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Ships and marine technology — Gasketed mechanical couplings for use in piping systems — Performance specification

Navires et technologie maritime — Accouplements mécaniques avec joints pour systèmes de tuyauteries — Spécification des performances

Reference number
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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 15837 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

Ships and marine technology — Gasketed mechanical couplings for use in piping systems — Performance specification

1 Scope

This International 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.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
class
differentiates joint characteristics such as rigid, flexible, restrained and unrestrained

2.2
failure
any leakage or joint separation, unless otherwise determined to be due to a pipe or fitting defect

2.3
fitting
a device used to change pipe direction, size or adapt to other joining methods

NOTE 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 fulfil system design specifications.

2.4
flexible
characteristic of a joint wherein there is available limited angular and axial pipe movement

2.5
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

NOTE A coupling may or may not provide mechanical restraint of the pipe or fitting.

2.6
working pressure grade
joint working pressure as established by tests using representative pipe or tube and the gasketed mechanical coupling (GMC)

2.7
grooved mechanical coupling (Type 1)
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

NOTE It is used to mechanically join and seal grooved pipe and/or fittings, forming a joint.

See Figure 1.

2.8
grooved mechanical coupling housing
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

2.9
plain-end mechanical coupling
plain-end GMCs consisting of Type II Classes 1, 2 and 3

2.9.1
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

NOTE These devices are used to create a seal and restrain plain-end pipe or fittings. See Figures 2 and 3.

2.9.2
Type II Class 3
device consisting of gasket(s), housing(s), sleeve, end rings and threaded fasteners as applicable

NOTE Tightening of the fasteners compresses the gasket(s), creating a seal on the outside of the plain-end pipe. See Figure 4.

2.10
joint
interface formed between pipe and pipe, pipe and fitting, or fitting and fitting where a GMC is used to seal this interface within a specified working pressure and, where applicable, provide mechanical holding strength

2.11
joint pressure rating
working pressure for the joint on the pipe or fitting material and thickness to be used in the actual piping application

2.12
leakage
escape of fluid (gaseous or liquid) from any point of the specimen

2.13
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

2.14
penalty-run specimens
additional specimen(s) which are tested in the place of the original specimen(s)

NOTE These additional specimen(s) are assembled using the same methods, along with additional GMCs of the same type, working pressure, class and configuration; and additional pipes or fittings with the same sizes, nominal wall thickness, material and material condition as the original test specimen.

2.15
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 which it is sealing

2.16

restrained

characteristic of the joint wherein thrust loads generated by internal pressure or external means are absorbed within the joint

2.17

rigid

characteristic of a joint where there is essentially no available free angular or axial pipe movement

2.18

specimen

a prepared assembly consisting of the test joint including a GMC and pipes or fittings

NOTE The specimen is placed in a controlled environment and tested to determine if the joint performs according to the standards established by the test.

2.19

type

differentiation of kind of pipe or fitting which gasketed mechanical couplings are used to join (that is, grooved or plain end)

2.20

unrestrained

characteristic of a joint wherein thrust generated by internal pressure or external means is not absorbed by the joint

2.21

size

dimensions of the piping system or component, primarily nominal diameter and wall thickness

2.22

life cycle

complete series and stages of events in the development and manufacture of a product, from the initial conceptualization through to production, modifications and maintenance

3 Classification

3.1 Design types

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

— Type I, grooved mechanical couplings;

— Type II, plain-end mechanical couplings.

3.2 Working pressures

Gasketed mechanical couplings (GMCs) are classified into various working pressures, or grades, based on successful completion of testing defined herein. Working pressures range from approximately 0,7 MPa to 30 MPa and vary by GMC manufacturer. The GMC manufacturer should be consulted for specific working pressures available.

3.3 Joint characteristics

Gasketed mechanical couplings (GMCs) are classified by the following joint characteristics:

— Class 1: rigid and restrained;

— Class 2: flexible and restrained;

— Class 3: flexible and unrestrained.

4 Ordering information

Orders for GMCs (Gasketed Mechanical Couplings) in accordance with this International Standard shall include the following characteristics:

— quantity (number of gasketed mechanical couplings);

— size;

— type (I, II);

— working pressure (consult GMC manufacturer);

— class (joint characteristic);

— housing material and finish;

— gasket material, including operating temperature limitations;

— bolt (stud) and nut material and finish;

— other requirements agreed to between purchaser and GMC manufacturer.

