

BS 8561:2013



BSI Standards Publication

Specification for mechanical fittings for use in the repair, connection and renovation of pressurized water supply pipelines – Requirements and test methods

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Contents

Foreword *ii*

1	Scope	1
2	Normative references	1
3	Terms and definitions	2
4	Classifications	4
5	Technical requirements	5
6	Performance requirements for fittings	8

Annexes

Annex A (informative) Fittings for PE100 – Basis for determination of end-loads resistance requirements 24

Annex B (normative) Test methods 29

Bibliography 47

List of figures

Figure 1 – External profile of grooved steel/ductile pipe: surface defects 19

Figure A.1 – The principal forces exerted on a joint due to positive internal pressure 25

Figure B.1 – Test assembly for all fittings excluding flange adaptors 30

Figure B.2 – Test assembly for flange adaptors 31

Figure B.3 – Pressure/life testing graph 35

Figure B.4 – Stress relaxation curves at a range of temperatures 37

Figure B.5 – Predicted 20 °C bolt-load relaxation curve 39

List of tables

Table 1 – Classifications for fitting/joint types 5

Table 2 – Performance testing of couplings and flange adaptors on pipe materials other than PE 11

Table 3 – Performance testing of repair clamps 14

Table 4 – Performance testing of under pressure tees (UPT), pipe saddles and joint encapsulation units 15

Table 5 – Performance testing of couplings and flange adaptors on PE pipe materials [including barrier pipe] 18

Table 6 – Flange bolt torques in Nm (1.5 × nominal torque to seal at the respective flange PN and DN) 21

Table B.1 – Pull-out test force at 80/60 °C for Type 1 fittings for PE100 pipe 42

Table B.2 – Pull-out test force at 80/60 °C for Type 2 fittings for PE100 pipe 43

Table B.3 – Pull-out test force at 23 °C for Type 1 fittings for PE100 pipe 44

Table B.4 – Pull-out test force at 23 °C for Type 2 fittings for PE100 pipe 45

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 48, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 December 2013. It was prepared by Technical Committee B/504, *Water supply*. A list of organizations represented on this committee can be obtained on request to its secretary.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the following regulations. The commentary in this British Standard reflects the state of the regulations at the time of publication.

Water fittings

In this document, the following national regulations, which apply to requirements relating to plumbing systems in premises to which a supply of public mains water (municipal water supply) has been provided, are referred to as the "Water Fittings Regulations [1]":

- The Water Supply (Water Fittings) Regulations 1999, as amended, in England and Wales;
- Scottish Water Byelaws 2004, in Scotland; and
- The Water Regulations (Northern Ireland) 2006, in Northern Ireland.

Public water supplies

These regulations refer to the standards of wholesomeness for water quality parameters where the water is intended for public supply. In this standard, the following national regulations, which apply standards of wholesomeness to water provided from the public mains supply (municipal supply), are referred to as the "Water Quality Regulations [2]":

- The Water Supply (Water Quality) Regulations 2000 as amended, in England;
- The Water Supply (Water Quality) Regulations (Northern Ireland) 2007 as amended, in Northern Ireland;
- The Water Supply (Water Quality) (Scotland) Regulations 2001 as amended, in Scotland; and
- The Water Supply (Water Quality) (Wales) Regulations 2010, in Wales.

Private water supplies

These regulations refer to the standards of wholesomeness for water quality parameters in premises where the water for human consumption or food production has been sourced from a private supply. In this standard, the following national regulations, which apply standards of wholesomeness to water provided from private water sources (non-municipal supply), are referred to as the "Private Water Supplies Regulations [3]":

- The Private Water Supplies Regulations 2009 as amended, in England;
- The Private Water Supplies Regulations (Northern Ireland) 2009 as amended, in Northern Ireland;
- The Private Water Supplies (Scotland) Regulations 2006 as amended, in Scotland; and
- The Private Water Supplies (Wales) Regulations 2010 as amended, in Wales.

1 Scope

This British Standard specifies the requirements and associated test methods applicable to fittings with flexible, flexible restrained and restrained joints intended for connection to existing water supply pipes for the purposes of localized repair, new branch connections or pipeline rehabilitation.

NOTE These fittings may additionally connect to new pipe materials to replace faulty sections of existing pipe.

It also specifies requirements for materials and dimensions and gives performance requirements for joints.

