BS ISO 4427-5:2019

BSI Standards Publication

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE)

Part 5: Fitness for purpose of the system

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National foreword

This British Standard is the UK implementation of ISO 4427-5:2019.

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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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INTERNATIONAL STANDARD

ISO 4427-5

Second edition
2019-08

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) —

Part 5: Fitness for purpose of the system

Systèmes de canalisations en plastique destinés à l'alimentation en eau et aux branchements et collecteurs d'assainissement sous pression — Polyéthylène (PE) —

Partie 5: Aptitude à l'emploi du système

Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fitting and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

This second edition cancels and replaces the first edition (ISO 4427-5:2007), which has been technically revised.

The main changes compared to the previous edition are:

— Update of the normative references;

— Technical consistency with ISO 4437-5 (see Reference [1] in the Bibliography).

A list of all parts in the ISO 4427 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 4427 series of standards are a set of system standards that specify the requirements for a piping system and its components when made from polyethylene (PE). The piping system is intended to be used in buried or above ground applications, for the conveyance of water for human consumption, raw water prior to treatment, drainage and sewerage under pressure, vacuum sewer systems, and water for other purposes.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by the ISO 4427 series, it does not provide information on the restriction on the use of products.

NOTE Guidance for assessment of conformity can be found in Reference [2] in the Bibliography .

INTERNATIONAL STANDARD ISO 4427-5:2019(E)

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) —

Part 5: Fitness for purpose of the system

1 Scope

This document specifies the characteristics of the fitness for purpose of pipes and/or fittings assemblies made from polyethylene (PE) for buried or above ground applications, intended for the conveyance of water for human consumption, raw water prior to treatment, drainage and sewerage under pressure, vacuum sewer systems, and water for other purposes.

NOTE 1 The intended uses include sea outfalls, laid in water and pipes suspended below bridges.

NOTE 2 This document is intended to be only used by the product manufacturer to assess the performance of components according to ISO 4427-2 and/or ISO 4427-3 when joined together under normal and extreme conditions. It is not intended for on-site testing of pipe systems.

This document also specifies the test parameters for the test methods referred to in this document.

In conjunction with the other parts of the ISO 4427 series, this document is applicable to PE pipes, fittings, their joints and to joints with components of PE and other materials, intended to be used under the following conditions:

a) a maximum allowable operating pressure (PFA) up to and including 25 bar[1)];

b) an operating temperature of 20 °C as the reference temperature.

NOTE 3 For other operating temperatures, guidance is given in ISO 4427-1: 2019, Annex A.

The ISO 4427 series covers a range of maximum allowable operating pressures and gives requirements concerning colours.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 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 1167-2, *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 1167-4, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies*

ISO 4427-1:2019, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part1: General*

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

ISO 4427-2:2019, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 2: Pipes*

ISO 4427-3:2019, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 3: Fittings*

ISO 11413:2019, *Plastics pipes and fittings — Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting*

ISO 11414:2009, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion*

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 13955, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

ISO 13956, *Plastics pipes and fittings — Decohesion test of polyethylene (PE) saddle fusion joints — Evaluation of ductility of fusion joint interface by tear test*

ISO 17885, *Plastics piping systems — Mechanical fittings for pressure piping systems — Specifications*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 4427-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Fitness for purpose of pipes and/or fittings assemblies

4.1 Method of preparation of assemblies for testing

4.1.1 General

The assemblies shall be made by using pipes conforming to ISO 4427-2 and fittings conforming to ISO 4427-3.

Test pieces for pressure testing shall be closed with pressure-tight, end-load-bearing end caps, plugs, or flanges which shall be provided with connections for the entry of water and release of air.

The peelable layer of peelable-layer pipe shall be removed in the area of the joint prior to jointing.

If failures that call for a redesign of the fitting are detected during testing according to this document, retesting according to ISO 4427-3 automatically becomes necessary.

4.1.2 Grouping

For testing purposes, the size groups for pipes and fittings shall be in accordance with Table 1.

