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Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals

Tubes et raccords en plastiques thermodurcissables renforcés de verre (PRV) — Méthodes d'essai pour confirmer la conception des assemblages mâle-femelle verrouillés, y compris ceux à double emboîture, avec joints d'étanchéité en élastomère

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Foreword

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Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7432 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 6, *Reinforced plastics pipes and fittings for all applications*.

Annex A forms a normative part of International Standard.

Introduction

In a pipework system, pipes and fittings of different nominal pressures and nominal stiffnesses may be used.

A joint may be made between pipes and/or fittings and should be designed such that its performance is equal to or better than the requirements for the pipeline, but not necessarily for the components being joined.

The requirements for the assembly of the joint are not included in this International Standard, but they should be in accordance with the manufacturer's recommendations.

The material-dependent parameters and/or performance requirements will be incorporated in the referring specification.

Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals

1 Scope

This International Standard specifies methods of test for joints with a locked socket and spigot, including double-socket joints, and with elastomeric seals, for buried and non-buried glass-reinforced thermosetting plastics (GRP) piping systems. This standard is applicable only to the joint, and specifies methods of test to prove its design. It assumes that the joint will be exposed to the effects of hydrostatic end thrust.

The tests, detailed in 7.2 to 7.6, are applicable to locked socket-and-spigot joints intended to be used in buried or non-buried applications.

With the exception of the bending test (7.5), these tests are applicable to joints with pipes and fittings of all nominal sizes. The test detailed in 7.5 is applicable to joints with pipes and fittings up to and including DN 600. The tests are suitable for evaluating joints intended for applications in which liquids are conveyed at particular temperatures specified in the referring specification.

2 Principle

A joint is subjected to a specified internal pressure. The methods include prolonged static tests at elevated pressures and cyclic testing.

A method is included to test the joint for resistance to a pressure differential. This also simulates an external positive pressure.

NOTE 1 The only reason for testing the joint for resistance to a pressure differential is to ensure adequate safety against infiltration of pollutants through the joint into the fluid carried in the piping system. Under the test conditions used, pipes with low stiffness may require support to prevent buckling.

A series of tests under bending is also included.

At the end of each of the tests, the joint is inspected for signs of leakage and damage, and if either has occurred then the joint has failed.

If the joint is to be used in systems where the maximum operating temperature is higher than the value given in the referring specification, the test conditions can be modified accordingly.

NOTE 2 It is assumed that the following test parameters are set by the specification making reference to this standard:

a) the total effective length L of the assembled test piece (see 4.1);

b) the number of test pieces to be used (see 4.2);

c) if applicable, any conditioning other than as specified in clause 5;

d) the test temperature and permissible deviations from it (see clause 6);

e) the nominal pressure relevant to the joint under test (see 4.1 and clause 7 as well as the Introduction);

f) if applicable, any criteria indicative of damage to the joint components [see clause 7 and item h) in clause 8];

g) the force F_1 to be applied in the misalignment test (see 7.4);

h) the acceptable increase in pressure over 1 h for a pressure-differential test (see 7.2).

3 Apparatus

3.1 End-sealing devices, of a size and type appropriate to the joint under test.

The end-sealing devices shall be securely fixed to the pipes to transmit the end thrust loads to the pipes.

3.2 Supports

3.2.1 Straps or cradles, for use as follows:

a) a support R (item 6 in Figure 2) positioned at least 500 mm from the spigot end of the pipe at the point of balance to provide support during testing with misalignment (see 7.4);

b) a strap or cradle (100 ± 5) mm wide (item 7 in Figure 2) supporting at least a 120° arc of the socket, as required for misalignment testing (see 7.4);

c) a strap or cradle (100 ± 5) mm wide supporting a 180° arc of the pipe barrel, positioned adjacent to the end of the joint being tested (item 5 in Figure 2) and through which the force F_1 necessary for misalignment testing (see 7.4) can be applied;

d) supports of sufficient width to carry the pipe components of the test piece (item 3 in Figure 2) and designed in such a way that they allow misalignment to occur.

The straps or cradles shall not have a detrimental effect on the test piece, e.g. by applying point loads.

3.2.2 Special supports, if necessary to prevent buckling of the pipe barrel during misalignment (see 7.4) or pressure-differential (7.2) testing. Such supports shall be positioned in such a way that they do not affect the force F_1 applied to the joint or the joint's response to such a load.

