BS ISO 14531-3:2010

BSI Standards Publication

Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications

Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)

National foreword

This British Standard is the UK implementation of ISO 14531-3:2010. It supersedes BS ISO 14531-3:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/88/2, Plastics piping for pressure applications.

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

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

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Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications —

Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)

Tubes et raccords en matières plastiques — Systèmes de tubes en polyéthylène réticulé (PE-X) pour le transport de combustibles gazeux — Série métrique — Spécifications —

Partie 3: Raccords pour assemblage mécanique (y compris transitions PE-X/métal)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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

ISO 14531-3 was prepared by Technical Committee ISO/TC 138, *Plastic pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastic pipes and fittings for the supply of gaseous fuels*.

This second edition cancels and replaces the first edition (ISO 14531-3:2006), of which it constitutes a minor revision.

ISO 14531 consists of the following parts, under the general title *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications*:

— *Part 1: Pipes*

— *Part 2: Fittings for heat-fusion jointing*

— *Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)*

— *Part 4: System design and installation guidelines*

Introduction

Further to the publication of International Standards for crosslinked polyethylene (PE-X) hot-water pipes, it has become evident that the properties of PE-X, in particular its high fracture resistance and a recently established socket and saddle fusion-jointing capability, render it suitable for use in high-performance gas-distribution systems. The philosophy of ISO 14531 is to provide the basis for the introduction of PE-X gas pipe systems by the specification of a performance envelope beyond that covered by existing PE standards in order to take its application into regimes of higher operating pressures and extremes of operating temperature.

This part of ISO 14531 is therefore one part of a four-part system standard covering pipes, fittings for heat-fusion jointing, fittings for mechanical jointing and design and installation guidelines. The content is suitable for use by procurement authorities and distribution engineers responsible for the design, installation and operation of pipeline systems.

This part of ISO 14531 is structured to ensure the supply of mechanical fittings with an end-load resistance greater than that exhibited by the pipe(s) to which the fittings are connected.

INTERNATIONAL STANDARD **ISO 14531-3:2010(E)**

Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications —

Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)

1 Scope

This part of ISO 14531 specifies the physical properties and mechanical-performance requirements for full-end-load-resistant mechanical fittings for use in the connection of crosslinked polyethylene (PE-X) pipes conforming to ISO 14531-1 and in the construction of transition assemblies for joining PE-X pipes to metal pipes having plain spigot, screw thread, compression socket and flange terminations. In addition, it lays down dimensional requirements and specifies some general material properties (including chemical resistance) together with a classification scheme for PE-X fitting materials produced in the form of pipe.

This part of ISO 14531, when used in conjunction with the other parts of ISO 14531, provides the basis for the design, manufacture and installation of PE-X piping systems (PE-X pipes, PE-X fusion fittings and mechanical fittings) for the supply of category D and category E hydrocarbon-based fuels (see ISO 13623) at

a) maximum operating pressures (MOPs) up to and including 16 bar[1)] and

b) a maximum operating temperature of +60 °C and

c) a minimum operating temperature of

   1) −50 °C;

   2) −35 °C;

   3) −20 °C.

Conformity to this part of ISO 14531-3 of mechanical fittings produced in accordance with ISO 10838-1, ISO 10838-2 or ISO 10838-3 may be claimed subject to the satisfactory conclusion of the tests listed in 5.6 and an end-use restriction on operating temperatures to the temperature range −20 °C to +40 °C.

NOTE It is recognized that mechanical fittings conforming to ISO 10838-1, ISO 10838-2 or ISO 10838-3 are limited to a maximum operating temperature of 40 °C. Provision is made in ISO 14531-4 for the use on a restricted-temperature basis of ISO 10838 fittings conforming to 5.6 in conjunction with PE-X pipes conforming to ISO 14531-1. The fitting manufacturer's technical file should also be consulted for relevant supporting information.

For installation purposes, this part of ISO 14531 provides for the jointing of mechanical fittings to PE-X pipes within the temperature range −5 °C to +40 °C.

1) 1 bar = 10^5 N/m^2 = 100 kPa.

2 Normative references

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

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

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

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 1167-3, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components*

ISO 16010, *Elastomeric seals — Material requirements for seals used in pipes and fittings carrying gaseous fuels and hydrocarbon fluids*

ISO 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

ISO 3458, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of leakproofness under internal pressure*

ISO 4437, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*

ISO 8085-3:2001, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 3: Electrofusion fittings*

ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO 10838-1:2000, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 1: Metal fittings for pipes of nominal outside diameter less than or equal to 63 mm*

ISO 10838-2:2000, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 2: Metal fittings for pipes of nominal outside diameter greater than 63 mm*

ISO 10838-3:2001, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 3: Thermoplastics fittings for pipes of nominal outside diameter less than or equal to 63 mm*

ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient*

ISO 13623, *Petroleum and natural gas industries — Pipeline transportation systems*

ISO 13951, *Plastics piping systems — Test method for the resistance of polyolefin pipe/pipe or pipe/fitting assemblies to tensile loading*

ISO 13957, *Plastics pipes and fittings — Polyethylene (PE) tapping tees — Test method for impact resistance*

