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

**Part 2:
Pipes**

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

Partie 2: Tubes



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Contents

Page

Foreword.....	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms, definitions, symbols and abbreviated terms.....	2
4 Material	2
4.1 Pipe material.....	2
4.2 Evaluation of σ_{PL} values.....	2
4.3 Influence on water intended for human consumption.....	4
5 General characteristics	4
5.1 Appearance	4
5.2 Opacity.....	4
6 Geometrical characteristics.....	5
6.1 General.....	5
6.2 Dimensions of pipe.....	5
7 Mechanical characteristics	8
8 Physical and chemical characteristics	9
9 System performance requirements	9
10 Marking	9
10.1 General requirements.....	9
10.2 Minimum required marking.....	10
Annex A (informative) Derivation of $S_{calc,max}$	11
Bibliography	13

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 22391-2 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*.

ISO 22391 consists of the following parts, 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*

Introduction

ISO 22391, the system standard, 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:

- a) no information is provided as to whether the products may 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 pipes. At the time of its publication, system standards for piping systems of other plastics materials used for the same application are

- ISO 15874:2003, *Plastics piping systems for hot and cold water installations — Polypropylene (PP)*,
- ISO 15875:2003, *Plastics piping systems for hot and cold water installations — Crosslinked polyethylene (PE-X)*,
- ISO 15876:2003, *Plastics piping systems for hot and cold water installations — Polybutylene (PB)*, and
- ISO 15877:2003, *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 2: Pipes

1 Scope

This part of ISO 22391 specifies the characteristics of pipe made from polyethylene of raised temperature resistance (PE-RT), 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) or heating systems — under the design pressures and temperatures appropriate to the class of application according to ISO 22391-1.

It covers a range of service conditions (classes of application), design pressures and pipe dimension classes, and also specifies test parameters and test methods. When used in conjunction with the other parts of ISO 22391, it is respectively 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, used for hot and cold water installations.

It is applicable to pipes with or without a barrier layer or layers.

It is not applicable for 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 1133:2005, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

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 1167-2:2006, *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 2505:2005, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

ISO 3126:2005, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 7686:2005, *Plastics pipes and fittings — Determination of opacity*

ISO 9080, *Plastics piping and ducting systems — Determination of long-term hydrostatic strength of thermoplastic materials in pipe form by extrapolation*

ISO 13760, *Plastics pipes for the conveyance of fluids under pressure — Miner's rule — Calculation method for cumulative damage*

ISO 22391-1:2006, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 1: General*

ISO 22391-3, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 3: Fittings*

ISO 22391-5, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 5: Fitness for purpose of the system*

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.