3.3 Source of hydrostatic pressure, to meet the needs of the test.

3.4 Means of measuring the gauge pressure at the top of the pipe to an accuracy within ± 1 % and of checking conformity to the specified pressures (see 7.2.4, 7.2.6, 7.3.2, 7.4.4, 7.4.7, 7.4.10, 7.5.4, 7.5.5 and 7.6.1).

3.5 Vacuum pump or equivalent, capable of producing the required negative gauge pressure (see 7.2).

3.6 Means of applying and measuring the required misalignment and bending forces F_1 and F_2 (see 7.4 and 7.5) to an accuracy within $\pm$ 5 %.

4 Test pieces

4.1 Assembly and test arrangement

The test piece shall comprise an assembly of two pieces of pipe of the correct size and pressure class, as specified in the referring specification, between which is located the joint to be tested.

For the tests detailed in 7.2, 7.3 and 7.6, the arrangement shall be as shown in Figure 1. For the test detailed in 7.4, the arrangement shall be as shown in Figure 2. For the test detailed in 7.5, the arrangement shall be as shown in Figure 3. For the test in 7.5, see annex A for details on determining the maximum deflection Δ (see Figure 3) at mid-span and the magnitude of the bending force F_2. In the test in 7.5, the length L shall be not greater than 8 m. In all these arrangements, a joint of the same size and design shall be used. The same test piece may be used for more than one test procedure providing it is undamaged and of sufficient size to enable the test conditions to be achieved.

The total effective length L of the assembly shall be not less than that specified in the referring specification and shall allow, if required, the joint under test to be located in the middle of the test arrangement.

The joint shall be assembled in accordance with the manufacturer's recommendations and the requirements of the referring specification.

4.2 Number of test pieces

The number of test pieces shall be as specified in the referring specification.

5 Conditioning

For any interval between assembly of the test pieces in accordance with clause 4 and conditioning performed in accordance with the following paragraph, store the test pieces at temperatures which do not exceed the test temperature (see clause 6).

Unless otherwise specified in the referring specification, following assembly condition the test pieces at the test temperature (see clause 6) for at least 24 h prior to testing.

6 Test temperature

Conduct the following procedure at the temperature specified in the referring specification.

7 Procedure

7.1 General

Subject a test piece (see clause 4) to the applicable tests in 7.2 to 7.6 (see Table 1 for a summary).

NOTE Each reference to hydrostatic pressure specifies a positive internal gauge pressure (i.e. relative to atmospheric pressure), and the nominal pressure is that relevant to the joint under test.

If a test is interrupted, record the details in the test report and repeat the particular test before carrying on to the next, if applicable. Failure of the end-sealing devices or the pipe shall not constitute failure of the joint but, if the test conditions are invalidated thereby, repeat the particular test after replacing the failed component.

7.2 Leaktightness when subjected to a pressure differential

7.2.1 Assemble the test piece as shown in Figure 1, using supports (see 3.2) if appropriate.

7.2.2 Fix the end-sealing devices to the pipes.

7.2.3 Condition the test piece in accordance with clause 5.

7.2.4 Connect to the vacuum pump (3.5).

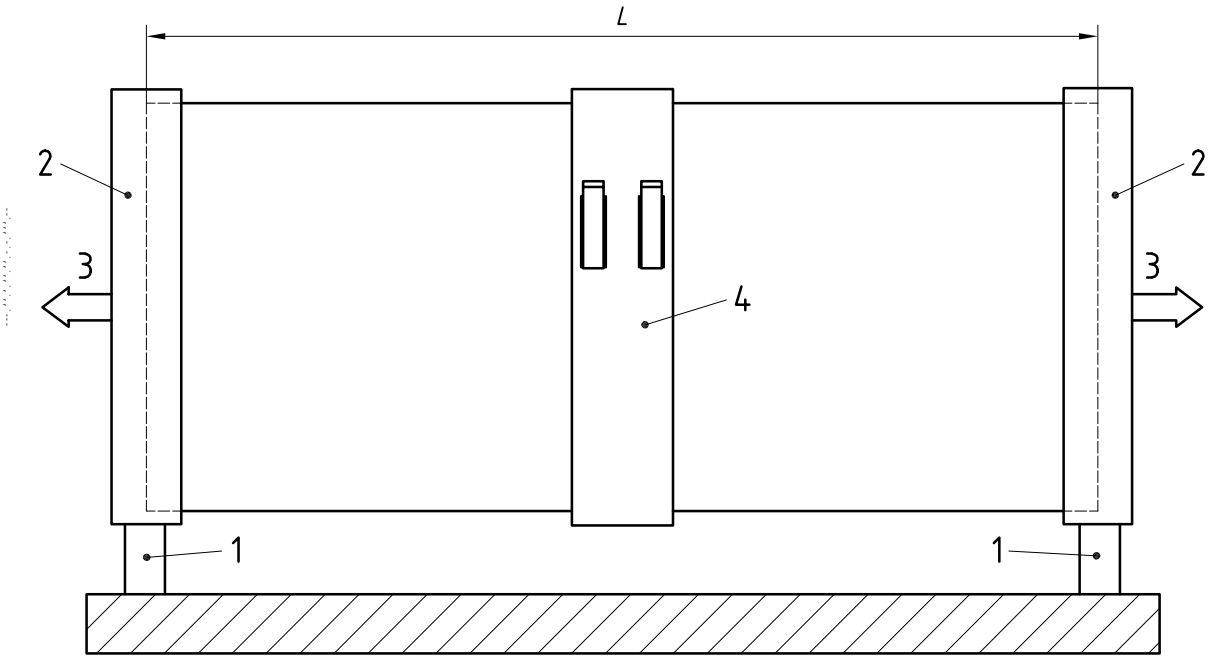
7.2.5 Reduce the pressure to at least 0,8 bar below atmospheric pressure (i.e. to approximately 0,2 bar absolute). Record the pressure achieved.

