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Ductile iron fittings for PVC-U or PE piping systems — Requirements and test methods

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National foreword

This British Standard is the UK implementation of EN 12842:2012. It supersedes BS EN 12842:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/10, Iron pipes and fittings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12842

August 2012

ICS 23.040.40

Supersedes EN 12842:2000

English Version

Ductile iron fittings for PVC-U or PE piping systems - Requirements and test methods

Raccords en fonte ductile pour systèmes de canalisations en PVC-U ou en PE - Prescriptions et méthodes d'essai

Duktile Gussformstücke für PVC-U oder PE-Rohrleitungssyteme - Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 23 June 2012.

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Foreword

This document (EN 12842:2012) has been prepared by Technical Committee CEN/TC 203 "Cast iron pipes, fittings and their joints", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2013, and conflicting national standards shall be withdrawn at the latest by February 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12842:2000.

The significant changes made since the previous version are as follows:

a) Wording (relating to accessories, fittings, coupling and flange adaptor) modified in accordance with EN 545;

b) Improvement of shear load test for flange adapter and one socket fitting;

c) Addition of aging test for PE pipe fittings and accessories.

This European Standard was prepared in co-operation with CEN/TC 155 "Plastics piping systems".

This standard is in conformity with the general requirements already established by CEN/TC 164 in the field of water supply.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the product covered by this standard:

— this standard provides no information as to whether the product may be used without restriction in any of the member states of the EU or EFTA;

— it should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of these products remain in force.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the requirements and associated test methods applicable to ductile iron fittings, ductile iron and mild steel couplings and flange adaptors and their joints to be used with poly(vinyl chloride) (PVC-U) pipes or polyethylene (PE) pipes. It is in conformity with EN 1452-1 to -5, ENV 1452-6 and -7 and EN 12201-1 to -5 respectively, for the construction of pipelines:

— to convey water (e.g. water intended for human consumption);

— with or without pressure;

— to be installed below or above ground, inside or outside buildings.

This European Standard is not intended to cover sewerage applications, where additional requirements may be necessary.

This European Standard is applicable to fittings which are:

— manufactured with socketed, flanged or spigot ends;

— supplied externally and internally coated;

— suitable for PE and PVC-U pipes with fluid temperatures between 0°C and 25°C, excluding frost, and for pressures up to 16 bar (PFA). For higher temperatures (up to 45°C for PVC-U or 40°C for PE) the PFA is derated as given in EN 1452 and EN 12201;

— not intended for use in areas subjected to reaction to fire regulations.

NOTE 1 This does not preclude special arrangements for the products to be used at higher temperatures. Temperature limitations and pressure limitations are those coming from the PVC-U or PE pipes.

This European Standard covers ductile iron fittings, couplings and flange adaptors cast by any type of foundry process or manufactured by fabrication of cast components, as well as corresponding joints, in a size range extending from DN 60 to DN 700, to be used with pipes of external diameter from 63 mm to 710 mm.

As long as no equivalent European Standard exists for mild steel accessories, this European Standard also covers couplings and flange adaptors for use with PVC-U and PE pipes which are fabricated partly or entirely from mild steel as well as corresponding joints, in a size range extending from DN 60 to DN 700, to be used with pipes of external diameter from 63 mm to 710 mm.

This European Standard specifies requirements for materials, dimensions and tolerances, mechanical properties and standard coatings. It also gives minimum performance requirements for all components, including restrained and non-restrained flexible joints. Joint design and gasket shapes are outside the scope of this standard.

This European Standard does not cover fittings, couplings and flange adaptors intended to be used with different pipe materials other than PVC-U and PE.

NOTE 2 Fittings, couplings and flange adaptors complying with the requirements of this European Standard for PVC-U also usually meet the requirements for PVC-O and PVC-A pipes. Where this is not the case, the manufacturer is expected to declare this in the relevant literature.

NOTE 3 In this European Standard, all pressures are relative pressures, expressed in bars (100 kPa = 1 bar).

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.

EN 681-1, *Elastomeric seals — Material requirements for pipe joint seals used in water and drainage applications — Part 1: Vulcanised rubber*

EN 805:2000, *Water supply — Requirements for systems and components outside buildings*

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

EN 10025-1:2004, *Hot rolled products of structural steels — General technical delivery conditions*

EN 10310, *Steel tubes and fittings for onshore and offshore pipelines — Internal and external polyamide powder based coatings*

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

EN 15189, *Ductile iron pipes, fittings and accessories — External polyurethane coating for pipes — Requirements and test methods*

EN 15655, *Ductile iron pipes, fittings and accessories — Internal polyurethane lining for pipes and fittings — Requirements and test methods*

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 (ISO 1167-1:2006)*

EN ISO 4016, *Hexagon head bolts — Product grade C (ISO 4016)*

EN ISO 4034, *Hexagon nuts — Product grade C (ISO 4034)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part1: Test method (ISO 6506-1)*

EN ISO 7091, *Plain washers — Normal series — Product grade C (ISO 7091)*

EN ISO 9001:2008, *Quality management systems — Requirements (ISO 9001:2008)*

EN ISO 13846:2000, *Plastic piping systems — End-load-bearing and non-end-load-bearing assemblies and joints for thermoplastics pressure piping — Test method for long-term leaktightness under internal water pressure (ISO 13846:2000)*

3 Terms and definitions

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

3.1
ductile iron
cast iron used for fittings in which graphite is present substantially in spheroïdal form

3.2
fitting
casting other than a pipe which allows pipeline deviation, change of direction or bore

[SOURCE: EN 545]

3.3
flange
end of a fitting or flange adaptor extending perpendicular to its axis, with bolt holes equally spaced on a circle

Note 1 to entry: A flange can be fixed (e.g. integrally cast or welded) or adjustable; an adjustable flange comprises a ring, in one or several parts assembled together, which bears on an end joint hub and can be freely rotated around the axis before jointing.

3.4
spigot
male end of a pipe or fitting

3.5
socket
female end of a pipe or fitting to make the connection with the spigot of the next component

3.6
gasket
sealing component of a joint

3.7
joint
connection between the ends of two components in which a gasket is used to effect a seal

3.8
flexible joint
joint which permits significant angular deflection both during and after installation and which can accept a slight offset of the centreline

3.9
push-in flexible joint
flexible joint assembled by pushing the spigot through the gasket in the socket of the mating component

3.10
mechanical flexible joint
flexible joint in which sealing is obtained by applying pressure to the gasket by mechanical means, e.g. a gland

3.11
restrained flexible joint
flexible joint in which a means is provided to prevent separation of the assembled joint

3.12
flanged joint
joint between two flanged ends

3.13
nominal size
DN/OD
alphanumeric designation of size for components of a pipework system, which is used for reference purposes

Note 1 to entry: It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

Note 2 to entry: Adapted from EN ISO 6708:1995, definition 2.1.

Note 3 to entry: Plastic pipes are only defined as DN/OD.

3.14
nominal outside diameter (d_n)
specified outside diameter, in millimetres, assigned to a nominal size DN/OD

[SOURCE: EN 12201-1]

3.15
minimum socket inside diameter ($d_{i\ min}$)
minimum value of the internal diameter of the socket mouth

3.16
nominal pressure PN
alphanumerical designation, which comprises a convenient rounded number used for reference purposes

Note 1 to entry: All components of the same nominal size, DN, designated by the same PN have compatible mating dimensions.

Note 2 to entry: Adapted from EN 1333:2006.

Note 3 to entry: In EN 1452 and EN 12201, the term nominal pressure (PN) at 20°C is used in place of PFA.

3.17
allowable operating pressure (PFA)
maximum hydrostatic pressure that a component is capable of withstanding continuously in service

[SOURCE: EN 805:2000]

Note 1 to entry: In EN 1452 and EN 12201, the term nominal pressure (PN) at 20°C is used in place of PFA.

3.18
leak tightness test pressure
pressure applied to a component during manufacture in order to ensure its leak tightness

3.19
allowable maximum operating pressure (PMA)
maximum pressure occurring from time to time, including surge, that a component is capable of withstanding in service

[SOURCE: EN 805:2000]

3.20
allowable test pressure (PEA)
maximum hydrostatic pressure that a newly installed component is capable of withstanding for a relatively short duration, in order to ensure the integrity and tightness of the pipeline

[SOURCE: EN 805:2000]

Note 1 to entry: This test pressure is different from the system test pressure (STP), which is related to the design pressure of the pipeline and is intended to ensure its integrity and leak tightness.

3.21
batch
quantity of castings from which a sample is taken for testing purposes during manufacture

3.22
performance test
proof of design test which is done once and is repeated only after change of design

3.23
length
effective length of a fitting, as shown on the figures of Clause 8

Note 1 to entry: For flanged fittings, the effective length L (l for branches) is equal to the overall length. For socketed fittings, the effective length is designated Z in plastics piping systems standards and L_u (l_u for branches) in EN 545; it is equal to the overall length minus the spigot insertion depth as given in the manufacturer's catalogues.

3.24
flange adaptor
accessory which:

— is used in a pipeline to make the connection with a spigot of a pipe or fitting and the flange of another component of the pipeline (e.g. pipe, fitting, valve etc.); and

— allows for angular and axial displacements for unrestrained joints and angular displacements for restrained flexible joints

Note 1 to entry: Some flange adaptors are designed such that they can be slid over the pipes in order to facilitate easy assembly.

Note 2 to entry: As defined in EN 545, Flange Adaptors are accessories.