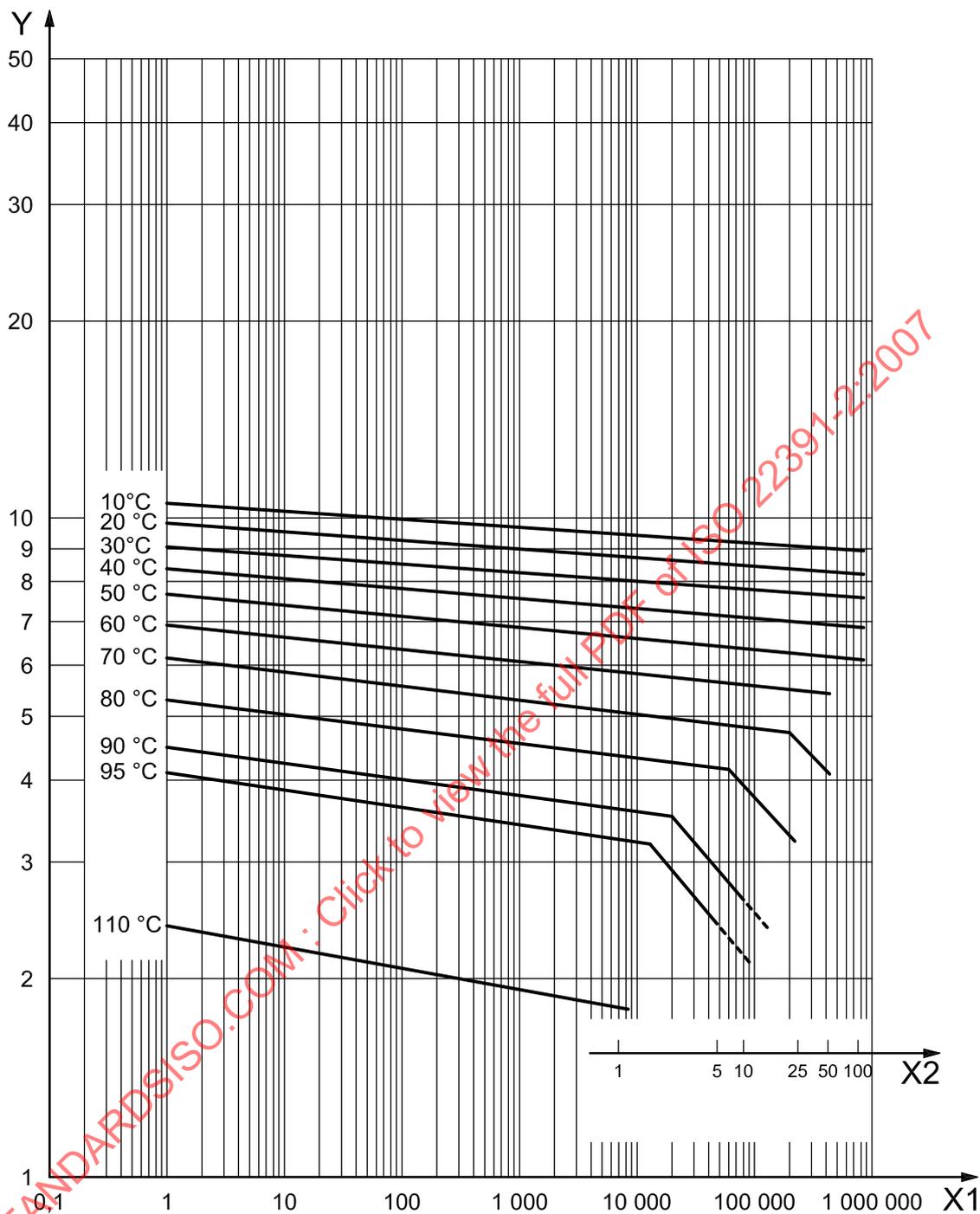
4 Material

4.1 Pipe material

The material of which the pipe is made shall be polyethylene of raised temperature resistance (PE-RT).

4.2 Evaluation of σ_{LPL} values

The pipe material shall be evaluated in accordance with ISO 9080 or equivalent, with internal pressure tests being carried out in accordance with ISO 1167-1 and ISO 1167-2, in order to determine the σ_{LPL} values. The σ_{LPL} value thus determined shall be at least as high as the corresponding values of the reference curves given in Figure 1 (taken from ISO 24033) over the complete range of times.



Key

X1 time, t , to fracture, h

X2 years

Y hoop stress, σ , MPa

Figure 1 — Expected strength of PE-RT pipes

ISO 22391-2:2007(E)

NOTE 1 One equivalent way of evaluation is to calculate the σ_{LPL} value for each temperature (for example 20 °C, 60 °C and 95 °C), individually.

NOTE 2 The reference curves in Figure 1 in the temperature range of 10 °C to 95 °C are derived from Equations (1) and (2).

First branch (i.e. the left-hand portion of the lines shown in Figure 1):

$$\log t = -190,481 - \frac{58219,035 \log \sigma}{T} + \frac{78763,07}{T} + 119,877 \log \sigma \quad (1)$$

Second branch (i.e. the right-hand portion of the lines shown in Figure 1):

$$\log t = -23,7954 - \frac{1723,318 \log \sigma}{T} + \frac{11150,56}{T} \quad (2)$$

In order to demonstrate conformance to the reference lines, pipe samples should be tested in accordance with ISO 1167-1 and ISO 1167-2 at the following temperatures and at various hoop stresses such that, at each of the temperatures, at least three failure times fall in each of the following time intervals.

Temperatures: 20 °C; 60 °C to 70 °C; 95 °C.

Time intervals: 10 h to 100 h; 100 h to 1 000 h; 1 000 h to 8 760 h and over.

In tests lasting more than 8 760 h without failure, any test time after 8 760 h can be considered as the failure time.

Conformance to the reference lines should be demonstrated by plotting the individual experimental results on the graph. At least 97,5 % of them should lie on or above the reference line.

4.3 Influence on water intended for human consumption

The material shall be in accordance with ISO 22391-1.

5 General characteristics

5.1 Appearance

When viewed without magnification, the internal and external surfaces of pipes shall be smooth, clean and free from an extent of scoring, cavities and other surface defects that would prevent conformance with this part of ISO 22391. The material shall not contain visible impurities. Slight variations in the appearance of the colour shall be permitted. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

5.2 Opacity

PE-RT pipes that are declared to be opaque shall not transmit more than 0,2 % of visible light when tested in accordance with ISO 7686.

6 Geometrical characteristics

6.1 General

6.1.1 Dimensions shall be measured in accordance with ISO 3126.

6.1.2 The maximum calculated pipe value of $S_{\text{calc,max}}$ for the applicable class of service condition and design pressure, p_D , shall be in accordance with Table 1.