7.2.6 Close the valve between the test piece and the vacuum pump and leave for 1 h.

7.2.7 At the end of this 1 h period, record any increase in pressure.

7.2.8 If an increase in pressure in excess of the acceptable level specified in the referring specification [see item h) in note 2 to clause 2] has occurred, then inspect for any sources of leakage. If any such sources are found in places other than the joint, return the test piece to atmospheric pressure, seal the sources of the leaks and repeat the test in 7.2.3. to 7.2.7. If such sources are found at the joint, stop the test and record the observations.

7.2.9 If an increase in pressure in excess of the acceptable level specified in the referring specification [see item h) in note 2 to clause 2] has not occurred, then restore atmospheric pressure and inspect for any signs of damage to the joint [see item f) in note 2 to clause 2]. If signs of damage are found, stop the test and record the observations. Otherwise proceed to the next test.



Key

1 Support (if required)
2 End-sealing device fixed to test piece
3 Thrust transmitted to test piece (will be negative in leaktightness test specified in 7.2)
4 Test joint
L Total effective length

NOTE The arrangement may be used either horizontally (as shown) or vertically.

Figure 1 — Test arrangement for the tests detailed in 7.2, 7.3 and 7.6

7.3 Initial leakage

7.3.1 Assemble the test arrangement as shown in Figure 1, using supports if appropriate (see 3.2).

7.3.2 Fix the end-sealing devices to the pipes.

7.3.3 Condition the test piece in accordance with clause 5.

7.3.4 Fill the test piece with water and vent to remove any air.

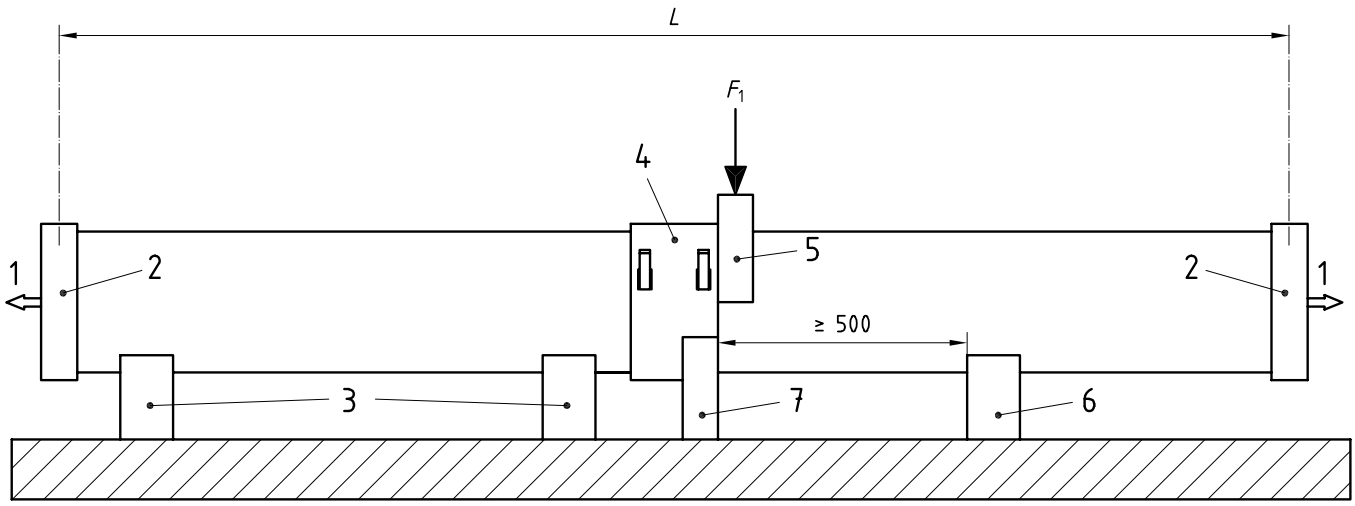
7.3.5 Apply an internal pressure of 1,5 times the nominal pressure of the joint, expressed in bars[1)], and maintain for 15 min (see Table 1).