5 Materials

The materials used for construction of GMCs shall be as agreed upon by the manufacturer and the purchaser, provided that such materials have been used to qualify the joint's performance in accordance with this International Standard.

6 Workmanship, finish and appearance

6.1 GMC machined surfaces

Machined surfaces shall be free from burrs, cracks, laps and seams which would affect the suitability for the intended service. Machined surface finishes shall be as specified by the manufacturer.

6.2 Unmachined surfaces

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.

7 Other requirements

7.1 Testing requirements

GMCs shall be subjected to the tests described in Annex A for the purpose of qualifying the GMC design. 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 upon agreement between the manufacturer and purchaser.

7.2 Qualification requirements

7.2.1 General

GMCs shall be qualified using specimens of the same type, working pressure and class. Each type, working pressure, 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 Sizing

All GMCs tested shall be comprised of an equal number of specimens from the smallest, intermediate, and largest sizes within the size range of the GMC being qualified. Through reasonable interpolations between the GMC sizes tested, other sizes of GMCs within the same type, working pressure and class will be considered qualified if the specimens pass the testing requirements. Extrapolation shall not be used for qualification purposes.

7.3 Qualification test report

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

7.4 Retest

A retest as specified in Clause 8 may be allowed when failure of 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.

7.5 Test equipment and inspection facilities

7.5.1 General

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

7.5.2 Calibration system requirements

Testing and inspection facilities shall maintain a calibration system for Measuring and Test Equipment in accordance with the national standards of the country in which the testing is conducted.

7.6 Test conditions

Test conditions shall be as follows.

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

— Fluid used in the testing of GMCs shall be water, air or nitrogen (N_2), as specified.

— Unless otherwise specified, GMCs shall be tested within the temperature range stated by the type of test being performed. When no temperature is specified within a test, the test shall be conducted at ambient conditions.

7.7 Performance requirements

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

8 Number of tests and retests for qualification testing

8.1 General

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

8.2 Penalty runs

8.2.1 General

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

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

b) If the leak or separation is determined to be unrelated to the design, the test specimen shall be run again with a replacement test specimen.

c) If the leak or separation cannot be shown to be either design related or non-design related, the manufacturer shall test three additional penalty-run specimens. The requirements specified in 8.2.2 shall apply.

8.2.2 Penalty-run specimens

Penalty-run specimens shall meet the following requirements.

— Penalty-run specimens shall be prepared when a GMC has failed any of the tests specified in Annex A.

— GMCs used for penalty run(s) shall be of the same type, working pressure and class as the failed GMC being replaced.

— The pipe or fitting used in penalty runs shall be of the same material, outside diameter and wall thickness as the pipe or fitting being replaced. Preparation of the penalty-run specimens shall be in accordance with Clause 9.

— Penalty-run specimens shall be identified in accordance with 9.3.

— 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.

9 Specimen preparation and installation

9.1 General

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

9.2 Assembly of specimens for test

9.2.1 General

The following are general test requirements:

— GMCs qualified under the requirements of this International Standard shall be tested and qualified as a completed assembly; that is, a joint;

— test specimens used in testing shall be assembled using a GMC of a single type, working pressure and class;

— the wall thickness and outside diameter. size of the pipe or fitting shall be as specified by the manufacturer for the GMC joint being qualified.

9.2.2 Prohibited assemblies

The intermixing of sub-components of the same type, working pressure and class, but of different brands or trade names, constitutes non-conformance with this standard and is prohibited.

9.3 Identification of test specimens

Test specimens shall be identified in accordance with the following requirements.

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

— 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.

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

9.4 Disposal

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

10 Test methods

10.1 General

Standard qualification tests for GMC are specified in Annex A. The following tests described are required for GMC qualification as applicable to the type, working pressure and class.

10.2 Certification of test results

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 International Standard 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.

10.3 In-process material tests

In-process material tests shall be performed in accordance with manufacturer's standard in-process test procedures.

11 Inspection

11.1 Terms of inspection

Inspection of GMCs 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.

11.2 Raw-material inspection

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.