ISO 14531-1, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 1: Pipes*

ISO 14531-2, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 2: Fittings for heat-fusion jointing*

ISO 14531-4:2006, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 4: System design and installation guidelines*

ISO 16010, *Elastomeric seals — Material requirements for seals used in pipes and fittings carrying gaseous fuels and hydrocarbon fluids*

ISO 19899, *Plastics piping systems — Polyolefin pipes and mechanical fitting assemblies — Test method for the resistance to end load (AREL test)*

3 Terms and definitions

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

3.1
mechanical fitting
fitting within a pipeline system that relies, fully or in part, upon the mechanical loading of component parts to effect a pipeline seal that provides pressure integrity, leaktightness and resistance to end loads

3.2
end-load resistance
resistance to end load transmitted via the connecting pipe and generated by internal pressure, pipeline external interference and thermally induced pipe stresses in any combination

NOTE Full-end-load resistance is the condition in which the joint is stronger than the connecting pipe when exposed to all applied end loads.

3.3
design temperature
θ
temperature used to determine the minimum required strength $MRS_{\theta, t}$

NOTE See ISO 14531-4.

3.4
design pressure
DP_F
pressure upon which design calculations are based

NOTE 1 See ISO 14531-4.

NOTE 2 For fittings, the design pressure is designated DP_F, whereas for pipes it is designated DP_P.

4 Materials

4.1 General

The materials from which the fitting components are manufactured shall have properties consistent with the production of a mechanical fitting with a pressure and end-load resistance equal to or better than that of the connecting PE-X pipes over the intended design life.

Materials (e.g. plastics, rubbers and metals) utilized in the manufacture of fittings conforming to this International Standard shall be supplied in accordance with a relevant ISO standard. For rubber ring seals, the applicable standard shall be ISO 16010; for PE and PE-X materials the standard shall be ISO 14531-2.

Alternative standards may be utilized in cases where suitable ISO standards do not exist. In such cases, fitness for purpose shall be established.

All metal parts susceptible to corrosion shall be adequately protected. When dissimilar metallic materials are used which may be in contact with moisture, steps shall be taken to avoid the possibility of galvanic corrosion.

The manufacturer of the fittings shall maintain the availability of a technical file (generally confidential) with all relevant data to prove the conformity of fittings to this part of ISO 14531. Any change in the materials used that is likely to affect product quality and performance shall require a re-assessment of material performance against the requirements of this part of ISO 14531.

4.2 Strength

The susceptibility of materials to crack failure in locations of high stress concentration, e.g. at threads, shall be examined. Materials shown to be vulnerable to brittle fracture throughout the specified operating temperature range(s) as given in Clause 1 shall be discarded as failing to conform to this part of ISO 14531.

Thermoplastic materials (reinforced and un-reinforced) incorporated in fitting components subjected to long-term, time-dependent tensile stresses shall be evaluated in the form of pipe in accordance with ISO 9080, and the MRS determined for classification in accordance with ISO 12162. Materials that are shown by the test to be likely to exhibit premature failure at the intended maximum operating temperature within the fitting design life shall be rejected as unsuitable for use.

Unclassified materials may be introduced provided fitting assemblies containing such unclassified material elements are subjected to long-term hydrostatic-strength tests to demonstrate that the MRS of the connecting PE-X pipe(s) is not impaired in such cases.

4.3 Chemical resistance

The selection of component materials shall take into account the effect of gas stream chemicals associated with the transport of category D and category E gaseous fuels, as classified by ISO 13623, on the material properties of components contained within the fitting assembly.

The demonstration of adequate chemical resistance shall be made by subjecting a joint assembly to the test listed in Table 1 and by the provision for consideration by the pipeline operator of relevant environmental stress cracking failure data from tests using chemical compounds encountered in, or external to, gas piping systems.

NOTE Materials should have a demonstrated resistance to environmental stress cracking when exposed, under stress, to chemical compounds encountered in, or external to, gas piping systems since liquids such as antifreeze agents, odorants and hydrocarbons are known to have a deleterious effect on some plastics, particularly under service conditions.

Table 1 — Chemical resistance

Characteristic	Units	Requirement	Test parameters	Test method
Resistance to gas constituents	h	No failure when tested to 1 000 h	Temperature: 80 °C Pipe hoop stress: 2 MPa	ISO 1167-1 Test piece in accordance with ISO 1167-2 Type A end caps Annex A

4.4 Lubricants

Lubricants and/or greases may be used to assist in joint assembly or for corrosion protection subject to the following measures being taken:

a) The fitting manufacturer shall provide evidence that the lubricant and/or grease does not have a deleterious effect on the performance of the component parts of the fitting likely to be in contact with the connecting PE-X pipe.

b) The fitting assemblies used for testing conformity with the requirements of this part of ISO 14531 shall have the lubrication in place.

c) Surfaces intended for fusion jointing shall be free of lubrication.

4.5 Reprocessable (re-work) material

PE-X shall not be reprocessed and used in the manufacture of fittings intended to conform to this part of ISO 14531.

