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English Version

Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 1: General

Systèmes de canalisations en plastique pour la distribution de combustibles gazeux - Polyéthylène (PE) - Partie 1: Généralités

Kunststoff-Rohrleitungssysteme für die Gasversorgung - Polyethylen (PE) - Teil 1: Allgemeines

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 155.

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Contents

Page

Foreword

This document (prEN 1555-1:2008) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 1555-1:2002.

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* (this standard)

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 4: Valves*

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

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

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dealing with recommended practice for installation which was initially submitted for CEN enquiry as prEN 1555-6 [1] was withdrawn when EN 12007-2 [2], prepared by CEN/TC 234 "Gas supply", was published with the title "Gas supply systems - Pipelines for maximum operating pressure up to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

Introduction

The System Standard, of which this is Part 1, specifies the requirements for 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 components of the piping system are specified in prEN 1555-2:2008, prEN 1555-3:2008 and prEN 1555-4:2008. Characteristics for fitness for purpose are covered in prEN 1555-5:2008. CEN/TS 1555-7 gives guidance for assessment of conformity. Recommended practice for installation is given in EN 12007-2, prepared by CEN/TC 234.

This part of EN 1555 covers the general aspects of the plastics piping system.

1 Scope

This part of EN 1555 specifies the general aspects of polyethylene (PE) piping systems in the field of the supply of gaseous fuels.

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, and 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 prEN 1555-5:2008.

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

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.

prEN 1555-2:2008, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes*

EN 12099, *Plastics piping systems — Polyethylene piping materials and components — Determination of volatile content*

EN ISO 472, *Plastics — Vocabulary (ISO 472:1999)*

EN ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics (ISO 1043-1:2001)*

EN ISO 1133:2005, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133:2005)*

EN ISO 1167-1:2006, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method (ISO 1167-1:2006)*

EN ISO 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 1167-2:2006)*

EN ISO 6259-1, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method (ISO 6259-1:1997)*

1 bar = 0,1 MPa

prEN ISO 9080, *Thermoplastics pipes for the transport of fluids — Methods of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastics pipe materials. (ISO/DIS 9080:2008)*

prEN ISO 12162:2007, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient (ISO/DIS 12162:2007)*

EN 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 13477:2008)*

EN ISO 13478, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST) (ISO/FDIS 13478:2007)*

prEN ISO 13479:2008, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes (notch test) (ISO/DIS 13479:2008)*

EN ISO 16871, *Plastics piping and ducting systems — Plastics pipes and fittings — Method for exposure to direct (natural) weathering (ISO 16871:2003)*

ISO 760:1978, *Determination of water content — Karl Fischer method (General method)*

ISO/FDIS 11357-6:2008, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 15512:2007, *Plastics — Determination of water content*

ISO 6259-3:1997, *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes*

ISO 6964:1986, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method and basic specification*

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

ISO/FDIS 11414:2008, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion*

ISO 13953:2001, *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 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

3 Terms and definitions, symbols and abbreviations

For the purposes of this European Standard, the following terms and definitions, symbols and abbreviations apply.

3.1 Terms and definitions

For the purposes of this document the terms and definitions given in EN ISO 472 and EN ISO 1043-1 apply in addition to the following.

3.1.1 Geometrical definitions

3.1.1.1
nominal size DN/OD
numerical designation of the size of a component, other than a component designated by thread size, which is a convenient round number, approximately equal to the manufacturing dimension in millimetres (mm) and related to the outside diameter

3.1.1.2
nominal outside diameter
d_n
specified outside diameter, in millimetres, assigned to a nominal size DN/OD

3.1.1.3
outside diameter (at any point)
d_e
value of the measurement of the outside diameter through its cross-section at any point of the pipe, rounded to the next greater 0,1 mm

3.1.1.4
mean outside diameter
d_{em}
value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by π (= 3,142), rounded to the next greater 0,1 mm

3.1.1.5
minimum mean outside diameter
$d_{em,min}$
minimum value for the mean outside diameter as specified for a given nominal size

3.1.1.6
maximum mean outside diameter
$d_{em,max}$
maximum value for the mean outside diameter as specified for a given nominal size

3.1.1.7
out-of-roundness (ovality)
difference between the maximum and the minimum outside diameter in the same cross-section of a pipe or spigot

3.1.1.8
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 For thermoplastics components conforming to prEN 1555:2008, the value of the nominal wall thickness, en, is identical to the specified minimum wall thickness at any point, e_{min}.

3.1.1.9
wall thickness (at any point)
e
wall thickness at any point around the circumference of a component

NOTE The symbol for the wall thickness of the fittings and valves body at any point is E.