Table 1 — Size groups for pipes and fittings

Size group	1	2	3	4	5
Nominal outside diameter, d_n	≥16 and <75	≥75 and <250	≥250 and <710	≥710 and <1 800	≥1 800

One diameter from each size group (see Table 1) per product type (see 4.1.3.) shall be taken as test pieces.

4.1.3 Fitting types

For testing purposes, assemblies shall be classified as follows:

— (A) electrofusion socket joints;

— (B) electrofusion saddle joints;

— (C) butt fusion joints;

— (D) mechanical joints;

— (E) socket fusion joint.

4.1.4 Electrofusion joints (A and B)

PE pipes and fittings intended to be used for jointing by electrofusion shall be prepared and assembled in accordance with ISO 11413. The conditions for the preparation of the joints are given in 4.2.2.1 for the assessment of fitness for purpose of the system under normal conditions and in 4.2.2.2 for the assessment of fitness for purpose of the system under extreme conditions.

For joints with electrofusion saddle fittings, the electrofusion saddle fitting shall be fused to the pipe while it is pressurized to the allowable maximum operating pressure. The pipe shall be cut immediately after the manufacturer's prescribed cooling time has elapsed.

For straight equal electrofusion socket fittings (couplers), test joints on selected diameters out of the product range shall be prepared with a gap of 0,05 d_n between the pipe end and the maximum theoretical depth of penetration of the fitting, where for diameters greater than 225 mm, the adjoining pipes shall be arranged to provide the maximum angular deflection possible for the fitting, limited to 1,5°.

4.1.5 Butt fusion joints (C)

PE pipes and spigot end fittings intended to be used for jointing by butt fusion shall be prepared and assembled in accordance with ISO 11414. The conditions for the preparation of the joints are given in 4.2.3.1 for the assessment of fitness for purpose of the system under normal conditions and in 4.2.3.2 for the assessment of fitness for purpose of the system under extreme conditions.

4.1.6 Mechanical joints (D)

For mechanical joints, the assembly of the PE pipe and the fitting shall be prepared in accordance with ISO 17885.

4.1.7 Socket fusion joints (E)

Socket fusion joints shall be prepared as recommended by the manufacturer.

4.2 Requirements for fitness for purpose of the assemblies

4.2.1 General

When tested in accordance with the test methods in Table 6 using the indicated parameters, joints prepared in accordance with 4.1 shall have mechanical characteristics conforming to the requirements given in Table 6, as applicable.

4.2.2 Fitness for purpose of the electrofusion assemblies (A and B)

4.2.2.1 Under normal conditions (ambient temperature 23 °C)

For the assessment of fitness for purpose of the system under normal conditions, electrofusion joints shall have the characteristic of decohesive resistance or cohesive strength, as applicable, conforming to the requirement given in Table 6, using the assembly condition 1 as specified in Annex C of ISO 11413:2019 at an ambient temperature of 23 °C ± 2 °C and the scheme listed in Table 2.

Table 2 — Scheme for electrofused assemblies

Electrofusion fitting	Pipe	
	PE80[a] SDR maximum[b]	PE 100 SDR minimum[b]
PE 80	X	X
PE 100	X	X

[a] If PE80 pipes with SDR maximum are not available, PE100 pipes with SDR maximum may be used.

[b] Pipe SDR maximum and pipe SDR minimum as declared by the fitting manufacturer.

The fitting manufacturer shall declare the pipes (e.g. SDR range, material designation) to which the fittings can be fused and the applicable fusion procedures and parameters (e.g. times, temperatures). If there is a need for deviation in fusion procedures, the fitting manufacturer shall state this clearly.

4.2.2.2 Under extreme conditions

For electrofusion joints, the characteristics to be examined for fitness for purpose of the fittings under extreme conditions shall conform to Table 3.

When tested in accordance with the test methods as specified in Table 6 using the indicated parameters, the joints shall have characteristics conforming to the requirements given in Table 6.