NOTE The derivation of $S_{\text{calc,max}}$ is provided by Annex A, where the method described takes account of the properties of PE-RT under the service conditions for the classes given in ISO 22391-1:2006, Table 1.

6.1.3 The values of outside diameter and/or wall thickness apply to the PE-RT pipe and, for design calculation purposes, are exclusive of any barrier layer thickness.

Table 1 — $S_{\text{calc,max}}$ values

p_D bar ^c	Application class			
	1	2	4	5
	$S_{\text{calc,max}}$ values ^a			
4	6,7 ^b	6,7 ^b	6,7 ^b	6,0
6	5,5	4,5	5,4	4,0
8	4,1	3,4	4,1	3,0
10	3,3	2,7	3,3	2,4

^a The values are rounded to the first place of decimals.

^b The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 22391-1:2006, Clause 4).

^c 1 bar = 0,1 MPa = 10⁵ Pa; 1 MPa = 1 N/mm²

6.2 Dimensions of pipe

6.2.1 Outside diameters

For the corresponding pipe dimension class, the mean outside diameter, d_{em} , of a pipe shall be in accordance with Table 2, 3, 4 or 5, as applicable.

6.2.2 Dimensions of pipe

For any particular class of service condition, design pressure and nominal size, the minimum wall thickness, e_{min} , shall be chosen such that the corresponding S series or S_{calc} value is less than or equal to the values of $S_{\text{calc,max}}$ given in Table 1.

For the corresponding pipe dimension class, the wall thicknesses, e_{min} and e_n , shall be in accordance with Table 2, 3, 4 or 5, as applicable, in respect of pipe series S or S_{calc} values. However, pipes intended to be joined together by fusion shall have a minimum wall thickness of 1,9 mm.

The tolerance on the wall thickness, e , shall be in accordance with Table 6.

Table 2 — Pipe dimensions for dimension class A
(sizes according to ISO 4065 and applicable for all classes of service condition)

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter $d_{em,min}$ $d_{em,max}$		Pipe series			
				S 5	S 4	S 3,2	S 2,5
				Wall thicknesses e_{min} and e_n			
12	12	12,0	12,3	1,3 ^a	1,4	1,7	2,0
16	16	16,0	16,3	1,5	1,8	2,2	2,7
20	20	20,0	20,3	1,9	2,3	2,8	3,4
25	25	25,0	25,3	2,3	2,8	3,5	4,2
32	32	32,0	32,3	2,9	3,6	4,4	5,4
40	40	40,0	40,4	3,7	4,5	5,5	6,7
50	50	50,0	50,5	4,6	5,6	6,9	8,3
63	63	63,0	63,6	5,8	7,1	8,6	10,5
75	75	75,0	75,7	6,8	8,4	10,3	12,5
90	90	90,0	90,9	8,2	10,1	12,3	15,0
110	110	110,0	111,0	10,0	12,3	15,1	18,3
125	125	125,0	126,2	11,4	14,0	17,1	20,8
140	140	140,0	141,3	12,7	15,7	19,2	23,3
160	160	160,0	161,5	14,6	17,9	21,9	26,6

^a A non-preferred wall thickness of 1,1 mm is permitted for $d_n = 12$.

Table 3 — Pipe dimensions for dimension class B1
(sizes based on copper pipe sizes and applicable for all classes of service condition)

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter		Wall thickness	
		$d_{em,min}$	$d_{em,max}$	e_n	e_{min}
10	10	9,9	10,2	1,5	1,5
				1,8	1,7
12	12	11,9	12,2	1,5	1,5
				2,0	1,9
15	15	14,9	15,2	1,5	1,5
				2,5	2,4
18	18	17,9	18,2	1,7	1,7
				2,5	2,4
22	22	21,9	22,2	2,0	2,0
				3,0	2,9
28	28	27,9	28,2	2,6	2,6
				4,0	3,9

Table 4 — Pipe dimensions for dimension class B2
(sizes based on copper pipe sizes and applicable for all classes of service condition)

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter		Wall thicknesses e_{\min} and e_n	S_{calc}
		$d_{\text{em,min}}$	$d_{\text{em,max}}$		
14,7	14,7	14,63	14,74	1,6	4,1
21	21	20,98	21,09	2,05	4,6
27,4	27,4	27,33	27,44	2,6	4,8
34	34	34,08	34,19	3,15	4,9

Table 5 — Pipe dimensions for dimension class C
(non-preferred pipe sizes, used, for example, for heating systems)

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter		Wall thicknesses e_{\min} and e_n	S_{calc}
		$d_{\text{em,min}}$	$d_{\text{em,max}}$		
12	12	12,0	12,3	2,0	2,5
14	14	14,0	14,3	2,0	3,0
15	15	15,0	15,3	2,0	3,2
16	16	16,0	16,3	2,0	3,5
17	17	17,0	17,3	2,0	3,8
18	18	18,0	18,3	2,0	4,0
20	20	20,0	20,3	2,0	4,5