3.1.1.10
minimum wall thickness (at any point)
e_{min}
minimum value for the wall thickness at any point around the circumference of a component, as specified

3.1.1.11
maximum wall thickness (at any point)
e_{max}
maximum value for the wall thickness at any point around the circumference of a component, as specified

3.1.1.12
mean wall thickness
e_m
arithmetical mean of a number of measurements of the wall thickness, regularly spaced around the circumference and in the same cross-section of a component, including the measured minimum and the measured maximum values of the wall thickness in that cross-section

3.1.1.13
tolerance
permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value

3.1.1.14
wall thickness tolerance
t_y
permitted difference between the wall thickness at any point, e, and the nominal wall thickness, e_n

NOTE $e_n \leq e \leq e_n + t_y$

3.1.1.15
standard dimension ratio (SDR)
numerical designation of a pipe series, which is a convenient round number, approximately equal to the dimension ratio of the nominal outside diameter, d_n, and the nominal wall thickness, e_n

3.1.2 Material definitions

3.1.2.1
virgin material
material in a form such as granules that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessable or recyclable materials have been added

3.1.2.2
own reprocessable material
material prepared from clean rejected unused pipes, fittings or valves, including trimmings from the production of pipes, fittings or valves, that will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer in the production of components by, for example injection-moulding or extrusion

3.1.2.3
compound
homogenous extruded mixture of base polymer (PE) and additives, i.e. anti-oxidants, pigments, UV-stabilisers and others, at a dosage level necessary for the processing and use of components conforming to the requirements of this standard

3.1.3 Definitions related to material characteristics

3.1.3.1
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 a temperature θ and time t

NOTE It is expressed in megapascals.

3.1.3.2
minimum required strength (MRS)
value of σ_{LPL} at 20 °C and 50 years, rounded down to the next smaller value of the R10 series or the R20 series conforming to ISO 3 [3] and ISO 497 [4], depending on the value of σ_{LPL}

3.1.3.3
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

3.1.3.4
design stress
σ_s
allowable stress for a given application, that is derived from the MRS by dividing it by the coefficient C, i.e.:

$$\sigma_S = \frac{\text{MRS}}{C}$$

NOTE It is expressed in megapascals.

3.1.3.5
melt-mass flow rate (MFR)
value relating to the viscosity of the molten material at a specified temperature and load, expressed in grams per 10 min (g/10 min)

3.1.4 Definitions related to service conditions

3.1.4.1
gaseous fuel
any fuel which is in gaseous state at a temperature of 15 °C, at the atmospheric pressure

3.1.4.2
maximum operating pressure (MOP)
maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use

NOTE It is expressed in bar and takes into account the physical and the mechanical characteristics of the components of a piping system and it is calculated using the following equation:

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

3.1.4.3
reference temperature
temperature for which the piping system is designed

NOTE 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.

3.1.5 Definitions related to joints

3.1.5.1
butt fusion joint (using heated tool)
joint made by heating the planed ends of pipes or spigot end fittings, 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

3.1.5.2
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

3.2 Symbols

C : design coefficient

d_e : outside diameter (at any point)

d_{em} : mean outside diameter

$d_{em,max}$: maximum mean outside diameter

$d_{em,min}$: minimum mean outside diameter

d_n : nominal outside diameter

E : wall thickness (at any point) of a fitting and valve body

e : wall thickness (at any point) of a pipe

e_m : mean wall thickness

e_{max} : maximum wall thickness (at any point)

e_{min} : minimum wall thickness (at any point)

e_n : nominal wall thickness

t_y : wall thickness tolerance

σ_s : design stress

3.3 Abbreviations

DN/OD : nominal size, outside diameter related

LPL : lower predicted limit

MFR : melt mass-flow rate

MOP : maximum operating pressure

MRS : minimum required strength

PE : polyethylene

R : series of preferred numbers, conforming to the Renard series

SDR : standard dimension ratio

4 Material

4.1 Material of the components

The pipes, fittings and valves shall be made of polyethylene compound.

4.2 Compound

4.2.1 Additives

The compound shall be made by adding to the polyethylene base polymer only those additives necessary for the manufacture of pipes, fittings and valves conforming to prEN 1555-2:2008, prEN 1555-3:2008 [5] or prEN 1555-4:2008 [6], as applicable, and for their fuseability, storage and use.

All additives used shall take into account national legislation.

4.2.2 Colour

The colour of the compound shall be yellow (PE 80), orange (PE 100), or black (PE 80 and PE 100). The carbon black used in the production of black compound shall have an average (primary) particle size of 10 nm to 25 nm.

