



International
Standard

ISO 4437-5

**Plastics piping systems for
the supply of gaseous fuels —
Polyethylene (PE) —**

**Part 5:
Fitness for purpose of the system**

*Systèmes de canalisations en plastique pour la distribution de
combustibles gazeux — Polyéthylène (PE) —*

Partie 5: Aptitude à l'emploi du système

**Second edition
2024-02**

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Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
3.1 Terms related to geometry	2
3.2 Terms related to material	3
3.3 Terms related to material characteristics	3
3.4 Terms related to service conditions	4
3.5 Terms related to joints	4
4 Symbols and abbreviated terms	5
4.1 Symbols	5
4.2 Abbreviated terms	6
5 Fitness for purpose of the system	6
5.1 Method of preparation of assemblies for testing	6
5.1.1 General	6
5.1.2 Butt fusion joints	6
5.1.3 Electrofusion joints	7
5.1.4 Mechanical joints	7
5.1.5 Socket fusion joints	7
5.2 Requirements for fitness for purpose	7
5.2.1 General	7
5.2.2 Fitness for purpose of the system for butt fusion joints	7
5.2.3 Fitness for purpose of the system for electrofusion joints	8
5.2.4 Fitness for purpose of the system for mechanical joints	9
5.3 Conditioning	10
5.4 Requirements	10
5.5 Testing of pipe with coextruded layers	11
6 Design coefficient	11
Annex A (informative) Derating coefficients for operating temperatures	12
Annex B (normative) Rapid crack propagation resistance of pipe at operating temperature less than 0 °C	13
Bibliography	14

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 document 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).

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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, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This second edition cancels and replaces the first edition (ISO 4437-5:2014), which has been technically revised.

The main changes are as follows:

- PE 100-RC type materials with enhanced resistance to slow crack growth (SCG) have been added;
- test methods have been updated and new methods have been added for PE 100-RC materials.

A list of all parts in the ISO 4437 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 4437 series specifies the requirements for a piping system and its components made from polyethylene (PE) compounds, which is intended to be used for the supply of gaseous fuels.

This document covers the characteristics of fitness for purpose of the system.

Requirements and test methods for materials and components of the piping system are specified in ISO 4437-1, ISO 4437-2, ISO 4437-3 and ISO 4437-4.

Recommended practice for design, handling and installation is given in ISO/TS 10839.

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Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) —

Part 5: Fitness for purpose of the system

1 Scope

This document specifies the requirements of fitness for purpose of assembled polyethylene (PE) piping systems in the field of the supply of gaseous fuels.

It specifies the requirements for electrofusion, socket fusion, butt fusion and mechanical joints.

It specifies the method of preparation of test piece joints and the tests to be carried out on these joints for assessing the fitness for purpose of the system under normal and extreme conditions.

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

This document is intended to be used only by the product manufacturer and test laboratories to assess the performance of components in accordance with ISO 4437-2, ISO 4437-3 and ISO 4437-4 when joined together under normal and extreme conditions in accordance with this document. It is not intended for on-site testing of pipe systems.

In conjunction with ISO 4437-1, ISO 4437-2, ISO 4437-3 and ISO 4437-4, this document is applicable to PE pipes, fittings and valves, their joints, and joints with components of PE and other materials intended to be used under the following conditions:

- a) a maximum operating pressure (MOP), up to and including 10 bar¹⁾, at a reference temperature of 20 °C for design purposes;
- b) an operating temperature between -20 °C and 40 °C.

For operating temperatures between 20 °C and 40 °C, derating coefficients are defined in [Annex A](#).

The ISO 4437 series covers a range of MOPs 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 4437-2, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes*

1) 1 bar = 0,1 MPa = 10⁵ Pa; 1 MPa = 1 N/mm².

ISO 4437-3, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*

ISO 4437-4, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 4: Valves*

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 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*

ISO 13478, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST)*

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 and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms related to geometry

3.1.1

nominal size

DN/OD

numerical designation of the size of a component related to the outside diameter

Note 1 to entry: It is a convenient round number approximately equal to the manufacturing dimension in millimetres (mm). It is not applicable to components designated by thread size.

3.1.2

nominal outside diameter

d_n

specified outside diameter assigned to a *nominal size* ([3.1.1](#))

Note 1 to entry: Nominal outside diameter is expressed in millimetres (mm).

