



AENOR N Mark Specific Rules for Multilayer piping systems for hot and cold water installations inside buildings

Note: This document is a translation of the Spanish document RP 001.71 rev. 9 approved by the Plastics Technical Certification Committee (CTC-001). Spanish version always prevails over this translation.

RP 001.71

Revision 9

Date 2023-10-16

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1 Objeto y alcance

Pursuant to paragraph 3.2 of the General Rules on the Certification of Products and Services with N Mark, hereafter the General Rules, the present Specific Rules describe the specific certification scheme for Multilayer piping systems for hot and cold water installations inside buildings. The present Specific Rules complete the AENOR N Mark Specific Rules for plastic materials – common requirements (RP 001.00). The General Rules always prevail over the present Specific Rules.

The N Mark for multilayered systems for hot and cold water installations inside buildings, hereafter the Mark, denotes product compliance with the UNE EN ISO 21003-1:2009, UNE EN ISO 21003-2:2009, UNE EN ISO 21003-2:2009 ERRATUM, UNE EN ISO 21003-2:2009/A1:2011, UNE EN ISO 21003-3:2009 and UNE EN ISO 21003-5:2009 standard or SANS 21103-1: 2008, SANS 21003-1: 2008, SANS 21003-2: 2008, SANS 21003-3: 2008, SANS 21003-5: 2008.

The scope of N Mark product certification defined in this Specific Rules it refers to multilayered systems for hot and cold water installations inside buildings made-up by pipes and fittings. The polymeric materials used for the stress-designed layers of the pipes are the following: polybutilene (PB), polyethylene of raised temperature resistance (PER-T); crosslinked polyethylene (PE-X), polypropylene (PP), **polypropylene random with modified crystal structure (PP-RCT)** and chlorinated poli (vinyl chloride) (PVC-C). The fittings can be manufactured of one of the mentioned materials, other plastics or metallic.

There are considered valid for a period of 5 years from the approved date of the review 0 of this Regulation for licensees of the Mark of multilayered pipes and 3 years for the new applicants, the service conditions established in the Annex E of this document providing that complies with the described in the mentioned annex. In this case it will not be necessary to present reference curves. Control points for internal pressure will be taken for the mentioned annex.

2 Definition and special requirements

Reference: It is called a reference of pipes to the set of the same ones that have the same diameter and nominal thickness, and in case of fittings to the set of the same ones that have the same nominal dimensions and forms.

Types of pipes:

Multilayer M pipe: Pipe comprised of polymeric stress-designed layers and one or more metallic stress-designed layers.

Multilayer P pipe: Pipe comprised of more than one polymeric stress-designed layer.

Groups of pressure:

Two groups of pressure are defined depending on the service pressure:

- **Group 1:** For service pressure 4 bar; 6 bar
- **Group 2:** For service pressure 8 bar; 10 bar

Groups of dimensions:

The following groups of dimensions are considered depending on the diameter

- **Group 1:** All the nominal dimensions minor or equal to 26 mm
- **Group 2:** All the nominal dimensions bigger than 26 and minor or equal to 63 mm
- **Group 3:** All the nominal dimensions bigger than 63 mm

Similar structure:

Similar structure by type is understood for more than one diameter of pipeline when the following conditions are fulfilled:

For type P:

- The same process technology is used.
- Materials having the same characteristics are used for each stress bearing layer: i.e. material type and specifications.
- The layers are assembled in the same sequence for different diameters.
- For all diameters of the same group, the standard dimension ratio (SDR) of each stress-designed layer is equal to the design value ± 10 .

For type M:

- The same process technology is used. For example: welding process, type of welding, etc.
- Materials having the same characteristics are used for each stress bearing layer: i.e. material type and specifications.
- The layers are assembled in the same sequence for different diameters.
- For all diameters of the same group, the metal layer standard dimension ratio (SDR_m) is ± 10 the same.

SDR: Outside diameter of the polymeric layer of a pipe divided by wall thickness of the polymeric layer.

SDR(m): Outside diameter of the metal layer of a pipe divided by the wall thickness of the metal layers.

Raw material: It means raw material the same material with equal technical specifications.

The characteristics that define the multilayer pipes are: the structure of the pipe with indication of the layers, raw materials of the layers with indication of the supplier and the reference of the material and thicknesses. In case of M type, besides the previous characteristics, the type of weld.

Besides the general documentation specified in the RP 01.00, it will have send together with the request the following additional documentation:

PIPES

For pipes type P, shall be submitted with the application, references curves corresponding to each of the similar structures inside every group of dimensions. It will be tested the diameter with higher SDR value.

For pipes type M, shall be submitted with the application, reference curves corresponding to each of the similar structures inside every group of dimension and type of weld. It will be tested the diameter with higher SDR_m value.

Reference curves will have to submit with an antiquity not higher than 10 years, though in case this requirement is not fulfilled, there will be presented a technical report to the Plastic Committee for its valuation.

Test reports for references curves should include will minimum the following:

- Identification of the pipe
- Identification of the manufacturing site
- Traceability of the material
- Type of weld
- All information that allows identify the product

When reference curves were received, it will be presented a report to the Committee to its validation and in case of, to accept them as valid.

