EOTA

www.eota.eu

EAD 280009-00-0802

December 2015

European Assessment Document for

Plastic piping kits for the transport system of hot and cold water, made of polyethylene raised temperature resistance (PE-RT)

CE

The reference title and language for this EAD is English. The applicable rules of copyright refer to the document elaborated in and published by EOTA.

This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

Plastics piping kits based on the EN ISO 22391 series[1], consisting of different components:

- plastics pipes made of PE-RT Type 0, Type I or Type II, (Polyethylene Raised Temperature Resistance) by extrusion, based on EN ISO 22391-2;
- metal and/or plastics fittings, based on EN ISO 22391-3.

The jointing technology is the same for mono and multilayer pipes and EN ISO 22391-5 applies as appropriate.

The PE-RT pipes can be equipped with or without an oxygen barrier layer and other layers. The build-up of the pipe is as depicted in figure 1.1.1, where the:

- Outer layer is the layer exposed to the outer environment;
- The adhesive layer(s) are embedded layers;
- The plastics oxygen barrier layer can be embedded;
- The inner layer is made of PE-RT and is in contact with the conveyed fluid.

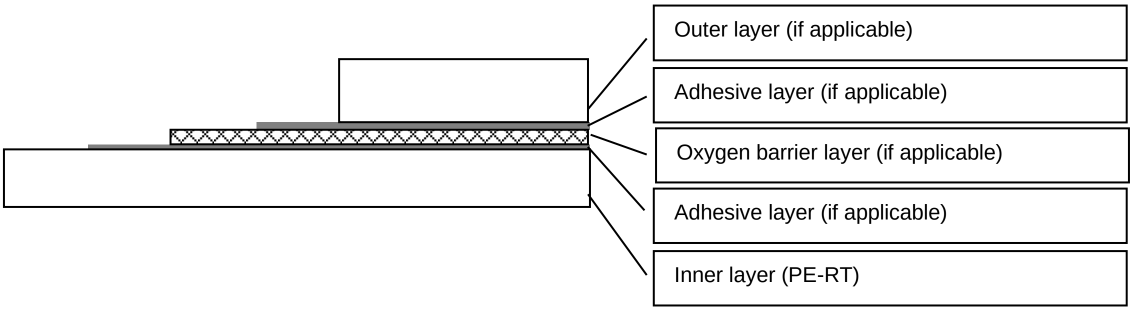


Figure 1.1.1: Schematic representation of the cross section of the wall of a PE-RT pipe with an eventual oxygen barrier layer and eventual outer protective layer. The cross section is made downwards from outer till inner layer of the pipe. The presented thickness of the layers in the drawing are not compulsory.

The dimension of the stress bearing layer(s) of the pipe (mean outer diameter and minimum wall thickness), measured in accordance with EN ISO 3126, shall meet the requirement of the allowed $S_{calc,max}$ value as described in Annex B and they shall be stated in the ETA.

If present, the type of oxygen barrier layer, adhesive layer(s) and outer layer shall be stated in the ETA.

NOTE: For the use of PE-RT material in hot water piping systems distinction is made between Type 0, Type I and Type II.
Type 0 has for the same temperature and time a lower hoop stress than Type I and Type II has a lower hoop stress than Type II. Type II allows a higher SDR (Standard Dimension Ratio) than Type 0 and Type I for the same temperature and time conditions. Type 0 and Type I are used mainly for hot water piping systems with a relative lower pressure (maximum 6 bar). Type II is used mainly for hot water piping systems with a pressure 6 or 10 bar.

The jointing of the metal or plastics fittings to the pipe are of a mechanical type, e.g., press-, compression-, push- or sliding sleeve fitting. The type and material of the fitting shall be stated in the ETA.

For the piping system the fitting is connected to the pipe in accordance with the installation instructions of the manufacturer (See figure 1.1.2). Each piping system is unique. Commercial connection systems not included in the kit of the manufacturer cannot be used. Therefore, the installation instructions are the only reference.

[1] All undated references to standards or to EAD's in this document are to be understood as references to the dated versions listed in chapter 4

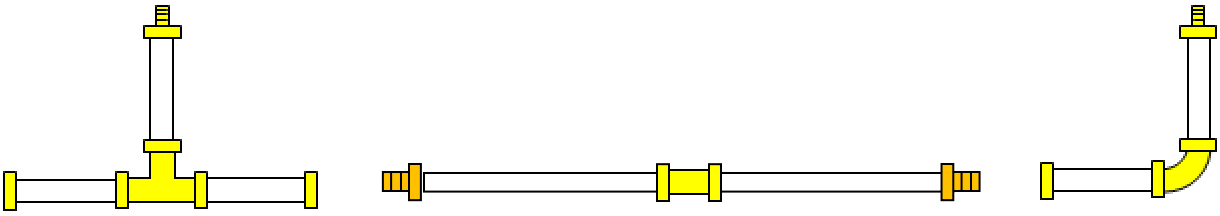


Figure 1.1.2: Schematic examples of an assembled piping system

This EAD is also applicable to the components as single products, provided that the products are placed individually on the market for an intended use as a part of a plastics piping system within the scope of this EAD.

The pipes, fittings and piping system are not covered by a harmonized European standard (hEN).
The elastomeric sealing elements for application type WB or WE are covered by EN 681-1 Annex ZA.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

For the 50 years lifetime of the kit, the characteristics of the components are decisive, crucial and representative for the performance of the kit.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

Plastics piping kits to be used for the conveyance of water inside buildings in accordance with application class 1, 2, 4 and/or 5 of ISO 10508.

Class 1 is for hot water supply with an operating temperature of 60°C. Class 2 is for hot water supply with an operating temperature of 70°C. Class 4 is for, e.g., floor heating and low temperature radiators. Class 5 is for, e.g., high temperature radiators.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the plastics piping kit made of PE-RT for the intended use of 50 years when installed in the works provided that the plastics piping kit made of PE-RT is subject to appropriate installation. These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

2 The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

1.3 Specific terms used in the EAD

Application class
Temperature profile of the application during a lifetime of 50 years in accordance with ISO 10508.

PE-RT
PE-RT type 0: mixture by manufacturer which is not covered by a product standard.
PE-RT type I: in accordance with EN ISO 22391-2.
PE-RT type II: in accordance with EN ISO 22391-2.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of plastics piping kits made of PE-RT is assessed in relation to the essential characteristics.

Table 2.1.1: Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
Basic Works Requirement 4: Safety and accessibility in use			
2	Behaviour to internal hydrostatic pressure	2.2.2.1	Level
3	Behaviour to bending	2.2.2.2	Level
4	Behaviour to pull-out	2.2.2.3	Level
5	Behaviour to thermal cycling	2.2.2.4	Level
6	Behaviour to vacuum	2.2.2.5	Level
7	Behaviour to Pressure cycling test	2.2.2.6	Level
8	Oxygen permeability of the kit	2.2.2.7	Level

Table 2.1.2 shows how the performance of plastics pipes made of PE-RT is assessed in relation to the essential characteristics.