3.25
coupling
accessory which:

— is used in a pipeline to make the connection between two spigots of pipes, fittings or valves, etc.; and

— allows for angular and axial displacements for unrestrained joints and angular displacements for restrained flexible joints

Note 1 to entry: Some couplings are designed such that they can be slid over the pipes in order to facilitate easy assembly.

Note 2 to entry: As defined in EN 545, Couplings are accessories.

4 Technical requirements

4.1 General

4.1.1 Fittings

Nominal sizes, minimum wall thicknesses, lengths and coatings are specified in 4.1.2, 4.2.1/4.2.2, 4.2.3 and 4.4 respectively. When, for specific needs, fittings with different lengths and/or coatings and other types of fittings than those given in Clause 8 are supplied with reference to this standard, they shall comply with all other requirements of this standard.

4.1.2 Standardized sizes

The standardised sizes of fittings, corresponding to the nominal outside diameter d_n (in millimetres) of the pipes to which they shall be connected, are as follows: 63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560, 630, 710.

4.1.3 Surface condition and repairs

Fittings, couplings and flange adaptors shall be free from defects and surface imperfections which could lead to non-compliance with Clauses 4 and 5.

When necessary, fittings, couplings and flange adaptors may be repaired, for example by welding, in order to remove surface imperfections and localised defects which do not extend through the entire wall thickness, provided that:

— the repairs are carried out according to the manufacturer's written procedure;

— the repaired products comply with all the requirements of Clauses 4 and 5.

4.1.4 Types of joints and interconnection

4.1.4.1 General

Rubber gasket materials shall comply with the requirements of EN 681-1 for the type WA. When materials other than rubber are necessary (e.g. for high temperature flanged joints), they shall comply with the appropriate European Technical Specification or, where no European Technical Specification exists, the appropriate International Standard.

4.1.4.2 Flexible joints

The dimensions of sockets for push-in and mechanical, restrained and non-restrained flexible joints shall comply with 4.2.4 and with any additional requirements related to the gasket design. This ensures interconnection between all fittings and all PVC-U and PE pipes.

In addition, each type of flexible joint shall be designed to fulfil the performance requirements of Clause 5.

Taking into account the temperature and pressure effects on PE pipe, all joints intended for use with PE pipe shall be restrained.

Supporting sleeves (inserts) may be necessary depending on pipe material, on pipe wall thickness, on joint design and on national requirements; they should provide adequate support over the entire compression area of the gasket and restraining mechanism.

Where applicable, the minimum thickness of the PE pipes should be declared by the manufacturer of the fittings.

4.1.4.3 Flanged joints

Flanges shall be designed such that they can be attached to flanges whose dimensions and tolerances comply with EN 1092-2. This ensures interconnection between all flanged components (pipes, fittings, valves etc.) of the same PN and DN.

Bolts and nuts shall comply as a minimum with the requirements of EN ISO 4016 and EN ISO 4034, grade 4.6. Where washers are required, they shall comply with EN ISO 7091.

Although it does not affect interconnection, the manufacturer shall state whether his products are normally delivered with fixed flanges or adjustable flanges.

Flange gaskets may be one of any type given in EN 1514 (all parts).

4.1.5 Materials in contact with water intended for human consumption

Components of a pipe system include several materials given in this standard. When used under the conditions for which they are designed, in permanent or in temporary contact with water intended for human consumption, ductile iron/mild steel fittings and their joints shall not change the quality of that water to such an extent that it fails to comply with the requirements of national regulations.

For this purpose, reference shall be made to the relevant national regulations and standards, transposing EN standards when available, dealing with the influence of materials on water quality and to the requirements for external systems and components as given in EN 805.

4.2 Dimensional requirements

4.2.1 Minimum wall thickness of ductile iron fittings, couplings and flange adaptors

The minimum wall thickness of the ductile iron, at any point, shall be as given in Table 1, provided that the requirements of 4.3, 4.6 and Clause 7 are complied with.

Table 1 — Minimum wall thickness of ductile iron fittings, couplings and flange adaptors

d_n	Minimum wall thickness mm
$d_n \leq 225$	4
$225 < d_n \leq 315$	5
$315 < d_n \leq 710$	6

NOTE The thickness given in Table 1 is the minimum wall thickness corresponding to the main part of the body. The actual thickness at any particular point might require to be increased to meet localised high stresses depending on the shape of the casting (e.g. at internal radius of bends, at the branch-body junction of tees, etc.).

4.2.2 Minimum wall thickness of mild steel couplings and flange adaptors

The minimum wall thickness of the steel, at any point, shall be as given in Table 2, provided that the requirements of 4.3, 4.6 and 7 are complied with.

Table 2 — Minimum wall thickness of mild steel couplings and flange adaptors

d_n	Minimum wall thickness for material grade as specified in 4.3.2 mm
$d_n \leq 315$	3
$315 < d_n \leq 560$	4
$560 < d_n \leq 710$	5

For higher grade materials, it is permissible to use thicknesses less than those specified in Table 2 with an absolute minimum of 3mm.

4.2.3 Length

The lengths (see 3.23) of fittings shall be as given in the manufacturers' catalogues taking into account the minimum lengths given in the tables of Clause 8.

4.2.4 Dimensions of sockets

The minimum internal diameter of sockets and the minimum depth of engagement of sockets shall comply with the values given in Tables 7 and 8.

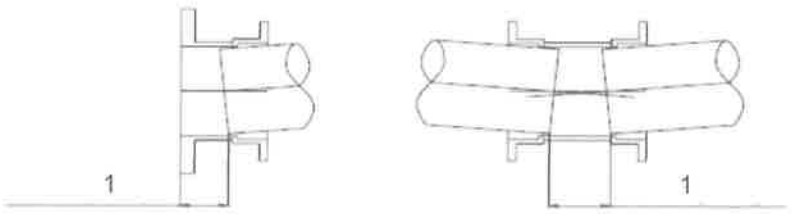
4.2.5 Jointing gap for couplings and flange adaptors

The manufacturer shall declare his maximum jointing gap for couplings and flange adaptors for PVC-U pipes (see Figure 1) and it shall not be less than the values given in Table 3.

NOTE The jointing gap between the pipes or the flange to be connected might be affected by the pipe contraction or expansion occurring as a result of temperature or pressure change.

Jointing gaps for PE pipes and restrained joints for PVC-U pipes are related to the joint design; the manufacturer shall declare these where relevant.

The manufacturer shall declare the minimum depth of engagement in the jointing instructions. The minimum depth of engagement shall be such that the pipes can support the loads imparted by the jointing/anchorage system.



Key

1 maximum joint gap
2 flange adaptor
3 coupling

Figure 1 — Jointing gap for couplings and flange adaptors

Table 3 — Dimensions of jointing gap for non-restrained couplings and flange adaptors for PVC-U pipes

PVC-U Pipes		
Nominal outside diameter of pipe d_n	Coupling jointing gap mm	Flange adaptor jointing gap mm
63	20	16
75	21	17
90	22	18
110	24	19
125	26	19
140	28	20
160	30	21
180	32	22
200	34	23
225	36	25
250	39	26
280	42	28
315	46	29
355	38	25
400	41	27
450	44	29
500	48	30
560	52	33
630	57	35
710	63	38

4.3 Material characteristics

4.3.1 Ductile iron

4.3.1.1 Tensile properties

Ductile iron fittings, couplings and flange adaptors shall have a minimum tensile strength of 420 MPa and a minimum elongation after fracture of 5 %. The tensile strength shall be tested in accordance with 6.1.

4.3.1.2 Hardness

The Brinell hardness, when measured in accordance with 6.2, shall not exceed 250 HBW. For components manufactured by welding, a higher Brinell hardness is allowed in the heat-affected zone of the weld.

4.3.2 Mild steel for couplings and flange adaptors

Mild steel for couplings and flange adaptors shall comply as a minimum with the requirements of EN 10025-1:2004, grade S275.

4.3.3 Fastener for couplings and flange adaptors

The maximum operating load on a fastener should not be greater than 80% of the yield strength of the fastener.

Fasteners shall be suitably protected to inhibit corrosion. The following coatings may be supplied:

— polymeric (e.g. epoxy/polyamide);

— zinc based corrosion protection;

— PTFE;

— a combination of the above.

4.4 Coatings

4.4.1 General

All fittings, couplings and flange adaptors shall be delivered with an external and internal epoxy coating in compliance with EN 14901. Alternatively, the following coatings may also be supplied:

a) External coatings:

   1) polyamide in accordance with EN 10310;

   2) polyurethane in accordance with EN 15189;

   3) enamel[1)].

b) Internal coatings (linings):

   1) polyamide in accordance with EN 10310;

   2) polyurethane in accordance with EN 15655;

   3) enamel[1)].

These external and internal coatings and their application process shall comply with the corresponding EN standards or, where no EN standard exists, they shall comply with ISO standards or with national standards valid in the place of use of the product, or with an agreed technical specification.

All coatings shall be works-applied.

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1) Enamel is a glass material containing raw material oxides fully or partly molten in the glass. This non-organic preparation can be laid in one or more layers on the metal part at a temperature higher than 480°C.

4.5 Marking

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

a) a reference to this European Standard (EN 12842);

b) the manufacturer's name or mark;

c) identification of the year of manufacture;

d) the identification of ductile iron or mild steel;

e) the d_n and/or the DN as relevant;

f) the PN rating of flanges for flange components;

g) "PVC" and/or "PE".

Items b) to f) shall be cast-on or cold stamped. Item a) and g) can be applied by any method e.g. painted on the castings or attached to the packaging.

