BRITISH STANDARD

BS EN
1555-5:2002

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

Part 5: Fitness for purpose of the system

The European Standard EN 1555-5:2002 has the status of a British Standard

ICS 23.040.01; 91.140.40

National foreword

This British Standard is the official English language version of EN 1555-5:2002. Collectively, EN 1555-1, EN 1555-2 and EN 1555-5 comprise a revision of BS 7281:1990 and EN 1555-3 comprises a revision of BS 7336:1990. It is intended that these British Standards will be declared obsolescent by December 2004.

NOTE 1 CEN/TC 234 in co-operation with CEN/TC 155 drafted an installation document for gas applications and this was published as EN 12007-2:2000, *Gas supply systems — Pipelines for maximum operating pressure up to and including 16 bar — Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar)*[1]. As a consequence of this, TC 155 agreed that they would not draft a Part 6 in the EN 1555 series.

NOTE 2 Part 7 has been prepared as a CEN/TS to allow further development. CEN/TS 1555-7 is not mandatory under the Public Procurement Directive.

The UK participation in its preparation was entrusted by Technical Committee PRI/88 (previously PRI/61), Plastics piping systems, to Subcommittee PRI/88/2 (previously PRI/61/2), Plastics piping for pressure applications, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Attention is drawn to any appropriate safety precautions. It is assumed in the drafting of a standard that the execution of its provisions is entrusted to appropriately qualified and competent people.

The UK National Annex NA attached to this standard provides additional information on the selection and installation of piping systems and components in the UK.

Attention is drawn to the following statutory regulations:

Health and Safety at Work etc. Act 1974 and subsequent regulations.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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

Compliance with a British Standard does not of itself confer immunity from legal obligations.

[1] It is the opinion of Technical Committee PRI/88 that the Code of Practice published by the gas industry represents established UK practice, copies of which are available from the current national network distributor, Transco.

This British Standard, was published under the authority of the Standards Policy and Strategy Committee on 7 January 2004

Summary of pages

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Kunststoff-Rohrleitungssysteme für die Gasversorgung - Polyethylen (PE) - Teil 5: Gebrauchstauglichkeit des Systems

This European Standard was approved by CEN on 1 November 2002.

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Contents

Foreword

This document EN 1555-5:2002 has been prepared by Technical Committee CEN /TC 155, "Plastics piping systems and ducting systems", the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2003, and conflicting national standards shall be withdrawn at the latest by December 2004.

It has been prepared in liaison with Technical Committee CEN/TC 234 "Gas supply".

This standard is a part of a System Standard for plastics piping systems of a particular material for a specified application. There are a number of such System Standards.

System Standards are based on the results of the work undertaken in ISO/TC 138 "Plastics pipes, fittings and valves for the transport of fluids", which is a Technical Committee of the International Organization for Standardization (ISO).

They are supported by separate standards on test methods to which references are made throughout the System Standard.

The System Standards are consistent with general standards on functional requirements and on recommended practice for installation.

EN 1555 consists of the following parts, under the general title *Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE):*

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 4: Valves*

— *Part 5: Fitness for purpose of the system* (this standard)

— *Part 7: Guidance for assessment of conformity* (to be published as CEN/TS).

NOTE The document dealing with recommended practice for installation which was initially submitted for CEN enquiry as prEN 1555-6 was withdrawn when EN 12007-2[1], prepared by CEN/TC 234 Gas supply, was published with the title "Gas supply systems - Pipelines for maximum operating pressure up to and including 16 bar - Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar)".

This document includes informative annexes A and B as well as a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard : Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The System Standard, of which this is Part 5, specifies the requirements of a piping system and its components made from polyethylene (PE) and which is intended to be used for the supply of gaseous fuels.

Requirements and test methods for material and components are specified in EN 1555-1, EN 1555-2, EN 1555- 3 and EN 1555-4. prCEN/TS 1555-7 gives guidance for assessment of conformity. Recommended practice for installation is given in EN 12007-2[1] prepared by CEN/TC 234.

This part of EN 1555 covers the characteristics of fitness for purpose of the system.