Non-pigmented compounds are permitted for the base pipe of peelable layer pipe providing the outer peelable layer is either black, yellow or orange, see Annex B of prEN 1555-2:2008.

4.2.3 Characteristics

4.2.3.1 Characteristics of the compound in the form of granules

The compound in the form of granules used for the manufacture of pipes, fittings and valves shall have characteristics conforming to the requirements given in Table 1.

Table 1 — Characteristics of the compound in the form of granules

Characteristic	Requirements [a]	Test parameters		Test method
		Parameter	Value	
Oxidation induction time (Thermal stability)	> 20 min	Test temperature Number of test pieces [b]	200 °C [c] 3	ISO/FDIS 11357-6:2008
Melt mass-flow rate (MFR)	(0,2 ≤ MFR ≤ 1,4) g/10 min Maximum deviation of ± 20 % of the nominated value [d]	Loading mass Test temperature Time Number of test pieces [b]	5 kg 190 °C 10 min Shall conform to EN ISO 1133:2005	EN ISO 1133:2005
Volatile content	≤ 350 mg/kg	Number of test pieces [b]	1	EN 12099
Water content [e]	≤ 300 mg/kg (Equivalent to < 0,03 % by mass)	Number of test pieces [b]	1	ISO 15512
Carbon black content [f]	(2 to 2,5) % (by mass)	Shall conform to ISO 6964		ISO 6964
Carbon black dispersion [f]	Grade ≤ 3 Rating of dispersion A1, A2, A3 or B	Preparation of test pieces Number of test pieces [b]	Free [g] Shall conform to ISO 18553	ISO 18553
Pigment dispersion [h]	Grade ≤ 3 Rating of dispersion A1, A2, A3 or B	Preparation of test pieces Number of test pieces [b]	Free [g] Shall conform to ISO 18553	ISO 18553

[a] Conformity to these requirements shall be proved by the compound producer.
[b] 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 CEN/TS 1555-7 [7].
[c] Test may be carried out at 210 °C providing that there is a clear correlation with the results at 200 °C. In case of dispute the reference temperature shall be 200 °C.
[d] Nominated value given by the compound manufacturer.
[e] Only applicable, if the measured volatile content is not in conformity to its specified requirement. In case of dispute the requirement for water content shall be used. As an alternative method, ISO 760:1978 may apply. The requirement applies to the compound producer at the stage of manufacturing and to the compound user at the stage of processing (if the water content exceeds the limit, drying is required prior to use.
[f] Only for black compound.
[g] In case of dispute, the test pieces shall be prepared by the compression method.
[h] Only for non-black compounds.

4.2.3.2 Characteristics of the compound in the form of pipe

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 2.

The compound in the form of pipe used for the manufacture of pipes, fittings and valves, shall have characteristics conforming to the requirements given in Table 2.

Table 2 — Characteristics of compound in the form of pipe

Characteristic	Requirements [a]	Test parameters		Test method
		Parameter	Value	
Resistance to gas condensate	No failure during the test period of all test pieces	End caps Test temperature Orientation Number of test pieces [b] Circumferential (hoop) stress Pipe dimensions: d_n e_n Type of test Test period Conditioning period (pipe filled with condensate)	Type a) of EN ISO 1167-1:2006 80 °C Free 3 2,0 MPa 32 mm 3 mm Synthetic condensate [c] in water 20 h 1500 h in air at 23 °C	EN ISO 1167-1:2006 and EN ISO 1167-2
Resistance to weathering [d]	The weathered test pieces shall fulfil the requirements of the following characteristics:	Preconditioning (weathering): Cumulative solar radiation Number of test pieces [b]	≥ 3,5 GJ/m^2 See below	EN ISO 16871
a) de-cohesion of an electrofusion joint	Sample prepared in accordance with ISO/FDIS 11413:2008, Jointing condition 1: 23 °C; ≤ 33% brittle failure			a) ISO 13954
b) hydrostatic strength (1000 h at 80 °C);	b) shall conform to Table 4 of prEN 1555-2:2008			b) EN ISO 1167-1:2006 and EN ISO 1167-2
c) elongation at break	c) shall conform to Table 4 of prEN 1555-2:2008.			c) EN ISO 6259-1 and ISO 6259-3
Resistance to rapid crack propagation (Critical pressure, p_c) ($e \geq 15$ mm)	$P_c \geq 1{,}5$ MOP with $p_c = 3{,}6\ p_{c,s4} + 2{,}6$ [e]	Test temperature Number of test pieces [b]	0 °C Shall conform to EN ISO 13477	EN ISO 13477
Resistance to slow crack growth (d_n: 110 mm or 125 mm – SDR 11)	No failure during the test period	Test temperature Internal test pressure: for PE 80 PE 100 Test period Type of test Number of test pieces [b]	80 °C 8,0 bar 9,2 bar 500 h Water-in-water Shall conform to prEN ISO 13479	prEN ISO 13479

[a] Conformity to these requirements shall be proved by the compound producer.