Non-crosslinked base material for PE-X components, produced in the course of manufacturing fittings conforming to this part of ISO 14531, may be reprocessed if derived from the same non-crosslinked material grade already employed in the relevant production. Products containing reprocessed material shall conform to the requirements of this part of ISO 14531.

The extent of any use of reprocessable PE 80 and PE 100 material shall be in accordance with ISO 4437 and ISO 8085 (see e.g. ISO 8085-3:2001, Subclause 5.3).

The manufacture of components from other thermoplastic materials shall utilize virgin material compounds unless an acceptable manufacturing history is available that demonstrates a capability of manufacturing components produced from reprocessable materials.

For metallic materials, refer to relevant ISO standards.

5 Fittings

5.1 Design

Mechanical fittings, including any integral heat-fusion joints, shall be designed for the connection of PE-X pipes conforming to ISO 14531-1 to create full-end-load, pressure-resistant pipe/fitting assemblies conforming to the requirements of this part of ISO 14531. Transition assemblies connecting PE-X pipes to metal pipes (e.g. steel or iron) shall also meet the requirements of this part of ISO 14531.

Terminating and integral heat-fusion joints made of PE or PE-X materials shall conform to ISO 14531-2.

The effect of pipe outside diameter and wall thickness tolerances specified in ISO 14531-1 shall be taken into account.

The provision of end-load resistance shall not rely on the influence of internal pressure.

The fitting design pressure DP_F at a design temperature θ of 20 °C shall be declared by the fitting manufacturer in accordance with Table 2 and recorded in the manufacturer's technical file. The declaration of design pressure shall take into account stress concentration effects generated by the fitting and joint assembly geometries and shall be supported by the provision of appropriate experimental data (see 5.5) or design calculations. The effect on the design pressure at 20 °C of variations in operating temperature from 0 °C to +60 °C shall be established and recorded in the technical file.

NOTE The pipeline operator is required by ISO 14531-4 to ensure that MOP $\leqslant$ DP_F.

Table 2 — Fitting design pressure DP_F ($\theta = 20$ °C)

Fitting type	DP_F bar
Type 1	2,0
Type 2	5,0
Type 3	10,0
Type 4	16,0

The fitting shall be designed to be leaktight throughout the pressure range extending from 25 mbar up to $1{,}5DP_F$ (see Table 3) and the temperature range(s) defined in Clause 1, in any combination.

Fitting design shall take into account the expectation on site of a minimum pipe/fitting component temperature of −5 °C and a maximum of +40 °C prior to joint construction. Preheating of components which are at temperatures less than −5 °C is permissible and, if applicable, both the equipment for this, and guidance on its use, shall be supplied by the fitting manufacturer.

Internal stiffeners incorporated in the design of the fitting shall comply with the following:

a) They shall be rigid with a continuous circular geometry in the *in situ* state and shall provide support over the entire area of pipe compression.

NOTE Stiffeners with convolutions should be assessed for pipe support on the basis of projected area.

b) They shall contain a means of readily indicating their location at their design position within the pipe and shall not be susceptible to longitudinal displacement after assembly.

c) Only one type of stiffener shall be used for each pipe diameter and pipe standard dimension ratio (SDR).

NOTE This is necessary to prevent several stiffeners being supplied for each pipe size in order to accommodate variations in connecting-pipe tolerances. In this way, the possibility of selecting an incorrect stiffener is avoided.

The fitting shall be capable of field assembly. Special mechanical assembly tools, if required, shall be supplied by the manufacturer. Assembly tooling shall be designed to avoid causing any visible deformation or weakening of the components being joined which could have an adverse effect on the performance of the joint assembly.

Transition fittings intended for connection to steel pipe by welding shall be designed to facilitate the conduct of the welding operation without detriment to the overall performance of the jointed assembly.

The design of fittings shall take into account the possible use above ground as well as below ground. Factors to consider shall include the effect of natural weathering and external corrosion.

Bore geometry arrangements shall ensure that the pressure drop across the fitting is kept to a minimum and that provision is made in the design of straight couplings greater than 125 mm diameter for the unrestricted passage of pipe pigging tools.

Joint assembly forces shall not induce twisting deformation of the connecting PE-X pipe(s).

Threading on metal terminations shall conform to ISO 7-1.

5.2 Appearance

When viewed without magnification, fitting components shall not show any signs of surface defects or inclusions that would prevent conformity of the fitting with this part of ISO 14531.

5.3 Dimensions

Fitting components shall be manufactured with dimensions and tolerances selected to ensure that the performance of the mechanical-fitting assembly incorporating PE-X pipes to ISO 14531-1 conforms to this part of ISO 14531, including leak-free operation at the design pressure throughout the pipeline service life.

The minimum internal bore diameter d_i shall be stated by the manufacturer in his technical file.

5.4 Mechanical performance

Mechanical fittings shall be assembled with PE-X pipes in accordance with the fitting manufacturer's instructions.

Test piece arrangements shall also reflect the possible connection of fittings to PE-X pipes produced by different process methods e.g. PE-Xa, PE-Xb (see ISO 14531-1).

When evaluated in accordance with the test methods specified in Table 3, using the parameters indicated, the jointed pipe/fitting test piece shall conform to the requirements given in Table 3.