Reference curves will be done as minimum at three temperatures: 20°, 95 ° and 60 ° or 70° or 80.

Data sheet (Annex C-1). Geometric and general characteristics of the pipes should be described (raw material, diameters, wall thickness and of each of the layers, and its tolerances). Adhesives are not considered as independent layer.

For pipes type M, in addition it will be necessary to indicate type of welding, wall thickness of metal layer, diameter and tolerances and tensile strength and elongation of the metal layer up to the point of break.

FITTINGS

For metallic fittings: Indication of raw materials used, treatment (tinned, plating, etc.), alloy (is), joint used and material of the joints, as well as drawings.

For plastic fittings: Indication of raw materials used, meetings used and material of the meetings, as well as the planes of the fittings.

SYSTEM

Instructions for the correct assembly of the system and tools used indicating type of clamp.

WATER QUALITY FOR HUMAN CONSUMPTION

With regard to potential adverse effects on water quality for human consumption caused by the products covered by the standard UNE-EN ISO 21003, the clients of the Mark, will provide to AENOR during the inspection visit the evidence that their product complies with the RD 140/2003.

Article 14 of the mentioned document states that "Products that are in contact with the water of human consumption, by themselves or by the practices that are used, shall not transmit to the water for human consumption, substances or properties that contaminate or get worse its quality, and involve a failure to comply the requirements specified in Annex I or a risk to the health of the population supplied.

For it, evidence must be provided of complying with the RD 3/2023 through migration test according to the UNE-EN 12873 Standard, performed every five years and/or certificates issued by competent authorities of compliance with the el RD 3/2023.

3 Sampling and testing for granting and maintaining of the product N Mark certificate

3.1 Test to be carried out in factory (See RP 001.00)

AENOR will carry out the tests indicated in table 1 during the initial or surveillance inspection.

3.2 Sampling and tests to be carried out by the laboratory (See RP 001.00)

AENOR will select and marked the necessary samples to carry out in the laboratory the tests indicated in table 1.

The manufacturer will send the selected samples to the laboratories indicated by AENOR. In case that the laboratory requested be necessary, the client of the certificate will send technical personnel for welds or assemblies needed to carry out the tests.

The criterion of valuation for all the tests is 1, in consequence no value will be allowed to be out of tolerances.

Dimensional tests, both pipe and fittings, will be carried out by AENOR in factory with habitual tools used by the manufacturer. In case of be necessary, samples will be sent to the laboratory to carry out dimensional control of wall thickness of the layers. Adhesive is not considered as an embedded layer.

Related to durability test for pipes type P, the stress designed layer shall be tested for thermal stability test.

For pipes type M, should be tested for thermal stability test the inner layer by a thermal stability test over a compact pipe made with the material of the internal layer, and with wall thickness that will be, at the maximum, two times of the thinnest wall thickness of the inner layer declared by the manufacturer in the Annex C1.

In case the material of the external layer is different from PP, PP-RCT, PE-RT, PEX, PB and PVC-C, it will be necessary to realize the test of thermal stability of the outside layer as described in point 10.2.2 of UNE EN ISO 21003-2. If the material is the same, only need to perform the test on the inner layer.

The ending of this test does not determine the granting of the certificate.

It will be necessary to be available during the visit of AENOR, a compact pipe in conformity with the paragraph 10.2.1 of the standard UNE-EN ISO 21003-2.

In case of that the raw material is pigmented by the manufacturer of the pipe or polymeric fitting, the valuation of the conformity of the result of the Melt Flow Index test will be assessed by the Committee.

Pressure test to apply for internal pressure tests will be obtained from the reference curves supplied by the manufacturer or from annex E for the classes of application/pressure of design 1/6; 2/6; 4/6; 5/6 (if apply).

Adherence by tensile test (for pipes type M) will be done in accordance with Annex F of this document. The requirement for conformity is $> 25 \text{ N / cm}$.

DIMENSIONAL REQUIREMENTS OF THE PIPES

Dimensional requirements are based on manufacturer's specification sheet and the dimensional requirements listed in Annex D.

DIMENSIONAL REQUIREMENTS OF THE FITTINGS

For metallic fittings: Dimensional requirements are based on the standard UNE-EN 1254-3.

For polymeric or plastic fittings: Dimensional requirements are based on the standard UNE-EN 21003-3 or the drawings provided by the manufacturer in case that do not exist.

REQUIREMENTS FOR METAL FITTINGS MATERIALS:

Stainless steel: The parts of stainless steel must be manufactured from steels included in the standard UNE-EN 10088-1 complying with the requirements of this Standard and standard UNE-EN 10028-7.

Aluminium: Parts of aluminium must be manufactured from aluminium included in the standard UNE-EN 573-3.