[b] 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 CEN/TS 1555-7 [6].

[c] 50 % (by mass) n-decane and 50 % (by mass) 1-3-5 trimethylbenzene.

[d] Only for non-black compounds.

[e] Full scale/S4 correlation factor is equal to 3,6 and is defined as the full scale/S4 critical absolute pressure ratio: $(p_{c,\text{full scale}} + 1) = 3{,}6\ (p_{c,s4} + 1)$.

If the requirement is not met or S4 test equipment not available, then (re)testing by using the full scale test shall be performed in accordance with prEN ISO 13478. In this case: $p_c = p_{c,\text{full scale}}$.

NOTE Attention is drawn to the fact that the correlation factor may be modified, when revising this Standard, according to the result of work of ISO/TC 138/SC4 "Plastics pipes, fittings and valves for the supply of gaseous fuels".

4.3 Fusion compatibility

4.3.1 The compounds conforming to Table 1 shall be fusible. This shall be demonstrated by the compound manufacturer for each compound of his own product range by checking that the requirement on tensile strength given in Table 3 is fulfilled for a butt fusion joint prepared by using the parameters as specified in Annex A of ISO/FDIS 11414:2008 at an ambient temperature of (23 ± 2) °C from pipes both manufactured from that compound.

4.3.2 Compounds conforming to Table 1 are considered fusible to each other. If requested, the compound manufacturer shall demonstrate this by checking that the requirement for the failure mode in a tensile test given in Table 3 is fulfilled for a butt fusion joint prepared by using the parameters as specified in Annex A of ISO/FDIS 11414:2008 at an ambient temperature of (23 ± 2) °C from two pipes manufactured from the compounds from his own range covered by this request.

Table 3 — Characteristic of compound in the form of butt fusion joint

Characteristic	Requirement [a]	Test parameters		Test method
		Parameter	Value	
Determination of the failure mode in a tensile test on buttfusion weld (d_n : 110 mm or 125 mm - SDR 11)	Test to failure: Ductile – pass Brittle – fail	Test temperature Number of test pieces [b]	23 °C Shall conform to ISO 13953	ISO 13953

[a] The conformity to these requirements shall be proved by the compound producer.
[b] 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 CEN/TS 1555-7 [6].

4.4 Classification and designation

Compounds shall be designated by the type of PE material. The level of minimum required strength (MRS) shall conform to Table 4 when tested in the form of pipe.

Table 4 — Classification and designation of compounds

Classification by MRS MPa	Designation
8,0	PE 80
10,0	PE 100

The compound shall be evaluated in accordance with EN ISO 9080 from pressure tests on pipe in accordance with EN ISO 1167-1:2006 and EN ISO 1167-2 performed on pipe at least at three temperatures, where two of the temperatures are fixed to 20 °C and 80 °C, and a third temperature is free between 30 °C and 70 °C, to find the σ_{LPL}. The MRS-value shall be derived from the σ_{LPL} and the compound shall be classified by the compound producer in accordance with prEN ISO 12162:2007.

At 80 °C, there shall be no knee detected in the regression curve at t < 5000 h.

The conformity of the designation of the compound to the classification given in Table 4 shall be demonstrated by the compound producer.

Where fittings are manufactured from the same compound as pipes, then the material classification shall be the same as for pipes.

For the classification of a compound intended only for the manufacture of fittings, the test pieces shall be made from extruded pipe.

4.5 Design coefficient and design stress

The design coefficient, C, for pipes, fittings and valves for the supply of gaseous fuels shall be greater or equal to 2.

The maximum value for the design stress, σ_s, shall be for PE 80, 4,0 MPa and for PE 100, 5,0 MPa.

4.6 External reprocessable and recyclable material

Reprocessable material obtained from external sources and recyclable material shall not be used.

Bibliography

[1] prEN 1555-6, *Plastics piping systems for gaseous fuels supply — Polyethylene (PE) — Part 6: Recommended practice for installation*

[2] 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)*

[3] ISO 3:1973, *Preferred numbers — Series of preferred numbers*

[4] ISO 497:1973, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

[5] prEN 1555-3:2008, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*

[6] prEN 1555-4:2008, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 4: Valves*

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