Jointed pipe/fitting test pieces shall be based upon the thinnest-walled and thickest-walled pipe for which the fitting was designed (largest and smallest SDR).

A declaration regarding the suitability of use with PE-X pipes, and any limiting conditions associated with such use, shall be included in the fitting manufacturer's technical file.

Test pieces subjected to hydrostatic-strength testing shall be tested using an internal pressure determined by the following equation:

$$p = \frac{20\sigma}{\frac{d_{e,min}}{e_{y,min}} - 1}$$

where

p is the internal test pressure, in bars;

σ is the value of the hydrostatic stress, in megapascals, corresponding to the test duration and test temperature conditions given in Table 3;

$d_{e,min}$ is the minimum value of the mean outside diameter specified for a given nominal diameter d_n of the adjoining pipe(s) (see ISO 14531-1);

$e_{y,min}$ is the minimum permissible value of the wall thickness e_y at any point around the circumference of the adjoining pipe(s) (see ISO 14531-1).

NOTE The control points for hydrostatic strength specified in Table 3 were derived using experimental data supplemented by theoretical calculations. As experience is gained in the implementation of this part of ISO 14531, the specification levels may be reviewed.

5.5 Validation of fitting design and design pressure DP_F

5.5.1 General

The fitting manufacturer shall declare a fitting design pressure that shall be validated by the conduct of a series of time-dependent pressure tests or by the results of a design/stress analysis of the fitting assembly. The pressure tests referred to in 5.5.2 and 5.5.3 are structured to focus on the determination of the strength of the fitting by minimizing the possibility of pipe failure.

5.5.2 Plastic-bodied fittings

The fitting design pressure DP_F at 20 °C shall be validated by the conduct of internal pressure tests on pipe/fitting assemblies (see Annex D).

5.5.3 Metal-bodied fittings

The fitting design pressure DP_F shall be validated by the conduct of internal pressure tests at 20 °C on pipe/fitting assemblies (see Annex E).

Table 3 — Mechanical characteristics of jointed PE-X pipe/mechanical fitting assemblies

Characteristic	Units	Requirement	Test parameters	Test method
Hydrostatic strength	h	No failure when tested to 1 000 h [a]	Temperature: 20 °C Pipe hoop stress: PE-X80 8,3 MPa PE-X100 10,4 MPa PE-X125 13,0 MPa	ISO 1167-1 Test piece in accordance with ISO 1167-3
		No failure when tested to 165 h	Temperature: 95 °C Pipe hoop stress: PE-X80 3,8 MPa PE-X100 4,8 MPa PE-X125 6,0 MPa	
		No failure when tested to 1 000 h	Temperature: 95 °C Pipe hoop stress: PE-X80 3,7 MPa PE-X100 4,7 MPa PE-X125 5,9 MPa	
Resistance to impact		No leakage	Temperature: −50 °C [b] Drop height: 2 m Mass of striker: 2,5 kg	Annex B ISO 13957 saddle fitting [c]
Tensile strength (constant-strain thermal cycling)		No failure in fitting or joint	Temperature: +60 °C/−50 °C [b, d] No. of cycles = 50	Annex C
Leaktightness		No leakage	Temperatures: −50 °C [b], +60 °C [d] Pressure: 25 mbar and 1,5DP_F (6 bar min.) Time: 24 h	ISO 3458 with air or inert gas and ISO 1167-1 type A end caps
Tensile strength at 23 °C		No leakage or pull-out of pipe from fitting	Temperature: (23 ± 2) °C	ISO 13951
Tensile strength at 80 °C (AREL test)		No leakage or pull-out of pipe from fitting	Temperature: (80 ± 1) °C	ISO 19899
Pressure drop/flow rate [c]	m^3/h	As measured air flow rate	Pressure drop: 0,1 mbar (> 63 mm) 0,5 mbar (⩽ 63 mm)	ISO 10838-1

[a] Tests may be conducted for 100 h at 20 °C using an appropriate stress level established by correlation with 1 000 h data. In cases of dispute, the test time shall be 1 000 h.

[b] Alternative test temperatures of −20 °C or −35 °C may be used to qualify material for minimum operating temperatures greater than −50 °C (see Clause 1). The minimum operating temperature shall be given in the fitting manufacturer's technical file.

[c] Tapping tee requirement only.

[d] Fittings conforming to ISO 10838-1, ISO 10838-2 or ISO 10838-3 shall be tested at a maximum temperature of 40 °C.

5.6 Performance requirements for fittings in conformity with ISO 10838

Mechanical fittings that conform to ISO 10838-1, ISO 10838-2 or ISO 10838-3 shall be deemed to be suitable for use with PE-X pipes conforming to ISO 14531-1 in the temperature range from −20 °C to +40 °C when the following tests are satisfactorily concluded:

a) Resistance to impact described in Table 3, conducted at a temperature of −20 °C (plastic-bodied fittings).

b) Constant-strain thermal cycling (see Table 3) between +40 °C and −20 °C in accordance with Annex C.

c) Leaktightness tests (see Table 3) at −20 °C and +40 °C.

d) Validation of the fitting design pressure DP_F (see 5.1 and 5.5).