It applies to fittings in the diameter range of DN 50 to DN 1 800 made for use on the following pipe materials other than polyethylene (PE):

- grey iron;
- ductile iron;
- steel;
- polyvinyl chloride (PVC);
- fibre cement; and
- glass-reinforced polyester (GRP).

It applies to fittings in the diameter range of DN 63 to DN 1 000 made for use on the following PE pipe material:

- PE80 material (medium-density polyethylene – MDPE);
- PE100 material (high-density polyethylene – HDPE); and
- PE barrier pipe for contaminated land [4].

This specification applies to fittings including (but not necessarily limited to) pipe couplings, flange adaptors, under pressure tees (including any similar components permanently installed on mains as part of flow isolation techniques or to facilitate equipment access into mains), repair clamps, pipe saddles and joint encapsulation units for both potable and non-potable applications.

It applies to fittings which seal to both the existing water supply pipe, including corroded or physically degraded pipe surfaces, and any new pipe by mechanical compression of elastomeric seals, though pressure actuated sealing may additionally be incorporated.

It also gives performance requirements for fittings designed to provide axial restraint when installed on the existing pipe. Joint design and gasket shapes are not covered by this British Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 4190, *ISO metric black hexagon bolts, screws and nuts – Specification*

BS EN 545, *Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods*

BS EN 681-1:1996, *Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanized rubber*

BS EN 1092-1, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges*

BS EN 1092-2, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 2: Cast iron flanges*

BS EN 1563, *Founding – Spheroidal graphite cast irons*

BS EN 10025-2, *Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels*

BS EN 10088-2, *Stainless steels – Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes*

BS EN 12201-1:2011, *Plastics piping systems for water supply, and for drainage and sewerage under pressure – Polyethylene (PE) – Part 1: General*

BS EN 12201-2:2011, *Plastics piping systems for water supply, and for drainage and sewerage under pressure – Polyethylene (PE) – Part 2: Pipes*

BS EN 14901, *Ductile iron pipes, fittings and accessories – Epoxy coating (heavy duty) of ductile iron fittings and accessories – Requirements and test methods*

BS EN ISO 1167-1:2006, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids – Determination of the resistance to internal pressure – Part 1: General method*

BS EN ISO 3506-1, *Mechanical properties of corrosion-resistant stainless steel fasteners – Part 1: Bolts, screws and studs*

BS EN ISO 9445 (all parts), *Continuously cold-rolled stainless steel – Tolerances on dimensions and form*

BS ISO 3384, *Rubber, vulcanized or thermoplastic – Determination of stress relaxation in compression at ambient and at elevated temperatures*

Other publications

[N1] WIS 4-52-01/02, *Polymeric anti-corrosion (Barrier) coatings – The use of polymeric anti-corrosion (Barrier) coatings*. Water UK.

[N2] WIS 4-52-03, *Anti-corrosion coatings on threaded fasteners*. Water UK.

3 Terms and definitions

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

3.1 allowable operating pressure (PFA)

maximum hydrostatic pressure that a component is capable of withstanding continuously in service

NOTE In BS EN 12201 (Parts 1 and 2), the term nominal pressure (PN) at 20 °C is used in place of PFA.

3.2 coupling

fitting providing connection between two spigot ends capable of absorbing a degree of ground/pipe movement and which provides a sufficient mechanical support to resist the self-weight of the pipe, the water contained therein, and the external imposed loadings (e.g. shear loadings from traffic/backfill/ground movement)

NOTE Couplings can be classified as Class A or Class B, see Table 1 for more details.

3.3 depth of engagement

when jointed, the distance between the end of the spigot and the face of the socket of the coupling or flange adaptor

NOTE This is also known as the "insertion depth".

3.4 flange adaptor

fitting providing connection between a spigot and a flange capable of absorbing a degree of ground/pipe movement and providing sufficient mechanical support to resist the self-weight of the pipe, the water contained therein and the external imposed loadings (e.g. shear loading from traffic/backfill/ground movement)

NOTE Flange adaptors can be classified as Class A or Class B, see Table 1 for more details.

3.5 flexible non-restrained joint

joint that permits significant angular deflection both during and after installation with no means provided to prevent separation of the assembled joint

3.6 flexible restrained joint

joint that permits significant angular deflection both during and after installation with a means provided to prevent separation of the assembled joint

NOTE 1 Flexible restrained joints can be classified as Type A or Type B, see Table 1 for more details.