Table 3 — Relationship between joints and characteristics

Electrofusion socket joint including socket fitting[a] (A)	Electrofusion joint including saddle fitting[a] (B)	Associated characteristics
Pipe: MRS maximum[b] SDR minimum[b] Joint: conditions 2.2 and 3.2[c]		Decohesive resistance

[a] If accepted by the end-user, the minimum and maximum energy conditions 2.2 and 3.2 can be replaced by a nominal energy at a given ambient temperature T_a defined by the fitting manufacturer (see ISO 11413:2019, 4.3).

[b] As declared by the fitting manufacturer according to 4.2.2.1.

[c] As specified in Annex C of ISO 11413:2019 with T_{min} and T_{max} as stated in the fitting manufacturer's technical specification.

Table 3 *(continued)*

Electrofusion socket joint including socket fitting[a] (A)	Electrofusion joint including saddle fitting[a] (B)	Associated characteristics
	Pipe: MRS maximum[b] SDR minimum[b] Joint: conditions 2.2 and 3.2[c]	Evaluation of ductility of fusion joint interface

[a] If accepted by the end-user, the minimum and maximum energy conditions 2.2 and 3.2 can be replaced by a nominal energy at a given ambient temperature T_a defined by the fitting manufacturer (see ISO 11413:2019, 4.3).

[b] As declared by the fitting manufacturer according to 4.2.2.1.

[c] As specified in Annex C of ISO 11413:2019 with T_{min} and T_{max} as stated in the fitting manufacturer's technical specification.

The fitting manufacturer shall declare according to Table 3, column(s) A or B, as applicable, the fitness for purpose of the assembly under extreme conditions with the type of pipe being specified.

4.2.3 Fitness for purpose of butt fusion assemblies (C)

4.2.3.1 Under normal conditions (ambient temperature 23 °C)

For the assessment of fitness for purpose of butt fusion assemblies under normal conditions, butt fusion joints shall have the characteristic of tensile strength conforming to the requirement given in Table 6, using the parameters as specified in ISO 11414:2009, Annex B, condition 1 at an ambient temperature of 23 °C ± 2 °C and the scheme listed in Table 4.

Table 4 — Scheme for butt-fused joints

Pipe/spigot end fitting	Pipe	
	PE 80	PE 100
PE 80	X	X[a]
PE 100	X[a]	X

[a] Only when requested by the purchaser.

NOTE Table 4 is to be interpreted as follows: as an example, for a pipe or a spigot end fitting made from a PE 80 compound, the joint is tested with a pipe made from PE 80 compound. When requested by the purchaser, for mixed compound joints, test pieces are used incorporating PE 80 and PE 100 compounds.

If pipes according to ISO 4427-2 are produced from different compounds, the pipe manufacturer shall declare, according to 4.2.3.1, which pipes are compatible for butt fusion.

The fitting manufacturer shall declare, according to 4.2.3.1, the standard dimension ratio (SDR) range and MRS values of pipes to which the manufacturer's fittings can be fused and the applicable fusion procedures and parameters (e.g. times, temperatures). If there is a need for deviation in fusion procedures, the fitting manufacturer shall state this clearly.

4.2.3.2 Under extreme conditions

For butt fusion joints, the characteristics to be examined for fitness for purpose of the system under extreme conditions shall conform to Table 5.

Table 5 — Relationship between joints and fitness for purpose of the system characteristics

Butt fusion joint (C)	Associated characteristics
Both components of the joint: same MRS and same SDR Joint: minimum and maximum condition[a]	Hydrostatic strength (80 °C, 165 h)
	Tensile strength for butt fusion joint
[a] As specified in ISO 11414:2009, Clause 7, item a) concerning misalignment and the limit values of fusion parameters conforming ISO 11414:2009, Annex B, conditions 2 and 3.	

When tested in accordance with the test methods as specified in Table 6 using the indicated parameters, the joints shall have characteristics conforming to the requirements given in Table 6.

The fitting manufacturer shall declare according to Table 5, as applicable, the fitness for purpose of butt fusion welds under extreme conditions.

The pipe manufacturer shall declare according to Table 5 the fitness for purpose of butt fusion welds produced from PE pipes, PE pipes with co-extruded layers, or PE pipes with peelable layers under extreme conditions.