1 Scope

This part of EN 1555 specifies requirements of fitness for purpose of the polyethylene (PE) piping system in the field of the supply of gaseous fuels.

It specifies the definitions of electrofusion, butt fusion and mechanical joints.

It also specifies the method of preparation of test piece joints, relating to installation recommendations given in EN 12007-2:2000[1] 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 also specifies the test parameters for the test methods referred to in this standard.

In conjunction with the other parts of EN 1555 (see Foreword) it is applicable to PE pipes, fittings, valves, their joints and to joints with components of other materials intended to be used under the following conditions:

a) a maximum operating pressure, MOP, up to and including 10 bar [1)];

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

NOTE 1 For other operating temperatures, derating coefficients should be used, see annex A.

EN 1555 covers a range of maximum operating pressures and gives requirements concerning colours and additives.

NOTE 2 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 921, *Plastics piping systems — Thermoplastics pipes — Determination of resistance to internal pressure at constant temperature*.

EN 1555-1:2002, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 1: General.*

EN 1555-2:2002, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes.*

EN 1555-3:2002, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings.*

EN 1555-4:2002, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 4: Valves.*

ISO 10838-1*, 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, *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*, 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 11413:1996, *Plastics pipes and fittings — Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting.*

ISO 11414:1996, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test assemblies by butt fusion.*

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1) 1 bar = 0,1 MPa

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/DIS 13956, *Plastics pipes and fittings — Determination of cohesive strength — Tear test for polyethylene (PE) assemblies.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions, symbols and abbreviations given in EN 1555-1:2002 apply, together with the following.

3.1
electrofusion joint
joint between a PE electrofusion socket or saddle fitting and a pipe or a spigot end fitting. The electrofusion fittings are heated 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

3.2
butt fusion joint (**using heated tool)**
joint made by heating the planed ends the surfaces of which match by holding them against a flat heating plate until the PE material reaches fusion temperature, removing the heating plate quickly and pushing the two softened ends against one another

3.3
mechanical joint
joint made by assembling a PE pipe with a fitting that generally includes a compression part to provide for pressure integrity, leaktightness and resistance to end loads. A support sleeve inserted into the pipe bore may be used to provide a permanent support for the PE pipe to prevent creep in the pipe wall under radial compressive forces. The metallic part of this fitting can be assembled to a metallic pipe by screw threads, compression joints, welded or brazed flanges or by other means

3.4
fusion compatibility
ability of two similar or dissimilar polyethylene materials to be fused together to form a joint which conforms to the performance requirements of this standard

4 Fitness for purpose

4.1 Method of preparation of assemblies for testing

4.1.1 General

The joints shall be made by using pipes conforming to EN 1555-2:2002, fittings conforming to EN 1555-3:2002 or valves conforming to EN 1555-4:2002.

Test pieces for pressure test 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.

4.1.2 Butt fusion joints

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 4.2.1.1 for the assessment of fitness for purpose under normal conditions and in 4.2.1.2 for the assessment of fitness for purpose under extreme conditions.

4.1.3 Electrofusion jointing

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 4.2.2.1 for the assessment of fitness for purpose under normal conditions and in 4.2.2.2 for the assessment of fitness for purpose under extreme conditions.

For joints with electrofusion socket fittings and joints with electrofusion saddle fittings, test joints shall be prepared to check the fitness for purpose of the fittings under extreme jointing 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 cut immediately after the manufacturer prescribed cooling time has elapsed.

NOTE These joints with electrofusion saddle fitting should be prepared taking into consideration national safety regulations.

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°.

4.1.4 Mechanical joints

For mechanical joints the assembly of the PE pipe and the fitting shall be prepared in accordance with ISO 10838-1, ISO 10838-2 or ISO 10838-3, as applicable.

4.2 Requirements for fitness for purpose

4.2.1 Fitness for purpose for butt fusion joints

4.2.1.1 Under normal conditions (ambient temperature 23 °C)

For the assessment of fitness for purpose under normal conditions, butt fusion joints shall have the characteristic of tensile strength conforming to the requirement given in Table 5, using the parameters as specified in annex A of ISO 11414:1996 at an ambient temperature of (23 ± 2) °C and the scheme listed in Table 1.