6 Elastomeric seals

The material of elastomeric sealing rings incorporated in the design of fitting and joint assemblies shall conform to ISO 16010. Compression-set requirements specified in ISO 16010 at a temperature of −15 °C shall also be applicable at the sub-zero temperatures given in Clause 1, item c).

The sealing ring and any associated lubricant shall have no detrimental effect on the properties of the connecting pipe or fitting. The effect of lubricants shall be established in accordance with 5.1 of ISO 10838-1:2000, ISO 10838-2:2000 or ISO 10838-3:2001, as applicable.

The leaktightness of sealing rings as installed within the fitting and pipe assembly shall not be impaired by variations in operating temperature throughout the ranges specified in Clause 1.

7 Marking

7.1 Legibility

Marking details shall be legible without magnification.

Legibility shall be maintained during storage, handling and use in accordance with ISO 14531-4.

7.2 Damage

Marking shall not initiate cracks or other types of failure in the fitting.

Marking shall not be applied to surfaces intended for fusion jointing.

7.3 Minimum marking requirements

The marking on PE-X fittings shall include the minimum information given in Table 4.

Table 4 — Minimum required marking

Item	Marking
Reference to this part of ISO 14531[a]	ISO 14531-3
Manufacturer or trademark[b]	Name or symbol
Fluid to be conveyed[a]	Gas
Nominal diameter(s) d_n of pipe(s) to which the fitting is intended to be joined	e.g. 125
Material classification of pipe(s) to which connection is permissible, including reference to pipe manufacturer[c]	e.g. PE-Xa 100/Manufacturer XXX
SDR of pipe(s) to which connection is permissible[a]	SDR (e.g. SDR 11 and/or SDR 17,6) or SDR range 11/26
Manufacturing information[b]	The production period (year and month in figures or in code) The name of or code for production site if manufacturer produces at different sites, nationally or internationally
Fitting type and design pressure DP_F[c]	e.g. type 1 (2 bar)
Operating temperature range, in degrees Celsius[c]	e.g. −50/+60

[a] This information may be printed on a label associated with the fitting or on a bag containing an individual fitting.

[b] To provide traceability.

[c] This information shall be included in manufacturer's technical file.

7.4 Labels

The following marking information shall be provided either on the fitting or on attached labels:

a) the grade of the pipes with which the fitting may be connected (grade A or B, as appropriate);

b) assembly requirements, e.g. tightening torque;

c) the designation of the shell thermoplastic material, if appropriate.

Annex A
(normative)

Resistance to gas constituents

A.1 Test piece

The following test shall be carried out on a 32 mm pipe/fitting assembly.

A.2 Procedure

Prepare a synthetic condensate comprising a mixture of 50 % (by mass) *n*-decane (99 % pure) and 50 % (by mass) 1,3,5-trimethylbenzene.

Condition the test piece by filling it with condensate and allowing it to stand in air for 1 500 h at (23 ± 2) °C. Immediately after the conditioning period, carry out the test specified in ISO 1167-1, using a test piece in accordance with ISO 1167-3, with the synthetic condensate inside the pipe and water outside, using the test parameters specified in Table 1.

A conditioning period of 24 h at 80 °C may be employed as an alternative but, in cases of dispute, the 1 500 h at 23 °C conditions shall apply.

Care shall be taken in handling the chemicals used in the test as well as to avoid contamination of equipment normally used for conventional testing with water.

A.3 Test report

The test report shall include the following information:

a) a reference to this part of ISO 14531, i.e. ISO 14531-3;

b) complete identification of the fitting, including manufacturer, nominal outside diameter d_n, type of material (e.g. PE-Xa) and production date;

c) the mean outside diameter of the pipe d_e;

d) the minimum wall thickness of the pipe e_y;

e) the conditioning parameters, including an analysis of the condensate;

f) the test pressure;

g) the duration of the test;

h) details of the location and mode of any failure;

i) any factors which may have affected the results, such as any incidents or any operating details not specified in this part of ISO 14531;

j) the date of the test.

Annex B
(normative)

Method of test of the integrity of a fitting after an external blow

B.1 Scope

This annex specifies a method for determining the integrity of a fitting following an externally applied impact force.

B.2 Principle

A pipe/mechanical-fitting assembly clamped to a horizontal base plate is struck once, under specific conditions, by a weight falling onto its most critical position, i.e. the position on the fitting assembly where damage is most likely to impair its performance. The assembly is then tested for any effects of the impact force upon leaktightness.

B.3 Apparatus

B.3.1 Clamping fixture, with a means of clamping to a rigid base the test assembly at each outlet pipe close to the pipe-to-fitting joint.

B.3.2 Falling-weight test machine, conforming to ISO 3127 and incorporating a type d25 striker.

B.3.3 Temperature-conditioning apparatus, capable of maintaining the test piece at a temperature within ± 1,5 °C of the value specified in Table 3.

B.4 Test piece

The test piece shall comprise an assembly of pipe(s) and fitting(s) in the as-manufactured condition. Mechanical joints shall be constructed at an ambient temperature of (23 ± 3) °C.