11.3 Quality-conformance inspection

GMC samples shall be visually and dimensionally examined to verify conformance to the manufacturer's drawings.

11.4 Process-control inspection

GMCs shall be inspected throughout the entire manufacturing and processing cycle. Methods of inspection shall be in conformance to the manufacturer's quality assurance procedures.

12 Product marking

12.1 General

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

12.2 Additional markings

Additional markings, other than those specified, which are part of the manufacturer's standard practice, may also be applied to GMCs.

13 Packaging

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

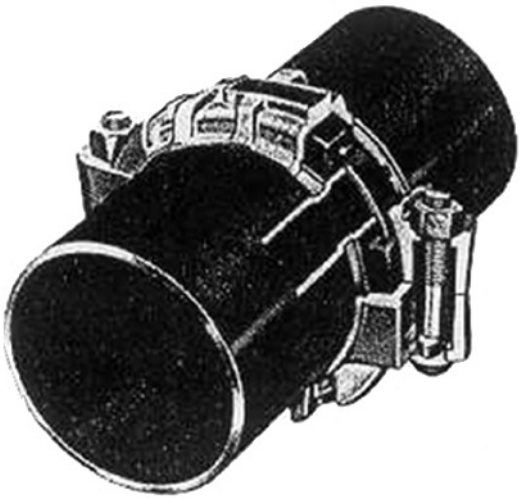


Figure 1 — Typical construction of Type I

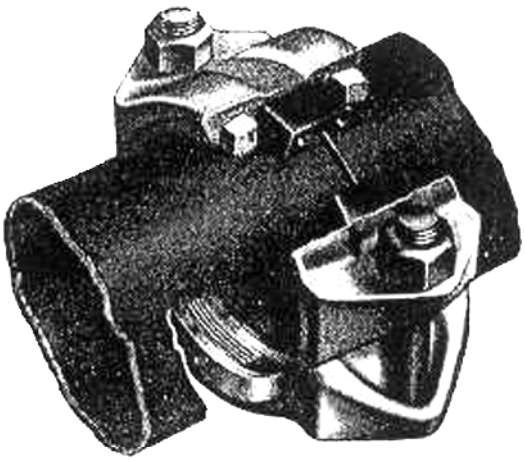


Figure 2 — Typical construction of Type II — Class 1

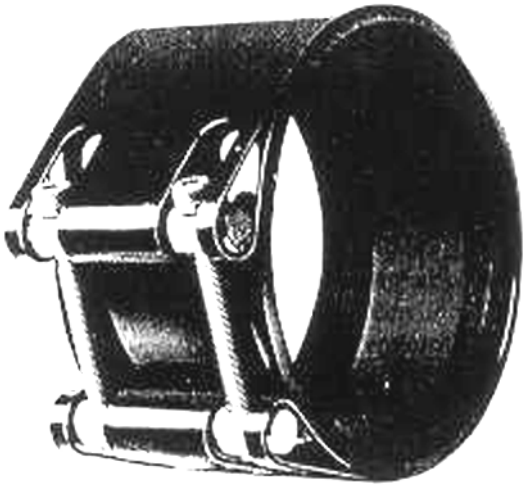


Figure 3 — Typical construction of Type II — Class 2

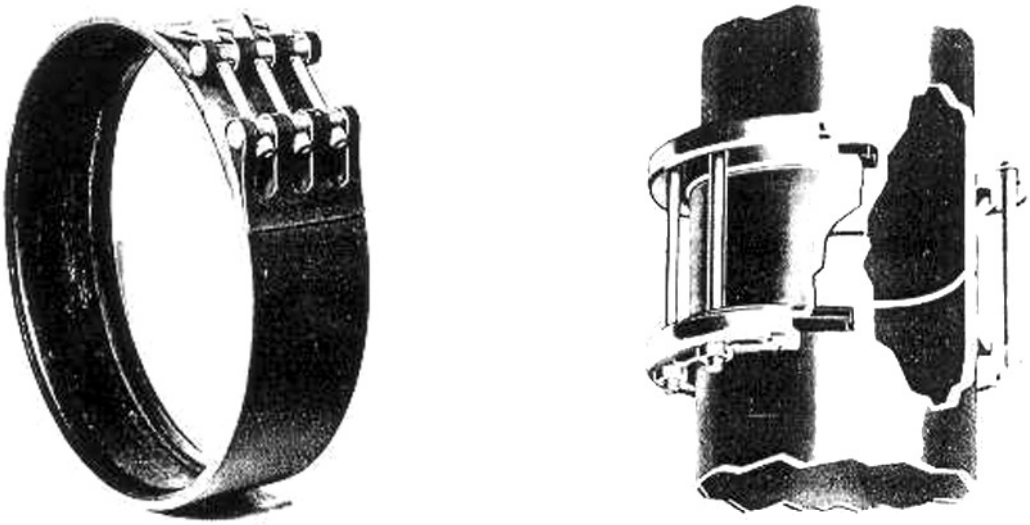


Figure 4 — Typical construction of Type II — Class 3

Annex A
(normative)

Tests to be used in the qualification of GMCs

A.1 General requirements

A.1.1 Scope

This clause lists the tests to be used in the qualification of GMCs. In addition, statements that apply to all tests are specified to minimize redundancy.

A.1.2 Safety concerns

The tests required to qualify GMCs 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 or limitations prior to use.

A.1.3 Order of tests

The test procedures appear in the order given in Table A.1.

Table A.1 — Test order

Name of test	Clause
Examination of specimens	A.2
Pneumatic proof (leak) test	A.3
Vacuum proof test	A.4
Hydrostatic proof test	A.5
Flexibility proof test	A.6
Hydrostatic burst test	A.7
Rigidity test	A.8
Bending-moment proof test	A.9
Bending-moment ultimate test	A.10

A.1.4 General testing requirements

General test requirements are as follows:

— Table A.2 provides information on the tests that shall be performed and the number of specimens for each test.

— Ambient temperature tests shall be performed at 24 °C ± 5 °C.

— 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 Clause 7.

— Pipe or fittings shall be prepared and installed in accordance with the manufacturer's recommendations.

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

— 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.