Copper or alloys of copper: brass fittings must comply with the requirements of the standard UNE EN 1254-3. Brass parts must comply and be manufactured with alloys included in the standards:

- Fittings for machining: UNE EN 12164 Rod for free machining
- Fittings for forging: UNE EN 12165 Semiproducts for forge
- Fittings manufactured from hollow bars: UNE EN 12168 Hollow Bars for machining.
- Ingots and casting: UNE EN 1982

In addition, regarding fittings resistant to dezincification "Dezincification resistance test" apply over the body of the fitting according to the standard UNE-EN ISO 6509. The requirement for South African market is a depth of penetration under 250 µm according to the standard SANS 226. For other markets the requirement according to the standard UNE-EN 1254-3 is as follow:

- **For the grade A:** Maximum 200 µm
- **For the grade B:** Mean not to exceed 200 µm and maximum 400 µm.

Temporarily and as new revisions of European standards with respect to copper alloys for brass fittings is published, are allowed all the alloys listed in "Common Approach" allowed, "Metallic materials" "part B: Common composition 4MS list.

https://www.umweltbundesamt.de/sites/default/files/medien/374/dokumente/150120_4ms_scheme_for_metallic_materials_part_b.pdf

REQUIREMENTES OF THE MATERIALS FOR PLASTIC FITTINGS

Plastic fittings must comply with the requirements of the standard UNE EN ISO 21003-3.

	TESTS	GRANTING/ MAINTANING
	PIPES	
TESTS TO BE CARRIED OUT BY THE INSPECTOR IN THE FACTORY	Appearance	10 pipes / coils randomly
	Mean outside diameter	1 pipe per reference minimum 10
	Total wall thickness	1 pipe per reference minimum 10
	Thickness of each layer	1 pipe per reference
	Ovality	1 pipe per reference
	FITTINGS	
	Appearance	1 fitting per diameter
	Dimensional control (plastic fitting, according drawings)	1 fitting per diameter
	Minimum cross section flow and minimum wall thickness (metallic fittings)	1 fitting per diameter
TESTS TO BE CARRIED OUT BY THE LABORATORY	PIPES	
	Opacity (Only if declares it, it does not apply for type M)	1 reference selecting the one with lowest wall thickness,
	Resistance to internal pressure 95°C 22 h (Apply if manufacturer present references curves)	2 references per dimension group, maximum 3 for two dimensions group and maximum 4 for three dimensions group
	Resistance to internal pressure 20°C 1h (Apply if manufacturers declared to follow conditions from Annex E)	2 references per dimension group, maximum 3 for two dimensions group and maximum 4 for three dimensions group
	Resistance to internal pressure 95°C 165 h	2 references per dimension group, maximum 3 for two dimensions group and maximum 4 for three dimensions group
	Thermal Durability (internal and external) See point 3.2 of the RP	Only at granting and every 5 years per material
	Delamination (before and after Thermal Cycling test)	Only at granting and every 5 years. 1 reference randomly
	Oxygen Permeability (Only if declares it, it does not apply for type M)	1 reference
	Crosslinking degree (for PE-X pipes) (on internal and external layer) (note 1)	1 reference per group of dimension
	Melt flow index (for PB, PP, PE-RT pipes) (on internal layer and raw material)	1 reference
	Oxidation induction time (for PE-RT pipes) (On internal and external layer) * Test Method according to UNE EN 728. Specification > 20 min.	1 reference
	Adherence by tensile of the layers (only for type M) according to Annex F. Specification ≥ 25 N/cm	2 references per dimension group, maximum 3 for two dimensions group and maximum 4 for three dimensions group

	Flexibility (only PP-RCT)	2 references per dimension group, maximum 3 for two dimensions group and maximum 4 for three dimensions group About the small diameter
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	TESTS	GRANTING/ MAINTANING
TESTS TO BE CARRIED OUT BY THE LABORATORY	FITTING/SYSTEM (*)	
	Chemical composition of the body of the fitting (just for metallic fittings)	5% references, minimum 2
	Opacity (if declares it)	1 reference
	Dezincification resistance test (just for fittings resistant to dezincification)	1 reference randomly
	Resistance to stress corrosion (ISO 6957)	3 references randomly
	Resistance to internal pressure 20°C 1 hour (for plastic fittings). This test can be performed together with the pipes at the pressure of the pipe and apply if it is following conditions from Annex E and also in case that reference curves were presented	5% references
	Melt flow index (for PB, PP, PE-RT fittings and raw material)	1 reference
	Resistance to internal pressure 95°C 1000 h (This test must be done together with the pipe)	2 % references
	Bending (Only type P)	50% of the diameters of the system
	Pull out (23°C and 80°, 90° or 95°C 1h)	
	Pressure cycling	
	Vacuum	
	Thermal cycling	1 diameter of the system

TABLE 1

(*) System test will be carried out by type of welding and type of clamp, being able to perform the thermal cycling test and the internal pressure test 95° 1000 h, combining different clamps.

(Note 1) For pipes PEX-b, if the test result of the crosslinking degree is "non-compliant" and the company requests the repetition of the mentioned test, the repetition will be performed on samples that are available in the laboratory and not witness sample.