NOTE 2 Some flexible restrained joints are intended for PE pipe in addition to other pipe materials and should be classified according to joints of fittings for polyethylene pipes for that application, see Table 1 for more details.

3.7 joint angular deflection

angle between the axis of the spigot and one end of the fitting that a single flexible joint can accommodate

3.8 joint encapsulation unit

fitting installed around a leaking pipe joint that seals to both sections of pipe barrel either side of the joint forming a pressure-tight container to contain the leakage

3.9 manufacturer's recommended bolt torque

bolt torque required for any specific installation condition, e.g. specific to pipe material

3.10 manufacturer's recommended maximum bolt torque

maximum value for any specific size of fitting

3.11 nominal pressure (PN)

alphanumeric designation related to a combination of mechanical and dimensional characteristics of a component of a pipework system, used for reference purposes, which comprises the letters PN followed by a dimensionless number

3.12 pipe nominal size (DN)

numerical designation of the size of pipe, which is a whole number approximately equal to the actual dimension in millimetres

NOTE For existing pipework in old imperial size pipe standards the nearest metric DN reference should be used.

3.13 pipe saddle

fitting attached and sealed to part of a pipe's surface to facilitate a connection to pipe with an outlet size greater than DN 50

NOTE 1 It is usually secured by clamp bands and seals only around the area that the connection is made. It may incorporate some form of valve to facilitate under pressure drilling and is usually used for smaller branch size threaded connections rather than for under pressure tees.

NOTE 2 Pipe saddles are not generally regarded as suitable for use on PE pipe material due to the visco-elastic properties of the pipe material affecting long-term sealing characteristics.

3.14 repair clamp

fitting installed around a leaking pipe barrel to effect a seal on both local and circumferential pipe defects

NOTE Repair clamps are not generally regarded as suitable for use on PE pipe material due to the visco-elastic properties of the pipe material affecting long-term sealing characteristics.

3.15 restrained joint

joint for PE pipe that permits no angular deflection both during and after installation with a means provided to prevent separation of the assembled joint

3.16 setting gap

when jointed, the distance between the ends of the spigots in a coupling or the end of the spigot and the flange face for a flange adaptor

3.17 under pressure tee (UPT)

fitting installed on/around a pipe to create a branch connection usually terminating in a flange outlet

NOTE 1 The fitting, along with other equipment and fittings, facilitates a live connection to the pipe without interruption to the supply flowing through it.

NOTE 2 Mechanical under pressure tees are not generally regarded as suitable for use on PE pipe material due to the visco-elastic properties of the pipe material affecting long-term sealing characteristics.

NOTE 3 Under pressure tees can be classified as Class A and Class B, see Table 1 for more details.

4 Classifications

Couplings, flange adaptors, under pressure tees, fittings for polyethylene pipes and flexible restrained joints shall be classified in accordance with Table 1.

NOTE Fitting types are defined in Clause 3.

Table 1 Classifications for fitting/joint types

Classification	Fitting type	Differentiating performance characteristics
Coupling	Coupling class A	Minimum shear resistance in newtons (N) that is 50 times the largest pipe nominal diameter (DN) that the fitting is intended to accommodate.
	Coupling class B	Minimum shear resistance in newtons (N) that is 25 times the largest pipe nominal diameter (DN) that the fitting is intended to accommodate.
Flange adaptor	Class A	Minimum shear resistance in newtons (N) that is 25 times the largest pipe nominal diameter (DN) that the fitting is intended to accommodate.
	Class B	Minimum shear resistance in newtons (N) that is 12 times the largest pipe nominal diameter (DN) that the fitting is intended to accommodate.
Under pressure tee	Class A	Provides full pipe surface contact sealing against the risk of pipe failure.
	Class B	Provides localized pipe surface contact sealing around the outlet.
Joints of fittings for polyethylene pipes	Type 1	The end-load resistance of the joint is greater than the strength of the pipe.
	Type 2	The end-load resistance of the joint is greater than the maximum axial forces (see Table B.4) assumed to be acting on the joint.
Flexible restrained joints	Type A	The joint gripping mechanism is not energized by or manufactured from materials of time-dependant properties (e.g. plastics or elastomers).
	Type B	The joint gripping mechanism is energized by or manufactured from materials of time-dependant properties (e.g. plastics or elastomers).