B.5 Procedure

a) Mount the assembly in the clamping fixture so that, when it is tested as described in c), the striker will impact upon the position on the assembly where damage is most likely to impair its performance.

   Set the falling-weight test machine so that the height of fall of the striker to the point of contact with the assembly is as specified in Table 3.

b) Place the clamped assembly in the temperature-conditioning apparatus and condition it at the temperature specified in Table 3 for a time at least as long as that specified in ISO 1167-1 for the appropriate fitting wall thickness. Any conditioning fluids used shall not affect the properties of the test piece.

c) Remove the assembly from the temperature-controlled environment. Position it in the test machine and release the falling weight so the striker falls onto the applicable point on the test assembly. The assembly shall be impacted within the following time interval after its removal from the conditioning environment:

   1) 30 s for $d_n \leqslant 110$ mm;

2) 90 s for $110 < d_n \leqslant 200$ mm;

3) 180 s for $d_n > 200$ mm.

d) Inspect the test piece visually for and record the details of the position and appearance of any evidence of cracking after impact.

e) Immediately implement the following consecutive procedures, avoiding delays between each step:

1) condition the test piece for 24 h at (23 ± 3) °C;

2) conduct a leaktightness test in accordance with ISO 3458 at a test pressure of 25 mbar;

3) conduct a second leaktightness test at 1,5 times the design pressure DP_F.

Use air or inert gas as the test medium for fittings intended for gas applications up to a leak test pressure of 6 bar if required by national safety regulations. The test medium for pressures greater than 6 bar shall be water.

At the end of each stage of the leaktightness test, inspect the test piece before depressurizing and record the position of any leakage. National safety regulations shall be taken into account during inspection for leakage.

NOTE Attention is drawn to the need to contain the possible effects of failure of components subjected to impact testing or destructive testing.

B.6 Test report

The test report shall include the following information:

a) a reference to this part of ISO 14531, i.e. ISO 14531-3;

b) full identification of the product, including manufacturer, type and size of fitting, and production date;

c) the test temperature;

d) a description of any visible evidence of cracking and/or leakage after impact;

e) any factors which may have affected the results, such as any incidents or operating details not specified in this part of ISO 14531;

f) the date of the test.

Annex C
(normative)

Constant-strain thermal-cycling test

C.1 Scope

This annex specifies a method for determining the strength and leaktightness of a mechanically jointed fitting/pipe assembly when subjected to forces generated by a combination of thermal cycling and constant-strain loading conditions.

C.2 Principle

A mechanically jointed fitting/pipe assembly initially conditioned at 60 °C, and with test piece end caps fully constrained against movement due to thermal contraction, is subjected to 50 thermal cycles between +60 °C and −30 °C, −15 °C or −1 °C. Leaktightness is then verified at a temperature of (20 ± 3) °C.

NOTE The test is designed to assess by accelerated testing the effect on joint performance of annual fluctuations in operating temperature over the design life of the system (e.g. 50 years). The envisaged variations in operating temperature are as referenced in Clause 1 but the minimum equivalent test temperatures of −30 °C (−50 °C), −15 °C (−35 °C) and −1 °C (−20 °C) are selected to take account of the effect of a more rapid cycling of temperature on the thermal stresses generated in the test assembly.

C.3 Apparatus

C.3.1 End caps, of type A construction as specified in ISO 1167-1. They shall be fully resistant to all end thrusts generated under the specified test conditions. They shall provide full restraint against movement induced by test piece contraction in the course of temperature cycling.

C.3.2 Temperature-conditioning chambers (two): Environmental chambers each capable of controlling the operating temperature at the specified values (60 °C and −30 °C, −15 °C or −1 °C) to within a mean of −1 °C to +3 °C with a maximum deviation of −2 °C to +4 °C.

C.4 Test piece

The test piece shall comprise a mechanically jointed assembly of pipe(s) and fitting(s) in the as-manufactured condition, suitably end-capped for connection to a source of pneumatic pressure. The free lengths of pipe between fittings and end caps shall be at least three times the nominal pipe outside diameter, with a minimum of 250 mm and a maximum of 1 000 mm.

C.5 Procedure

Construct the test piece at an ambient temperature of (20 ± 3) °C, using the assembly conditions specified by the fitting manufacturer.

Carry out an assessment of test piece integrity in accordance with ISO 3458 at an ambient temperature of (20 ± 3) °C, using a hydrostatic pressure of 6,0 bar.

Depressurize and fully drain the water from the test piece, place the test piece in the high-temperature chamber and condition it for a period of 3 h at 60 °C. Fit the interconnecting end-cap-restraining system.

NOTE It is strongly recommended that a protective screen or equivalent be placed in position at this stage for protection of the personnel carrying out the test.

Carry out the following temperature-cycling procedure:

a) Transfer the test piece to the low-temperature chamber and condition it for 10 h at −30 °C, −15 °C or −1 °C, as appropriate. The minimum transfer time is 1,0 h and the maximum 2,0 h.

b) Return the test piece to the high-temperature chamber and condition it for 10 h at 60 °C. The minimum transfer time is 1,0 h and the maximum 2,0 h.

c) Repeatedly cycle the test piece as specified in Table 3.

d) Following completion of temperature cycling, subject the test piece to a leaktightness test in accordance with ISO 3458 at an ambient temperature of (20 ± 3) °C, using a pneumatic pressure of 6 bar.