4.6 Leak tightness

4.6.1 Fittings, couplings and flange adaptors

Fittings, couplings and flange adaptors shall be leak tight at their allowable test pressure (PEA).

Ductile iron fittings, couplings and flange adaptors shall be tested in accordance with 6.3 and shall exhibit no visible leakage, sweating or any other sign of failure.

4.6.2 Joints

Joints shall be designed in conformity with Clause 5 in order:

a) to durably withstand without leakage the allowable maximum operating pressure (PMA) of corresponding pipes and fittings under all normal service conditions, including foreseeable surge pressures and joint movements (angular and axial);

b) to be leak tight under negative internal pressure, which may occur under surge conditions.

5 Performance requirements for joints

5.1 General

In order to ensure the fitness for purpose of the joints in the field of water supply, there shall be a performance test (see 3.22) for at least one d_n for each of the groupings given below:

— d_n 63 to d_n 140 (preferred d_n: 110);

— d_n 160 to d_n 315 (preferred d_n: 200);

— d_n 355 to d_n 710 (preferred d_n: 400).

One end of a coupling is classified as the joint as long as both ends are to the same design. Where the joint design for a coupling is the same as a flange adaptor, testing need only be carried out on either coupling or flange adaptor.

One d_n is representative of a grouping when the performances are based on the same design parameters throughout the size range. Performance tests shall be carried out with PVC-U pipes and with PE pipes when the joint is meant to be used with either PVC-U pipes or PE pipes.

If a grouping covers products of different designs and/or manufactured by different processes, the grouping shall be sub-divided.

If for a manufacturer a grouping contains only one d_n, this d_n shall be tested instead of the preferred d_n.

The PFA for a fitting with a flange on one or more sides cannot under any circumstance be higher than the rating of the flange(s).

5.2 Leak tightness of flexible joints

5.2.1 General

The allowable angular deflection per joint declared by the manufacturer shall be not less than those given in Table 4.

Table 4 — Allowable angular deflection

	Push in joints and mechanical restrained joints	Mechanical non-restrained joints
d_n 63 to 315	1,5°	3,5°
d_n 355 to 630	1,0°	2,5°
d_n 710	0,5°	1,5°

All non-restrained joints shall be designed to provide axial movement; thereby the allowable withdrawal shall be declared by the manufacturer.

NOTE This permits the installed pipeline to accommodate ground movements and/or thermal effects without incurring additional stresses.

The manufacturer shall declare the lowest and the highest pipe pressure class for which the fitting is intended to be used.

5.2.2 Test conditions

All joint designs shall be performance tested with the lowest and the highest PVC-U and PE pipe pressure class as declared by the manufacturer. Where supporting sleeves (inserts) are required for joints for PE pipes, it shall be clearly stated and such supports shall be included in the test assembly. The tests results shall record the PE grade diameter and SDR rating. The following conditions of tolerance and joint movement are applicable:

a) joint of maximum annulus (see 5.2.3.1), aligned, withdrawn to the allowable value declared by the manufacturer, and subjected to shear (see 5.2.3.2);

b) joint of maximum annulus (see 5.2.3.1), deflected to the allowable value declared by the manufacturer (see 5.2.1).

The application of a shear load, as stated in 5.2.2 a), is only required for PVC-U pipes.

The joints shall exhibit no visible leakage when subjected to the following tests:

— test 1: positive internal hydrostatic pressure in accordance with 7.1; the test pressure shall be (1,5 p) bar, where p is the allowable operating pressure (PFA) of the joint declared by the manufacturer;

— test 2: negative internal pressure in accordance with 7.2 of 0,8 bar below atmospheric pressure (approximately 0,2 bar absolute pressure);

— test 3: cyclic internal hydraulic pressure in accordance with 7.3. The test shall comprise at least 24 000 cycles between 0,5p and p, where p is the allowable operating pressure (PFA) of the joint declared by the manufacturer.

NOTE The test pressures in test 1 and test 2 and the test durations given in 7.1 and 7.2 are in accordance with, or slightly more stringent than, the requirements of PVC-U and PE piping systems standards.

Table 5 summarises the test requirements and the test conditions given in 5.2.2, 5.2.3, 5.2.4, 7.1, 7.2 and 7.3.

Table 5 — Summary of test conditions

Test	Test requirements	Test conditions PVC-U pipes	Test conditions PE pipes
Positive internal hydrostatic pressure	— test pressure: (1,5 x PFA) bar — test duration: 2 h — no leakage during test period	— joint of maximum annulus, aligned, withdrawn, and subjected to shear load — temperature between 15 °C and 25 °C	— joint of maximum annulus, aligned and withdrawn — temperature between 15 °C and 25 °C
		— joint of maximum annulus, deflected — temperature between 15 °C and 25 °C	— joint of maximum annulus, deflected — temperature between 15 °C and 25 °C
Negative internal pressure	— test pressure: - 0,8 bar — test duration: 2 h — maximum pressure change during test period: 0,08 bar	— joint of maximum annulus, aligned, withdrawn, and subjected to shear load — temperature between 15 °C and 25 °C	— joint of maximum annulus, aligned and withdrawn — temperature between 15 °C and 25 °C
		— joint of maximum annulus, deflected — temperature between 15 °C and 25 °C	— joint of maximum annulus, deflected — temperature between 15 °C and 25 °C
Cyclic internal hydraulic pressure	— test pressure: between 0,5 PFA and PFA — test period: 24 000 cycles	— joint of maximum annulus, aligned, withdrawn and subjected to shear load — temperature between 15 °C and 25 °C	— joint of maximum annulus, aligned and withdrawn — temperature between 15 °C and 25 °C

5.2.3 Test parameters

5.2.3.1 Annulus

All joints shall be performance tested at the extremes of manufacturing tolerance such that the annular gap between the sealing surfaces of the socket and of the spigot is equal to the maximum design value plus 0 %,

minus 5 %. It is permissible to machine socket internal surfaces to achieve the required annulus for the performance test even though the resultant diameter can be slightly outside the normal manufacturing tolerance.

5.2.3.2 Shear

When applicable, joints shall be performance tested with a resultant shear force across one joint of not less than 10 x d_n in Newton, taking into account the weight of the pipe and of its contents and the geometry of the test assembly (see 7.1).

5.2.4 Restrained flexible joints

All restrained joint designs shall be performance tested in accordance with 7.1, 7.2 and 7.3 following the requirements of 5.2.2 and 5.2.3 except that:

— the withdrawal condition of 5.2.2 a) shall not apply;

— there shall be no external axial restraint in positive internal pressure tests so that the joint is subjected to the full end thrust.

During the positive internal pressure tests, the axial movement shall reach a stable value and cease.

When the restraining mechanism and the sealing component of the restrained joint are independent, such a joint need not be subjected to test 2 of 5.2.2 if the unrestrained version of the joint has passed this test.

5.3 Long term hydrostatic strength test

5.3.1 PE pipes

This test is applicable to restrained joints for PE pipe.

When tested by the method described in 7.4, the jointed assembly shall not leak nor shall the pipe fracture when subjected to the test pressures resulting from the stresses given in the following test options:

a) PE 100 pipes:

   1) Temperature 80 °C with a circumferential stress of 5,3 N/mm^2 for 165 h;

   2) Temperature 80 °C with a circumferential stress of 5,0 N/mm^2 for 1 000 h;

   3) Temperature 60 °C with a circumferential stress of 6,8 N/mm^2 for 165 h;

   4) Temperature 60 °C with a circumferential stress of 6,5 N/mm^2 for 1 000 h;

   5) Temperature 50 °C with a circumferential stress of 7,8 N/mm^2 for 165 h;

   6) Temperature 50 °C with a circumferential stress of 7,4 N/mm^2 for 1 000 h.

b) PE 80 pipes:

   1) Temperature 80 °C with a circumferential stress of 4,3 N/mm^2 for 165 h;

   2) Temperature 80 °C with a circumferential stress of 4,1 N/mm^2 for 1 000 h;

   3) Temperature 60 °C with a circumferential stress of 5,5 N/mm^2 for 165 h;

   4) Temperature 60 °C with a circumferential stress of 5,2 N/mm^2 for 1 000 h;

5) Temperature 50 °C with a circumferential stress of 6,3 N/mm^2 for 165 h;

6) Temperature 50 °C with a circumferential stress of 6,0 N/mm^2 for 1 000 h.

The pressure to be applied for the options (a) to (f) shall be calculated using the following Formula (1):

$$P = (20\sigma)\left(\frac{e_n}{d_n - e_n}\right) \quad (1)$$

where

P is the test pressure, in bars;

σ is the circumferential stress to be induced by the test pressure (a) to (f) in 5.3.1, in megapascals;

d_n is the nominal outside diameter of the test piece, in millimetres;

e_n is the nominal wall thickness of the free length of the test piece, in millimetres.

If after the test period the sample has not failed, the test shall be discontinued and the sample subjected to the test as detailed in 5.3.2.

5.3.2 Pull out test at 25 °C

After having been subjected to the requirements of 5.3.1, the assembly shall be tested by the method described in 7.5.

The pipe shall not fracture within the jointed assembly. Whilst initial movement of the pipe within the joint is allowed, no further such movement is permitted after the test loads calculated from Formula (2) has been attained:

$$F = \frac{1{,}2\,p\pi D^2}{4} \times 10^{-4} \quad (2)$$

where

F is the longitudinal test force to be applied, in kilonewtons;

1,2 is the safety factor;

p is the maximum working pressure (PFA) of the pipe, in bars;

D is the external diameter, in millimetres.

