INTERNATIONAL STANDARD

ISO 15877-5

Second edition
2009-03-15

Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C) —

Part 5: Fitness for purpose of the system

Systèmes de canalisations en plastique pour les installations d'eau chaude et froide — Poly(chlorure de vinyle) chloré (PVC-C) —

Partie 5: Aptitude à l'emploi du système

Reference number
ISO 15877-5:2009(E)

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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 15877-5 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in collaboration with ISO 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*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This part of ISO 15877 is 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.

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

This second edition cancels and replaces the first edition (ISO 15877-5:2003).

ISO 15877 consists of the following parts [1)], under the general title *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

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

— *Part 7: Guidance for the assessment of conformity* (ISO/TS 15877-7)

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 [2].

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At the date of publication of this part of ISO 15877, 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 22391:— [2] (all parts), *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT)*

2) To be published. (Revisions of ISO 22391-1:2007, ISO 22391-2:2007, ISO 22391-3:2007, ISO 22391-5:2007.)

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Introduction

The System Standard, of which this is Part 5, specifies the requirements for a piping system and its components when made from chlorinated poly(vinyl chloride) (PVC-C). The piping system is intended to be used for hot and cold water installations and heating system installations.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the product covered by ISO 15877, the following are relevant.

a) This part of ISO 15877 provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA.

b) It should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

Requirements and test methods for components of the piping system are specified in ISO 15877-1, ISO 15877-2 and ISO 15877-3 of this System Standard. ISO/TS 15877-7 gives guidance for the assessment of conformity.

This part of ISO 15877 specifies the characteristics of fitness for purpose of the piping systems.

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Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C) —

Part 5: Fitness for purpose of the system

1 Scope

This part of ISO 15877 specifies the characteristics of the fitness for purpose of chlorinated poly(vinyl chloride) (PVC-C) piping systems, intended to be used for hot and cold water installations within buildings for the conveyance of water, whether or not intended for human consumption, (domestic systems) and for heating systems, under design pressures and temperatures according to the class of application (see Table 1 of ISO 15877-1:2009).

This part of ISO 15877 covers a range of service conditions (application classes) and design pressure classes. For values of T_D, T_{max} and T_{mal} in excess of those in Table 1 of ISO 15877-1:2009, this part of ISO 15877 does not apply.

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.

It also specifies the test parameters for the test methods referred to in this part of ISO 15877.

In conjunction with the other parts of ISO 15877, it is applicable to PVC-C pipes, fittings, their joints and joints with components of other plastics and non-plastics materials intended to be used for hot and cold water installations.

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 15877-1:2009, *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C) — Part 1: General*

ISO 15877-2:2009, *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C) — 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 12293, *Plastics piping systems — Thermoplastics pipes and fittings for hot and cold water — Test method for the resistance of mounted assemblies to temperature cycling*

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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 and definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions, symbols and abbreviated terms given in ISO 15877-1 apply.

4 Fitness for purpose of the joints and the piping system

4.1 General

When tested in accordance with the applicable test methods as specified in Table 1, using the indicated parameters given in 4.2 to 4.6, as applicable, the joints and the piping system shall have characteristics conforming to the requirements given in the applicable clauses.

For testing, the fittings shall be connected to the corresponding pipes for which they are intended to be used. The assembly instructions of the manufacturer of the components shall be taken into account.

Table 1 specifies the tests applicable for each different type of jointing system covered by this part of ISO 15877.

Table 1 — Joint tests

Test	Jointing system [a]		Test parameters	Test method
	SC	M		
Internal pressure test	Y	Y	Shall conform to 4.2	ISO 1167-1
Pull-out test	N	Y	Shall conform to 4.3	EN 712
Thermal cycling test	Y	Y	Shall conform to 4.4	EN 12293
Pressure cycling test	Y	Y	Shall conform to 4.5	EN 12295
Vacuum test	Y	Y	Shall conform to 4.6	EN 12294

[a] SC – Solvent cement joint;
M – Mechanical joint;
Y – denotes test applicable;
N – denotes test not applicable.

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4.2 Internal pressure test

4.2.1 General

When tested in accordance with the test method specified in Table 2, using the indicated parameters, the joint assemblies shall not leak.

Solvent cement joints comprising PVC-C pipes and fittings shall be tested in accordance with 4.2.2. When testing mechanical joint assemblies with compression fittings, the requirements given in 4.2.3 shall apply.

Table 2 — General test parameters for testing resistance to internal pressure

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure	No failure during the test period	Sampling procedure Type of end caps Orientation of test piece Type of test	Not specified [a] Types A or B Vertical Water-in-air	ISO 1167-1
[a] For guidance, see ISO/TS 15877-7 [1].				

4.2.2 Solvent cement joints

The solvent cement joint shall be tested in the form of test pieces comprising couplers with solvent cemented pipe sections.

The fittings shall be connected to the corresponding pipe conforming to ISO 15877-2, using solvent cement in such a way that the required hydrostatic test pressure, p_J, given in Table 3 or Table 4, can be applied.