NOTE The manufacturer should be consulted as to the suitability of Type B flexible restraint joints (3.6) and restrained joints (3.15) as defined in this standard for above ground applications.

5 Technical requirements

NOTE Fittings that already conform to BS EN standards for pipe couplings should take into account the additional requirements in this British Standard when used for the purposes of repair and connection to existing water supply pipes.

5.1 Fitting design life

Fittings shall be designed for a service life at PFA of at least 50 years.

5.2 Axial movement (withdrawal)

Each flexible non-restrained joint in a coupling or flange adaptor receiving a spigot shall be capable, when pressurized to the allowable operating pressure (PFA), of accommodating a minimum 5 mm of axial movement (withdrawal) without leakage for the service life of the fitting.

5.3 Joint angular deflection

The minimum angular deflection of a flexible joint under all assembly conditions shall be determined by the following ranges of pipe nominal diameters:

- up to and including (uti) DN 450 = 3.0°;
- > DN 450 to DN 600 = 2.5°;
- > DN 600 to DN 750 = 2.0°;
- > DN 750 to DN 1 200 = 1.5°; and
- > DN 1 200 to DN 1 800 = 1.0°.

NOTE This includes joint encapsulation units when installed on pipe joints where deflection has occurred.

The minimum joint angular deflection for repair clamps and class A under pressure tees shall be 0.25° uti pipe nominal diameter DN 200; above this diameter there is no requirement for pipe angular deflection.

5.4 End-load performance of joints of fittings intended for PE pipe materials

The following three types of fittings shall be classified according to their level of end-load performance (see Annex A):

- Type 1 fittings: where the end-load resistance of the joint is greater than the longitudinal strength of the pipe;
- Type 2 fittings: where the end-load resistance of the joint is greater than the maximum axial forces assumed to be acting on the joint.

NOTE The requirement for Type 1 or Type 2 end-load resistance fittings for a particular application should be assessed by the end user.

5.5 Material characteristics

5.5.1 General

Where non-ferrous materials other than those covered by this British Standard are used in the construction of a fitting, they shall be of at least the same durability under service conditions and shall provide the required service life of the fitting.

All fittings for potable water applications shall ensure the constructional materials, coatings, seals or gaskets coming into contact with potable water present no risk to human health with regard to affecting the quality, appearance, smell or taste.

NOTE Attention is drawn to the following legislation for materials that are in contact with potable water; the Water Fittings Regulations [1], the Water Quality Regulations [2], and Private Water Supplies Regulations [3]. The specific legislation which applies in any circumstance will be dependent on where the fitting is to be used or the source(s) of the water supply. If in doubt contact the local water supplier or Local Authority's private water supply team (usually located within the Environmental Health teams) for advice.

5.5.2 Ductile iron

Ductile iron shall conform to BS EN 1563 or BS EN 545.

5.5.3 Sheet stainless steel

Sheet stainless steel shall conform to BS EN 10088-2 and BS EN ISO 9445.

5.5.4 Mild steel

Mild steel shall conform to BS EN 10025-2.

5.5.5 Fasteners

5.5.5.1 General

Fastener materials shall be either stainless steel or mild steel with corrosion protection.

5.5.5.2 Mild steel

Mild steel fasteners shall conform to BS 4190 (all tensile grades).

5.5.5.3 Stainless steel

Stainless steel fasteners conforming to BS EN ISO 3506-1 shall be protected against galling (seizure) by the selection of appropriate grades of material or applied lubricants.

5.5.6 Gaskets

Gaskets shall be manufactured from materials in accordance with BS EN 681-1:1996, type WA (cold potable water applications).

5.5.7 Coatings

All parts of ferrous components (excluding stainless steel) of fittings shall be protected from corrosion in accordance with BS EN 14901 or WIS 4-52-01/02 [N1] and/or WIS 4-52-03 [N2] as applicable.

NOTE BS EN 14901 might be applicable to components of fittings made from ferrous materials other than ductile iron.

5.5.8 Dimensional requirements for flanged joints

Flanged joints shall be designed such that they can be attached to flanges whose dimensions and tolerances are in accordance with BS EN 1092-2.

NOTE 1 This ensures interconnection between all flanged components (pipes, fittings, valves, etc.) of the same PN and DN, and adequate joint performance.