5.3.3 PVC-U pipes

This test is applicable to both non-restrained and restrained joints for PVC-U pipe.

When tested by the method described in 7.6, the jointed assembly shall not leak at any point of the jointing areas during the test period when subjected to the test pressure from one of the following test options:

a) Pipe with a design stress of 10 MPa:

1) Temperature 20°C for 1000 hours; test pressure = 1,7p

2) Temperature 40°C for 1000 hours; test pressure = 1,3p

b) Pipe with a design stress of 12,5 MPa:

1) Temperature 20 °C for 1 000 h; test pressure = 1,65p

2) Temperature 40 °C for 1 000 h; test pressure = 1,3p

where p is the nominal pressure rating of the pipe/fitting, in bars.

5.4 Flanged joints

The performance of flanged joints is deemed to be satisfactory as long as they comprise two metallic flanges in accordance with 4.1.4.3.

6 Test methods

6.1 Tensile testing for ductile iron

6.1.1 Samples

The thickness of the sample and the diameter of the test bar shall be as given in Table 6.

At the manufacturer's discretion, samples shall be either cast integrally with the castings or cast separately. In the latter case it shall be cast from the same metal as that used for the castings. If the castings are subjected to heat treatment, the samples shall be subjected to the same heat treatment cycle.

6.1.2 Preparation of test bar

A test bar shall be machined from each sample to be representative of the metal at the mid thickness of the sample, with a cylindrical part having the diameter given in Table 6.

The test bar shall have a gauge length equal to at least five times the nominal test bar diameter. The ends of the test bar shall be such that they will fit the testing machine.

The surface roughness profile of the cylindrical part of the test bar shall be such that $Rz \leq 6,3$.

If the specified diameter of the test bar is greater than 60 % of the measured minimum thickness of the sample, it is allowed to machine a test bar with a smaller diameter, or cut another sample in a thicker part of the fitting.

Table 6 — Dimensions of test bar

Type of casting	Nominal diameter of the test bar mm	Limit deviations on diameter mm	Tolerance on shape[a] mm
a) Integrally cast samples	5,0	± 0,06	0,03
b) Separately cast samples:			
1) sample thickness 12,5 mm for casting thickness less than 12 mm	6,0	± 0,06	0,03
2) sample thickness 25 mm for casting thickness 12 mm and over	12,0 or 14,0	± 0,09	0,04

[a] Maximum difference between the smallest and the largest measured diameter of the test bar.

The tensile strength shall be calculated either:

— from the nominal diameter of the test bar when it has been machined to fulfil all the tolerances given in Table 6, or if it is not the case,

— from the actual diameter of the test bar measured before the test.

The actual diameter shall be measured using a measuring device having an error limit ≤ 0,5 % and shall be within ± 10 % of the nominal diameter.

6.1.3 Apparatus and test method

The tensile test shall be carried out in accordance with EN 10002-1.

6.1.4 Test results

Test results shall comply with 4.3.1.1. If they do not comply, the manufacturer shall:

a) in the case where the metal does not achieve the required mechanical properties, investigate the reason and ensure that all castings in the batch are either re-heat treated or rejected. Castings which have been re-heat treated are then re-tested in accordance with 6.1;

b) in the case of a defect in the test bar, carry out a further test. If it passes, the batch is accepted; if not, the manufacturer may proceed as in a) above.

The manufacturer may limit the amount of rejection by making tests until the rejected batch of castings is bracketed, in order of manufacture, by a successful test at each end of the interval in question.

6.2 Brinell hardness for ductile iron

When Brinell hardness tests are carried out (see 4.3.1.2), they shall be performed either on the casting in dispute or on a sample cut from the casting. The surface to be tested shall be suitably prepared by local grinding to ensure a flat surface and the test shall be carried out in accordance with EN ISO 6506-1 using a ball of 2,5 mm or 5 mm or 10 mm diameter.

6.3 Works leak tightness test

6.3.1 General

At the discretion of the manufacturer, fittings, couplings and flange adaptors shall be submitted to an air test (see 6.3.2) or to a hydrostatic pressure test (see 6.3.3) or to any other leak tightness test of equivalent performance. Fittings shall be tested before application of their internal and external coatings.

The test apparatus shall be suitable for applying the specified test pressures to the fittings. It shall be equipped with an industrial pressure gauge with an error limit of ± 3 %.

6.3.2 Air test

When the air test is carried out, it shall be with an internal pressure of at least 1 bar and a visual inspection time not less than 10 s. For leak detection, the castings shall be either uniformly coated on their external surface by a suitable foaming agent or submerged in water.

6.3.3 Hydrostatic pressure test

When the hydrostatic pressure test is carried out, it shall be with the following minimum test pressures:

— d_n 63 to d_n 630: 16 bar;

— d_n 710: 10 bar.

The internal hydrostatic pressure shall be raised steadily until it reaches the test pressure which shall be maintained for a sufficient time to allow visual inspection. The total duration of the pressure cycle shall be not less than 15 s, including 10 s at test pressure.

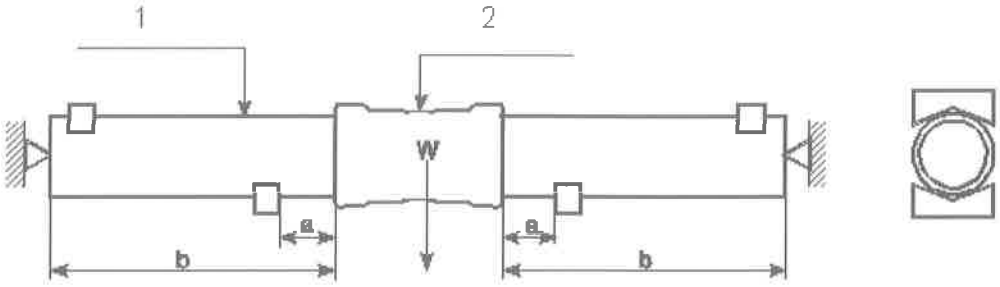
7 Performance tests

7.1 Leak tightness of joints to internal hydrostatic pressure

7.1.1 Couplings and 2 sockets fittings

The test shall be carried out on an assembled joint comprising a fitting, including sockets, and two plastic pipes section (see Figure 2).

The test apparatus shall be capable of providing suitable end and lateral restraints whether the joint is in the aligned position, deflected or subjected to a shear load. It shall be equipped with a pressure gauge with an accuracy in relation to the range of measured pressures of ≤ 3 %.



Key

1 plastic pipe section
2 ductile iron fitting
a distance between block support and socket face
b length of pipe section
W vertical force

Figure 2 — Internal hydrostatic testing for couplings and 2 sockets fittings

The testing equipment shall be as shown in Figure 2. The plastic pipes shall be supported by means of V shaped blocks with an angle of (120 ± 10)°, located at a distance, a, of $0{,}2d_n$ in mm, from the socket face, and up to a maximum of 50 mm. The length of each pipe section, b, shall be at least $2d_n$, in mm, and with a minimum of 1 m. The vertical force, W, shall be applied to the fitting. The vertical force, W, shall be such that the resultant shear force, F, across the joints is equal to the value specified in 5.2.3.2 taking into account the mass, M, of the fitting and its contents and the geometry of the test assembly, as given in Formula (3):

$$W = 2F - M \tag{3}$$

The test assembly shall be filled with water and suitably vented of air. The test shall not begin before the temperature of the test assembly has stabilised between 15 °C and 25 °C. The pressure shall be raised steadily until it reaches the test pressure given in 5.2.2; the rate of pressure increase shall not exceed 1 bar per s. The test pressure shall be kept constant within ± 0,5 bar for at least 2 h.

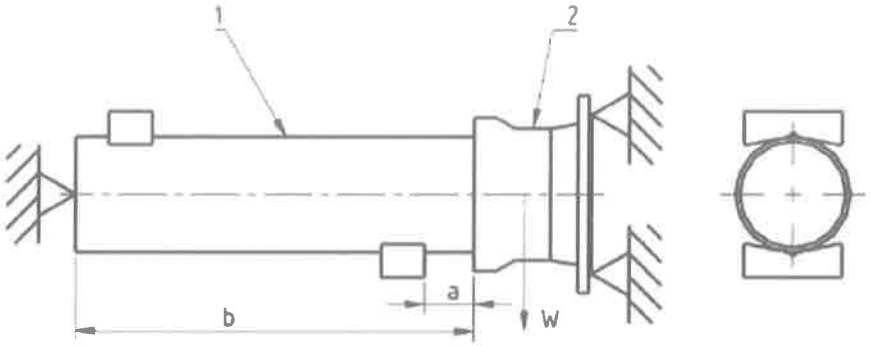
All necessary safety precautions should be taken for the duration of the pressure test.

For a restrained joint, the test assembly, the test apparatus and the test procedure are identical, except that there shall be no end restraint so that the axial thrust is taken by the restrained joint under test.

7.1.2 Flange adaptors and 1 socket fitting

For a flange adaptor and 1 socket fitting, half of the test apparatus shall be used (see Figure 3).

The test apparatus shall be capable of providing suitable end and lateral restraints whether the joint is in the aligned position, deflected or subjected to a shear load. It shall be equipped with a pressure gauge with an accuracy in relation to the range of measured pressures of ≤ 3 %.