Before testing, store the fittings with solvent cemented pipe sections for setting for at least 20 d at ambient temperature and, after that, 4 d at 80 °C, unless the manufacturer of the adhesive has prescribed other setting times.

The free ends of the pipe sections shall be provided with end caps in such a way that the axial forces caused by the internal pressure are transferred to the solvent cement joint.

The hydrostatic test pressure, p_J, shall be calculated in relation to the class of service conditions and the design pressure using Equation (1):

$$p_J = p_D \times \frac{\sigma_F}{\sigma_{DF}} \tag{1}$$

where

p_J is the hydrostatic test pressure, in bar [3)], to be applied to the solvent cement joint assembly during the test period;

σ_F is the value of the hydrostatic stress, in megapascals, of the fitting material, corresponding to the test duration and test temperature conditions given in Table 3 or Table 4, as applicable;

σ_{DF} is the design stress, in megapascals, in the fitting material as determined for the appropriate class of service conditions from data produced in accordance with Table A.2 of ISO 15877-2:2009;

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

3) 1 bar = 0,1 MPa = 0,1 N/mm^2 = 10^5 N/m^2.

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Table 3 — Derivation of hydrostatic test pressure of solvent cement joints for PVC-C Type I

		Class 1	Class 2
Maximum design temperature T_{max}	°C	80	80
Design stress in the fitting material σ_{DF}	MPa	3,17	3,08
Test temperature T_{Test}	°C	80	80
Test duration t	h	⩾ 3 000	⩾ 3 000
Hydrostatic stress of the fitting material σ_F	MPa	6,14	6,14
Test pressure p_J	in bars		
for a design pressure, p_D, of:	4 bar	7,7	8,0
	6 bar	11,6	12,0
	8 bar	15,5	15,9
	10 bar	19,4	19,9
Number of test pieces		3	3

Table 4 — Derivation of hydrostatic test pressure of solvent cement joints for PVC-C Type II

		Class 1	Class 2	Class 4	Class 5
Maximum design temperature T_{max}	°C	80	80	70	90
Design stress in the fitting material σ_{DF}	MPa	3,74	3,21	4,31	2,26
Test temperature T_{Test}	°C	95	95	80	95
Test duration t	h	⩾ 1 000	⩾ 1 000	⩾ 1 000	⩾ 1 000
Hydrostatic stress of the fitting material σ_F	MPa	4,37	4,37	8,59	4,37
Test pressure p_J	in bars				
for a design pressure, p_D, of:	4 bar	4,7	5,5	8,0	7,7
	6 bar	7,0	8,2	12,0	11,6
	8 bar	9,4	10,9	[15,9] [a]	[15,5] [a]
	10 bar	11,7	13,6	[19,9] [a]	[19,4] [a]
Number of test pieces		3	3	3	3

[a] Calculated values provided for informational purposes only and shall not be interpreted for practical use.

If, during the testing of solvent cement joints according to this clause, leaks resulting from deformations induced by differential elongation occur, 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.

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4.2.3 Mechanical joints

The mechanical joint assemblies shall be tested in the form of test pieces comprising compression fittings with mounted pipe sections.

The compression fittings shall be connected to the corresponding pipe conforming to ISO 15877-2 in such a way that the required hydrostatic test pressure, p_J, given in Table 5 or Table 6, as applicable, can be applied.

The hydrostatic test pressure, p_J, shall be calculated in relation to the class of service conditions and the design pressure, using Equation (2):

$$p_J = p_D \times \frac{\sigma_P}{\sigma_{DP}} \tag{2}$$

where

p_J is the hydrostatic test pressure, in bars, to be applied to the mechanical joint assembly during the test period;

σ_P is the value of the hydrostatic stress, in megapascals, of the pipe material, corresponding to the test duration and the test temperature conditions given in Table 5 or Table 6, as applicable;

σ_{DP} is the design stress, in megapascals, in the pipe material as determined for the appropriate class of service conditions from data produced in accordance with Table A.2 of ISO 15877-2:2009;

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

Table 5 — Derivation of hydrostatic test pressure of mechanical joints for PVC-C Type I

		Class 1	Class 2
Maximum design temperature T_{max}	°C	80	80
Design stress in the pipe material σ_{DP}	MPa	4,38	4,16
Test temperature T_{Test}	°C	80	80
Test duration t	h	$\geqslant$ 3 000	$\geqslant$ 3 000
Hydrostatic stress of the pipe material σ_P	MPa	8,25	8,25
Test pressure p_J	in bars		
for a design pressure, p_D, of	4 bar	7,5	7,9
	6 bar	11,3	11,9
	8 bar	15,1	15,9
	10 bar	18,8	19,8
Number of test pieces		3	3

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Table 6 — Derivation of hydrostatic test pressure of mechanical joints for PVC-C Type II