7.3.6 Inspect the joint for signs of leakage or damage and record the observations. If no leakage or damage is found, proceed to the next test. Otherwise stop the test.

7.4 Misalignment with internal pressure and end thrust

7.4.1 Using a test piece conforming to clause 4, together with supports, straps or cradles (see 3.2) as appropriate, assemble the test arrangement as shown in Figure 2.

Dimensions in millimetres



Key

1 Thrust transmitted to test piece
2 End-sealing device fixed to test piece
3 Support
4 Test joint
F_1 Misalignment force
L Total effective length
5 Strap or cradle [see item c) in 3.2.1]
6 Support R [see item a) in 3.2.1]
7 Strap or cradle [see item b) in 3.2.1]

Figure 2 — Test arrangement for tests detailed in 7.4 and 7.6

7.4.2 Connect the end-sealing devices to the pipes in such a way that the full loads induced by the internal pressure will be transmitted along the pipes to the joint under test.

7.4.3 Condition the test piece in accordance with clause 5.

7.4.4 Fill the test piece with water and vent to remove any air.

7.4.5 Apply an internal pressure of 1,5 times the nominal pressure of the joint, expressed in bars, and maintain within ± 2 % for 15 min (see Table 1).

1) 1 bar = 10^5 N/m^2 = 0,1 MPa.

7.4.6 Inspect the joint for signs of leakage and record the observations. If no leakage is found, proceed in accordance with 7.4.7. Otherwise stop the test.

7.4.7 Apply a misalignment force F_1, as specified in the referring specification, to the test piece as shown in Figure 2.

NOTE The system may be depressurized before applying the load F_1 and then re-pressurized before proceeding to 7.4.7.

7.4.8 Inspect the joint for signs of leakage or damage and record the observations. If no leakage or damage is found, proceed in accordance with 7.4.9. Otherwise stop the test.

7.4.9 Maintain the pressure of 1,5 times the nominal pressure of the joint, expressed in bars, within ± 2 % for 24 h (see Table 1).

7.4.10 Inspect the joint for signs of leakage or damage and record the observations. If no leakage or damage is found, proceed in accordance with 7.4.11. Otherwise stop the test.

7.4.11 Reduce the pressure to atmospheric.

7.4.12 Steadily raise the internal pressure to 1,5 times the nominal pressure of the joint, expressed in bars, and reduce again to atmospheric pressure so as to complete the cycle in a time between 1,5 min and 3 min.

7.4.13 Repeat this cycle a further nine times.

7.4.14 Inspect the joint for signs of leakage and record the observations.

7.5 Resistance of joint to bending and pressure including hydrostatic end thrust

7.5.1 Assemble the test arrangement as shown in Figure 3 using a test piece conforming to clause 4 and having an effective length not exceeding 8 m. Determine the values of F_2 and Δ in accordance with annex A.

7.5.2 Connect the end-sealing devices to the pipes in such a way that the full loads induced by the internal pressure will be transmitted along the pipes to the joint under test.

7.5.3 If the manufacturer's declared angular deflection of the joint is greater than 1,4°, then apply the declared deflection, position the stop to prevent further movement and proceed in accordance with 7.5.5.

7.5.4 If the manufacturer's declared angular deflection of the joint is 1,4° or less, then position the stop to prevent a deflection greater than Δ.