NOTE 2 Flanges may additionally accommodate connection to other, older flange standards, e.g. BS 10.

5.6 Product information

5.6.1 Marking requirements

All fittings shall be legibly and durably marked, and shall bear at least the following information:

- a) manufacturer's name or mark;
- b) the year of manufacture;
- c) DN and PN rating of flanges where applicable;

- d) identification of the minimum and maximum outside pipe diameters over which the product works;
- e) reference to this British Standard ¹⁾; and
- f) PFA of the fitting.

Where the fittings are cast, items a) to d) shall be cast on where practicable.

NOTE 1 Items e) and f) may be applied by any method, e.g. painting on the casting or attached to the packaging.

NOTE 2 A durable label fixed to the fitting may also be used where it is impracticable to cast on, or for non-cast products.

5.6.2 Additional information

The following information shall be supplied on or with each product:

- minimum depth of engagement and/or maximum setting gap;
- maximum allowable angular deflection;
- suitability of the coupling or flange adaptor for different pipe materials with either non-restrained or restrained joints;
- need for pipe supporting sleeves/inserts;
- manufacturer's recommended bolt torque; and
- where specified, manufacturers' recommended bolt torque and gasket types for flanged joints.

For fittings intended for use on PE, the following additional information shall be supplied on or with each product:

- joint end-load restraint performance, i.e. Type 1 or Type 2; and
- jointing instructions.

6 Performance requirements for fittings

COMMENTARY ON CLAUSE 6

GRP pipe might require special procedures or condition assessment so that fittings can make satisfactory connections to them. Advice on the suitability of fittings for these and any special installation requirements should be obtained from the fitting's manufacturer.

For work on fibre cement pipes, due care and attention should be taken with regards to health and safety. Special procedures or condition assessment might be required so that fittings can make satisfactory connections to them. Advice on the suitability of fittings for these and any special installation requirements should be obtained from the manufacturer.

The maximum and minimum pipe outside diameters and rated working pressure (PFA) for which fittings are designed to operate should be defined by the manufacturer and included in their literature.

Fittings intended for use on existing PE pipes should be designed to take into account the tendency of the pipe outside diameter (OD) to increase with time due to internal pressure.

¹⁾ Marking BS 8561 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Performance and test requirements for PE pipe fittings are based upon PE100 pipe material (high-density polyethylene). Fittings meeting these requirements are also suitable for repair and for connection to PE80 pipe material (medium-density polyethylene).

If manufacturers wish to determine compliance with the Regulator's specification and the Water Fittings Regulations [1] relating to below ground fittings, the specification's set different test requirements for the following two tests.

- *Leak tightness under positive pressure (6.5), a test pressure of $2 \times PFA$ is applicable.*
- *Leak tightness under negative internal pressure (6.6), a test pressure of 0.1 bar absolute is applicable.*

NOTE For further information, the Water Regulations Advisory Scheme (WRAS) should be contacted.

6.1 General

Performance tests shall be carried out in accordance with Table 2 to Table 5 for at least one size in each of the following groupings:

- Pipe materials other than PE:
 - DN 50 to DN 300;
 - > DN 300 to DN 700;
 - > DN 700 to DN 1 200; and
 - > DN 1 200 to DN 1 800.
- PE pipe materials:
 - DN 63 to DN 315;
 - DN 355 to DN 560; and
 - DN 630 to DN 1 000.

NOTE Where joint design is identical for couplings and flange adaptors, flange adaptors may be used as test specimens to determine joint performance in the relevant tests contained in Annex B.

6.2 Test conditions

6.2.1 General

All fittings shall be performance tested under the most unfavourable conditions of tolerance and joint movement in accordance with Table 2 to Table 5. With the exception of restrained joints for PE, the angular deflection shall be the maximum value declared by the manufacturer, but shall be not less than the values given in Table 2.

6.2.2 Annulus

6.2.2.1 General

Fittings where the main body of fitting does not adjust to the pipe diameter shall be performance tested as detailed in Table 2 to Table 5, at the extremes of their component's manufacturing tolerance, as declared by the manufacturer.

6.2.2.2 Maximum annulus

The annular gap between the sealing surface of the fitting and the spigot (including the grooved spigot) shall be equal to the maximum design gap within a tolerance of $\pm 5\%$.