4 Manufacturer internal control

4.1 Characteristics under factory production control

Characteristics under factory production control are:

Raw materials: The manufacturer must ensure that the mixtures and compounds involved in the manufacture of pipes having appropriate characteristics. In the same way, the specifications provided in the Certificate of Analysis of material received, comply with established purchase requirements.

Raw materials fittings: The manufacturer must ensure that the mixtures and compounds involved in the manufacture of fittings having suitable characteristics. See table 2 for metal and plastic accessories.

Dimensions of pipes: the manufacturer must verify following the frequency stated in Table 2 that the pipe dimensions comply with its technical specifications and dimensional requirements listed in Annex D.

Dimensions of fittings: the manufacturer must verify periodically by sampling statistics, that the dimensions of the fittings comply with the drawings and tolerances as well as the standard for fittings to apply this standard (cooper fittings and copper alloys).

This requirement applies to all parts of the fitting: body of the fitting, joint, sleeve.

Joins: the manufacturer shall have available all the times the certificates of the supplier of joints and verify in every delivery that comply with its specifications and with the standards UNE-EN 681-1 and 681-2.

Manufacturing Controls: Tests and their frequency are stated in table 2, as proceed. In addition, must comply as stated at section 3.2.

Controls on the final product: Tests and their frequency are stated in table 2, as proceed. In addition, must comply as stated at section 3.2.

TESTS	FRECUENCY
RAW MATERIALS	
Tensile strength and elongation of the metal layer (only for pipe type M)	Raw material certificate for each delivery batch
Chemical composition, in case of the manufacturer of the fitting produce the raw material (for metal fittings)	One fitting for each raw material batch
Chemical composition, in case of the manufacturer of the fitting does not produce the raw material (for metal fittings)	Raw material certificate for each delivery batch
Dezincification resistance test over raw material (just for fittings resistant to dezincification)	Once a year, one sample
PIPES	
Appearance	Every 4 hours / production line
Mean outside diameter	Every 4 hours / production line
Total wall thickness	Every 4 hours / production line
Thickness of each layer	<u>For pipes type P</u> : per production period / minimum once a day <u>For pipes type M</u> : per production period / minimum per each batch of metal strip
Ovality (Apply if manufacturer declared)	Per period of production
Opacity (only if declares it, it does not apply for pipe type M)	Once a year per raw material selecting the one with lowest wall thickness
Resistance to internal pressure 95°C 22 h (Apply if manufacturer present references curves)	Once every two weeks per line
Resistance to internal pressure 20°C 1h (Apply if manufacturers declared to follow conditions from Annex E)	Once every two weeks per line
Resistance to internal pressure 95°C 165h	Once every two weeks per line
Resistance to internal pressure 95°C 1000 h	At granting all the references that have not been tested with reference curves. And, in maintenance once a year the 50% of the references per group of dimensions alternating references to cover the full range
Thermal Durability (internal and external) See point 3.2 of the RP	Initially per material
Delamination (before and after Thermal Cycling test)	Once per year on some of the references manufactured
Oxygen Permeability (Only if the manufacturer declares it, it does not apply for type M)	Once a year on some of the references manufactured
Crosslinking degree (per each PE-X layer) (note 1)	Per period of production/minimum twice a week
Melt flow index(for pipes with PP, PB, PERT) (On internal layer and raw material)	Every three batches of raw material
Oxidation induction time (per each PE-RT layer) * Test method according to UNE EN 728 Specification > 20 min.	Minimum twice per year, per raw material supplier on pipe and raw material
Adherence by tensile (For pipe type M) according to ANNEX F Requirement ≥ 25 N/cm	Every 8 hours
Characteristics that define embedded layer for type P	According to manufacturer's internal procedures
Flexibility (only PP-RCT)	Every three period of production

TESTS	FRECUENCY
FITTING/SYSTEM	
Appearance	According to the manufacturer internal procedure
Minimum cross section flow and minimum wall thickness (metallic fittings)	
Dimensional control (plastic fitting, according to drawings)	
Characteristics of the compound (for plastic fittings)	Raw material certificate for each delivery batch
Opacity (only if the manufacturer of the plastic fitting declares it)	Once per year selecting the one with lowest wall thickness
Resistance to internal pressure 20°C 1 hour (for plastic fittings) This test can be performed together with the pipes at the pressure of the pipe and apply if it is follow conditions from Annex E and also in case that reference curves were presented	Once per production period. Minimum once per week
Resistance to internal pressure 95 °1000 h (This test must be done together with the pipe) (*)	Every four months alternating the diameters to cover the whole range
Bending (Only type P) (*)	Once a year / 1 diameter
Pull out (23°C and 95°C 1h) (*)	Once a year / 1 diameter
Thermal cycling (*)	Once a year / 1 diameter
Pressure cycling (*)	Once a year / 1 diameter
Vacuum (*)	Once a year / 1 diameter

TABLE 2

(*) **System** test will be carried out by type of welding and type of clamp, being able to perform the thermal cycling test and the internal pressure test 95° 1000 h, combining different clamps.

(Note 1) For pipes PEX-b, if the test result of the crosslinking degree is "non-compliant" and the company requests the repetition of the mentioned test, the repetition will be performed on samples that are available in the laboratory and not witness sample.