Key

1 plastic pipe section
2 1 socket fitting or flange adaptor
a distance between block support and socket face
b length of pipe section
W Vertical force

Figure 3 — Internal hydrostatic testing for flange adaptor and 1 socket fitting

The testing equipment shall be as shown in Figure 2. The plastic pipes shall be supported by means of V shaped blocks with an angle of (120 ± 10)°, located at a distance a, of $0{,}2d_n$ in mm, from the socket face, and up to a maximum of 50 mm. The length of each pipe section, b, shall be at least $2d_n$, in mm, and with a minimum of 1 m. The vertical force, W, shall be applied to the fitting. The vertical force, W, shall be such that the resultant shear force F across the joints is equal to the value specified in 5.2.3.2 taking into account the mass, M, of the fitting and its contents and the geometry of the test assembly, as given in Formula (4):

$$W = F - M \tag{4}$$

The test assembly shall be filled with water and suitably vented of air. The test shall not begin before the temperature of the test assembly has stabilised between 15 °C and 25 °C. The pressure shall be raised steadily until it reaches the test pressure given in 5.2.2; the rate of pressure increase shall not exceed 1 bar per s. The test pressure shall be kept constant within ± 0,5 bar for at least 2 h.

All necessary safety precautions should be taken for the duration of the pressure test.

For a restrained joint, the test assembly, the test apparatus and the test procedure are identical, except that there shall be no end restraint so that the axial thrust is taken by the restrained joint under test

7.2 Leak tightness of joints to negative internal pressure

The test assembly and test apparatus shall be as given in 7.1 with the pipe sections axially restrained to prevent them moving towards each other.

The test assembly shall be empty of water and shall be evacuated to a negative internal pressure of 0,8 bar (see 5.2.2) and then isolated from the vacuum pump. The test assembly shall be left under vacuum for 2 h during which the pressure shall not have changed by more than 0,08 bar. The test shall begin at a temperature between 15 °C and 25 °C, which is then kept constant at ± 2 °C for the duration of the test.

For a restrained joint, the test assembly, the test apparatus and the test procedure are identical.

7.3 Leak tightness of joints to dynamic internal pressure

The test assembly and test apparatus shall be as given in 7.1. The test assembly shall be filled with water and suitably vented of air.

The pressure shall be steadily increased up to p, the allowable operating pressure of the joint and then automatically monitored according to the following pressure cycle:

a) steady pressure reduction to 0,5 p;

b) maintain 0,5 p for at least 5 s;

c) steady pressure increase to p;

d) maintain p for at least 5 s.

The pressure may vary during steps b) and d) either side of the specified pressure, but the difference between the mean pressure b) and the mean pressure d) shall be at least 5 bar.

The number of cycles shall be recorded and the test stopped automatically in the occurrence of a failure of the joint.

For a restrained joint, the test assembly, the test apparatus and the test procedure are identical, except that there shall be no end restraint so that the axial thrust is taken by the restrained joint under test. In addition any axial movement at the spigot shall be measured every 15 min.

All necessary safety precautions should be taken for the duration of the pressure test.

7.4 Long term hydrostatic strength test for joints of fittings for PE pipes

7.4.1 Test piece

A test piece shall be assembled with PE 100 or PE 80 pipe in accordance with the manufacturer's instructions.

Specimens shall be conditioned prior to test by being kept at (25 +0/-4) °C in air for not less than 24 h. For hydrostatic tests involving liquid immersion, the specimens shall be conditioned in the liquid at the test temperature for not less than 24 h.

The end caps used shall comply with EN ISO 1167-1:2006, type A. There shall be a free length of pipe, between the two fittings or a fitting and an end cap, of not less than three times the nominal size of the fitting for test pieces of nominal size up to and including 315 and a minimum of 1 m for sizes greater than nominal size 315.

7.4.2 Test procedure

The test shall be carried out in accordance with EN ISO 1167-1 and the assembly shall be subjected to the relevant pressure, temperature and time as detailed in 5.3.1.

Failure of the pipe within a distance of less than 0.1 L (where L is the free length between fitting and end cap) from the mouth of the fitting shall be disregarded and a new test piece evaluated. Any axial movement of the pipe within the joint at the end of the test shall be determined and recorded using suitable equipment having an error limit of ± 0,5mm.

7.5 Pull out test at 25 °C for restrained joints for PE pipes

7.5.1 Test piece

The test piece from the successful long term hydrostatic strength test shall be used.

7.5.2 Apparatus

The apparatus shall be capable of applying a tensile load as required in 5.3.2, at a cross head speed of not more than 25 mm/min.

7.5.3 Test procedure

Plain metal plugs shall be inserted in the end of the PE pipe(s) to support the pipe(s) under the action of the loading grips of the testing equipment.

The test shall be carried out at a temperature of (25 +0/-4)°C. A tensile axial load shall be applied to the fitting under test at a cross-head speed of (25 ± 1) mm/min until the maximum load is reached.

The fitting passes the test provided the minimum load as calculated in 5.3.2 is attained without pull out occurring and no further axial movement once the test load has been attained. If fracture of the pipe occurs, the test shall be repeated on a completely new assembly. If the pipe yields at a distance greater than 0.1 L from the mouth of the socket or loading grip, the fitting shall be deemed to have satisfied the requirements of this test.

7.6 Long term hydrostatic strength test for joints of fittings for PVC-U pipe

7.6.1 Test piece

A test piece shall be assembled with PVC-U pipe in accordance with the manufacturer's instructions.

Specimens shall be conditioned prior to test by being kept in the test room or conditioning chamber for at least 3 h for test temperatures more than 25 °C or for at least 20 min for test temperatures equal to or less than 25 °C. If the test temperature is specified as 'ambient temperature', carry out the conditioning at any temperature between 15 °C and 25 °C. During subsequent testing, maintain the test temperature constant to within ± 2 °C and within the range of 15 °C to 25 °C.

There shall be a free length of pipe, between the two fittings or a fitting and an end cap, equal to d_n, but not less than 150 mm.

For non-restrained joints, tie rods or external frames shall be used as necessary to prevent any separation.

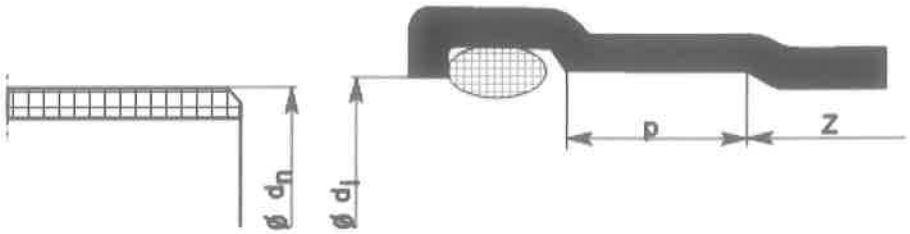
7.6.2 Test procedure

The test shall be carried out in accordance with EN ISO 13846 and the assembly shall be subjected to the relevant pressure, temperature and time as detailed in 5.3.3.

If rupture occurs in the pipe section between the joints under test or in an end closure not included as part of the test assembly, the test shall be disregarded and the failed component replaced by another. After replacement, the test procedure shall be continued. If the failure of the component causes damage to any of the joints or assemblies on test, these test pieces shall be rejected and the test procedure repeated.

8 Tables of dimensions

8.1 Dimensions of sockets for push-in flexible joints



Key

p depth of engagement
Z effective length
d_n nominal outside diameter of pipe
d_i socket inside diameter

Figure 4 — Description of dimensions for push-in flexible joints

Table 7 — Dimensions of sockets for push-in flexible joints

	PVC-U Pipes			PE pipes		
Nominal outside diameter of the pipe d_n	Tolerance x on d_n a b	Minimum socket inside diameter d_i c	Minimum depth of engagement p f	Tolerance x on d_n a d	Minimum socket inside diameter d_i e	Minimum depth of engagement p f
63	0.3	63.4	42	0.4	63.5	42
75	0.3	75.4	42	0.5	75.6	42
90	0.3	90.4	44	0.6	90.7	44
110	0.4	110.5	47	0.7	110.8	47
125	0.4	125.5	49	0.8	125.9	49
140	0.5	140.6	51	0.9	141.0	51
160	0.5	160.6	54	1.0	161.1	54
180	0.6	180.7	57	1.1	181.2	57
200	0.6	200.7	60	1.2	201.3	60
225	0.7	225.8	64	1.4	226.5	64
250	0.8	250.9	68	1.5	251.6	68
280	0.9	281.0	72	1.7	281.8	72
315	1.0	316.1	78	1.8	316.9	78
355	1.1	356.2	84	2.2	357.3	84
400	1.2	401.3	90	2.4	402.5	90
450	1.4	451.5	98	2.7	452.8	98
500	1.5	501.6	105	3.0	503.1	105
560	1.7	561.8	114	3.4	563.5	114
630	1.9	632.0	125	3.8	633.9	125
710	2.0	712.3	125	6.4	716.7	125

a The tolerance is expressed in the form d_n + x, 0 mm, where "x" is the value of the tolerance.

b From EN ISO 1452-2:2009, Table 1.

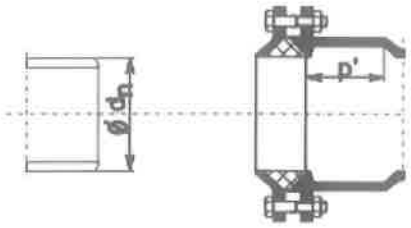
c From EN ISO 1452-2:2009, Table 5.

d From EN 12201-2:2011, Table 1.

e d_i is calculated using the same minimum annular gap as for push-in flexible joints for PVC-U pipes.

f The minimum values p are the result of the work done by the joint Ad-hoc group CEN/TC 155-CEN/TC 203.

