INTERNATIONAL STANDARD

ISO 22391-5

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Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) —

Part 5: Fitness for purpose of the system

Systèmes de canalisations en plastique pour les installations d'eau chaude et froide — Polyéthylène de meilleure résistance à la température (PE-RT) —

Partie 5: Aptitude à l'emploi du système

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Foreword

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

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

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

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

ISO 22391-5 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings 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 22391-5:2007), which is extended from only dealing with PE-RT material (referred to as Type I) to cover PE-RT materials Type I and Type II.

ISO 22391 consists of the following parts[1)], under the general title *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

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

1) This System Standard does not incorporate a Part 4: Ancillary equipment or a Part 6: Guidance for installation. For ancillary equipment, separate standards can apply. Guidance for installation of plastics piping systems made from different materials, intended to be used for hot and cold water installations, is covered by ENV 12108.

Introduction

The System Standard, of which this is Part 5, specifies the requirements for a piping system and its components when made from polyethylene of raised temperature resistance (PE-RT). The piping system is intended to be used for hot and cold water installations.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by ISO 22391, the following are relevant.

a) This part of ISO 22391 provides no information as to whether the products can be used without restriction.

b) Existing national regulations concerning the use and/or characteristics of the products remain in force.

This part of ISO 22391 specifies the characteristics of fitness for purpose of the system. At the date of publication of this part of ISO 22391, System Standards Series for piping systems of other plastics materials used for the same application are the following:

ISO 15874 (all parts), *Plastics piping systems for hot and cold water installations — Polypropylene (PP)*

ISO 15875 (all parts), *Plastics piping systems for hot and cold water installations — Crosslinked polyethylene (PE-X)*

ISO 15876 (all parts), *Plastics piping systems for hot and cold water installations — Polybutylene (PB)*

ISO 15877 (all parts), *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C)*

Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) —

Part 5: Fitness for purpose of the system

1 Scope

This part of ISO 22391 specifies the characteristics of the fitness for purpose of piping systems made of

— polyethylene of raised temperature resistance (PE-RT), Type I, and

— polyethylene of raised temperature resistance (PE-RT), Type II,

intended to be used for hot and cold water installations within buildings for the conveyance of water, whether or not the water is intended for human consumption (domestic systems) and for heating systems, under the design pressures and temperatures appropriate to the class of application according to ISO 22391-1.

This part of ISO 22391 covers a range of service conditions (classes of application), design pressures and pipe dimension classes, and also specifies test parameters and test methods. In conjunction with the other parts of ISO 22391, it is applicable to PE-RT pipes, fittings, their joints, and to joints having components of PE-RT as well as of other plastics and non-plastics materials, respectively, used for hot and cold water installations.

It is not applicable to values of design temperature, maximum design temperature or malfunction temperature in excess of those specified in ISO 22391-1.

NOTE 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.

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

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

ISO 22391-1:2009, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 1: General*

ISO 22391-2:2009, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 2: Pipes*

EN 712, *Thermoplastics piping systems — End-load bearing mechanical joints between pressure pipes and fittings — Test method for resistance to pull-out under constant longitudinal force*

EN 713, *Plastics piping systems — Mechanical joints between fittings and polyolefin pressure pipes — Test method for leaktightness under internal pressure of assemblies subjected to bending*

EN 12293, *Plastics piping systems — Thermoplastics pipes and fittings for hot and cold water — Test method for the resistance of mounted assemblies to temperature cycling*

EN 12294, *Plastics piping systems — Systems for hot and cold water — Test method for leaktightness under vacuum*

EN 12295, *Plastics piping systems — Thermoplastics pipes and associated fittings for hot and cold water — Test method for resistance of joints to pressure cycling*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 22391-1 apply.

4 Fitness for purpose of joints and piping system

4.1 General

The joints and the piping system shall be tested in accordance with Table 1 and 4.2 to 4.7, as applicable. When tested, their characteristics shall be in accordance with the requirements of the corresponding subclauses.

For the tests given in Table 1, applicable for each of the different types of jointing system covered by this part of ISO 22391, the fittings shall be connected to the pipe with which they are intended to be used.