— Failure of any test specimen which is related to separation or leakage at the end cap, adapter or plug 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 Clause 9.

— Failure of any test specimen at the GMC pipe or fitting joint being tested constitutes failure of the GMC design. GMCs shall be assembled in accordance with manufacturer's recommended procedures.

— Qualification of a GMC shall be based upon a successful passing of the tests described in A.2 through A.10. The flexibility test (see A.6) does not apply to Class 1 GMCs, the rigidity test (see A.8) does not apply to Classes 2 and 3 GMCs and the Bending-moment proof test (see A.9) does not apply to Type II Class 2 or 3 GMCs.

Table A.2 — Testing requirements

Description of test	Number of specimens	Applicability of test
A.2 Examination of specimens	All	Types I and II – Classes 1, 2, 3
A.3 Pneumatic proof (leak) test	3	Types I and II – Classes 1, 2, 3
A.4 Vacuum proof test	3	Types I and II – Classes 1, 2, 3
A.5 Hydrostatic proof test	3	Types I and II – Classes 1, 2, 3
A.6 Flexibility proof test	3	Types I and II – Classes 2 and Type II Class 3
A.7 Hydrostatic burst test	3	Types I and II – Classes 1, 2, 3
A.8 Rigidity proof test	3	Types I and II – Class 1
A.9 Bending-moment proof test	3	Type I – Class 1, 2 and Type II – Class 1
A.10 Bending-moment ultimate test	3	Type I – Class 1, 2 and Type II – Class 1
NOTE As far as practical, specimens may be used for more than one test.		

A.2 Examination of specimens

A.2.1 Scope

This procedure covers the inspection and examination of test specimens prepared in accordance with the requirements specified in Clause 9.

A.2.2 Significance and use

GMCs 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 GMCs 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 GMCs qualified using the tests specified herein.

A.2.3 Procedures

GMC test specimens shall be assembled in accordance with the manufacturer's assembly procedures. The materials used to assemble the test specimens shall be in accordance with Clause 9. The pipe or fitting dimensions may vary (tolerances), as allowed by the manufacturer. Quality and workmanship of the test specimens shall be in accordance with the requirements specified in Clause 6. End caps or adapters used to close off pipe or fitting ends shall be at the discretion of the manufacturer or designated testing facility. During visual examination of the test specimens, any unusual findings in accordance with the requirements specified in Clause 11 shall be recorded.