C.6 Test report

The test report shall include the following information:

a) a reference to this part of ISO 14531, i.e. ISO 14531-3;

b) full identification of the product, including manufacturer, type and size of fitting(s) and production date;

c) the number of test pieces tested;

d) the maximum and minimum test temperatures;

e) the number of test cycles completed;

f) a description of any visible evidence of failure;

g) any factors which may have affected the results, such as any incidents or any operating details not specified in this part of ISO 14531;

h) the date of the test.

Annex D
(informative)

Validation of fitting design pressure DP_F at 20 °C (plastic bodied fittings)

D.1 Scope

This annex specifies a method for the validation of the fitting design pressure DP_F declared by the fitting manufacturer and recorded in his technical file. The method relates to the conduct of long-term internal-pressure tests at 20 °C on test piece assemblies of pipes and fittings in which the free length(s) of pipe have been restricted to minimize the possibility of pipe failure in order to focus upon the failure characteristics of the fitting.

D.2 Principle

The method embraces two distinct features. The first is the generation and use of short-term fitting/joint failure data in conjunction with a theoretical (50 year) resistance to internal pressure requirement based on DP_F to establish a limit-line characteristic that defines the test times for further long-term pre-determined fixed-duration assembly tests. The second is the selection and application of a test pressure corresponding to a test time of 1 000 h on the basis of the limit-line characteristic. The satisfactory completion of the 1 000 h test period without premature failure of the test piece validates the declared DP_F. The conduct of the test is described schematically in Figure D.1.

D.3 Test piece

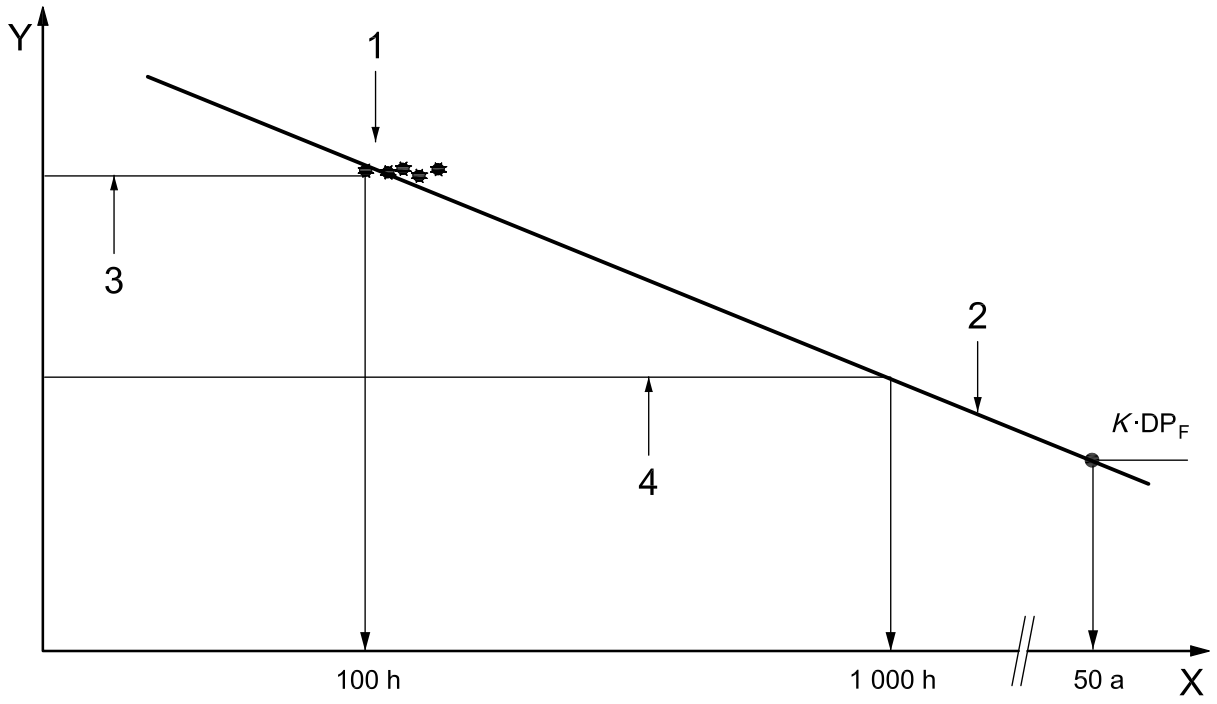
The test piece shall comprise an assembly, constructed in accordance with ISO 1167-3, of pipes and fittings with full-end-load-bearing end caps for testing in accordance with ISO 1167-1. The free length of pipe between fittings and end caps shall not exceed d_e.