Table 2.1.2: Essential characteristics of the plastics pipes of PE-RT and methods and criteria for assessing the performance of the plastics pipes of PE-RT in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
1	Long-term hydrostatic strength	2.2.3.1	Level
2	Longitudinal reversion	2.2.3.2	Level
3	Thermal stability (PE-RT)	2.2.3.3	Level
4	Melt Mass Flow Rate (PE-RT)	2.2.3.4	Level
5	Behaviour to internal hydrostatic pressure	2.2.3.5	Level
6	Geometrical characteristics	2.2.3.6	Level
7	Peak melting point of the adhesive	2.2.3.7	Level
8	Thermal stability outer layer material	2.2.3.8	Level

Table 2.1.3 shows how the performance of metal fittings is assessed in relation to the essential characteristics.

Table 2.1.3: Essential characteristics of the metal fittings and methods and criteria for assessing the performance of the metal fittings in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
1	Behaviour to pressure	2.2.4.1	Level
2	Dezincification resistance	2.2.4.2	Level
3	Geometrical characteristics	2.2.4.3	Level
4	Resistance to stress corrosion	2.2.4.4	Level

Table 2.1.4 shows how the performance of plastics fittings is assessed in relation to the essential characteristics.

Table 2.1.4: Essential characteristics of the plastics fittings and methods and criteria for assessing the performance of the plastics fittings in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
1	Long-term hydrostatic strength	2.2.5.1	Level
2	Thermal stability	2.2.5.2	Level
3	Effects of heating for plastic fittings	2.2.5.3	Level
4	Geometrical characteristics	2.2.5.4	Level

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

Testing will be limited only to the essential characteristics which the manufacturer intends to declare. If for any components covered by harmonized standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

PE-RT Type 0 is only suitable for class 4.

2.2.1 Reaction to fire

The plastic pipes, the plastic fittings and the assembled system (pipe and fitting) shall be tested, using the test method(s) relevant for the corresponding reaction to fire class in accordance with EN 13501-1, in order to be classified in accordance with Commission Delegated Regulation (EU) 2016/364 in connection with EN 13501-1.

Testing in accordance with EN ISO 11925-2 (ignitability test)

This test method is relevant for classes B, C, D, E and F.

Due to the very limited size of the specimens as prescribed by the test standard, it is widely impossible to test the assembled system. Therefore, all essential components of the assembled system (i.e., plastic pipes and plastic fittings) shall be tested separately.

The not essentially flat components shall be tested in accordance with EN ISO 11925-2 Annex B.

Testing in accordance with EN 13823:2020 (Single burning item test)

This test method is relevant for classes A2, B, C and D (in some cases also for A1).

Mounting and fixing provisions for this test for the assembled system are indicated in Annex C.

The metal fittings are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the Commission Decision (96/603/EC) which has then been amended with EC Decision 2000/605/EC without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

Therefore, the performance of these products is covered.

The fire class shall be stated in the ETA.

2.2.2 Characteristics of the kit

2.2.2.1 Behaviour to internal hydrostatic pressure

The behaviour to internal hydrostatic pressure of the assembled system composed with the pipes and at least three fittings in accordance with the manufacturer installation instructions of the defined system shall be tested in accordance with EN ISO 1167-1 and EN ISO 1167-2 and assembled at room temperature in accordance with EN ISO 1167- for end-load-bearing assemblies on the leak tightness under internal pressure with the parameters in table 2.2.2.1.1 or table 2.2.2.1.2.

EN ISO 1167-1 applies with the following exceptions for chapter 4 Principle:

1. The point a) does not apply because fittings of the piping system are used instead of end caps.
2. The point h) does not apply because there are no requirements to initiate additional testing.

EN ISO 1167-4 applies with the following exceptions for chapter 3 Principle:

1. The point d), e) and f) do not apply because no adhesive bonded fittings are part the piping system.
2. The point g) does not apply because testing of tolerance variations is not applicable.

Table 2.2.2.1.1: Test parameters for the behaviour to internal hydrostatic pressure on the assembled system for PE-RT type I and PE-RT type II

Environment: water/water or water/air		Application Class							
		Class 1		Class 2		Class 4		Class 5	
Maximum operating temperature, T_{max} (°C)		80		80		70		90	
Test temperature, T_{test} (°C)		95		95		80		95	
PE-RT type		I	II	I	II	I	II	I	II
Test pressure (bar) for an operating pressure p_D :	4 bar	5.1[1)]	4,8[1)]	5.1[1)]	4,8[1)]	6.8[1)]	6,4[1)]	5.8	5,0
	6 bar	6.3	6,1	7.7	6,4	8.4	8,5	8.7	7,5
	8 bar	8.3	8,1	10.2	8,5	11.2	11,4	11.5	10,0
	10 bar	10.4	10,2	12.8	10,6	14.0	14,2	14.4	12,4
Maximum test time (h)[2)]		1000		1000		1000		1000	
Number of test pieces		1x smallest d_n, 1x middle d_n, 1x largest d_n		1x smallest d_n, 1x middle d_n, 1x largest d_n		1x smallest d_n, 1x middle d_n, 1x largest d_n		1x smallest d_n, 1x middle d_n, 1x largest d_n	

1) If the cold water requirement (20°C, 10 bar, 50 years) is higher than the calculated value for the applicable class and pressure then the cold water requirement shall determine this value.

2) There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-5 standard

Table 2.2.2.1.2: Test parameters for the behaviour to internal hydrostatic pressure on the assembled system for PE-RT type 0

	Application Class 4
Maximum operating temperature, T_{max} (°C)	70
Calculatedstress for 50 years of pipe material, σ_{DP} (MPa)	$\sigma_{DP,4}$
Test temperature, T_{test} (°C)	80
Hydrostatic stress of pipe material, σ_P (MPa)	σ_p
for a operating pressure, p_D (bar) of:	X [2)]
Test pressure, p_J (bar) [1),]	p_J
Maximum test time (h)[3)]	1000
Number of test pieces	1x smallest d_n, 1x middle d_n, 1x largest d_n

[1)] If the cold-water requirement (20°C, 10 bar, 50 years) is higher than the calculated value for the applicable class and pressure then the cold-water requirement shall determine this value.
[2)] X = 4 or 6 bar.
[3)] There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-5 standard

The test pressure p_J for a given time to failure and test temperature shall be calculated by the following equation:

$$p_J = p_D \cdot \frac{\sigma_P}{\sigma_{DP}}$$

Where:

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

p_D is the operating pressure of 4, 6, 8 or 10 bar.

σ_P are the hydrostatic stress values, in MPa, of the pipe material corresponding to time to failure and test temperature points as determined in 2.2.3.1.

σ_{DP} are the calculated stress values for 50 years, in MPa, for the pipe material as determined for the defined class in accordance with 2.2.3.1.
The calculation of σ_{DP} is described in annex B.

The testing time until leakage with a maximum of 1000 hour shall be stated in the ETA. The results cover the behaviour to internal hydrostatic pressure for all defined dimensions of the piping system.

2.2.2.2 Behaviour to bending

This test shall only be performed on assembled systems containing pipes of nominal diameter greater than or equal to 32 mm and fittings of the defined system in accordance with the manufacturer installation instructions. The assembled system shall then be tested in accordance with EN ISO 3503 on the leak tightness under internal pressure when subjected to bending with the test parameters specified in table 2.2.2.2.1 or table 2.2.2.2.2.