A.2.4 Test report

The following information shall be recorded in the test report at the time of examination:

a) date examined;

b) GMC specimen number;

c) pipe or fitting material and finish;

d) measured pipe or fitting outside diameter;

e) wall thickness.

A.3 Pneumatic proof (leak) test

A.3.1 Scope

This clause covers pneumatic proof (leak) testing of GMC test specimens.

A.3.2 Significance and use

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). 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.

A.3.3 Test procedure

The following procedures shall be followed.

— 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.

— The pneumatic proof test shall be performed at ambient temperature.

— The chamber shall be equipped with calibrated pressure gauges to permit visual readings of the actual internal pressure being applied.

— Nitrogen (N_2) or dry air shall be used to internally pressurize the test specimens to 0,55 MPa or to 0,25 times the proposed rated pressure, whichever is less. The tolerance on the internal pressure shall be 0,03 MPa. A stabilization period shall be allowed to remove surface bubbles. The test period following stabilization shall be 5 min. 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.

— 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 as described in Clause 8.

A.3.4 Methods

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

a) Method I

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

b) Method 2

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

A.4 Vacuum proof test

A.4.1 Scope

This clause outlines vacuum proof testing of GMC specimens.

A.4.2 Significance and use

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 min, it shall pass the test.

A.4.3 Test procedure

The following procedures apply to the vacuum test.

— 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.

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

— The vacuum proof test shall be performed at ambient temperature.

— 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 of Mercury (Hg) vacuum $\pm$ 5 % and then isolated using appropriate isolation valves. Following a stabilization period, the vacuum of 635 mm 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 min test period, the specimen shall fail the test. Proceed as described in Clause 8.

— If there is no evidence of loss of vacuum during the 5 min test period, the test specimen shall pass the vacuum test.

A.5 Hydrostatic proof test

A.5.1 Scope

This clause covers hydrostatic proof (leak) testing of GMC test specimens.

A.5.2 Significance and use

This test is performed by internally pressurizing the test specimens using water. The initial pressure applied 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. If the specimen still shows no evidence of leakage after this test, the specimens shall pass the test.

A.5.3 Test procedure

The following procedures apply to the hydrostatic proof test.

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

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

— The chamber shall be equipped with calibrated pressure gauges to permit visual readings of actual internal pressure being applied.

— The hydrostatic proof test shall be performed at ambient temperature.

— The test specimens shall be initially pressurized to 0,25 times the proposed rated pressure for a total period of 5. The tolerance on the pressure shall be 0,03 MPa. 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 as described in Clause 8.

— If there is no evidence of leakage after the initial 5 min period, the internal pressure shall be gradually increased at a rate that does not exceed 30 MPa/min to 150 % ($\pm$ 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 as described in Clause 8.

A.6 Flexibility proof test

A.6.1 Scope

This clause covers flexibility proof testing of GMCs of Types I and II Class 2 and Type II Class 3.

A.6.2 Significance and use

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

A.6.3 Test procedure

A.6.3.1 Type I Class 2

Pipe shall be grooved (rolled or cut as applicable) in accordance with the manufacturer's recommendation(s) and a line scribed 25 mm from each groove away from the 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 25 % of GMC proposed rating or 0,69 MPa, 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 as described in A.11.2 to the same assembled specimen used for the axial movement test with no internal pressure and measuring 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.

A.6.3.2 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 150 % of the maximum deflection angle specified by the manufacturer. No damage to the GMC or leakage shall be allowed during the test. The holding time for this test shall be not 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.

A.6.3.3 Type II Class 3

The pipe shall be prepared in accordance with the coupling manufacturer's recommendations. The GMC shall be assembled with the pipes touching or as far into the GMC as permitted by the coupling design or as recommended by the manufacturer. A line shall be scribed 25 mm from the outside of the coupling on each pipe (see Figure A.1). 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 of total axial movement for 254 mm and larger pipe. Smaller sizes shall be allowed to move axially to the maximum allowed by the manufacturer. 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 angle 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 shall be not less than 10 min.

A.7 Hydrostatic burst test

A.7.1 Scope

This clause covers the test requirements for burst testing.

A.7.2 Significance and use

This test verifies the mechanical integrity of the pipe or fitting and GMC to withstand, without leakage or bursting, a minimum pressure equal to four 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.