4.2.4 Fitness for purpose of the mechanical assemblies (D)

Mechanical assemblies shall conform to ISO 17885, with fitness for purpose to be agreed between the manufacturer and the customer.

4.2.5 Fitness for purpose of socket fusion assemblies (E)

Fitness for purpose of the socket fusion assemblies shall be agreed between the manufacturer and the customer.

4.3 Conditioning

The test pieces shall be conditioned at 23 °C ± 2 °C before testing, unless otherwise specified by the applicable test method as specified in Table 6.

4.4 Requirements

The requirements for characteristics of fitness for purpose of the system are given in Table 6.

Table 6 — Characteristics for fitness for purpose of assemblies

Characteristic	Requirements	Test parameters			Test method
		Parameter		Value	
Hydrostatic strength (80 °C, 165 h) (C)	No failure during the test period[a]	End caps		ISO 1167-1:2006 Type A	ISO 1167-1:2006 together with ISO 1167-2, or ISO 1167-4, as applicable
		Orientation		Free	
		Conditioning time		Shall conform to ISO 1167-1:2006	
		Number of test pieces[b]		3	
		Type of test[c]		Water-in-water	
		Circumferential (hoop) stress in pipe[d] for:	PE 80	4,5 MPa	
			PE 100	5,4 MPa	
		Test period		165 h	
		Test temperature		80 °C	
Decohesive resistance (A)	Length of initiation rupture ≤ $L/3$ in brittle failure[e]	Test temperature		23 °C	ISO 13954
		Number of test pieces[b]		Shall conform to ISO 13954	
		Test temperature		23 °C	ISO 13955
		Number of test pieces[b,f]		Shall conform to ISO 13955	
Evaluation of ductility of fusion joint interface[d,g] (B)	L_d ≤ 50 % and A_d ≤ 25 %, brittle failure	Test temperature		23 °C	ISO 13956
		Number of test pieces[b]		Shall conform to ISO 13956	
Tensile strength for butt fusion[h] (C)	Test to failure: ductile: pass brittle: fail	Test temperature		23 °C	ISO 13953
		Number of test pieces[b]		Shall conform to ISO 13953	

[a] Only brittle failures shall be taken into account. If a ductile failure occurs before 165 h, the test is permitted to be repeated according to 4.5.

[b] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 5. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in Reference [2] in the Bibliography.

[c] Alternatively, for d_n > 450 mm, the test can also be performed water in air. In case of dispute, water-in-water shall be used.

[d] The test pressure shall be calculated using the design standard dimension ratio (SDR) of the fitting.

[e] Longest length of brittle failure in any of the test samples, with L being the nominal length of the fusion zone of the electrofusion socket fitting.

[f] Test sample can be mechanically reduced in wall thickness for testing purpose of large diameter fittings by keeping a minimum of 15 mm wall thickness of each component.

[g] Alternatively, for fittings type (B) d_n > 450 mm, this characteristic can be checked by the strip-bend test according to ISO 21751 (see Reference [3] in the Bibliography.)

[h] Applicable to d_n 90 mm and above.

4.5 Retest in case of failure at 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure; however, if a sample in the 165 h test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the recommended stress/time points given in Table 7.

Table 7 — Circumferential (hoop) stress at 80 °C and associated minimum test period

PE40		PE 80		PE100	
Stress	**Minimum test time**	**Stress**	**Minimum test time**	**Stress**	**Minimum test time**
MPa	h	MPa	h	MPa	h
2,5	165	4,5	165	5,4	165
2,4	230	4,4	233	5,3	265
2,3	323	4,3	331	5,2	399
2,2	463	4,2	474	5,1	629
2,1	675	4,1	685	5,0	1 000
2,0	1 000	4,0	1 000	—	—

Bibliography

[1] ISO 4437-5, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 5: Fitness for purpose of the system*

[2] CEN/TS 12201-7, *Plastics piping systems for water supply — Polyethylene (PE) — Part 7: Guidance for the assessment of conformity*

[3] ISO 21751, *Plastics pipes and fittings — Decohesion test of electrofusion assemblies — Strip-bend test*