3.1.3

nominal wall thickness

e_n
numerical designation of the wall thickness of a component, which is a convenient round number, approximately equal to the manufacturing dimension in millimetres (mm)

Note 1 to entry: For thermoplastics components conforming to the ISO 4437 series, the value of the nominal wall thickness, e_n , is identical to the specified *minimum wall thickness at any point* (3.1.5).

3.1.4

wall thickness at any point

e
wall thickness at any point around the circumference of a component rounded to the next greater 0,1 mm

Note 1 to entry: The symbol for the wall thickness of a fitting and valve body at any point is E .

3.1.5

minimum wall thickness at any point

$e_{\min}$
minimum value for the *wall thickness at any point* (3.1.4) around the circumference of a component

3.1.6

standard dimension ratio

SDR

numerical designation of a *pipe series* (3.1.7), which is a convenient round number, approximately equal to the dimension ratio of the *nominal outside diameter* (3.1.2) and the *nominal wall thickness* (3.1.3)

3.1.7

pipe series

S
number for pipe designation

Note 1 to entry: The relationship between the pipe series, S , and the *standard dimension ratio (SDR)* (3.1.6) is given by the following formula, as specified in ISO 4065.

$$S = \frac{SDR - 1}{2}$$

3.2 Terms related to material

3.2.1

compound

homogenous extruded mixture of *base polymer* (3.2.2) (polyethylene) and additives (i.e. anti-oxidants, pigments, carbon black, UV-stabilizers and others) at a dosage level necessary for the processing and use of components

3.2.2

base polymer

polymer produced by the material supplier for the manufacture of the *compound* (3.2.1)

3.3 Terms related to material characteristics

3.3.1

lower confidence limit of the predicted hydrostatic strength

σ_{LPL}
quantity, with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at temperature θ and time t

Note 1 to entry: It is expressed in megapascals (MPa).

3.3.2

minimum required strength**MRS**

value of the *lower confidence limit of the predicted hydrostatic strength* (3.3.1) at 20 °C and 50 years, rounded down to the next smaller value of the R10 series or R20 series

Note 1 to entry: Only *compounds* (3.2.1) with an MRS of 8 MPa or 10 MPa are specified in this document.

Note 2 to entry: The R10 series and the R20 series conform to ISO 3.

Note 3 to entry: It is expressed in megapascals (MPa).

[SOURCE: ISO 12162:2009, 3.3, modified — Note 1 to entry has been removed and replaced with new Notes 1 to 3 to entry.]

3.3.3

design coefficient**C**

coefficient with a value greater than 1 which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit

3.4 Terms related to service conditions

3.4.1

gaseous fuel

fuel which is in gaseous state at a temperature of 15 °C at atmospheric pressure

Note 1 to entry: There are proposals to inject gases from renewable sources in natural gas networks, e.g. hydrogen (H₂). This is the subject of ongoing research.

3.4.2

maximum operating pressure**MOP**

maximum effective pressure of the fluid in the piping system which is allowed in continuous use

Note 1 to entry: It is expressed in bar. It takes into account the physical and the mechanical characteristics of the components of a piping system. It is calculated using the following formula:

$$MOP = \frac{20 \times MRS}{C \times (SDR - 1)}$$

Note 2 to entry: Research on long-term performance prediction of polyethylene gas distribution systems shows a possible service life of at least 100 years; see References [7], [8] and [9].

3.4.3

reference temperature

temperature for which the piping system is designed

Note 1 to entry: It is used as the base for further calculation when designing a piping system or parts of a piping system for operating temperatures different from the reference temperature.

3.5 Terms related to joints

3.5.1

butt fusion joint

joint made by heating the planed ends of pipes or *spigot end fittings* (3.5.5), the surfaces of which are fused together by holding them against a flat heating plate until the polyethylene material reaches fusion temperature, removing the heating plate quickly and pushing the two softened ends against one another

3.5.2**electrofusion joint**

joint between a polyethylene *electrofusion socket fitting* (3.5.3) or *electrofusion saddle fitting* (3.5.4) and a pipe or *spigot end fitting* (3.5.5) made by heating the electrofusion fitting by the Joule effect of the heating element incorporated at their jointing surfaces, causing the material adjacent to them to melt, and the pipe and fitting surfaces to fuse

3.5.3**electrofusion socket fitting**

polyethylene (PE) fitting which contains one or more integrated heating elements that are capable of transforming electrical energy into heat to realise a fusion joint with a spigot end or a pipe