5 Marking of certified products

PIPES

The marking on the pipes will carry out every meter and will include as minimum the following:

- Reference to the word AENOR;
- AENOR N Mark logotype;
- **Certificate number** or contract number signed with AENOR: 001/XXX;

- Number of the applicable standard UNE-EN ISO 21003;
- Manufacturer identification, trademark;
- Nominal outside diameter and nominal wall thickness;
- Pipe composition (for PE-X: type of crosslinking, for PP: type of polypropylene, for PE-RT: Type I or Type II, **for PP-RCT: flexible**);
- Application class combined with design pressure;
- Indicate the word “opaque” and/or “permeability”. (Only if the manufacturer has declared it);
- Manufacture’s information (code or date of manufacture).

Additionally, it is inform that it is permitted to mark the maximum service pressure at either 20 °C or any other temperature provided this one is not considered malfunction temperature, according to table 1 of the standards: UNE EN 15874-1, UNE EN 15875-1, UNE EN 15876-1, UNE EN 15877-1 and UNE ISO 22391-1.

FITTINGS

The minimum required marking of the body of the fitting is the following:

- Trademark;
- Nominal diameter (It will be possible mark on the sleeve or on other parts of the fitting assembled in the body of the fitting as long as the manufacturer guarantees that it is marketed together unequivocally);
- Identification of the material (only for plastic fittings; for PE-X: type of crosslinking, for PP: type of polypropylene, for PE-RT: Type I or Type II);
- Manufacturing year/month or code.

PACKAGING

The minimum required marking of the fittings packaging is the following:

- Application class combined with design pressure;
- Reference to the word “opaque” and/or “permeability”. (Only if the manufacturer has declared it);
- Manufacturing year/month , only if has not been marked on the fitting;
- Number of the applicable standard;
- Reference to the word AENOR;
- AENOR Mark logotype;
- **Certificate number or** the contract signed with AENOR: 001/XXX.

SYSTEM

The licensee company shall include as minimum the following data at commercial and technical documentation for systems:

- Trademark of the system;
- Reference to the word AENOR;
- AENOR Mark logotype;
- Type of joint;
- Application class combined with design pressure;
- Diameter range certified of pipes and fittings;
- Tool to use and instructions for proper installation of the system including the type of clamp.

In case of this documentation includes certified and not certified products, the N Mark use shall be in that way that never leads into mistake about which products are certified and which are not.

Annex C

Descriptive questionnaire for Multilayer piping systems

CLIENT:

PIPES MANUFACTURER COMPANY:

FITTINGS MANUFACTURER COMPANY:

DESCRIPTION OF THE TYPE OF JOINT:

TYPE OF CLAMP:

SITE WHERE MANUFACTURER INTERNAL CONTROL TESTS FOR THE SYSTEM ARE GOING TO BE CARRIED OUT:

FACTORY OF THE PIPES SITE ☐ OF THE FITTING ☐ EXTERNAL LAB ☐

OTHER (to indicate _____)

TRADEMARK(S).

PIPES

DIMENSIONS (DN X THICKNESS)	APPLICATION CLASS/DESIGN PRESSURE	OPACITY YES / NO	OXYGEN PERMEABILITY YES/NO

FITTINGS

FIGURE	MATERIAL	MANUFACTURER INTERNAL REFERENCE

For any modification of the indicated date, the client shall send to the Committee Secretary this updated descriptive questionnaire.

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SIGNATURE AND STAMP OF THE MANUFACTURER

Annex C1

Data sheet

TYPE OF CONSTRUCTION:

TYPE OF WELDING (ONLY TYPE M):

RAW MATERIAL OF EACH LAYER	SUPPLIER	REFERENCE

DIMENSIONS OF EACH LAYER: (included tolerances)

DIMENSIONS (DN X THICKNESS)	e1 internal	e2 embedde d	e3 external	D interior	D embedde d	D total	SDR or SDRm

For any modification of the indicated date, the client shall send to the Committee Secretary this updated descriptive questionnaire.

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DATE, SIGNATURE AND STAMP OF THE MANUFACTURER

Annex D

Tolerances

The tolerances to be applied in dimensional control of diameter, wall thicknesses and over thickness of each layer are the following:

Mean Outside diameter: A tolerance of 1% of the nominal diameter and at least 0.3.

Thickness of the layers: It will be the indicated for the manufacturer from the data sheet with a tolerance that will result to apply the following formula:

Tolerance of the layers (in millimetres) = $0.1 * s + 0,2$, where

s = thickness rounding to 0,1 mm immediately superior

Adhesives are not considered as independent layers.

Annex E

Geometrical characteristics and minimum reference curves

E.1 Geometric characteristics

E.1.1 Dimensions. Mean outside diameter d_{em} and minimum wall thickness $e_{mín}$ of pipe shall conform to table 1.

The tolerance on wall thickness e shall conform to table 2.

The thickness of the aluminium layer must be of 0,2 mm minimum.