7.5.5 Condition the test piece in accordance with clause 5.

7.5.6 Fill the test piece with water and vent to remove any air.

7.5.7 Apply, if required, the bending force F_2.

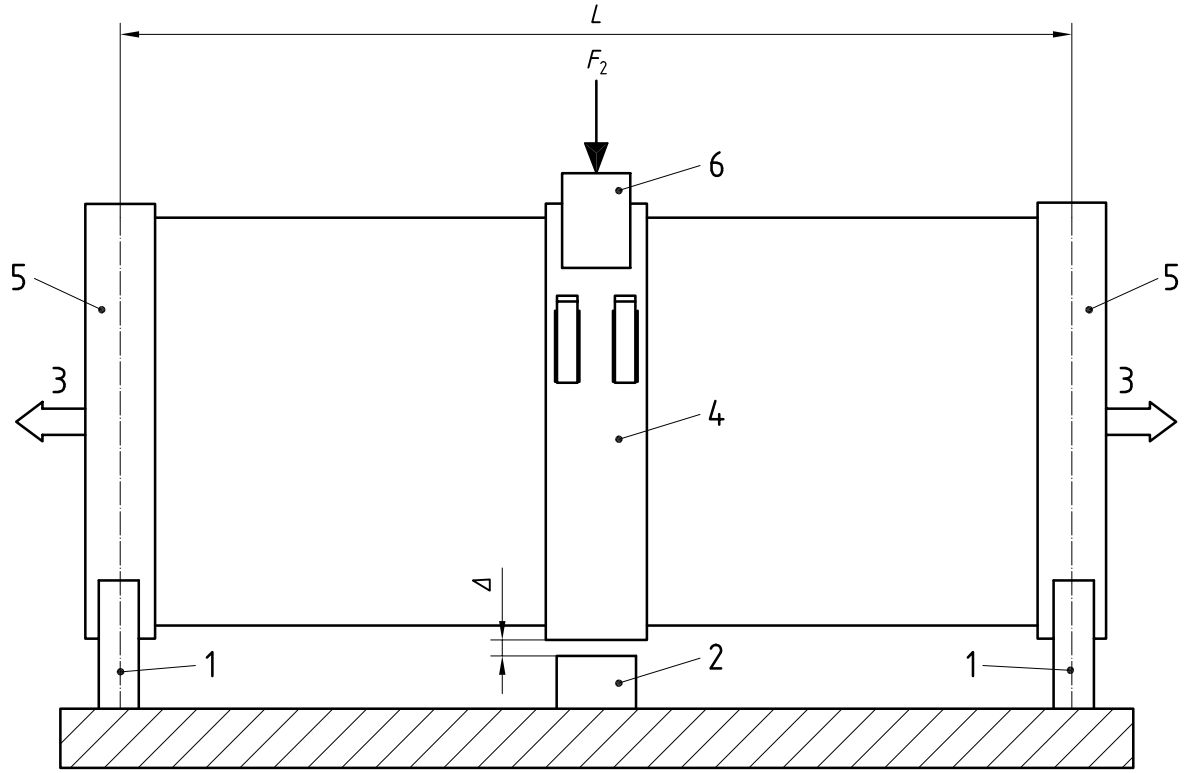
7.5.8 Apply an initial hydrostatic pressure of 1,5 times the nominal pressure of the joint, expressed in bars, and maintain within ± 2 % for 15 min. Inspect the joint for signs of leakage or damage. If either has occurred, stop the test and record the observations. Otherwise continue in accordance with 7.5.9.

7.5.9 Maintain the hydrostatic pressure of 1,5 times the nominal pressure of the joint, expressed in bars, within ± 2 % for not less than 24 h.

7.5.10 Check and record whether or not the joint is resting on the stop.

7.5.11 Reduce the pressure to atmospheric.

7.5.12 Inspect the joint and record any signs of leakage or damage. If neither is found, proceed to the next test.



Key

1 Support
2 Stop
3 Thrust transmitted to test piece
4 Test joint
5 End-sealing device fixed to test piece
6 Strap or cradle for application of force F_2

F_2 Bending force (if required)
L Total effective length (not exceeding 8 m)
Δ Limiting deflection at mid-span

Figure 3 — Test arrangement for test detailed in 7.5

7.6 Short-term resistance to internal pressure including hydrostatic end thrust

7.6.1 Using a test piece conforming to clause 4, together with supports, straps or cradles (see 3.2) if required, assemble the test arrangement as shown in Figure 1 or Figure 2.

7.6.2 Fix the end-sealing devices to the pipes in such a way that the full loads induced by the internal pressure will be transmitted along the pipes to the joint under test.