Table 2.2.2.2.1: Test parameters for the bending test on the assembled system for PE-RT type I and PE-RT type II

Environment: water/air		Application Class							
		Class 1		Class 2		Class 4		Class 5	
Maximum operating temperature, T_{max} (°C)		80		80		70		90	
Test temperature, T_{test} (°C)		20		20		20		20	
PE-RT type		I	II	I	II	I	II	I	II
Test pressure (bar) for an operating pressure p_D :	4 bar	14.8[1)]	14.5[1)]	14.8[1)]	14.5[1)]	14.8[1)]	14.5[1)]	16.6	15.0
	6 bar	18.0	18.4	22.1	19.3	18.2	19.2	24.8	22.6
	8 bar	24.0	24.5	29.4	25.7	24.2	25.6	33.1	30.1
	10 bar	29.9	30.7	36.8	32.1	30.3	32.0	41.4	37.6
Maximum test time (h)[2)]		1		1		1		1	
Number of test pieces		3x smallest d_n, 3x middle d_n, 3x largest d_n		3x smallest d_n, 3x middle d_n, 3x largest d_n		3x smallest d_n, 3x middle d_n, 3x largest d_n		3x smallest d_n, 3x middle d_n, 3x largest d_n	

1) If the cold water requirement (20°C, 10 bar, 50 years) is higher than the calculated value for the applicable class and pressure then the cold water requirement shall determine this value.

2) There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-5 standard

Table 2.2.2.2.2: Test parameters for the bending test on the assembled system for PE-RT type 0

	Application Class 4
Maximum operating temperature, T_{max} (°C)	70
Calculated stress for 50 years of pipe material, σ_{DP} (MPa)	$\sigma_{DP,4}$
Test temperature, T_{test} (°C)	20
Hydrostatic stress of pipe material, σ_P (MPa)	σ_p
for a operating pressure, p_D (bar) of:	X [2)]
Test pressure, p_J (bar)[1)]	p_J
Maximum test time (h)[3)]	1
Number of test pieces	3x smallest d_n, 3x middle d_n, 3x largest d_n

1) If the cold water requirement (20°C, 10 bar, 50 years) is higher than the calculated value for the applicable class and pressure then the cold water requirement shall determine this value.

2) X = 4 or 6 bar.

3) There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-5 standard.

The test pressure p_J for a given time to failure and test temperature shall be determined by the following equation:

$$p_J = p_D \cdot \frac{\sigma_P}{\sigma_{DP}}$$

Where:

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

p_D is the operating pressure of 4, 6, 8 or 10 bar.

σ_P are the hydrostatic stress values, in MPa, of the pipe material corresponding to time to failure and test temperature points as determined in 2.2.3.1.

σ_{DP} are the calculated stress values for 50 years, in MPa, for the pipe material as determined for the defined class in accordance with 2.2.3.1.
The calculation of σ_{DP} is described in annex B.

The testing time until leakage with a maximum of 1 hour shall be stated in the ETA. The results cover the behaviour to bending for all defined dimensions of the piping system.

2.2.2.3 Behaviour to pull-out

The assembled system composed with the pipes and fittings system in accordance with the manufacturer installation instructions of the defined system shall be tested in accordance with EN ISO 3501 for a maximum time of 1 hour on the pull-out force of the jointing, expressed in Newton with the test parameters for class 1, 2, 4 and class 5 in accordance with EN ISO 22391-5, clause 4.4, table 6.

The number of test pieces: 3x smallest d_n,
3x middle d_n,
3x largest d_n.

The testing time until separation with a maximum of 1 hour shall be stated in the ETA. The results cover the behaviour to pull-out for all defined dimensions of the piping system.

2.2.2.4 Behaviour to thermal cycling

The assembled system composed with the pipes and fittings system in accordance with the manufacturer installation instructions shall be tested in accordance with EN ISO 19893 on the leak tightness under internal pressure when subjected to thermal cycling with the applicable test parameters specified for class 1, 2, 4 and class 5 in accordance with EN ISO 22391-5, clause 4.5, table 7.
The tensile stress is 2.2 MPa for PE-RT type 0 and type I and 2.6 MPa for PE-RT type II and is applicable on all variants of pipes in accordance with clause 1.1.

Maximum numbers of cycles: 5000 for diameter ≤160 mm and 500 for diameter >160 mm.

The number of test pieces: 1x smallest d_n,
1x middle d_n,
1x largest d_n

The amount of cycles until leakage with a maximum of 5000 cycles shall be stated in the ETA. The results cover the behaviour to thermal cycling for all defined dimensions of the piping system.

2.2.2.5 Behaviour to vacuum

The assembled system composed with the pipes and fittings system in accordance with the manufacturer installation instructions of the defined system shall be tested in accordance with EN ISO 13056 on the leak tightness under vacuum, expressed in change of vacuum with the parameters in accordance with EN ISO 22391-5, clause 4.7, table 9.

The number of test pieces: 3x smallest d_n,
3x middle d_n,
3x largest d_n

The change in pressure after 1 hour shall be stated in the ETA. The results cover the leak tightness for all defined dimensions of the piping system.

2.2.2.6 Behaviour to pressure cycling

The assembled system in accordance with the manufacturer installation instructions shall be tested in accordance with EN ISO 19892 on the leak tightness with the test parameters in accordance with EN ISO 22391-5, clause 4.6, table 8.

Maximum numbers of cycles: 10000

The number of test pieces: 3x smallest d_n,
3x middle d_n,
3x largest d_n

The amount of cycles until leakage with a maximum of 10000 cycles shall be stated in the ETA. The results cover the behaviour to pressure cycling for all defined dimensions of the piping system.

2.2.2.7 Oxygen permeability of the kit

The oxygen permeability of the kit shall be tested in accordance with ISO 17455 and expressed as oxygen permeation flux in g/m².h (F_{ox}) or mg/m².day ($F_{ox,day}$) with the following parameters:

Table 2.2.2.7.1: Test parameters for the oxygen permeability test on the piping system

	Application Class	
	Class 4	Class 5
Method type	I or II	I or II
Test temperature, T_{test} (°C)	40	80
Number of test pieces	1x one d_n	1x one d_n

The maximum oxygen permeability shall be stated in the ETA.

2.2.3 Characteristics of pipe

2.2.3.1 Long-term hydrostatic strength

The long-term hydrostatic strength of the PE-RT material shall be determined in accordance with EN ISO 9080.

The number of test pieces shall conform to EN ISO 9080.

The relevant calculated stress (σ_D) for 50 years for the required class is calculated and is used to calculate the $S_{calc,max}$-value in accordance with Annex B.

2.2.3.2 Longitudinal reversion

The longitudinal reversion (in %) of the pipe inclusive eventual functional and protective layers, shall be determined in accordance with EN ISO 2505, the method "in air" or the method "in liquid" can be used but the reference method is "in liquid".

The testing parameters in accordance with table 1 of EN ISO 2505 at 110°C ("PE80/100").