A.7.3 Test procedure

The following procedures apply to the burst test.

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

— Test specimens shall be placed in a burst chamber. GMCs of Classes 1 and 2 shall not be longitudinally restrained.

— The chamber shall be equipped with calibrated pressure gauges to permit visual readings of the actual pressure being applied.

— The hydrostatic burst test shall be performed at ambient temperature.

— Class 1 test specimens shall be subjected to a gradual increase of pressure at a rate not to exceed 30 MPa/min to four times the proposed rated pressure of the specimen assembly. If leakage or bursting occurs below four 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. If there is no evidence of leakage or bursting when four 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 four times the proposed rated pressure of the specimen assembly has been attained. Pressure attained at the time of bursting shall be recorded in the Qualification Test Results.

— For GMCs of Class 2 and Class 3, the specimen shall be mounted in a test fixture such that the joint is held fixed at its maximum angular deflected position (determined from Clause A.6). This test specimen shall then be subjected to a gradual increase of pressure at a rate not to exceed 30 MPa/min to four times the proposed rated pressure of the specimen assembly. If leakage or bursting occurs before four 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 bursting when four times the proposed rated pressure of the specimen assembly is attained, the pressure shall be gradually increased until bursting occurs. The test specimens have passed the hydrostatic burst test when four times the proposed rated pressure of the specimen assembly has been attained. Pressure attained at the time of bursting shall be recorded in the Qualification Test Results.

A.8 Rigidity proof test

A.8.1 Scope

This clause covers rigidity proof testing of Class 1 GMC specimens.

A.8.2 Significance and use

The significance of this test is to demonstrate the suitability of the GMC for use when the pipe 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. The GMC is to be pressurized with water to its rated pressure during applications 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 1 with the test moment applied at the GMC, and there is no evidence of leakage. Angle 1 shall be calculated as follows: Angle 1 $=$ 60′ (minutes) – 0,08′ (minutes) $\times$ (nominal pipe size, in millimetres).

A.8.3 Test procedure

The test shall be conducted with a specimen of test pipe not less than 0,38 m in length. The support points for the pipe shall be not less than 0,30 m 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 pipe or fittings/GMC joint. The initial included angle shall be measured and recorded. Do not apply any bending moment while measuring the initial angle. The bending moment calculated as described in A.11.3 shall be applied 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. If there is no evidence of leakage and the included angle has not changed by more than Angle 1, the GMC shall pass the test. Angle 1 shall be calculated as follows: Angle 1 $=$ 60′ (minutes) – 0,08′ (minutes) $\times$ (nominal pipe size in millimetres). The deflection angle (e) shall be defined as the difference between the initial and final included angles given above.

A.9 Bending-moment proof test

A.9.1 Scope

This clause covers the bending-moment proof test for GMC specimens of Type I Classes 1 and 2 and Type II Class 1.

A.9.2 Significance and use

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.

A.9.3 Test procedure

The test shall be conducted with a specimen of test pipe at least 0,38 m in length. The support points for the pipe shall be a minimum of 0,30 m 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 A.11.4) shall be applied to the joint and held for not less than 1 min. The test shall be conducted at ambient temperature. If the GMC withstands this moment and shows no evidence of leakage, it shall pass this test.

A.10 Bending-moment ultimate test

A.10.1 Scope

This clause covers the bending-moment ultimate test for GMC specimens of Type I Classes 1 and 2 and Type II Class 1.

A.10.2 Significance and use

This test verifies the safety factors available in the GMC compared to the bending moment from A.9. 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. A specimen that withstands two times the bending moment for A.9 without failure has passed this test.

A.10.3 Procedure for test

The test shall be conducted with a specimen of test pipe not less than 0,38 m in length. The support points for the pipe shall be not less than 0,30 m 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. 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 exceeding 27,116 N-m/min. GMCs that withstand two times the test moment from A.9 without evidence of leakage shall pass the test. The moment at failure shall be recorded.