Table 1 — Joint tests

Test	Jointing system			Test parameters (subclause of this part of ISO 22391 in which given)	Test method
	SW	EF	M		
Internal pressure test	Yes	Yes	Yes	4.2	ISO 1167-1 and ISO 1167-2
Bending test	N/A	N/A	Yes	4.3	EN 713
Pull-out test	N/A	N/A	Yes	4.4	EN 712
Thermal cycling test	Yes	Yes	Yes	4.5	EN 12293
Pressure cycling test	N/A	N/A	Yes	4.6	EN 12295
Leaktightness under vacuum test	N/A	N/A	Yes	4.7	EN 12294
SW Socket fusion joint.					
EF Electrofusion joint.					
M Mechanical joint.					
Yes Test applicable.					
N/A Not applicable.					

4.2 Internal pressure test

When tested in accordance with ISO 1167-1 and ISO 1167-2, using the test parameters specified in Table 2 or Table 3 for the relevant classes, the joint assemblies shall not leak.

The test pressure, p_J, for a given time to failure and test temperature shall be determined using Equation (1):

$$p_J = p_D \times \frac{\sigma_P}{\sigma_{DP}} \quad (1)$$

where

p_J is the hydrostatic test pressure, in bar[2)], to be applied to the joint assembly during the test period;

σ_P is the hydrostatic stress value, in megapascals (MPa), for the pipe material corresponding to time-to-failure/test temperature points, as given in Table 2;

σ_{DP} is the design stress value, in megapascals (MPa), for the pipe material as determined for each class and according to ISO 22391-2:2009, Table A.2;

p_D is the design pressure of 4 bar, 6 bar, 8 bar or 10 bar, as applicable.

In special circumstances, if joint tests according to this subclause cause leaks resulting from differential-elongation-induced deformations, a test pressure may be determined from the stress and creep data (relative to a design period of 50 years) for the different materials used.

Table 2 — Test parameters for internal pressure test for PE-RT Type I

	Application class			
	1	2	4	5
Maximum design temperature, T_{max}, °C	80	80	70	90
Design stress of pipe material, σ_{DP}, MPa	3,29	2,68	3,25	2,38
Test temperature[a], T_{test}, °C	95	95	80	95
Test duration, t, h	1 000	1 000	1 000	1 000
Hydrostatic stress of pipe material, σ_P, MPa	3,4	3,4	4,5	3,4
Test pressure, p_J, bar for a design pressure, p_D, of				
4 bar	5,1[b]	5,1[b]	6,8[b]	5,8
6 bar	6,3	7,7	8,4	8,7
8 bar	8,3	10,2	11,2	11,5
10 bar	10,4	12,8	14,0	14,4
Number of test pieces	3	3	3	3

[a] Generally the highest test temperature is taken to be (T_{max} + 10) °C with an upper limit of 95 °C. However, in order to match existing test facilities, the highest test temperature for classes 1 and 2 is also set at 95 °C. The hydrostatic stresses given correspond to the given test.

[b] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 22391-1:2009, Clause 4).

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

Table 3 — Test parameters for internal pressure test for PE-RT Type II

	Application class			
	1	2	4	5
Maximum design temperature, T_{max}, °C	80	80	70	90
Design stress of pipe material, σ_{DP}, MPa	3,53	3,37	3,38	2,88
Test temperature[a], T_{test}, °C	95	95	80	95
Test duration, t, h	1 000	1 000	1 000	1 000
Hydrostatic stress of pipe material, σ_P, MPa	3,6	3,6	4,8	3,6
Test pressure, p_J, bar for a design pressure, p_D, of				
4 bar	4,8[b]	4,8[b]	6,4[b]	5,0
6 bar	6,1	6,4	8,5	7,5
8 bar	8,1	8,5	11,4	10,0
10 bar	10,2	10,6	14,2	12,4
Number of test pieces	3	3	3	3

[a] Generally the highest test temperature is taken to be (T_{max} + 10) °C with an upper limit of 95 °C. However, in order to match existing test facilities, the highest test temperature for classes 1 and 2 is also set at 95 °C. The hydrostatic stresses given correspond to the given test.

[b] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 22391-1:2009, Clause 4).

4.3 Bending test

When tested in accordance with EN 713, to the applicable pressure for the 20 °C, 1 h condition, using the test parameters according to Table 4 or Table 5 and a bending radius equal to the minimum radius of bending for the pipes as recommended by the system supplier, the joint assembly shall not leak.

This test is only applicable to pipes of nominal diameter greater than or equal to 32 mm.