7.6.3 Condition the test piece in accordance with clause 5.

7.6.4 Fill the test piece with water and vent to remove any air.

7.6.5 Raise the hydrostatic pressure so that a pressure equal to 3 times the nominal pressure of the joint, expressed in bars, is reached in not more than 8 min. Maintain this pressure within $\pm$ 2 % for 6 min. During this time, the joint shall not fracture but leakage of the joint does not constitute a failure.

7.6.6 Reduce the pressure to atmospheric and empty the test piece.

7.6.7 Inspect the joint and record any signs of fracture.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard and to the referring specification;

b) details of the pipes used, including their nominal pressure (PN) class(es);

c) details of the joint, including the jointing materials and jointing procedure used;

d) the temperature range during the test;

e) a description of the tests to which the joint was subjected;

f) the positive and negative pressures applied, in bars;

g) any observations on the leaktightness of the joint during each test;

h) any observations on the condition of the joint after each test;

i) details of interruptions, if any, to the test sequence;

j) the misalignment force F_1 applied in the misalignment test;

k) the bending force F_2 applied and effective test piece length L used in the bending test;

l) the angular deflection used in the bending test;

m) whether or not the test piece rested on the stop during the bending test;

n) any factors which may have influenced the results, such as any incidents or any operating details not specified in this International Standard;

o) the dates and times of the period of testing;

p) the sequence of the tests.

Table 1 — Summary of pressure tests — Conditions and suggested sequence

Test	Test pressure	Duration	Subclause and figure
Pressure differential	– 0,8 bar (– 0,08 MPa)	1 h	7.2 and Figure 1
Initial leakage	1,5 × PN	15 min	7.3 and Figure 1
Misalignment with internal pressure and end thrust	Preliminary pressure: 1,5 × PN	15 min	7.4.1 to 7.4.5 and Figure 2
	Maintained pressure: 1,5 × PN	24 h	7.4.6 to 7.4.9 and Figure 2
	Pressure cycle: atmospheric to 1,5 × PN and back to atmospheric	10 cycles of 1,5 min to 3,0 min each	7.4.10 to 7.4.13 and Figure 2
Resistance to bending with end thrust	Preliminary pressure: 1,5 × PN	15 min	7.5.1 to 7.5.7 and Figure 3
	Maintained pressure: 1,5 × PN	24 h	7.5.8 to 7.5.11 and Figure 3
Short-term resistance to internal pressure	3,0 × PN	6 min	7.6 and Figure 1 or Figure 2

NOTE 1 Nominal pressure (PN) is an alphanumeric designation of pressure related to the resistance of a component of a piping system to internal pressure. For the purposes of this table, PN is expressed in bars.

NOTE 2 A test sequence other than that given in this table may be used.

Annex A
(normative)

Equations for calculating the force F_2 and limiting deflection used in the bending test (7.5)

The test arrangement in 7.5 is a simply supported pipe with an effective length L (i.e. span between supports) not exceeding 8 m. The main load is provided by the weight of the pipe plus contents. The pipe is allowed to bend before coming into contact with a stop that supports the pipe if it tries to bend more than a limiting deflection Δ calculated using equation (A.1).

The test arrangement required will depend upon the manufacturer's declared angular deflection for the joint. If the angle is greater than or equal to 1,4°, then the angular deflection is the controlling condition and the test is performed not with the test piece as a beam but merely with the joint bent to the declared value and maintained at this deflection for the duration of the test. If, however, the declared deflection is less than 1,4°, then the test is performed with the arrangement shown in Figure 3 with an additional force F_2, determined in accordance with equation (A.2), applied at mid-span and the stop positioned at the distance Δ below the joint which is determined from equation (A.1).

$$\Delta = 5{,}75 \times L \tag{A.1}$$

$$F_2 = \left(\frac{32}{L} - \frac{L}{2}\right) \times \left(W_\mathrm{p} + W_\mathrm{w}\right) + \left(\frac{8}{L} - 1\right) \times W_\mathrm{j} \tag{A.2}$$

where

F_2 is the additional force applied at mid-span, in kilonewtons;

Δ is the limiting deflection at mid-span, in millimetres;

L is the effective length (i.e. the span between the supports), in metres;

W_p is the weight per unit length of the pipe empty, in kilonewtons per metre;

W_w is the weight of water per unit length of the pipe when full, in kilonewtons per metre;

W_j is the weight of the joint, in kilonewtons.

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