8.2 Dimensions of sockets for mechanical flexible joints



Key

p' depth of engagement
d_n nominal outside diameter of pipe

Figure 5 — Description of dimensions for mechanical flexible joints

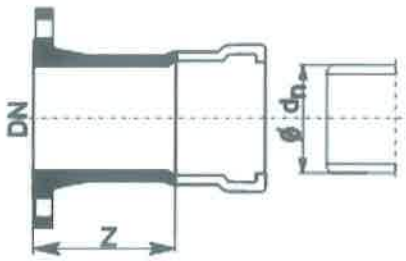
Table 8 — Dimensions of sockets for mechanical flexible joints

	PVC-U pipes	PE pipes	
Nominal outside diameter of the pipe d_n	**Tolerance x on d_n** *a c*	**Tolerance x on d_n** *a b*	**Minimum depth of engagement** p'
63	0.3	0.4	33
75	0.3	0.5	33
90	0.3	0.6	34
110	0.4	0.7	36
125	0.4	0.8	36
140	0.5	0.9	37
160	0.5	1.0	39
180	0.6	1.1	40
200	0.6	1.2	41
225	0.7	1.4	43
250	0.8	1.5	44
280	0.9	1.7	46
315	1.0	1.8	48
355	1.1	2.2	44
400	1.2	2.4	46
450	1.4	2.7	49
500	1.5	3.0	51
560	1.7	3.4	53
630	1.9	3.8	57
710	2.0	6.4	47

a The tolerance is expressed in the form d_n + x, 0 mm, where "x" is the value of the tolerance.
b From EN 12201-2:2011, Table 1.
c From EN ISO 1452-2:2009, Table 1.

8.3 Dimensions of fittings

8.3.1 Flanged socket



Key

DN nominal diameter of the flange
Z effective length
d_n nominal outside diameter of pipe

Figure 6 — Flanged socket

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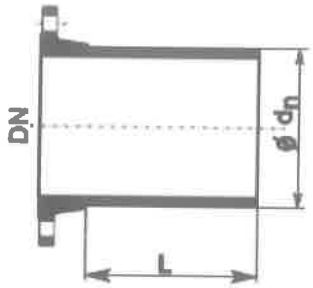
Table 9 — Dimensions of flanged socket

Nominal outside diameter of the pipe d_n	Nominal diameter of the flange DN	Minimum effective length Z
63	50	15
63	60	15
75	60	15
75	65	15
90	80	15
110	100	15
125	100	15
125	125	20
140	125	20
160	150	35
180	150	35
200	200	40
225	200	40
250	200	40
250	250	50
280	250	50
315	300	60
355	300	60
400	350	70
400	400	70
450	400	70
500	500	80
560	500	80
630	600	90
710	700	100

8.3.2 Flanged spigot



Key

DN nominal diameter of flange
L length
d_n nominal outside diameter

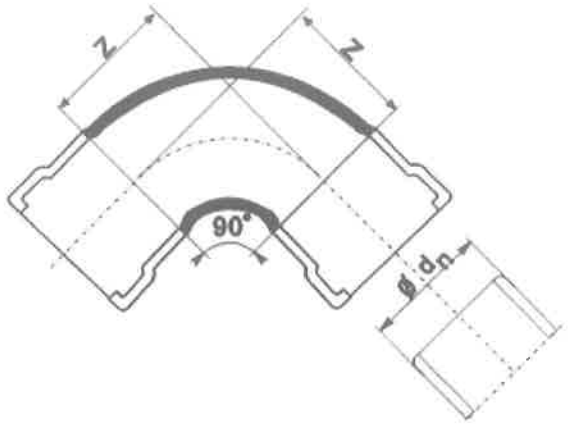
Figure 7 — Flanged spigot

Table 10— Dimensions of flanged spigot

Nominal outside diameter d_n	Tolerance on d_n a	Nominal diameter of the flange DN	Minimum length L
63	0,3	50	93
63	0,3	60	93
75	0,3	60	98
75	0,3	65	98
90	0,3	80	102
110	0,4	100	110
125	0,4	100	114
125	0,4	125	114
140	0,5	125	119
160	0,5	150	127
180	0,6	150	133
200	0,6	200	139
225	0,7	200	147
250	0,8	200	156
250	0,8	250	156
280	0,9	250	166
315	1,0	300	176
355	1,1	300	187
400	1,2	350	198
400	1,2	400	198
450	1,4	400	212
500	1,5	500	224
560	1,7	500	241
630	1,9	600	260
710	2,0	700	281

a The tolerance is expressed in the form d_n + x, 0 mm, where "x" is the value of the tolerance.

8.3.3 Double socket bend 90° (1/4)



Key

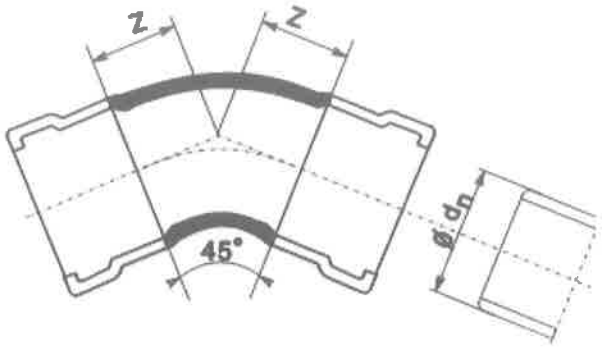
Z effective length
d_n nominal outside diameter of pipe

Figure 8 — Double socket bend 90° (1/4)

Table 11 — Dimensions of double socket bend 90° (1/4)

Nominal outside diameter of the pipe d_n	Minimum effective length Z
63	65
75	70
90	75
110	85
125	110
140	110
160	130
180	160
200	160
225	160
250	185
280	205
315	215

8.3.4 Double socket bend 45° (1/8)



Key

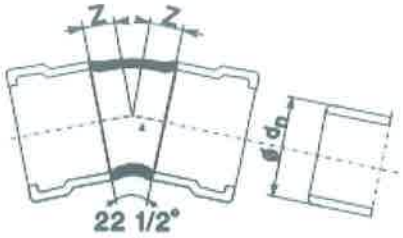
Z effective length
d_n nominal outside diameter of pipe

Figure 9 — Double socket bend 45° (1/8)

Table 12 — Dimensions of double socket bend 45° (1/8)

Nominal outside diameter of the pipe d_n	Minimum effective length Z
63	40
75	40
90	50
110	60
125	65
140	65
160	70
180	70
200	70
225	80
250	110
280	130
315	135
355	170
400	175
450	200

8.3.5 Double socket bend 22 ½° (1/16)



Key

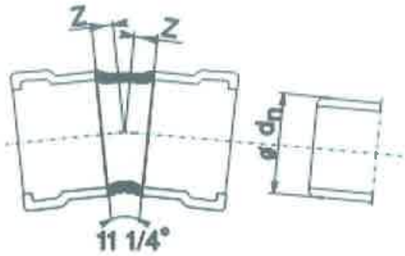
Z effective length
d_n nominal outside diameter of pipe

Figure 10 — Double socket bend 22 ½° (1/16)

Table 13 — Dimensions of double socket bend 22 ½° (1/16)

Nominal outside diameter of the pipe d_n	Minimum effective length Z
63	20
75	25
90	25
110	30
125	30
140	30
160	35
180	40
200	40
225	45
250	50
280	75
315	85
355	95
400	110
450	120

8.3.6 Double socket bend 11 ¼° (1/32)



Key

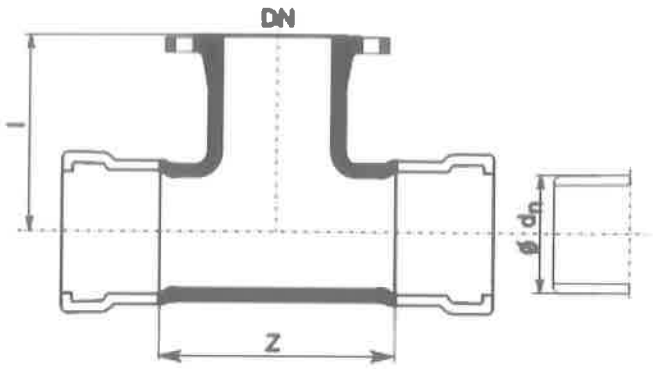
Z effective length
d_n nominal outside diameter of pipe

Figure 11 — Double socket bend 11 ¼° (1/32)

Table 14 — Dimensions of double socket bend 11 ¼° (1/32)

Nominal outside diameter of the pipe d_n	Minimum effective length Z
63	20
75	25
90	25
110	30
125	30
140	30
160	30
180	30
200	30
225	40
250	40
280	50
315	55
355	60
400	65
450	70

8.3.7 Double socket tee with flanged branch dn 63 to 160



Key

Z effective length
DN nominal diameter of branch
l height
d_n nominal outside diameter of pipe

Figure 12 — Double socket tee with flanged branch

Table 15 — Dimensions of double socket tee with flanged branch d_n 63 to 160

Nominal outside diameter of the pipe d_n	Nominal diameter of the branch DN	Minimum effective length Z	Minimum height l
63	60	70	140
75	60-65	85	140
90	60-65	90	155
	80	105	160
110	60-65	90	165
	80	105	170
	100	125	170
125	60-65	90	160
	80	105	170
	100	125	180
	125	150	180
140	60-65	90	180
	80	105	185
	100	125	195
	125	150	200
160	60-65	90	190
	80	105	200
	100	125	205
	125	150	210
	150	175	220