The number of test pieces: 3x one d_n for the range e ≤ 8 mm;
3x one d_n for the range 8 < e ≤ 16 mm.

The maximum longitudinal reversion shall be stated in the ETA.

2.2.3.3 Thermal stability (PE-RT)

For the thermal stability (in h) a pipe has to be produced preferably without functional and protective layers. The thermal stability for this pipe shall be determined by a hydrostatic pressure test in accordance with EN ISO 1167-1 and EN ISO 1167-2 with the applicable parameters in table 2.2.3.3.1, except that just 1 specimen is tested in accordance with EN ISO 22391-2/Table 10 unlike EN ISO 1167-1/6.2 which is recommending 3 pieces.

Table 2.2.3.3.1: Test parameters for the Thermal stability (PE-RT)

	PE-RT Type 0		PE-RT Type I	PE-RT Type II
Temperature	95°C	110°C	110°C	110°C
Hydrostatic hoop stress(σ)[1)]	σ_P MPa	σ_P MPa	1.9 MPa	2.3 MPa
Maximum test time[2)]	8760 h	3000 h	8760 h	8760 h
End caps	Type A	Type A	Type A	Type A
Medium	Water in water	Water in air	Water in air	Water in air
Number of test pieces	1x one d_n	1x one d_n	1x one d_n	1x one d_n

1) The σ_P value of PE-RT type 0 is equal to the σ_{LPL} value derived from the long-term strength in accordance with paragraph 2.2.3.1.
The σ value of PE-RT type I and type II are taken from ISO 22391-2.

2) There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-2 standard.

The testing time until leakage with a maximum test time as stated in table 2.2.3.3.1 shall be stated in the ETA.

2.2.3.4 Melt Mass Flow Rate (PE-RT)

The melt mass flow rate (MFR) (in g/10 min) of the PE-RT pipe and used raw PE-RT material shall be determined in accordance with EN ISO 1133-1 with the following test conditions:

Load	:	2.16 kg
Test temperature	:	190°C
Time	:	10 min
Number of test pieces	:	Shall conform to EN ISO 1133-1, one d_n

The maximum allowable deviation of the melt mass flow rate of the pipe in comparison with the MFR of the raw PE-RT material shall be stated in the ETA.

2.2.3.5 Behaviour to internal hydrostatic pressure

For the behaviour to internal hydrostatic pressure (in h) a pipe has to be produced preferably without functional and protective layers.

The behaviour to the internal hydrostatic pressure shall be determined in accordance with EN ISO 1167-1 and EN ISO 1167-2 with the applicable test parameters in table 2.2.3.5.1:

Table 2.2.3.5.1: Test parameters for the behaviour to internal hydrostatic pressure

		PE-RT Type 0	PE-RT Type I	PE-RT Type II
Testing temperature (in °C)	Maximum test time (h) [2]	σ [1] (in N/mm²)	σ [1] (in N/mm²)	σ [1] (in N/mm²)
95	1000	σ_P	3.4	3.6

[1] The σ_P value of PE-RT type 0 is equal to the σ_{LPL} value derived from the long-term strength in accordance with paragraph 2.2.3.1.
The σ value of PE-RT type I and type II are taken from ISO 22391-2.

[2] There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-2 standard

End caps:	Type A
Medium:	Water in water
Number of test pieces:	3x one d_n

The testing time until leakage with a maximum test time of 1000 hours shall be stated in the ETA.

2.2.3.6 Geometrical characteristics

For the 50-year lifetime the geometrical characteristics are determined by:

- the mean outer diameter: d_{em} (in mm);
- minimum wall thickness: e (in mm);
- out of roundness: ovality (in mm);
- overall service (operating) coefficient taken from EN ISO 22391-2 Annex A;
- S_{calc}
- $S_{calc,max}$ (calculation see Annex B).

The S_{calc} value, outer diameter, wall thickness and the level of tolerances shall be stated in the ETA.

2.2.3.7 Peak melting temperature of the adhesive material

The peak melting point of the adhesive is to ensure that the layers of the product do not delaminate at the application temperature Therefore, this property of the component refers to the Safety in use of the product.

For the adhesive, the peak melting temperature (in °C) shall be determined in accordance with ISO 11357-3.

The specimen shall conform to ISO 11357-1 clause 6.

The minimum peak melting temperature shall be stated in the ETA.

2.2.3.8 Thermal stability of the outer layer material (when applicable)

The thermal stability of the outer layer material is to ensure that the outer layer of the product does not downgrade during the lifetime of the pipe. Therefore, this property of the component refers to the Safety in use of the product.

If the outer layer is made of PE-RT material the thermal stability is assessed in accordance with 2.2.3.3.

In the case that the outer layer is not made of PE-RT material the thermal stability shall be determined in accordance with Annex A.
The number of test pieces is stated in Annex A.

The minimum thermal stability shall be stated in the ETA.

2.2.4 Characteristics of metal fittings

2.2.4.1 Behaviour to Pressure

The bodies of the fittings shall be tested in accordance with clause 5.2.11 of EN 1254-3, clause 5.2.2 of EN 1254-6 or 5.2.13.2 of EN 1254-8.

Number of test pieces: 1x one d_n.

The result of the test shall be stated in the ETA.

2.2.4.2 Dezincification resistance

The dezincification resistance shall be tested in accordance with clause 4.5.2.1 of EN 1254-3, only for metal fittings with a zinc content of at least 15% in accordance with grade A or B.

Number of test pieces: 1x one d_n.

The maximum depth of dezincification for grade A and the mean plus maximum depth for grade B shall be stated in the ETA.

2.2.4.3 Geometrical characteristics

The dimensions of the fittings (in mm) shall be measured in accordance with EN ISO 3126.

The number of test pieces: each d_n.

The dimensions and tolerances of the fittings are to be stated in the ETA and be suited to the dimensions and tolerances of the pipes as stated in clause 2.2.3.6 of this EAD.

2.2.4.4 Resistance to stress corrosion

For fittings made of copper alloys the resistance to stress corrosion shall be determined in accordance with ISO 6957 with a test solution of pH 9.5 and without prior pickling.

Copper-tin-zinc alloys and copper-zinc-silicon alloys containing ≥ 2% Si are deemed to be resistant to stress corrosion.

Fittings made of copper-zinc alloys with a hardness BHW 2,5/62,5 ≤ 110 (in accordance with EN ISO 6506-1) or an hardness HV_5 ≤ 134 (in accordance with EN ISO 6507-1) are deemed to be resistant to stress corrosion.

The resistance to stress corrosion shall be stated in the ETA.

2.2.5 Characteristics of plastics fittings

2.2.5.1 Long-term hydrostatic strength

The long-term hydrostatic strength of the fitting material shall be carried out in accordance with EN ISO 9080. From this test the LPL value is calculated.

The number of test pieces shall conform to EN ISO 9080.

The lower prediction limit (LPL) values are to be stated in the ETA.

2.2.5.2 Thermal stability

The thermal stability for the fitting, expressed in testing time shall be determined by a hydrostatic pressure test in accordance with EN ISO 1167-1 and EN ISO 1167-2 with the applicable parameters in table 2.2.5.2.1, except that just 1 specimen is tested in accordance with EN ISO 22391-2/Table 10 unlike EN ISO 1167-1/6.2 which is recommending 3 pieces.