D.4 Procedure

Following ISO 1167-1, subject the pipe/fitting test piece assembly to an internal pressure greater than $1{,}05 \times K \times DP_F$ to produce at least five fitting/joint failures in times greater than 100 h. Plot the failure data as log time vs log pressure and determine the average failure time and the corresponding standard deviation for the test data. The “no failure” limit line is then formed by a straight line drawn through a first point with the coordinates $1{,}05 \times K \times DP_F$ and the average failure time less two standard deviations and a second point with the coordinates $K \times DP_F$ and 50 years, as shown in Figure D.1.

NOTE The value of $K \times DP_F$ may be varied provided the value is stated in the manufacturer's technical file, to permit comparison with the C-factor specified by the pipeline operator (see 4.1.5.4 in ISO 14531-4:2006).

Using the limit line, select and apply the test pressure corresponding to a test period of 1 000 h. The DP_F shall be considered validated upon completion of the 1 000 h test without failure of the test piece assembly.



Key

X log (time t)

Y log (test pressure p_t)

1 fitting/joint failure points (minimum five)

2 limit line for “no failure” assembly tests

3 test pressure $\geqslant 1{,}05 \times K \times DP_F$ to give failure periods of at least 100 h

4 test pressure to give limit-line test time of 1 000 h

Figure D.1 — Schematic diagram of DP_F validation test procedure

D.5 Test report

The test report shall include the following information:

a) a reference to this part of ISO 14531, i.e. ISO 14531-3;

b) full identification of the product, including manufacturer, type and size of fitting(s) and production date;

c) the number of test pieces tested;

d) the test pressure;

e) the duration of the test;

f) the DP_F multiple at 50 years;

g) a description of any visible evidence of failure;

h) any factors which may have affected the results, such as any incidents or any operating details not specified in this part of ISO 14531;

i) the date of the test.

Annex E
(normative)

Validation of fitting design pressure DP_F at 20 °C (metal bodied fittings)

E.1 Scope

This annex specifies a method for the validation of the fitting design pressure DP_F declared by the fitting manufacturer and recorded in the technical file. The method relates to the conduct of short-term internal-pressure tests at 20 °C on test piece assemblies of pipes and fittings.

E.2 Principle

A test piece, constructed in accordance with ISO 1167-3 and consisting of a metal-bodied fitting assembled with PE-X pipe(s) of reduced free length capable of withstanding a pressure which is high compared to that generated in the method specified in ISO 1167-1, is placed in a controlled-temperature environment and subjected to an essentially continuously increasing internal hydraulic pressure until failure of the test piece occurs. The method is designed to establish the short-term failure pressure of the fitting/joint assembly. The DP_F shall be considered validated if the failure pressure is equal to or greater than $K \times DP_F$.

NOTE The value of $K \times DP_F$ may be varied provided the value is stated in the manufacturer's technical file, to permit comparison with the C-factor specified by the pipeline operator (see 4.1.5.4 in ISO 14531-4:2006).

E.3 Apparatus

E.3.1 Constant-temperature water bath, conforming to the requirements of ISO 1167-1, that is capable of being kept within the temperature range (20 ± 2) °C.

E.3.2 Pressure test equipment, conforming to the requirements of ISO 1167-1, that is also capable of applying a continuously increasing internal hydraulic pressure at a ramp rate of (5 ± 1) bar/min until failure of the test piece occurs.

E.3.3 Pressure gauge, with an accuracy of better than 1 % of full-scale deflection and with a maximum-pressure indicating hand. The gauge shall be selected so that the pressure reading at failure is approximately at the middle of the gauge scale. The gauge should preferably be equipped with a surge protection device.

The gauge shall be located at a position within the pressure system that indicates the internal pressure of the test piece without being affected by pressure transients within the pressure supply lines, etc.

E.4 Test piece

The test piece shall be an assembly of mechanical fitting(s) connected to PE-X pipes with a free length between fittings of any type of $2d_e$. It shall be constructed in accordance with ISO 1167-3.

The pipe used shall be the thickest-walled pipe for which the fitting has been designed.

The test piece shall be closed with type A end caps as described in ISO 1167-1.

E.5 Procedure

E.5.1 Conditioning

The test piece shall be conditioned at (20 ± 2) °C for at least as long as the period specified in ISO 1167-1 for the appropriate pipe wall thickness.

E.5.2 Pressurization

Attach the end caps to the test piece and fill it with water at ambient temperature.

Connect the test piece to the pressure source, ensuring that the test piece is not pressurized and that air is not entrapped within the test assembly.

Immerse the test piece in the constant-temperature bath and condition it in accordance with E.5.1.

Pressurize the test piece by increasing the pressure uniformly at a rate of 5 bar/min until failure of the test piece occurs.

Record the pressure reading at failure.

On completion of the test, inspect the test piece and record the position and mode of failure.

E.6 Test report

The test report shall include the following information:

a) a reference to this part of ISO 14531, i.e. ISO 14531-3;

b) full identification of the pipes and fittings used, including manufacturer, material, type and size of fitting and pipe and production date;

c) particulars of the jointing procedure used to construct the test piece;

d) the pressure at failure;

e) the time to failure;

f) the failure position;

g) the type of failure, e.g ductile in fitting, brittle along fusion interface;

h) any factors which may have affected the results, such as any incidents or any operating details not specified in this part of ISO 14531;

i) the date of the test.

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