3.5.4**electrofusion saddle fitting**

polyethylene (PE) fitting which contains one or more integrated heating elements that are capable of transforming electrical energy into heat to realize a fusion joint onto a pipe

3.5.5**spigot end fitting**

polyethylene (PE) fitting where the outside diameter of the spigot end is equal to the *nominal outside diameter* (3.1.2) of the corresponding pipe

3.5.6**socket fusion joint**

joint between a polyethylene socket fusion fitting and a pipe or a *spigot end fitting* (3.5.5)

Note 1 to entry: The socket fusion fittings are heated by a purpose-made heated tool causing the material on the jointing surfaces to melt and the pipe and fitting surfaces to fuse.

3.5.7**mechanical joint**

joint made by assembling a polyethylene (PE) pipe to another PE pipe, or any other element using a fitting that generally includes a compression part, to provide for pressure integrity, leaktightness and resistance to end loads

3.5.8**mechanical fitting**

fitting for assembling plastics pipes with each other or with a metal pipe or fitting, that includes one or more compression zones to provide pressure integrity, leak tightness and resistance to end loads

[SOURCE: ISO 17885:2021, 3.1.1]

4 Symbols and abbreviated terms**4.1 Symbols**

For the purposes of this document, the following symbols apply.

A_d	percentage of decohesion (area)
C	design coefficient
D_F	derating factor
d_n	nominal outside diameter
E	wall thickness (at any point) of a fitting and valve body
e	wall thickness (at any point) around the circumference of a component

$e_{\min}$	minimum wall thickness (at any point)
e_n	nominal wall thickness
L_2	nominal length of the fusion zone of the electrofusion socket fitting
L_d	percentage of decohesion (length)
p_c	critical pressure
S	pipe series
T_a	ambient temperature at which a joint is made
$T_{\max}$	maximum permitted ambient temperature for joint assembly
$T_{\min}$	minimum permitted ambient temperature for joint assembly
t	time
θ	temperature
σ_{LPL}	lower confidence limit of the predicted hydrostatic strength

4.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

DN/OD	nominal size, outside diameter-related
LPL	lower predicted limit
MOP	maximum operating pressure
MRS	minimum required strength
PE	polyethylene
RC	raised crack resistance
SDR	standard dimension ratio

5 Fitness for purpose of the system

5.1 Method of preparation of assemblies for testing

5.1.1 General

The joints shall be made by using pipes conforming to ISO 4437-2, fittings conforming to ISO 4437-3 or valves conforming to ISO 4437-4.

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.

5.1.2 Butt fusion joints

PE pipes, spigot end fittings and valves 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

[5.2.2.1](#) for the assessment of fitness for purpose of the system under normal conditions and in [5.2.2.2](#) for the assessment of fitness for purpose of the system under extreme conditions.

5.1.3 Electrofusion joints

PE pipes, fittings and valves 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 [5.2.3.1](#) for the assessment of fitness for purpose of the system under normal conditions and in [5.2.3.2](#) 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 pneumatically pressurized to the allowable maximum operating pressure. The pipe shall be tapped immediately after the manufacturer prescribed cooling time has elapsed. The pipe tapping process shall follow the manufacturer's prescribed instructions.

NOTE Safety precautions are expected to be taken into consideration when joints with electrofusion saddle fittings are being prepared on a pressurized pipe system.

For electrofusion 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. For diameters greater than 225 mm, the adjoining pipes shall be arranged to provide the maximum angular deflection possible for the fitting, limited to $1,5^\circ$.

5.1.4 Mechanical joints

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

5.1.5 Socket fusion joints

Fitness for purpose of the system testing shall be agreed between the manufacturer and the end user.

5.2 Requirements for fitness for purpose

5.2.1 General

When tested in accordance with the test methods as specified in [Table 5](#) using the indicated parameters, pipes and fittings shall have mechanical characteristics conforming to the requirements given in [Table 5](#), as applicable to the following types of joint assemblies with pipe:

- (A) electrofusion socket fittings;
- (B) electrofusion saddle fitting;
- (C) spigot end fitting;
- (D) pipes.