Table2.2.5.2.1: Test parameters for the Thermal stability

Temperature	110°C
Hydrostatic hoop stress	in MPa, derived from the long-term strength in 2.2.5.1
Maximum test time[1)]	8760 h
End caps	Type A
Medium	Water in air
Number of test pieces	1 x one d_n

[1)] There are robust experiences that this time limit is reasonable and commonly accepted as in the EN ISO 22391-2 standard

The testing time until leakage with a maximum test time of 8760 hours shall be stated in the ETA.

2.2.5.3 Effects of heating for plastic fittings

Plastic fittings shall be tested on the effects of heating in accordance with EN ISO 580, method A.

The temperature and time are dependent of the plastics material and are to be stated in the ETA.

The number of test pieces: 3x smallest d_n,
3x middle d_n,
3x largest d_n.

The result shall be stated in the ETA.

2.2.5.4 Geometrical characteristics

The dimensions of the fittings (in mm) shall be measured in accordance with EN ISO 3126.

The number of test pieces: each d_n.

The dimensions and tolerances of the fittings are to be stated in the ETA and be suited to the dimensions and tolerances of the pipes as stated in clause 2.2.3.6 of this EAD.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 1999/472/EC, as amended by Commission Decision 2001/596/EC.

The system is 4 for any use except for uses subject to regulations on reaction to fire performance.

For uses subject to regulations on reaction to fire the applicable AVCP systems are 1, 3 or 4 depending on the conditions defined in the said Decision.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

The manufacturer (regarding the components he buys from the market with DoP) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

Table 3.2.1: Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
	Factory production control (FPC) **[including testing of samples taken at the factory in accordance with a prescribed test plan]***				
1	**Incoming materials**				
	Pipe: inner layer PE-RT material - Melt mass flow rate - Oxidation induction time - Density	3.4.1.1 3.4.1.2 3.4.1.3	Laid down in control plan	CS[1)]x one d_n 3 samples in accordance with EN ISO 1183-1.	Per delivery
	Pipe: Plastic oxygen barrier layer - Thermal stability	3.4.2.1	Laid down in control plan	in accordance with Annex A	At first delivery
	Pipe: adhesive material - Peak melting point	2.2.3.7	Laid down in control plan	in accordance with ISO 11357-3.	Per delivery
	Pipe: Outer layer material - PE-RT material - Other material	2.2.3.8 2.2.3.8	Laid down in control plan	in accordance with EN ISO 9080 in accordance with Annex A	At first delivery
2	**Pipe:** - Dimensions - Longitudinal reversion - Melt Mass Flow Rate (PE-RT) - Hydrostatic strength - Opacity	2.2.3.6 2.2.3.2 2.2.3.4 3.4.3.1 3.4.3.2	Laid down in control plan	Continuous 3x one d_n CS[1)]x one d_n 3x one d_n 1x thinnest d_n.	Per batch Per batch Per batch Per batch At first production
3	**Metal Fitting:** - **dimensions**	2.2.4.3	Laid down in control plan	continuous	Per batch
4	**Plastics Fitting:** - **dimensions** - **Opacity**	2.2.5.4 3.4.4.1	Laid down in control plan	Continuous 1x thinnest d_n.	Per batch At first production

1) CS: Conform EN(-ISO) standard.

3.3 Tasks of the notified body

The intervention of the notified body under AVCP system 1 is only necessary for reaction to fire for products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).

In this case the cornerstones of the tasks to be undertaken by the notified body under AVCP system 1 are laid down in Table 3.3.1.

Table 3.3.1: Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire (for system 1 only)					
1	The notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).	Verification of the factory production control related to reaction to fire, to be implemented by the manufacturer.	As defined in clause 2.2.1 of EAD	As defined in clause 2.2.1 of EAD	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire (for system 1 only)					
2	The notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).	Verification of the controls carried out by the manufacturer on the raw materials, on the process and on the product as indicated in Tables 3.2.1.	As defined in clause 2.2.1 of EAD	As defined in clause 2.2.1 of EAD	1/year

3.4 Special methods of control and testing used for the assessment and verification of constancy of performance

3.4.1 PE-RT material of the stress bearing layer(s)

3.4.1.1 Melt mass flow rate

The melt flow rate of the PE-RT material is required to determine the difference between the melt flow rate of the raw PE-RT material and the produced PE-RT pipe (see 2.2.3.4).

The melt mass flow rate (MFR) shall be determined in accordance with EN ISO 1133-1 with the following test conditions:

Load	:	2.16 kg
Test temperature	:	190°C
Time	:	10 min
Minimum number of cut-offs	:	3

The melt mass flow rate (MFR) is checked with the specifications of the supplier.

3.4.1.2 Oxidation induction time

The oxidation induction time (OIT) of the raw PE-RT material is a measure of the initial thermal stability of the raw PE-RT material and has influence on the thermal stability of the produced pipe (see 2.2.3.3).

The oxidation induction time (OIT) shall be determined in accordance with EN ISO 11357-6 at a temperature of 210°C. The number of test pieces shall be 3.

The oxidation induction time (OIT) is checked with the specifications of the supplier.

3.4.1.3 Density

The density is a measure for the quality of the raw PE-RT material.

The density shall be determined in accordance with EN- ISO 1183-1, method B, at a temperature of 23°C. The number of test pieces shall conform to EN- ISO 1183-1.

The density is checked with the specifications of the supplier.

3.4.2 Plastics oxygen barrier material

3.4.2.1 Thermal stability

The thermal stability of the barrier layer is to ensure that the oxygen permeability level (see 2.2.2.7) of this layer remains during the lifetime of the kit.

For the material of the plastics oxygen barrier layer, the thermal stability (T_{50y}) shall be determined in accordance with Annex A. The number of test pieces is stated in Annex A.

3.4.3 Pipes

3.4.3.1 Behaviour to internal hydrostatic pressure

During production this test ensures the end quality of the pipe (see 2.2.3.5).

The behaviour to the internal hydrostatic pressure, expressed in testing time shall be determined in accordance with EN ISO 1167-1 and EN ISO 1167-2 with the following testing conditions:

		PE-RT Type 0	PE-RT Type I	PE-RT Type II
Testing temperature (in °C)	Time (h)	σ (in N/mm²)	σ (in N/mm²)	σ (in N/mm²)
20	1	σ_P	9.9	10.8
95	165	σ_P	3.6	3.7

The σ_P value of PE-RT type 0 is equal to the LPL value derived from the long-term strength in accordance with paragraph 2.2.3.1.
The σ value of PE-RT type I and type II are taken from ISO 22391-2.

3.4.3.2 Opacity

Pipes including the eventual functional and outer layers which are declared to be opaque shall be tested on the opacity. The opacity shall be determined in accordance with EN ISO 7686 as a percentage of visible light transmittance.

The number of test pieces: 1x thinnest d_n.