8.3.8 Double socket tee with flanged branch dn 180 to 280

Table 16 — Dimensions of double socket tee with flanged branch d_n 180 to 280

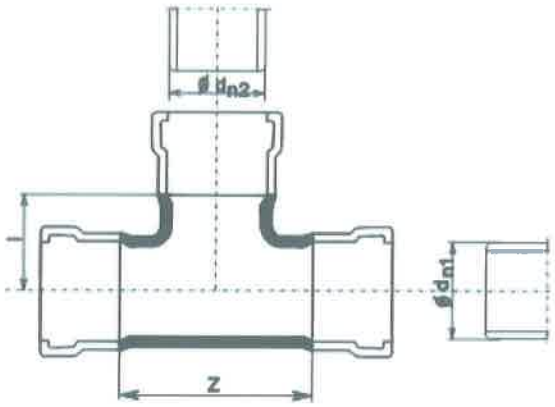
Nominal outside diameter of the pipe d_n	Nominal diameter of the branch DN	Minimum effective length Z	Minimum height I
180	60-65	90	215
	80	105	225
	100	125	230
	125	150	240
	150	175	245
	200	220	250
200	60-65	125	215
	80	140	225
	100	160	230
	125	185	240
	150	210	245
	200	260	250
225	60-65	125	215
	80	140	225
	100	160	230
	125	185	240
	150	210	245
	200	260	260
250	60-65	140	250
	80	155	250
	100	175	255
	125	200	260
	150	225	265
	200	275	275
	250	325	285
280	60-65	140	260
	80	155	265
	100	175	270
	150	225	280
	200	275	280
	250	325	290

8.3.9 Double socket tee with flanged branch dn 315 to 600

Table 17 — Dimensions of double socket tee with flanged branch d_n 315 to 600

Nominal outside diameter of the pipe d_n	Nominal diameter of the branch DN	Minimum effective length Z	Minimum height l
315	60-65	140	290
	80	155	295
	100	175	300
	125	200	305
	150	225	310
	200	275	310
	250	325	310
	300	375	310
355	60-65	140	320
	80	155	325
	100	175	330
	150	225	340
	200	275	350
	250	325	360
	350	420	380
400	80	175	340
	100	210	355
	150	275	360
	200	325	365
	250	370	375
	300	420	385
	400	520	395
450	100	210	340
	150	275	360
	200	325	365
	250	370	375
	300	420	385
	400	520	395
	450	570	460
500	150	275	380
	300	420	440
600	150	275	400
	300	420	460

8.3.10 All socket tee dn 63 to 160



Key

Z effective length
l height
d_{n1} nominal outside diameter of pipe
d_{n2} nominal outside diameter of branch

Figure 13 — All socket tee

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Table 18 — Dimensions of all socket tee d_n 63 to 160

Nominal outside diameter of the pipe d_{n1}	Nominal outside diameter of the branch d_{n2}	Minimum effective length Z	Minimum height I
63	63	70	30
75	63	70	45
	75	85	45
90	63	75	50
	75	90	50
	90	105	50
110	63	75	60
	75	90	60
	90	105	60
	110	125	60
125	63	75	70
	75	90	70
	90	105	70
	110	125	70
	125	150	70
140	63	75	75
	75	90	75
	90	105	75
	110	125	75
	125	150	75
	140	150	75
160	63	75	85
	75	90	85
	90	105	85
	110	125	85
	125	125	85
	140	150	85
	160	175	85

8.3.11 All socket tee dn 180 to 315

Table 19 — Dimensions of all socket tee d_n 180 to 315

Nominal outside diameter of the pipe d_{n1}	Nominal outside diameter of the branch d_{n2}	Minimum effective length Z	Minimum height I
180	63	75	95
	90	90	95
	110	125	95
	160	175	95
	180	190	95
200	63	110	105
	90	140	105
	110	160	105
	125	160	105
	140	185	105
	160	210	105
	180	230	105
	200	240	105
225	63	110	120
	90	140	120
	110	160	120
	160	210	120
	200	240	120
	225	260	120
250	90	155	130
	110	175	130
	160	225	130
	200	250	130
	225	270	130
	250	300	130
280	90	155	145
	110	175	145
	160	225	145
	200	250	145
	250	300	145
	280	325	145
315	110	175	165
	160	225	165
	200	250	165
	250	300	165
	280	325	165
	315	375	165

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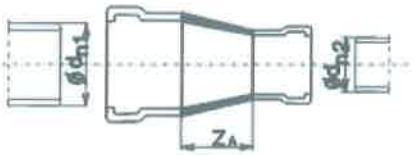
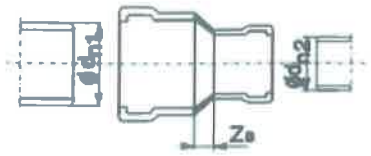
8.3.12 Double socket taper dn 63 to 225



Key

Z_A effective length
d_{n1} nominal outside diameter of pipe
d_{n2} nominal outside diameter of pipe

Figure 14 — Double socket taper - Series A



Key

Z_B effective length
d_{n1} nominal outside diameter of pipe
d_{n2} nominal outside diameter of pipe

Figure 15 — Double socket taper - Series B

Table 20 — Dimensions of double socket taper d_n 63 to 225

Nominal outside diameter of the pipe		Minimum effective length	
		Series A long	Series B short
d_{n1}	d_{n2}	Z_A	Z_B
75	63	80	20
90	63	80	25
	75	80	20
110	63	160	35
	75	120	35
	90	85	30
125	75	190	55
	90	135	45
	110	100	40
140	75	190	55
	90	135	45
	110	100	40
	125	100	40
160	90	190	55
	110	150	50
	125	100	40
	140	100	40
180	90	250	90
	110	250	80
	125	200	70
	140	145	65
	160	145	60
200	90	250	95
	110	250	85
	125	250	75
	140	200	70
	160	145	70
	180	145	60
225	125	250	80
	140	200	75
	160	145	70
	180	145	65
	200	145	60

8.3.13 Double socket taper d_n 250 to 450

Table 21 — Dimensions of double socket taper d_n 250 to 450

Nominal outside diameter of the pipe		Minimum effective length	
		Series A long	Series B short
d_{n1}	d_{n2}	Z_A	Z_B
250	125	300	95
	160	250	90
	200	150	80
280	160	250	100
	200	150	80
	250	150	60
315	200	250	105
	250	150	90
	280	150	80
355	200	360	160
	250	260	110
	315	160	100
400	250	360	200
	315	260	160
	355	155	155
450	315	360	175
	355	260	160
	400	160	155

9 Evaluation of conformity

9.1 General

The conformity of fittings, couplings, flange adaptors and their joints with the requirements of this European Standard and with the declared values (including classes) shall be demonstrated by:

a) initial performance testing (3.22);

b) factory production control by the manufacturer, including product assessment.

For the purposes of testing, the products may be grouped into families (see 5.1), where it is considered that the results for one or more characteristics from any product within the family are representative for the same characteristics for all products within that family.

9.2 Initial performance testing

9.2.1 General

Initial performance testing shall be carried out to show conformity with this European Standard. Tests previously performed in accordance with the provisions of this European Standard (same product, same characteristic(s), test method, sampling procedure, system of attestation of conformity, etc.) may be taken into account. In addition, initial performance testing shall be carried out at the beginning of the production of a new type of product or at the beginning of a new method of production (where this may affect the stated properties).

Where components are used whose characteristics have already been determined by the component manufacturer, on the basis of conformity with other product standards, these characteristics need not be reassessed, provided that:

— the components' performance or method of assessment remain the same;

— the characteristics of the component are suitable for the intended end use of the finished product; and insofar as

— the manufacturing process does not have a detrimental affect on the determined characteristics.

Components and raw materials CE marked in accordance with appropriate harmonised European specifications may be presumed to have the performances stated with the CE marking. Nevertheless, this presumption does not replace the responsibility of the manufacturer of the pipeline product to ensure that the product as a whole is correctly designed and its component products have the necessary performance values to meet the design.

9.2.2 Characteristics

All characteristics in Clause 5 shall be subject to initial performance testing except for the release of dangerous substances which may be assessed indirectly by controlling the content of the substance concerned.

Whenever a change occurs in the product, the raw material or supplier of the components, or the production process (subject to the definition of a family), which would change significantly one or more of the characteristics, the performance tests shall be repeated for the appropriate characteristics.

9.2.3 Treatment of calculated values and design

In those cases where conformity with this standard is based on calculations, performance testing will be limited to the verification of the calculations made and the resulting products' correspondence to the assumptions made in the design.

9.2.4 Sampling, testing and conformity criteria

9.2.4.1 Sampling procedure

Initial performance testing shall be performed on samples of products representative for the manufactured product type.

The random sampling method shall be used, except for the assessment of the leak tightness of joints which requires samples at the extreme of tolerances (see 5.2).

9.2.4.2 Testing and compliance criteria

The number of test samples to be tested (or assessed) shall be in accordance with Table 22.

The results of all performance tests shall be recorded and held by the manufacturer for at least ten years after the last date or production of the product(s) to which they apply.