		Class 1		Class 2		Class 4		Class 5	
Maximum design temperature T_{max}	°C	80		80		70		90	
Design stress in the pipe material σ_{DP}	MPa	4,79		4,55		5,52		2,86	
Test temperature T_{Test}	°C	80	95	80	95	70	80	95	95
Test duration t	h	⩾ 3 000	⩾ 1 000	⩾ 3 000	⩾ 1 000	⩾ 3 000	⩾ 1 000	⩾ 3 000	⩾ 1 000
Hydrostatic stress of the pipe material σ_P	MPa	9,15	4,68	9,15	4,68	13,20	10,18	4,06	4,68
Test pressure p_J	in bars								
for a design pressure, p_D, of	4 bar	7,6	3,9	8,1	4,1	11,7	9,0	5,7	6,6
	6 bar	11,5	5,9	12,1	6,2	17,5	13,5	8,5	9,8
	8 bar [a]	15,3	[7,8] [a]	16,1	[8,2] [a]	[23,4] [a]	[18,0] [a]	[11,4] [a]	[13,1] [a]
	10 bar [a]	19,1	[9,8] [a]	20,1	[10,3] [a]	[29,2] [a]	[22,5] [a]	[14,2] [a]	[16,4] [a]
Number of test pieces		3		3		3		3	

[a] Calculated values provided for informational purposes only and shall not be interpreted for practical use.

If, during the testing of mechanical joint assemblies according to this clause, leaks resulting from deformations induced by differential elongation occur, 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.

4.3 Pull-out test

When tested in accordance with EN 712, using the parameters specified in Table 7, the joint assemblies shall withstand the pull-out force, F, without being separated.

The force, F, shall be calculated using Equation (3):

$$F = \frac{\pi}{4} \times d_n{}^2 \times p_D \tag{3}$$

where

F is the force, in newtons;

d_n is the nominal outside diameter of the pipe, in millimetres;

p_D is the design pressure at 4 bar, 6 bar, 8 bar or 10 bar, as applicable, expressed in megapascals. In the case of the classification “All classes”, the design pressure shall be 10 bar, in megapascals.

Table 7 — Test parameters for pull-out test for PVC-C

	All classes	Class 1	Class 2	Class 4	Class 5
Maximum design temperature T_{max} °C	—	80	80	70	90
Test temperature T_{Test} °C	23	90	90	80	95
Test period t h	1	1	1	1	1
Pull-out force F N	1,5 × F	F	F	F	F
Number of test pieces	3	3	3	3	3

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4.4 Thermal cycling

When tested in accordance with EN 12293, using the parameters specified in Table 8, the pipes, fittings or joints, as applicable, shall withstand the test pressure without leakage.

The test shall be done with the configuration for rigid pipes.

Table 8 — Test parameters for thermal cycling for PVC-C

		Application class 1	Application class 2	Application class 4	Application class 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 pipes and fittings in accordance with the configuration for rigid pipes given in EN 12293.			

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

The tensile stress, σ_t, to be used to calculate the pre-stress force as required in EN 12293 shall be 3,4 MPa.

NOTE The tensile stress, σ_t, is calculated using Equation (4):

$$\sigma_t = \alpha_T \times \Delta T \times E \quad (4)$$

where

σ_t is the tensile stress, in megapascals;

α_T is the coefficient of thermal expansion, in reciprocal kelvins;

ΔT is the temperature difference, in kelvins;

E is the modulus of elasticity, in megapascals.

For the purposes of this part of ISO 15877, the following values apply:

$\alpha_T = 0{,}7 \times 10^{-4}\ K^{-1}$;
$\Delta T = 20$ K;
$E = 2\,400$ MPa

4.5 Pressure cycling

When tested in accordance with the test method specified in Table 9, using the indicated parameters, the pipes, fittings or joints, as applicable, shall withstand the test pressure without leakage.

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Table 9 — Test parameters for pressure cycling

<table>
<tr><th>Characteristic</th><th>Requirements</th><th colspan="2">Test parameters</th><th>Test method</th></tr>
<tr><td>Pressure cycling</td><td>No leakage</td><td colspan="2">Test temperature
Number of test pieces
Frequency of test cycles
Number of cycles

Test pressure limits as follows:
<table><tr><th>Design pressure, p_D</th><th colspan="2">Test pressure limits</th></tr><tr><td></td><td>Upper limit</td><td>Lower limit</td></tr><tr><td>4 bar
6 bar
8 bar
10 bar</td><td>6,0 bar
9,0 bar
12,0 bar
15,0 bar</td><td>0,5 bar
0,5 bar
0,5 bar
0,5 bar</td></tr></table></td><td>(23 ± 2) °C
3
(30 ± 5) cycles per min
10 000</td><td>EN 12295</td></tr>
</table>

4.6 Leaktightness under vacuum

When tested in accordance with the test method specified in Table 10, using the indicated parameters, the change in vacuum pressure shall not be greater than 0,05 bar.

Table 10 — Test parameters for leaktightness under vacuum

Characteristic	Requirements	Test parameters		Test method
Leaktightness under vacuum	Change in vacuum pressure ⩽ 0,05 bar	Test temperature Test duration Test pressure Number of test pieces	23 °C 1 h −0,8 bar 3	EN 12294

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Bibliography

[1] ISO/TS 15877-7, *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C) — Part 7: Guidance for the assessment of conformity*

[2] ENV 12108, *Plastics piping systems — Guidance for the installation inside buildings of pressure piping systems for hot and cold water intended for human consumption*

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