3.4.4 Plastic fittings

3.4.4.1 Opacity

Plastics fittings which are declared to be opaque shall be tested on the opacity. The opacity shall be determined in accordance with EN ISO 7686 as a percentage of visible light transmittance.

The number of test pieces: 1x thinnest d_n.

4 REFERENCE DOCUMENTS

EN 681-1:1996/A1:1998/ A2: 2002/A3:2005	Elastomeric seals - Materials requirements for pipe joints seals used in water and drainage applications - Part 1: Vulcanized rubber.
EN 1254-3:2021	Copper and copper alloys – Plumbing fittings - Part 3: Fittings with compression ends for use with plastics pipes
EN 1254-6:2021	Copper and copper alloys - Plumbing fittings - Part 6: Fittings with push-fit ends
EN 1254-8:2021	Copper and copper alloys - Plumbing fittings - Part 8: Fittings with press ends for use with plastics and multilayer pipes
EN 12107:1997	Plastics piping systems – Injection-moulded thermoplastics fittings, valves and ancillary equipment – Determination of the long-term hydrostatic strength of thermoplastics materials for injection moulding of piping components
EN 13501-1:2019	Fire classification of construction products and building elements –Part 1 Classification using data from reaction to fire tests
EN 13823:2020	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
EN 15715:2009	Thermal insulation products - Instructions for mounting and fixing for reaction to fire testing - Factory made products
EN 16000: 2010	Plastics piping systems - Systems within the building structure - Mounting and fixing of components in the test apparatus to thermal attack by a single burning item
EN ISO 527-1:2019	Plastics - Determination of tensile properties - Part 1: General principles.
EN ISO 527-2:2012	Plastics - Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics.
EN ISO 527-3: 2018	Plastics - Determination of tensile properties - Part 3: Test conditions for films and sheets
EN ISO 580:2005	Plastics piping and ducting systems - Injection moulded thermoplastic fittings - Method for visually assessing the effects of heating.
EN ISO 1133-1:2011	Plastics - Determination of melt mass-flow rate (MFR) and the me volume-flow rate (MVR) of thermoplastics
EN ISO 1167-1:2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluid -- Determination of the resistance to internal pressure -- Part 1: Genera method.
EN ISO 1167-2:2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluid -- Determination of the resistance to internal pressure -- Part 2 Preparation of pipe test pieces.
EN ISO 1167-4:2007	Thermoplastics pipes, fittings and assemblies for the conveyance of fluid -- Determination of the resistance to internal pressure -- Part 4 Preparation of assemblies.
EN ISO 1183-1:2004	Plastics – Methods for determining the density of non-cellular plastics - Part 1: Immersion method, pyknometer method and titration method
EN ISO 2505:2005	Thermoplastics pipes - Longitudinal reversion - Test methods an parameters
EN ISO 2578:1998	Plastics - Determination of time-temperature limits after prolonge exposure to heat
EN ISO 3126:2005	Plastics piping systems - Plastics components - Determination c dimensions.

EN ISO 3501:2015	Plastics piping systems — Mechanical joints between fittings and pressur pipes — Test method for resistance to pull-out under constant longitudina force
EN ISO 3503:2015	Plastics piping systems — Mechanical joints between fittings and pressur pipes — Test method for leak tightness under internal pressure c assemblies subjected to bending
EN ISO 6506-1:2014	Metallic materials - Brinell hardness test - Part 1: Test method
EN ISO 6507-1:2018	Metallic materials - Vickers hardness test - Part 1: Test method
EN ISO 6259-1:2001	Thermoplastics pipes – Determination of tensile properties - Part 1 General test method
EN ISO 7686:2005	Plastics pipes and fittings - Determination of opacity
EN ISO 9080:2012	Plastics piping and ducting systems - Determination of the long-terr hydrostatic strength of thermoplastics materials in pipe form b extrapolation
EN ISO 11357-3:2018	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determinatio of temperature and enthalpy of melting and crystallization
EN ISO 11357-6:2018	Plastics - Differential scanning calorimetry (DSC) - Part 6: Determinatio of oxidation induction time (isothermal OIT) and oxidation inductio temperature (dynamic OIT)
EN ISO 11925-2:2020	Reaction to fire tests - Ignitability of products subjected to direc impingement of flame - Part 2: Single-flame source test
EN ISO 13056: 2018	Plastics piping systems - Systems for hot and cold water - Test method fo leak tightness under vacuum.
EN ISO 13760:1998	Plastics pipes for the conveyance of fluids under pressure – Miner´s rul – Calculation method for cumulative damage
EN ISO 19892:2018	Plastics piping systems - Thermoplastics pipes and associated fittings fo hot and cold water - Test methods for resistance of joints to pressur cycling
EN ISO 19893: 2018	Plastics piping systems - Thermoplastics pipes and fittings for hot and col water - Test method for the resistance of mounted assemblies t temperature cycling
EN ISO 22391-2:2009	Plastics piping systems for hot and cold-water installations – Polyethylen of raised temperature resistance (PE-RT) - Part 2: pipes
EN ISO 22391-3:2009/ Amd1;2021/Amd2:2021	Plastics piping systems for hot and cold-water installations – Polyethylen of raised temperature resistance (PE-RT) - Part 2: fittings
EN ISO 22391-5 :2009/ Amd 2020/correction 2021-03	Plastics piping systems for hot and cold-water installations – Polyethylen of raised temperature resistance (PE-RT) - Part 5: Fitness for purpose c the system
ISO 6957:1988	Copper alloys - Ammonia test for stress corrosion resistance
ISO 10508:2006	Plastics piping system for hot and cold-water installations – Guidance fo classification and design
ISO 17455- 2005	Plastics piping systems – Multilayer pipes – Determination of the oxyge permeability of the barrier pipe

ANNEX A – DETERMINATION OF THE THERMAL STABILITY FOR AN ESTIMATED WORKING TIME OF 50 YEARS

A.1 Principle

Tensile test samples made of the material that has to be examined are exposed to different temperatures. After certain exposure times at the specified temperatures, the elongation at break is determined. This elongation at break as a percentage of the elongation at break of the non-exposed tensile bars is plotted versus the logarithmic exposure time for the different temperatures.

In a thermal endurance graph (Arrhenius graph) the logarithm of the time to reach the specified elongation at break percentage is plotted versus the reciprocal thermodynamic (absolute) test temperature.

The Arrhenius plot is extrapolated to determine the temperature at which the elongation at break would be reduced to 25 % over 50 years.

NOTE This way to determine the thermal stability at 50 years is derived from EN ISO 2578, determination of the temperature index (TI).

A.2 Apparatus

The oven shall be in accordance with EN ISO 2578 clause 9, with temperature tolerances of ± 2°C.

The tensile test machine shall be in accordance with EN ISO 527-1 clause 5.

The test speed will be stated by the manufacturer and taken from the recommend test speed as described clause 5.1.2 of EN ISO 527-1.

A.3 Sample Preparation

The test pieces shall be produced with the use of the same or equivalent technology as the product (e.g., extruded sheets, injection moulded or extruded test pieces).

The type of test pieces shall be in accordance with EN ISO 527-2 clause 6 or EN ISO 527-3 clause 6 depending on the material.