Table 22 — Number of test samples for initial performance testing

Items to be tested	Number of samples (minimum)			Test method in accordance with	Requirements in accordance with
Leak tightness of flexible joints	1 of each dn grouping				
To positive internal pressure	dn 63	dn 160	dn 355	7.1	5.2.2
To negative internal pressure	to	to	to	7.2	5.2.2
To dynamic internal pressure	dn 140	dn 315	dn 710	7.3	5.2.2
Long term hydrostatic strength test	1 of each dn grouping				
	dn 63 to dn 140	dn 160 to dn 315	dn 355 to dn 710	7.4	5.3
Pull out test	Carried out as above following long term hydrostatic strength test			7.5	5.4

9.3 Factory production control (FPC)

9.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market conform to the declared performance characteristics and to all requirements of this standard. The FPC system shall consist of procedures (works' manual), regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product. Records shall remain legible, readily identifiable and retrievable.

The FPC system may be part of a Quality Management System, e.g. in accordance with EN ISO 9001.

An FPC system conforming to the requirements of EN ISO 9001, and made specific to the requirements of this European Standard, shall be considered to satisfy the above requirements.

The results of inspections, tests or assessments requiring action shall be recorded, as shall any action taken. The action to be taken when control values or criteria are not met shall be recorded and retained for the period specified in the manufacturer's FPC procedures.

If the manufacturer has the component designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, the FPC of the original manufacturer may be taken into account. However, where subcontracting takes place, the manufacturer shall retain the overall control of the component and ensure that he receives all the information that is necessary to fulfil his responsibilities according to this European Standard.

9.3.2 FPC requirements for all manufacturers

9.3.2.1 General

The manufacturer shall establish procedures to ensure that the production tolerances allow for the products performances to be in conformity with the declared values, derived from initial performance testing.

The characteristics, and the means of verification, are given in Table 23. The minimum testing frequencies apply to permanent production in large quantities with a stable process. The actual testing frequencies to be used in order to ensure permanent conformity of the products shall be fixed by the manufacturer's FPC, taking into account the production rate and the process control measures which are implemented.

The manufacturer shall record the results of the tests specified above. These records shall at least include the following information:

a) identification of the product tested;

b) date of sampling and testing;

c) test methods performed;

d) test results.

Table 23 — Minimum frequency of product testing as part of FPC

Items to be tested	Test method in accordance with	Requirements in accordance with	Minimum frequency of test
Material characteristics of ductile iron			
Tensile testing	6.1	4.3.1.1	see 9.3.2.2
Brinell hardness	6.2	4.3.1.2	1 per week
Coatings of fittings			
Epoxy coating	EN 14901	4.4.1	1 per shift
Leak tightness for fittings			
Works leak tightness test	6.3	4.6	100 %

9.3.2.2 FPC for tensile testing

During the manufacturing process, the manufacturer shall carry out suitable tests in order to verify the tensile properties of the ductile iron specified in 4.3.1.1. These tests may be:

a) a batch sampling system whereby samples are obtained from the fittings, from samples cast separately or attached with the castings concerned. Test bars are machined from these samples and tensile tested in accordance with 6.1; or

b) a system of process control (e.g. by non-destructive testing) where a positive correlation can be demonstrated with the tensile properties specified in 4.3.1.1. Testing verification procedures are based on the use of comparator samples having known and verifiable properties. This system is supported by tensile testing in accordance with 6.1.

The frequency of testing is related to the system of production and quality control used by the manufacturer. The maximum batch sizes shall be as given in Table 24.

Table 24 — Maximum batch sizes for tensile testing

Type of casting	d_n	Maximum batch size	
		Batch sampling system	Process control system
Ductile iron fittings	63 to 710	4 t [a]	48 t [a]

[a] Weight of crude castings, excluding the risers.

9.3.3 Manufacturer-specific FPC system requirements

9.3.3.1 Personnel

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product conformity, shall be defined. This applies in particular to personnel that need to initiate actions to prevent product non-conformities from occurring and actions in case of non-conformities, and to identify and register product conformity problems. Personnel performing work affecting product conformity shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

9.3.3.2 Equipment

All weighing, measuring and testing equipment necessary to achieve or produce evidence of conformity shall be calibrated or verified and regularly inspected according to documented procedures, frequencies and criteria. Control of monitoring and measuring devices shall comply with the appropriate clause of EN ISO 9001.

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process.

Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

9.3.3.3 Design process

The factory production control system shall document the various stages in the design of the products and identify the checking procedure and those individuals responsible for all stages of design.

During the design process itself, a record shall be kept of all checks, their results, and any corrective actions taken. This record shall be sufficiently detailed and accurate to demonstrate that all stages of the design phase, and all checks, have been carried out satisfactorily. Compliance with EN ISO 9001:2008, 7.3, shall be deemed to satisfy the requirements of this sub-clause.

9.3.3.4 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their conformity. The verification of conformity of the raw materials with the specification shall be in accordance with EN ISO 9001:2008, 7.4.3.

9.3.3.5 In-process control

The manufacturer shall plan and carry out production under controlled conditions. Compliance with EN ISO 9001:2008, 7.5.1 and 7.5.2, shall be deemed to satisfy the requirements of this sub-clause.

9.3.3.6 Non-conforming products

The manufacturer shall have written procedures which specify how non-conforming products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures. Compliance with EN ISO 9001:2008, 8.3, shall be deemed to satisfy the requirements of this sub-clause.

9.3.3.7 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence. Compliance with EN ISO 9001:2008, 8.5.2, shall be deemed to satisfy the requirements of this sub-clause.

Bibliography

[1] EN 545, *Ductile iron pipes, fittings, accessories and their joints for water pipelines — Requirements and test methods*

[2] EN 1333:2006, *Flanges and their joints — Pipework components — Definition and selection of PN*

[3] EN 1514 (all parts), *Flanges and their joints — Dimensions of gaskets for PN-designated flanges*

[4] EN 12201, *Plastic piping systems for water supply — Polyethylene (PE)* (parts 1 to 5)

[5] EN 45011, *General requirements for bodies operating product certification systems (ISO/IEC Guide 65:1996)*

[6] EN 45012, *General requirements for bodies operating assessment and certification/registration of quality systems (ISO/IEC Guide 62:1996)*

[7] EN ISO 1452, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 1: General (ISO 1452-1)*

[8] EN ISO 1452, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 2: Pipes (ISO 1452-2)*

[9] EN ISO 1452, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 3: Fittings (ISO 1452-3)*

[10] EN ISO 1452, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 4: Valves (ISO 1452-4)*

[11] EN ISO 1452, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 5: Fitness for purpose of the system (ISO 1452-5)*

[12] EN ISO 6708:1995, *Pipework components — Definition and selection of DN (nominal size) (ISO 6708:1995)*

[13] EN ISO 9000, *Quality management systems — Fundamentals and vocabulary (ISO 9000:2005)*

[14] EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1)*

[15] ENV 1452-6, *Plastics piping systems for water supply — Unplasticized poly(vinyl chloride) (PVC-U) — Part 6: Guidance for installation*

[16] ENV 1452-7, *Plastics piping systems for water supply — Unplasticized poly(vinyl chloride) (PVC-U) — Part 7: Guidance for the assessment of conformity*

[17] Council Directive 98/83/EC [known as "Drinking Water Directive"]of 3 November 1998 on the quality of water intended for human consumption, Official Journal L 330,5.12 1998, p.32-54

[18] Council Directive 89/106/EEc [known as "Construction Product Directive"] of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member states relating to construction products , Official Journal L40, 11.2, 1989, p. 12-26

National Annex
(informative)

Additional information on the selection and use of joints of fittings for use in the construction of PVC-U and PE piping systems in the UK

NA.1 Introduction

The UK Technical Committee PSE/10 gives the following advice concerning the selection and use of fittings for PVC-U and PE piping systems.

NA.2 Fittings to be used in the construction of PE pipelines

Where fittings are used to make joints to PE pipe, the UK experience indicates that the minimum level of end load resistance should be Type 2 in accordance with WIS 4-24-01 [2]. This is to account for the forces generated from thermal contraction, hydrostatic pressure and contraction from this internal pressurization. The calculations to determine these forces are included in WIS IGN 4-01-02 [3] and tabulated in WIS 4-24-01 [2] as relevant test forces. Where external mechanical influences may develop in a PE pipeline in addition to those forces above, e.g. ground settlement, then UK experience indicates that Type 1 fittings should be considered for such applications and fittings should include internal pipe support sleeves.

NA.3 Design Life

BS EN 805 requires that water supply systems have a 50 year minimum design life.

NOTE It is the opinion of the UK Technical Committee PSE/10 that the tests contained in WIS 04-21-02 [1] and WIS 04-24-01 [2] for assessing long-term joint performance represent established UK practice.

NA.4 Restrained Joints

Where fittings are specified with end load restraint on PVC-U pipes, then their selection and use should be carefully considered on any types of PVC-U pipe that could be deemed as notch sensitive. Also, users should be aware that the use of a restrained joint in a single location may transfer axial loads along a length of pipe to the next unrestrained joint which may withdraw as a consequence.

NOTE Relevant standards that have product information on pipe materials are listed in the bibliography of EN 12842. The relevant information within these WIS standards and Guidance Notes is being amalgamated into BS 8561 which is to be published shortly.

Bibliography

[1] WRc. WIS 04-21-02 (Issue 1) Specification for mechanical couplings and repair clamps for iron pipes for the conveyance of cold potable water (underground use) for the size range 40 to 1600mm/1.5 to 48" inclusive

[2] WRc. WIS 04-24-01 (Issue 2) Specification for mechanical fittings and joints for polyethylene pipes for nominal sizes 90 to 1000

[3] WRc. WIS IGN 04-01-02 (Issue 2) The determination of end-loads for the performance testing of pipeline fittings

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