Table E1 - Dimensions of pipes

Nominal Diameter DN/OD	Nominal outside diameter	Mean outside diameter		Wall thickness		S_{calc}
	d_n	$d_{em,mín.}$	$d_{em,máx.}$	Nominal thickness, e_n	Minimum thickness, $e_{mín.}$	
	mm	mm	mm	mm	mm	
14	14	14,0	14,3	2	1,9	3,0
15	15	15,0	15,3	2	1,9	3,25
16	16	16,0	16,3	2	1,9	3,5
				2,25	2,05	3,1
18	18	18,0	18,3	2	1,9	4,0
20	20	20,0	20,3	2	1,9	4,5
				2,25	2,05	3,9
				2,5	2,3	3,5
22	22	22,0	22,3	2,5	2,3	3,9
25	25	25,0	25,3	2,5	2,3	4,5
26	26	26,0	26,3	3	2,8	3,8
28	28	28,0	28,3	3	2,8	4,2
32	32	32,0	32,3	3	2,8	4,8
40	40	40,0	40,4	3,5	3,2	5,2
				4	3,8	4,5
50	50	50,0	50,5	4,5	4,3	5,1
63	63	63,0	63,6	6	5,7	4,8
75	75	75,0	75,7	7,5	7,2	4,5
90	90	90,0	90,9	8,5	8,2	4,8
110	110	110,0	111,0	10	9,7	5,0

(*) Requirements stated in this annex are derived from the former UNE 53 960 EX and UNE 53 961 EX and apply for products related to those standards.

Table E2 - Tolerances on wall thickness (mm)

Minimum thickness $e_{\min.}$		Tolerance ¹⁾
>	≤	
1,0	2,0	0,45
2,0	4,0	0,6
4,0	5,0	0,7
5,0	6,0	0,8
6,0	7,0	0,9
7,0	8,0	1
8,0	9,0	1,1
9,0	10,0	1,2
1) The tolerance should be expressed as $^{+x}_0$ mm, where x is the value of tolerance given in the table		

E.1.2 Ovality. Difference between the average outside diameter and the maximum or minimum external diameter, measured in any right section. There takes the ovality of major absolute value.

The ovality, measured directly after manufacture, shall conform to table E3.

Table E3 - Maximum ovality (mm)

Nominal diameter (d_n)	Ovality
$14 < d_n \leq 32$	0,50
$32 < d_n \leq 50$	0,80
$50 < d_n \leq 75$	1,00
$75 < d_n \leq 110$	1,5

The ovality will not be measured on pipes whit ratio e / d_n equal or less than 0.05.

E.2 Minimum reference curves

All pipes should be adequate for the conveyance of cold water for a period of 50 years, at a temperature of 20 °C and a pressure design of 10 bar.

For application classes 1, 2, 4 y 5 all pipes must be suitable for the conveyance of water over a period of 50 years at a minimum design pressure of 6 bar.

Based on these reference curves, are chosen certain points, circled in the attached figures (see figures 1 y 2) as a minimum test condition that must comply multilayer pipes in accordance with this document.

For temperatures lower than or equal to 70 °C, the overall design stress should be 1.5 to 50 years of continuous use. For temperatures above 70 °C, after a certain number of hours, no there is no extrapolation of the reference curves up to 50 years. Overall service design stress is considered to 25 years of continuous use or whenever the number of hours accumulated no more than 25 years. The ratio between the value of the minimum burst pressure, extrapolated to 25 years reference curves, and the value of the design pressure will serve to define the maximum working pressure at that temperature. For temperatures above 70°, it has been taken as overall service design of 2.

Control points for multilayer pipes

Characteristic	Requirement	Parameter test		Test method
Internal Pressure	without break	Pressure: Temperature: Time: Number of test pieces: Type of test:	40 bar 20 °C 1 h 3 Water-in-air or water-in -water	UNE-EN 1167
	without break	Pressure: Temperature: Time: Number of test pieces: Type of test:	16 bar 95 °C 165 h 3 Water-in-air or water-in-water	
	without break	Pressure: Temperature: Time: Number of test pieces: Type of test:	15 bar 95 °C 1 000 h 3 Water-in-air or water-in -water	

Classification of service conditions

Application class	T _D	Time T _D	T _{max}	Time T _{max}	T _{mal}	Time T _{mal}	Typical application field
	°C	Years	°C	Years	°C	h	
1	60	49	80	1	95	100	Hot water supply (60 °C)
2	70	49	80	1	95	100	Hot water supply (70 °C)
4	20	2,5	70	2,5	100	100	Under floor heating and low temperatures radiator
	plus accumulated						
	40	20					
	plus accumulated						
	60	25					
5	20	14	90	1	100	100	High temperatures radiators
	plus accumulated						
	60	25					
	plus accumulated						
	80	10					
T _D : Design temperature (work temperature)							
T _{máx} .: Maximum temperature							
T _{mal} : Malfunction temperature							