5.2.2 Fitness for purpose of the system for butt fusion joints

5.2.2.1 Under normal conditions (ambient temperature: 23°C)

For the assessment of fitness for purpose of the system under normal conditions, butt fusion joints shall have characteristics of hydrostatic strength and tensile strength conforming to the requirements given in [Table 5](#), using the parameters as specified in ISO 11414:2009 Annex B, condition 1, at an ambient temperature of $(23 \pm 2)^\circ\text{C}$ and the scheme listed in [Table 1](#).

Table 1 — Scheme for butt fusion joints

Pipe/spigot end fitting/ valve with spigot ends	Pipe	
	PE 80	PE 100 or PE 100-RC
PE 80	X	X ^a
PE 100 or PE 100-RC	X ^a	X
^a Only when requested by the purchaser. For example, a PE 100 pipe shall be tested with a PE 100 or PE 100-RC pipe. Only when requested by the purchaser shall a PE 80 pipe be incorporated in the test assembly.		

The pipe manufacturer shall declare which pipes from their own product range manufactured from different compounds conforming to ISO 4437-2 are compatible to each other for butt fusion.

The fitting or valve manufacturer shall declare the SDR range and MRS values of pipes to which spigot end fittings and/or spigot end valves can be fused by using the same procedures (e.g. times, temperatures, fusion pressures) to conform to this document. If there is a need for deviation in fusion procedures, the fitting or valve manufacturer shall state this clearly.

5.2.2.2 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 2](#). Extreme conditions are specified in ISO 11414:2009, Annex B.

Table 2 — Characteristics for fitness for purpose of the system

Butt fusion joint (C) (D)	Associated characteristics
Both components of the joint: same MRS and same SDR Joint: minimum and maximum condition ^a	Hydrostatic strength (80 °C, 165 h)
Both components of the joint: same MRS and same SDR Joint: minimum and maximum condition ^a	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 to ISO 11414:2009, Annex B, conditions 2 and 3.	

When tested in accordance with the test methods as specified in [Table 5](#) using the indicated parameters, the joints shall have characteristics conforming to the requirements given in [Table 5](#).

The fitting or valve manufacturer shall declare, according to [Table 2](#), the fitness for purpose of the system under extreme conditions of the fittings or valves.

The pipe manufacturer shall declare, according to [Table 2](#), the fitness for purpose of the system under extreme conditions of pipes (PE pipes, PE pipes with co-extruded layers and PE pipes with peelable layers).

5.2.3 Fitness for purpose of the system for electrofusion joints

5.2.3.1 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 requirements given in [Table 5](#), using assembly condition 1 as specified in ISO 11413:2019, Annex C, at an ambient temperature of (23 ± 2) °C and the scheme listed in [Table 3](#).

Table 3 — Scheme for electrofusion joints

Electrofusion fitting/valve with electrofusion socket	Pipe ^a	
	PE 80 ^b SDR maximum	PE 100 or PE 100-RC SDR minimum
PE 80	X	X
PE 100 or PE 100-RC	X	X
^a Pipe SDR maximum and pipe SDR minimum, as declared by the fitting/valve manufacturer.		
^b If pipes with PE 80 SDR maximum are not available, PE 100 or PE 100-RC pipes with SDR maximum may be used.		

The fitting or valve manufacturer shall declare the SDR range and MRS values of pipes conforming to ISO 4437-2 to which fittings conforming to ISO 4437-3 or/and valves conforming to ISO 4437-4 can be fused by using the same procedures to conform to this document. If there is a need for deviation from fusion procedures and parameters, the fitting or valve manufacturer shall state this clearly.

5.2.3.2 Under extreme conditions

For electrofusion joints, the characteristics to be examined for fitness for purpose of the system under extreme conditions shall conform to [Table 4](#). Extreme conditions are specified in ISO 11413:2019, Annex C.

When tested in accordance with the test methods as specified in [Table 5](#) using the indicated parameters, the joints shall have characteristics conforming to the requirements given in [Table 5](#).

Table 4 — Relation between joints and fitness for purpose of the system characteristics

Electrofusion 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
	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 , specified by the fitting manufacturer (see ISO 11413:2019, 4.3).		
^b As declared by the fitting manufacturer according to 5.2.3.1 .		
^c As specified in ISO 11413:2019, Annex C, with T_{min} and T_{max} as stated in the fitting manufacturer's technical specification.		

The fitting or valve manufacturer shall declare, according to [Table 4](#), column(s) A or B, as applicable, the fitness for purpose of the system under extreme conditions of the fittings or valves with the type of pipe being specified.