Table 1 — Scheme for butt-fused joints

Pipe/spigot end fitting/valve with spigot ends	Pipe	
	PE 80	PE 100
PE 80	X	X [a]
PE 100	X [a]	X
a Only when requested by the purchaser.		

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

The pipe manufacturer shall declare, according to 4.2.1.1, which pipes from his own product range conforming to EN 1555-2 are compatible to each other for butt fusion.

The fitting or valve manufacturer shall declare, according to 4.2.1.1 the SDR range and MRS values of pipes conforming to EN 1555-2 to which his fittings conforming to EN 1555-3 or and his valves conforming to EN 1555-4 can be fused by using the same procedures (e.g. times, temperatures, fusion pressures) to conform to this standard. If there is a need for deviation in fusion procedures the fitting or valve manufacturer shall state this clearly.

4.2.1.2 Under extreme conditions

For butt fusion joints the characteristics to be examined for fitness for purpose under extreme conditions shall conform to Table 2.

Table 2 — Relation between the joints and fitness for purpose 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)
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 concerning misalignment (clause 6a) and the limit values of fusion parameters (annex B).	

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, as applicable, the fitness for purpose under extreme conditions of his fittings or valves.

The pipe manufacturer shall declare according to Table 2 the fitness for purpose under extreme conditions of his pipes.

4.2.2 Fitness for purpose for electrofusion joints

4.2.2.1 Under normal conditions (ambient temperature 23 °C)

For the assessment of fitness for purpose under normal conditions, electrofusion joints shall have the characteristic of decohesive resistance or cohesive strength, as applicable, conforming to the requirement given in Table 5, using the assembly condition 1 as specified in annex C of ISO 11413:1996 at an ambient temperature of (23 ± 2) °C and the scheme listed in Table 3.

Table 3 — Scheme for electrofused joints

Electrofusion fitting/valve with electrofusion socket	Pipe	
	PE 80 SDR maximum	PE 100 SDR minimum
PE 80	X	X
PE 100	X	X

NOTE The table should be interpreted as follows: as an example, for an electrofusion fitting or a valve with electrofusion socket made from a PE 80 compound, a joint should be tested with a pipe made from PE 80 compound and a SDR maximum and an other joint should be tested with a pipe made from PE 100 compound and a SDR minimum.

The fitting or valve manufacturer shall declare, according to 4.2.2.1 the SDR range and MRS values of pipes conforming to EN 1555-2 to which his fittings conforming to EN 1555-3 or and his valves conforming to EN 1555-4 can be fused by using the same procedures (e.g. times, temperatures, fusion pressures) to conform to this standard. If there is a need for deviation in fusion procedures the fitting or valve manufacturer shall state this clearly.

4.2.2.2 Under extreme conditions

For electrofusion joints the characteristics to be examined for fitness for purpose under extreme conditions shall conform to Table 4.

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 the joints and fitness for purpose 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 and 3 [c]		Decohesive resistance
	Pipe: MRS maximum [b] SDR minimum [b] Joint: conditions 2 and 3 [c]	Cohesive strength

a If accepted by the purchaser, the minimum and maximum energy conditions 2 and 3 may be replaced by a nominal energy at a given ambient temperature T_a defined by the fitting manufacturer (see 3.4 of ISO 11413:1996).
b As declared by the fitting manufacturer according to 4.2.2.1.
c As specified in annex C of ISO 11413:1996 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, B, as applicable, the fitness for purpose under extreme conditions of his fittings or valves.

Table 5 — Characteristics for fitness for purpose of the system

Characteristic	Requirements	Test parameters		Test method
		Parameter	Value	
Hydrostatic strength (80°C, 165 h) (C)	No failure during the test period [b]	End caps Orientation Conditioning time Number of test pieces [a] Type of test Circumferential (hoop) stress for: PE 80 PE 100 Test period Test temperature	Type a) Free Shall conform to EN 921 3 Water-in water 4,5 MPa 5,4 MPa 165 h 80 °C	EN 921
Decohesive resistance (A)	Length of initiation rupture ≤ *L* /3 in brittle failure [c]	Test temperature Number of test pieces [a]	23 °C Shall conform to ISO 13954 and ISO 13955	ISO 13954 ISO 13955
Cohesive strength (B)	Surface of rupture ≤ 25 % brittle failure	Test temperature Number of test pieces [a]	23 °C Shall conform to ISO/DIS 13956	ISO/DIS 13956
Tensile strength for butt fusion (C)	Test to failure: ductile: pass brittle: fail	Test temperature Number of test pieces [a]	23 °C Shall conform to ISO 13953	ISO 13953

a The numbers of test pieces given indicate the numbers required to establish a value for the characteristic described in the table.