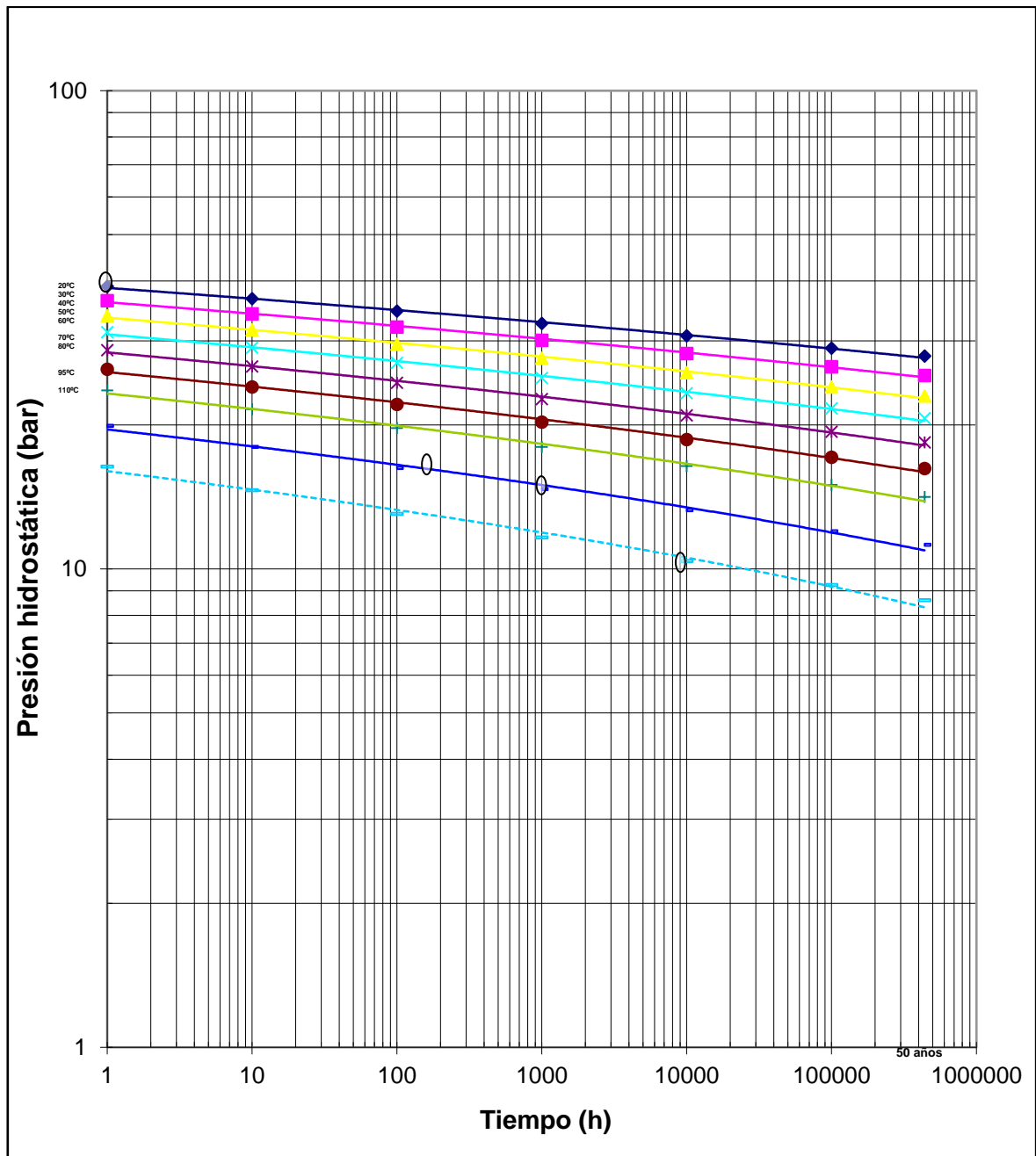


Figure 1 - Minimum lines of references of the multi-layer pipes Plastic Polymer /Al/PE-RT