Table 6 — Tolerances on wall thicknesses

Minimum wall thickness		Tolerance ^a x	Minimum wall thickness		Tolerance ^a x
>	≤		>	≤	
1,0	2,0	0,3	11,0	12,0	1,3
2,0	3,0	0,4	12,0	13,0	1,4
3,0	4,0	0,5	13,0	14,0	1,5
4,0	5,0	0,6	14,0	15,0	1,6
5,0	6,0	0,7	15,0	16,0	1,7
6,0	7,0	0,8	16,0	17,0	1,8
7,0	8,0	0,9	17,0	18,0	1,9
8,0	9,0	1,0	18,0	19,0	2,0
9,0	10,0	1,1	19,0	20,0	2,1
10,0	11,0	1,2	20,0	21,0	2,2
			21,0	22,0	2,3

^a The tolerance is expressed in the form $^{+x}_0$ mm, where x is the value of the tolerance given. The level of the tolerances is according to ISO 11922-1:1997, Grade V.

7 Mechanical characteristics

The pipe shall be tested using the test methods and test parameters in accordance with Table 7. The pipe shall withstand the hydrostatic (hoop) stress without bursting. In the case of pipes with a barrier layer or layers, testing shall be carried out on test pieces without the barrier layer(s).

Table 7 — Mechanical characteristics of pipes

Characteristic	Requirement	Test parameters				Test methods
		For individual tests				
Resistance to internal pressure	No failure during the test period	Hydrostatic (hoop) stress	Test temperature	Test period	Number of test pieces	ISO 1167-1 and ISO 1167-2
		MPa	°C	h		
		9,9	20	1	3	
		3,8	95	22	3	
		3,6	95	165	3	
		3,4	95	1 000	3	
		For all tests				
Sampling procedure	Type of end cap		Orientation of test piece		Not specified	
Type of test					Type a) Not specified Water-in-water	

8 Physical and chemical characteristics

The pipe shall be tested using the test method and test parameters, and conforming to the requirements, in accordance with Table 8.

Table 8 — Physical and chemical characteristics of pipes

Characteristic	Requirement	Test parameters		Test methods
		Parameter	Value	
Longitudinal reversion	≤ 2 %	Temperature	110 °C	ISO 2505
		Duration of exposure:		
		$e_n \leq 8$ mm	1 h	
		$8 \text{ mm} < e_n \leq 16$ mm	2 h	
		$e_n > 16$ mm	4 h	
		Number of test pieces	3	
Thermal stability by hydrostatic pressure testing	No bursting during test period	Sampling procedure	Not specified	ISO 1167-1 and ISO 1167-2
		End cap	Type a)	
		Orientation	Not specified	
		Type of test	Water-in-air	
		Hydrostatic (hoop) stress	1,9 MPa	
		Test temperature	110 °C	
		Test period	8760 h	
		Number of test pieces	1	
Melt mass flow rate (MFR)	30 % maximum difference compared to compound	Mass	5 kg	ISO 1133
		Test temperature	190 °C	
		Test period	10 min	
		Number of test pieces	3	

9 System performance requirements

Pipes conforming to this part of ISO 22391 and fittings conforming to ISO 22391-3 jointed together shall be in accordance with ISO 22391-5.

10 Marking

10.1 General requirements

10.1.1 Marking details shall be printed or formed directly on the pipe not less than once per metre such that, after storage, handling and installation (e.g. in accordance with EN 12108) legibility is maintained.

NOTE The manufacturer is not responsible for marking being illegible on the components (owing to actions such as painting, scratching, covering of the components or by use of detergent), unless this is agreed or specified by the manufacturer.

10.1.2 Marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe.

10.1.3 If printing is used, the colour of the printed information shall differ from the basic colouring of the pipe.

10.1.4 The size of the marking shall be such that the marking is legible without magnification.

10.2 Minimum required marking

The minimum required marking of pipes conforming to ISO 22391 shall be in accordance with Table 9.

Table 9 — Minimum required marking

Aspect	Marking or symbol
Identification of conformity	ISO 22391
Manufacturer's name and/or trade mark	Name or code
Nominal outside diameter and nominal wall thickness	e.g. 32 × 4,4
Pipe dimension class	e.g. A
Material	PE-RT
Application class combined with design pressure	e.g. Class 1/10 bar
Opacity ^a	e.g. opaque
Manufacturer's information	b
NOTE Attention is drawn to the possible need to include CE marking when required for legislative purposes.	
^a If declared by the manufacturer. ^b To provide traceability the following details shall be given: <ul style="list-style-type: none"> — the production period, year and month, in figures or in code; — a name or code for the production site if the manufacturer is producing at different sites. 	