A.11 Calculation of bending moments for the flexibility proof test, the rigidity proof test, the bending-moment proof test and the bending-moment ultimate test

A.11.1 Nominal bending moment

The nominal bending moment is the moment calculated at a GMC/pipe or fitting joint when the joint is equidistant between pipe hangers and the pipe is filled with water. It is the manufacturer's responsibility to specify the maximum allowable hanger spacing for each GMC/pipe or fitting combination. The moment is calculated as follows:

$$M = \frac{WL^2}{8}$$

where

W is the combined weight of the water and pipe per unit length, in kilograms per metre;

L is the distance between pipe hangers, in metres.

EXAMPLE For 50 mm DN Schedule 40 steel pipe and hanger spacing of 4,6 m:

$$M = \frac{WL^2}{8}$$

$W = 7{,}59$ kg/m, combined pipe weight + water weight per metre;

$L = 4{,}6$ m, distance between pipe hangers.

$M = 7{,}59\ (4{,}6)^2/8 = 20{,}1$ kg · m $= 197$ N · m.

A.11.2 Moment used for the flexibility proof test

For the flexibility proof test described in A.6, apply a moment equal to 40 % of the nominal bending moment, M, calculated as in A.11.1.

A.11.3 Moment used for the rigidity proof test

For the rigidity proof test described in A.8, apply a moment equal to the nominal bending moment, M, calculated in A.11.1.

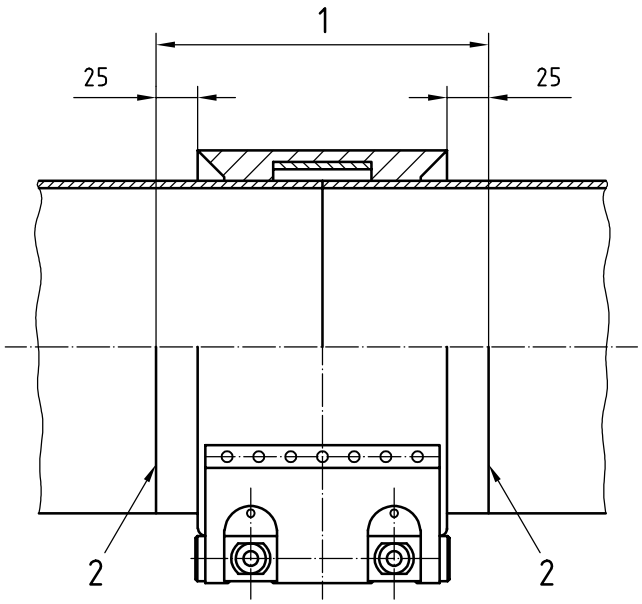
A.11.4 Moment used for the bending proof test

For the bending-moment proof test described in A.9, apply a moment equal to four times the moment calculated in A.11.1.

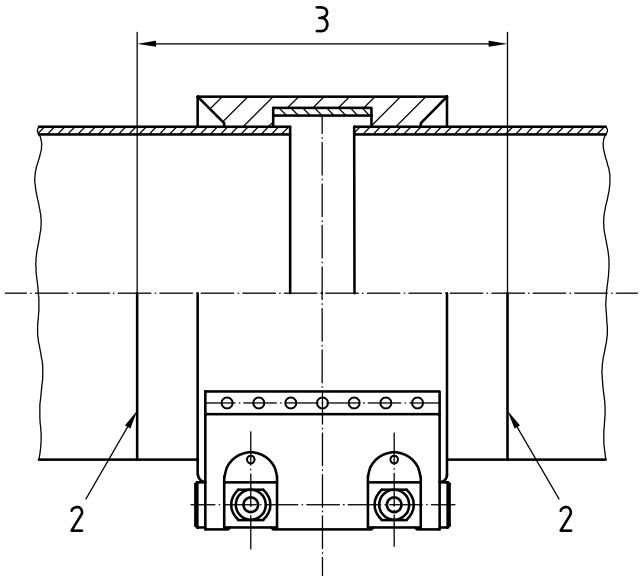
A.11.5 Moment used for the bending-moment ultimate test

For the bending-moment ultimate test described in A.10, apply a moment equal to twice the moment calculated in A.11.4. Note that this moment is eight times the nominal moment calculated in A.11.1.

Dimensions in millimetres



a) Before test



b) After test

Key

1 original line spacing
2 scribed line on pipe outside diameter before axial movement test
3 line spacing after test
4 scribed line on pipe outside diameter after axial movement test

Figure A.1 — Sketch of axial movement test

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