NOTE 1 This condition is also referred to as bottom tolerance (BT).

NOTE 2 The fitting internal surface and/or the external diameter of the spigot may be machined to achieve the required annulus for the performance test even though the resultant diameters can be outside the manufacturer's declared manufacturing tolerance.

NOTE 3 Any machining of the fitting components should not detrimentally affect the performance/integrity of the fitting when tested.

6.2.2.3 Minimum annulus

The annular gap between the sealing surface of the fitting and the spigot shall be equal to the minimum design gap within a tolerance as below:

- a) sizes up to and including DN 600 tolerance of ± 0.2 mm;
- b) sizes greater than DN 600 tolerance of ± 0.5 mm.

NOTE 1 This condition is also referred to as top tolerance (TT).

NOTE 2 The fitting internal surface and/or the external diameter of the spigot may be machined to achieve the required annulus for the performance test even though the resultant diameters can be outside the manufacturer's declared manufacturing tolerance.

NOTE 3 Any machining of the fitting components should not detrimentally affect the performance/integrity of the fitting when tested.

6.2.3 Pipe outside diameter

Fittings where the body of the fitting adjusts to the pipe diameter, e.g. repair clamps and flexible body coupling designs, shall be performance tested at the extremes of the pipe outside diameters for which they are declared by the manufacturer to accommodate.

For test purposes pipe outside diameters shall be manufactured to the declared maximum and minimum outside diameters with the following tolerances as measured using circumference tape:

- a) minimum designed pipe diameter minus 0 mm plus 1 mm or minus 0% plus 0.1% whichever is the larger; and
- b) maximum designed pipe diameter minus 1 mm plus 0 mm or minus 0.1% plus 0% whichever is the larger.

NOTE These conditions are referred to as TT (top tolerance) largest pipe diameter and BT (bottom tolerance) smallest pipe diameter.

6.2.4 Setting gap and depth of engagement

These parameters shall be determined by the manufacturer and used when tested in accordance with Annex B.

Table 2 Performance testing of couplings and flange adaptors on pipe materials other than PE

Performance requirements	Test conditions	Joint types	Test description	Test parameters	Test pipe material	Test pipe size/annulus	Test procedure	
							Coupling	Flange adaptor
Strength and resistance to distortion (6.4)	Single pipe/pipe(s) aligned	Flexible non-restrained joints and flexible restrained joints	Strength and distortion of fitting and fasteners	1.5 x manufacturer's recommended maximum bolt torque PFA for 2 h	Steel	Max Annulus (BT)	B.1	B.1
			Strength and distortion of connecting flange	1.5 x manufacturer's recommended maximum bolt torque PFA for 2 h	Steel	Min Annulus (TT)	B.1	B.1
Initial leak tightness (6.5)	Pipe(s) aligned	Flexible non-restrained joints	Short-term hydrostatic test	(1.5 x PFA) + 5 bar for 2 h	Steel (see Note 2)	Max Annulus (BT)	B.2.2	B.2.3
					Steel (see Note 2)	Min Annulus (TT)	B.2.2	B.2.3
	Pipe(s) under shear (6.3) and withdrawal (5.2)	Flexible non-restrained joints	Short-term hydrostatic test	(1.5 x PFA) + 5 bar for 2 h	Steel (see Note 2)	Max Annulus (BT)	B.2.2	B.2.3
					Steel (see Note 2)	Min Annulus (TT)	B.2.2	B.2.3
	Pipe(s) under angular deflection (5.3)	Flexible non-restrained joints	Short-term hydrostatic test	(1.5 x PFA) + 5 bar for 2 h	Steel (see Note 2)	Max Annulus (BT)	B.2.2	B.2.3
					Steel (see Note 2)	Min Annulus (TT)	B.2.2	B.2.3
	Pipe(s) aligned and shear (6.3)	Flexible restrained joints (6.9)	Short-term hydrostatic test (see Note 1)	(1.5 x PFA) + 5 bar for 2 h	Steel (see Note 2)	Max Annulus (BT)	B.2.2	B.2.3
					Steel (see Note 2)	Min Annulus (TT)	B.2.2	B.2.3
					Steel (see Note 2)	Max Annulus (BT)	B.2.2	B.2.3
					Steel (see Note 2)	Min Annulus (TT)	B.2.2	B.2.3