The numbers of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. For guidance see prCEN/TS 1555-7[2].

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

c *L* is the nominal length of the fusion zone of the electrofusion socket fitting.

Table 6 — Circumferential (hoop) stress at 80 °C and associated minimum test period

PE 80		PE 100	
Stress MPa	Minimum test time h	Stress MPa	Minimum test time 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	1000
4,0	1000	-	-

4.2.3 Fitness for purpose for mechanical joints

For fitness for purpose of mechanical joints the performances of the joints shall conform to ISO 10838-1, ISO 10838-2 or ISO 10838-3, as applicable.

5 Overall service (design) coefficient

The minimum value of the overall service (design) coefficient, *C*, for pipes, fittings and valves for the supply of gaseous fuels shall be 2, or higher values according to national legislation (see EN 1555-1).

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

a) operating temperature range;

b) specific material aspects, for instance Rapid Crack Propagation (RCP);

NOTE 1 For information about RCP resistance at temperature less than 0 °C, see annex B.

c) storage and laying conditions.

NOTE 2 For information about derating coefficients for other operating temperatures, see annex A.

Annex A
(informative)

Derating coefficients for operating temperatures

Derating factor (D_F) is a coefficient used in the calculation of MOP, which takes into account the influence of operating temperature.

Table A.1 gives derating coefficients for various operating temperatures.

Table A.1 — Temperature derating coefficients

Temperature	Derating coefficient (D_F)
20 °C	1,0
30 °C	1,1
40 °C	1,3

For other temperatures between each step, linear interpolation is permitted.

The calculation of MOP for a given operating temperature is based on the following equation:

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

in which the value of the overall service coefficient "*C*" should not be less than 2.

Annex B
(informative)

Rapid crack propagation (RCP) resistance at temperature less than 0 °C

Piping system intended for the distribution of gas at temperature less than 0 °C, e.g. liquid petroleum gas (LPG) systems, should be subjected to additional rapid crack propagation (RCP) evaluation in accordance with ISO 13477:1997[3] or EN ISO 13478:1997[4], to determine the critical pressure p_c at the minimum expected operating temperature.

An additional marking “LPG” should be applied (see EN 12007-2:2000[1]).

Bibliography

[1] EN 12007-2:2000, *Gas supply systems - Pipelines for maximum operating pressure up to and including 16 bar - Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar).*

[2] prCEN/TS 1555-7, *Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 7: Guidance for the assessment of conformity.*

[3] ISO 13477:1997, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale-steady-state test (S4 test).*

[4] EN ISO 13478:1997, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full scale test (FST) (ISO 13478:1997).*

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National Annex NA
(informative)

Additional information on the selection and installation of piping systems and components in the UK

The responsible UK committee gives the following advice concerning the selection and installation of piping systems and components conforming to this British Standard.

a) Gas supply companies and other entities deemed to be within the scope of the Public Procurement Directive (PPD) are obliged to use EN 1555-1, EN 1555-2, EN 1555-3, EN 1555-4 and EN 1555-5, produced under EC/U mandate, if they wish to purchase PE pipe systems or components within its scope.

b) Attention is drawn to **4.1.1** and the requirements that joints shall be made by using pipes conforming to EN 1555-2:2002, fittings conforming to EN 1555-3:2002 or valves conforming to EN 1555-4:2002, as the tests confirm the compatibility of the components and the efficacy and fitness for purpose of pipes and jointing systems of assemblies of components in withstanding variations in assembly conditions and the operating pressures and temperatures generated within gas distribution systems.

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