Table 4 — Test parameters for bending test for PE-RT Type I

	Application class			
	1	2	4	5
Maximum design temperature, T_{max}, °C	80	80	70	90
Design stress of pipe material, σ_{DP}, MPa	3,29	2,68	3,25	2,38
Test temperature, T_{test}, °C	20	20	20	20
Test duration, t, h	1	1	1	1
Hydrostatic stress of pipe material, σ_P, MPa	9,9	9,9	9,9	9,9
Test pressure, p_J, bar for a design pressure, p_D, of				
4 bar	14,8[a]	14,8[a]	14,8[a]	16,6
6 bar	18,0	22,1	18,2	24,8
8 bar	24,0	29,4	24,3	33,1
10 bar	29,9	36,8	30,3	41,4
Number of test pieces	3	3	3	3

[a] Being higher, the 20 °C, 10 bar, 50 years, cold water requirement determines this value (see ISO 22391-1:2009, Clause 4).

Table 5 — Test parameters for bending test for PE-RT Type II

	Application class			
	1	**2**	**4**	**5**
Maximum design temperature, T_{max}, °C	80	80	70	90
Design stress of pipe material, σ_{DP}, MPa	3,53	3,37	3,38	2,88
Test temperature, T_{test}, °C	20	20	20	20
Test duration, t, h	1	1	1	1
Hydrostatic stress of pipe material, σ_P, MPa	10,84	10,84	10,84	10,84
Test pressure, p_J, bar for a design pressure, p_D, of				
4 bar	14,5[a]	14,5[a]	14,5[a]	15,0
6 bar	18,4	19,3	19,2	22,6
8 bar	24,5	25,7	25,6	30,1
10 bar	30,7	32,1	32,0	37,6
Number of test pieces	3	3	3	3

[a] Being higher, the 20 °C, 10 bar, 50 years, cold water requirement determines this value (see ISO 22391-1:2009, Clause 4).

4.4 Pull-out test

When tested in accordance with EN 712, using the test parameters according to Table 6, the joint assemblies shall withstand the pull-out force without being separated.

The force, F, expressed in newtons (N), shall be calculated using Equation (2):

$$F = \frac{\pi}{4} d_n{}^2 \times p_D \tag{2}$$

where

d_n is the nominal outside diameter of the pipe, expressed in millimetres (mm);

p_D is the design pressure of 4 bar, 6 bar, 8 bar or 10 bar, as applicable, expressed in megapascals (MPa).

For “All”, in Table 6, the design pressure shall be 10 bar, expressed in megapascals (MPa).

Table 6 — Test parameters for pull-out test

	Application class				
	All	**1**	**2**	**4**	**5**
Maximum design temperature, T_{max}, °C	—	80	80	70	90
Test temperature, T_{test}, °C	23	90	90	80	95
Test duration, t, h	1	1	1	1	1
Pull-out force, N	$1{,}5 \times F$	F	F	F	F
Number of test pieces	3	3	3	3	3

4.5 Thermal cycling test

When tested in accordance with EN 12293, using the test parameters specified in Table 7, the pipes, fittings or joints, as applicable, shall withstand the test without leakage.

The test for flexible pipes shall only be used when the manufacturer declares that the pipe can be bent to the configuration shown. The bending radius shall not be smaller than the minimum declared bending radius. In all other cases, the test for rigid pipes shall apply.

Table 7 — Test parameters for thermal cycling test

	Application class			
	1	2	4	5
Maximum design temperature, T_{max}, °C	80	80	70	90
Highest test temperature, °C	90	90	80	95
Lowest test temperature, °C	20	20	20	20
Test pressure, bar	p_D	p_D	p_D	p_D
Number of cycles[a]	5 000	5 000	5 000	5 000
Number of test pieces	One set of fittings in accordance with the configuration of EN 12293.			

[a] Each cycle shall comprise 15^{+1}_{0} min at the highest test temperature and 15^{+1}_{0} min at the lowest (i.e. the duration of one cycle is 30^{+2}_{0} min).

The tensile stress, σ_t, used to calculate the pre-stress force required by EN 12293 shall be 2,2 MPa for PE-RT Type I and 2,6 MPa for PE-RT Type II.

The tensile stress, σ_t, expressed in megapascals (MPa), shall be calculated using Equation (3):

$$\sigma_t = \alpha \times \Delta T \times E \tag{3}$$

where

α is the coefficient of thermal expansion, expressed in reciprocal kelvin (1/K);

ΔT is the temperature difference, expressed in kelvin (K);

E is the modulus of elasticity, expressed in megapascals (MPa).

For the purposes of this part of ISO 22391:

α = $1{,}9 \times 10^{-4}$ K^{-1}

ΔT = 20 K

E = 580 MPa for PE-RT Type I

E = 680 MPa for PE-RT Type II