5.2.4 Fitness for purpose of the system for mechanical joints

For fitness for purpose of the system of mechanical joints, the performance of the joints shall conform to ISO 17885.

For testing mechanical fittings in accordance with ISO 17885, the nominal pressure is determined by the MOP declared by the manufacturer multiplied by 1,6.

5.3 Conditioning

The test pieces shall be conditioned at $(23 \pm 2) ^\circ\text{C}$ before testing, unless otherwise specified by the applicable test method as specified in [Table 5](#).

5.4 Requirements

The requirements for characteristics of fitness for purpose of the system are given in [Table 5](#).

Table 5 — Characteristics for fitness for purpose of the system

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Hydrostatic strength (80 °C, 165 h) (C) (D)	No failure during the test period of any test piece ^a	End caps	Type A ^b of ISO 1167-1:2006	ISO 1167-1:2006 together with ISO 1167-2, or ISO 1167-4, as applicable
		Orientation	Free	
		Conditioning time at test temperature	Shall conform to ISO 1167-1:2006	
		Number of test pieces ^c	3	
		Type of test	Water internal and water external to the test piece ("water-in-water") ^d	
		Circumferential (hoop) stress ^e for:		
		PE 80	4,5 MPa	
		PE 100 and PE 100-RC	5,4 MPa	
Decohesive resistance (A)	Length of initiation rupture $\leq 1/3L_2$ in brittle failure ^f	Test temperature	23 °C	ISO 13954 ^{h, i}
		Test speed	25 mm/min	
		Number of test pieces ^c	Shall conform to ISO 13954 ^g	
		Test temperature	23 °C	ISO 13955 ^{h, i}
		Test speed	100 mm/min	
		Number of test pieces ^c	Shall conform to ISO 13955	
Evaluation of ductility of fusion joint interface (B)	$L_d \leq 50\%$ and $A_d \leq 25\%$, brittle failure	Test temperature	23 °C	ISO 13956 ^h
		Number of test pieces ^c	Shall conform to ISO 13956	

Table 5 (continued)

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Tensile strength for butt fusion ^k (C) (D)	Test to failure: ductile: pass brittle: fail	Test temperature	23 °C	ISO 13953
		Number of test pieces ^c	Shall conform to ISO 13953	

^a Only brittle failures shall be taken into account. If a ductile failure occurs before 165 h, the test can be repeated at a lower stress. The stress and the associated test period shall be selected from Table 6 or from a line based on the stress/time points given in Table 6.

^b Type B end caps may be used for tests for diameters ≥ 500 mm.

^c The number of test pieces given indicates the number required to establish a value for the characteristic described in this table. 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 CEN/TS 1555-7.^[6]

^d Alternatively, for $d_n > 450$ mm, the test may be carried out water-in-air. In case of dispute, water-in-water shall be used.

^e For testing assemblies with fittings, the test pressure shall be calculated using the design SDR of the fitting. Test pressure for pipe shall be calculated using nominal dimensions.

^f Longest length of brittle failure in any of the test samples, with L_2 being the nominal length of the fusion zone of the electrofusion socket fitting.

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

^h For type A and type B fittings, alternatively the strip-bend test in accordance with ISO 21751 may be used.

ⁱ In case of dispute ISO 13954 shall apply.

^j In case of use of the strip-bend test in accordance with ISO 21751, only the L_d requirement of ≤ 50 % shall be considered.

^k Applicable to $d_n \geq 90$ mm.

Table 6 — Test parameters for the retest of the hydrostatic strength at 80 °C

PE 80		PE 100 and PE 100-RC	
Stress MPa	Minimum test period h	Stress MPa	Minimum test period h
4,5	165	5,4	165
4,4	233	5,3	256
4,3	331	5,2	399
4,2	474	5,1	629
4,1	685	5,0	1 000
4,0	1 000	—	—

5.5 Testing of pipe with coextruded layers

There shall be no evidence of delamination of layers during or after testing of joints of coextruded pipe.

6 Design coefficient

The minimum value of the design coefficient, C , for pipes, fittings and valves for the supply of gaseous fuels shall be 2.

To this value, other coefficients may be applied, taking into account different aspects such as:

- operating temperature range. (For information about derating coefficients for other operating temperatures, see Annex A);
- specific material aspects, e.g. rapid crack propagation (RCP). (RCP resistance of pipes at operating temperatures less than 0 °C shall be as given in Annex B);
- laying conditions.