The number of test pieces shall be 5 at least for each temperature/exposure time to determine the elongation at break.

The number of exposure temperatures shall be at least 3.

A.4 Procedure

Manufacturing of the test pieces shall be in accordance with clause A.3 of this annex.

For the determination of the elongation at break, five test pieces shall be tensile tested on a tensile test machine in accordance with EN ISO 527-2 or EN ISO 527-3. The test temperature shall be (23±2)°C.

The mean elongation at break of the non-exposed test pieces is set to be 100%.

For the determination of the elongation at break of the exposed test pieces, the exposure temperatures are between 110 and 150°C depending on the material. The maximum exposure temperature shall be at least 15°C below the crystalline melting temperature.

The minimum of 5 test pieces are exposed for each temperature/exposure time.

The mean elongation at break of the exposed test pieces is stated as a percentage of the elongation at break of the non-exposed test pieces (relative elongation at break). In order to calculate the relation between time and temperature (Fig A.4.2) the distribution of data is needed. The distribution lines can be built when the results of the elongation at break values are as follows:

- at least one value of the relative elongation at break lays between 50 and 75%;

- at least two values of the relative elongation at break lays between 25 and 50%;
- at least one value of the relative elongation at break lays lower than 25%.

The relative elongation at break values shall be plotted versus the logarithm of their exposure times (see figure A.4.1). A curve shall be constructed for each temperature. The point at which these curves intersects the horizontal line representing the specified percentage of the elongation at break is taken as the time to failure. This specified percentage shall be 25%.

The calculation of the thermal endurance curve (Arrhenius plot) is based on the failure times to reach the specified elongation at break percentage and the respective thermodynamic (absolute) exposure temperatures in Kelvin. If mean values are used, the logarithmic mean represents the time to failure.

The logarithm of the calculated elongation at break is plotted versus the reciprocal absolute temperature (see figure A.4.2). From this graph a first-order regression line can be calculated in accordance with Annex A of EN ISO 2578.

By using the first-order regression line of the thermal endurance curve, the temperature of the 25%-elongation-at-break-value shall be determined for an extrapolated exposure time of 50 years (T_{50y}).

Calculation example temperature at 50 years: see table A.1.

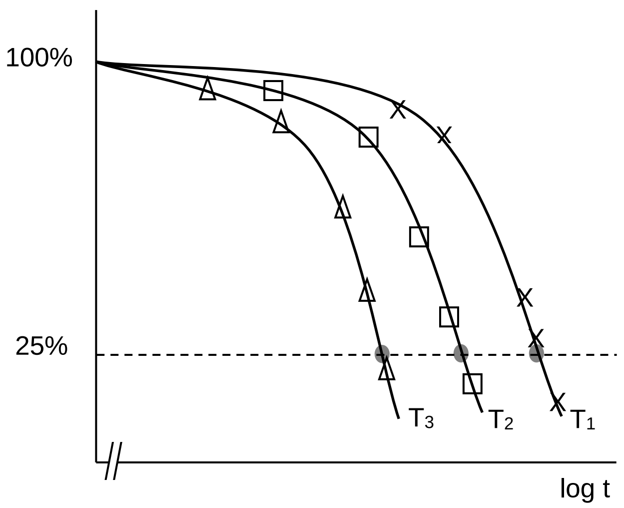


Figure A.4.1: relative elongation at break vs. time

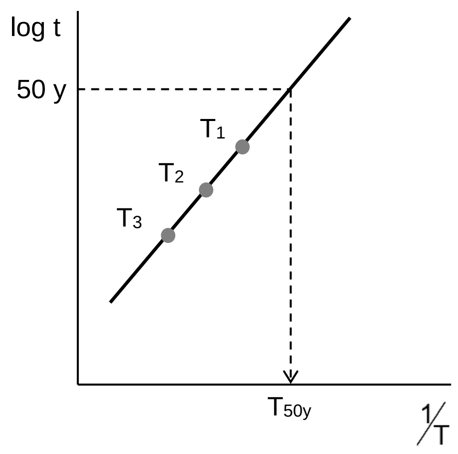


Figure A.4.2: Time vs. temperature

Table A.1 Example calculation

Temperature (T) (°C)	**X= 1/T (K^{-1})**	**X^2 =1/T^2 (K^{-2})**	**time at 25% relative elongation at break (h)**	**Y = $\log_{10}t$**	**XY = ($\log_{10}t$)/T**
190	2,15983E-03	4,66485E-06	8130	3,910090546	8,44512E-03
200	2,11416E-03	4,46969E-06	6130	3,787460475	8,00732E-03
210	2,07039E-03	4,28653E-06	4950	3,694605199	7,64929E-03
sum Σ	6,34439E-03	1,34211E-05		11,39215622	2,41017E-02

N=3

$$b = \frac{N*\sum XY - \sum X * \sum Y}{N*\sum X^2 - (\sum X)^2} = \frac{(3*2{,}41017E-02) - (6{,}34439E-03 * 11{,}39215622)}{(3*1{,}34211E-05) - (6{,}34439E-03)^2} = 2{,}41143E+03$$

$$a = \frac{(\sum Y - b*\sum X)}{N} = \frac{(11{,}39215622 - 2{,}41143E+03*6{,}34439E-03)}{3} = -1{,}30229$$

Temperature(°C) at 50 years (Y=438000 hours):

$$\frac{b}{Y-a} - 273 = \frac{2{,}41143E+03}{(\log_{10} 438000) + 1{,}30229} - 273 = 74{,}3\ °C$$

ANNEX B – DERIVATION OF $S_{CALC,MAX}$ VALUES

B.1 Principle

This annex details the principles regarding the derivation of $S_{calc,max}$-values and, hence, of the minimum wall thickness of pipes relative to the classes of service conditions (classes 1, 2, 4 or 5 in accordance with ISO 10508) and the applicable operating pressure (4, 6, 8 or 10 bar).

B.2 Procedure

B.2.1 Calculated stress for 50 years

The calculated stress, σ_{DP}, for a particular class of service conditions (application class 1, 2, 4 or 5 in accordance with ISO 10508) is calculated from the equations of the long-term strength curves as stated in 2.2.3.1 of this EAD by using Miner´s rule. The overall service (operating) coefficients are to be stated in the ETA in accordance with table B.2.1.1.

Table B.2.1.1: Overall service (operating) coefficients

	Overall service (operating) coefficient C
Operating temperature (T_D)	1.5
Maximum temperature (T_{max})	1.3
Malfunction temperature (T_{mal})	1.0
Cold water temperature (T_{cold})	1.25

The resulting calculated stress, σ_{DP}, shall be calculated relative to the application class by using Miner´s rule in accordance with EN ISO 13760 and in accordance with table B.2.1.2.

Table B.2.1.2: Calculated stress for 50 years

Application class	Calculated stress for 50 years, σ_{DP} (MPa)
1	$\sigma_{D,1}$
2	$\sigma_{D,2}$
4	$\sigma_{D,4}$
5	$\sigma_{D,5}$
20°C/50 years	σ_{cold}
The values for σ_{DP} shall be rounded to the second place of decimals.	

