test shall be conducted with a specimen using test pipe not less than .38 meters (15 inches) in length. The support points for the pipe shall be not less than .305 meters (12 inches) from the GMC. The test load may be applied directly to the GMC or on the pipe adjacent to the GMC. In either case, the applied load shall be such that the described test moment acts at the GMC. This test shall be conducted at ambient temperature (see A1.3.2). The joint shall be internally pressurized to the proposed rated pressure (±5 %) of the specimen. Increasing moments shall be applied to the GMC while maintaining the internal pressure at the proposed rated pressure until failure occurs. This bending moment shall be applied at a rate not to exceed 27,116 Newton meters (20,000 Ft-Lbs) per minute. GMCs that withstand two times the test moment from Annex A9 without evidence of leakage shall pass the test. The moment at failure shall be recorded.

A10.4 Precision and Bias

A10.4.1 The precision of this test shall be the calibrated accuracy of the pressure gages. The gages used to measure the pressure applied to the specimen and to the bending apparatus, as applicable, shall be calibrated to ±1 % or better throughout the range used for the test. There is no bias for this test because the allowable tolerance of ±5 % is well above the range of accuracy required to attain accurate readings.