B.2.2 Derivation of maximum value of Scalc (Scalc,max)

$S_{calc,max}$ is the smaller value of either

$$\sigma_D / p_D \quad \text{or} \quad \sigma_{cold} / (p_D = 10\ \text{bar})$$

where all values are expressed in MPa.

The values for $S_{calc,max}$ shall be rounded to the first place of decimals.

B.2.3 Use of $S_{calc,max}$ to determine the nominal wall thickness

The S_{calc} value will be stated for each application class and operating pressure, in such a way that S_{calc} is not greater than $S_{calc,max}$.

ANNEX C - REACTION TO FIRE TEST OF THE ASSEMBLED SYSTEM (PIPE AND FITTING) – MOUNTING AND FIXING IN ACCORDANCE WITH EN 13823

C1 General

In this Annex the “mounting and fixing” procedure in accordance with EN 13823 to determine the reaction to fire performance of the assembled system (pipe and fitting) is formulated.
This ‘mounting and fixing” procedure can be based alternatively on the two following methods described below. They are not equivalent and method A is the reference one.

C2 Method A

Method A is in accordance with EN 16000.

C3 Method B

C.3.1 Test piece

The length of the test piece shall be (1500 ± 5) mm.

The test piece is an assembly of pipe sections and fittings.

The test piece shall consist of pieces of pipes interconnected with 5 fittings, evenly divided over the length of the test piece. The two “end” fittings are situated (150 ± 5) mm from both ends of the test piece:

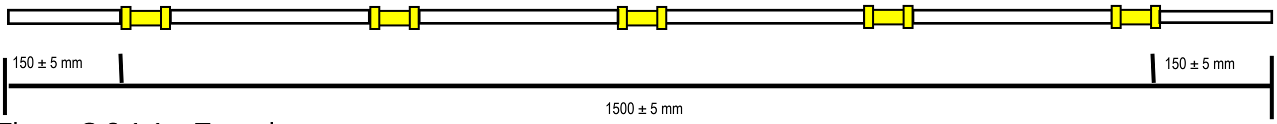


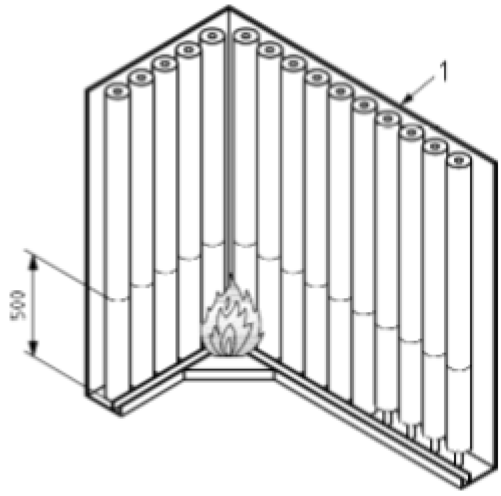
Figure C.3.1.1 – Test piece

C.3.2 Mounting and fixing of the test piece

The test piece shall be mounted and fixed conform the corner test figuration in the figure C.3.2.1, with the following specification.

- The length of the wings are respectively (495 ± 5) mm and (1000 ± 5) mm in accordance with clause 5.1.1 of EN 13823;
- The height of the wing is (1500 ± 5) mm in accordance with clause 5.1.1 of EN 13823;
- The distance between the test pieces shall be (10 ± 0.5) mm;
- The distance between the test piece and the backing board shall be (10 ± 0.5) mm;
- The fixing shall be such that for the duration of the test the position of the test piece shall not change. Each test piece shall be fixed to the backing board with appropriate metal pipe clips located under each fitting.

NOTE: *The corner test configuration is in line with the corner test figuration as given in Figure 4 of EN 15715. Instead of metal rods to fix the test pieces, metal pipe clips are used to assemble the test piece on the backing board.*



a) Front view

Key:

1 Backing board
2 Burner
3 U-profile

Figure C.3.2.1 Figure 4 of EN 15715 as example for the front view

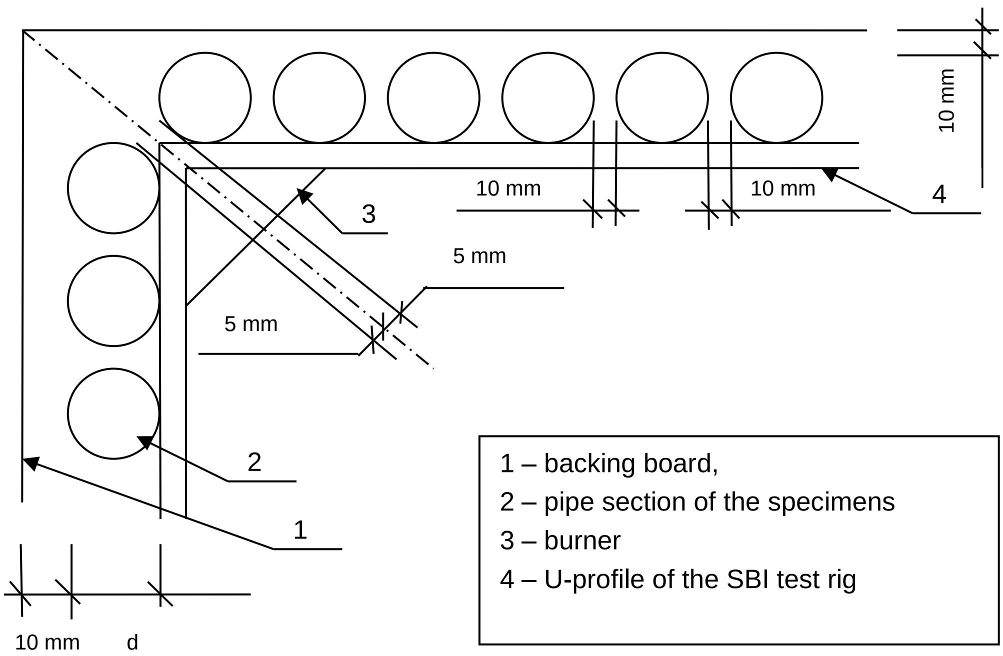


Figure C.3.2.2 – Principle corner test figuration for mounting and fixing top view

C.3.3 Test procedure

To identify the most onerous test configuration the following 4 tests shall be performed:

- Test 1 : Smallest DN with the minimum wall thickness
- Test 2 : Smallest DN with the maximum wall thickness
- Test 3 : Largest DN with the minimum wall thickness

- Test 4 : Largest DN with the maximum wall thickness.

The number of test pieces is dependent on the diameter to be tested.

The number shall be such that as many test pieces as possible shall be mounted on each wing of the SBI test apparatus (see figure C.3.2.2), taking into account a distance of (10 ± 0.5) mm between each test piece.

The test (DN/wall thickness) which has given the most onerous test result shall then be subjected to two further repeated tests with the same DN/wall thickness.

C.3.4 Validity of test results of a product range

A test performed with one test piece of DN 160 or DN 180 with the corresponding maximum wall thickness covers also the higher DN with the maximum wall thickness up till DN 250.

NOTE: *The choice of DN 160 or DN 180 depends on the product range in the delivery program of the manufacturer.*