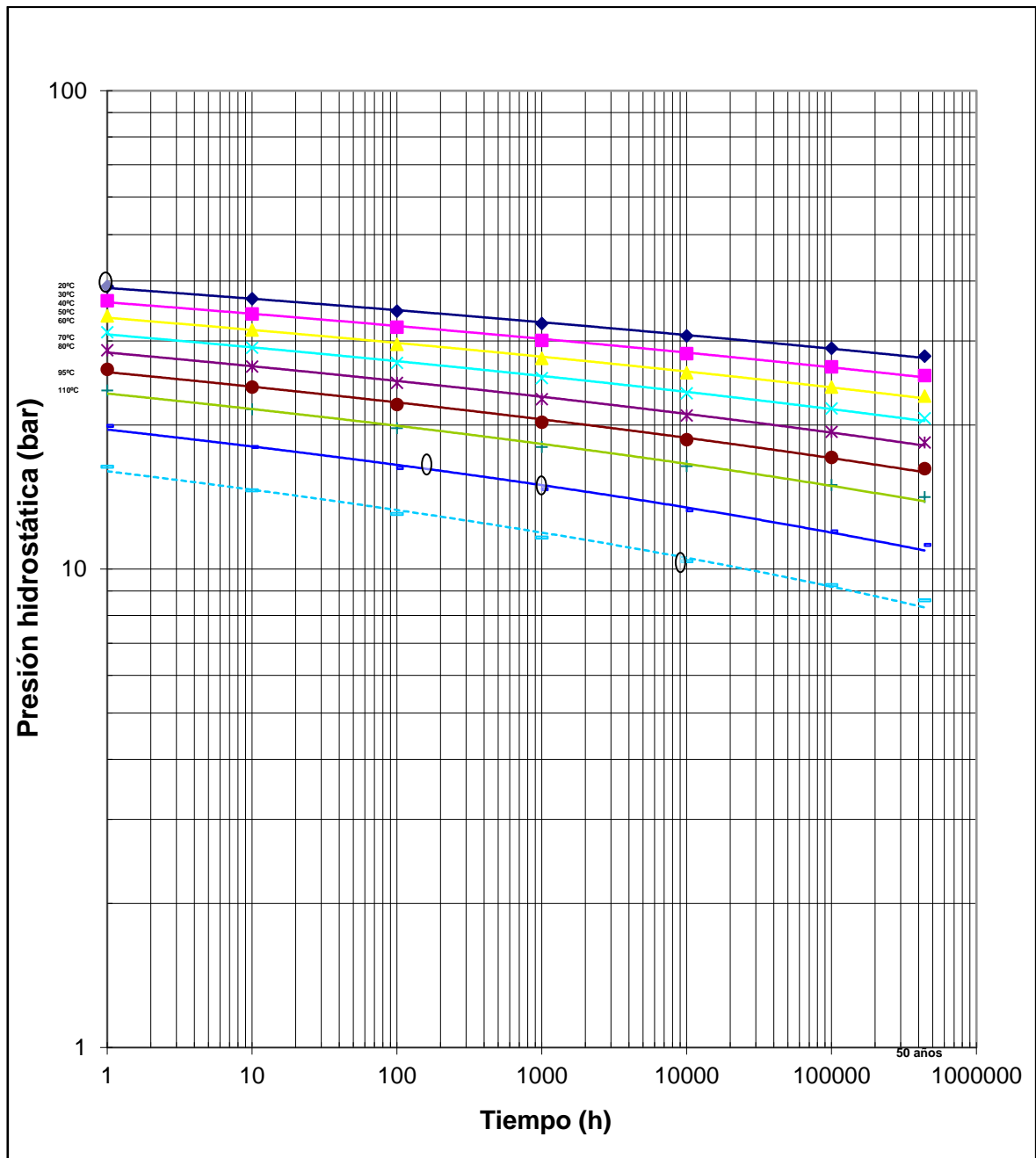


Figure 2 - Minimum lines of references of the multi-layer pipes Plastic Polymer/Al/PE-X

Annex F

Determination of adherence by tensile

F.1 Principle

Asses the adhesion of the inner layer of the pipe to the aluminium layer by a tensile test.

F.2 Preparation of test specimens

Extract five pieces of 10 mm length from a sample of pipe. These pieces shall be evenly spaced along the sample.

Test specimens are placed on the cylinder (see point F.3) and outer and middle layers are cut mechanically on the opposite point of the welding line. Following, separate the layers of the inner layer from the point of cut approximately 5 mm in order to fix them into the clamp of the traction device (see point F.3).

F.3 Device for tensile test, class A

Stretching device as shown in figure 1c (See standard UNE 53417)

Cylinder diameter is 95% of the inner diameter of the pipe.

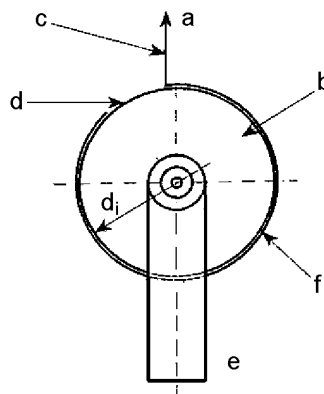


Fig. 1 - Scheme of the tensile test

Legend

- a is the fixed clamp
- b is the cylinder of ball bearings
- c is the outer layer and intermediate layer separated
- d is the inner layer
- di is the inside diameter of the pipe
- e is the tool holder piece on supports, and
- f is the welding point

F.4 Testing procedure

Once prepared and placed test specimens in the device as described in section F.2, separate the outer and embedded layers of the inner layer at a temperature of $23\text{ °C} \pm 2\text{ °C}$ using a traction speed of $50\text{ mm/min} \pm 5\text{ mm/min}$. It shall record the diagram displacement/force, from which it is determined the average tensile strength in N/cm.

F.5 Test report

- a) Test specimen's dimensions
- b) Average tensile strength in N/cm in accordance with paragraph F.4
- c) Reference to the test method of the Specific Rules
- d) Date of the test

Annex G

Changes

Relevant test shall be carried out whenever there is a change in design, in material and/or in the production method, etc, according to the frequency established in tables 1 and 2 of these documents. Those tests shall be carried out both by AENOR and manufacturer as internal control with the exception of references curves that just must be done by the manufacturer.

If reference curves has been done at 20°C, 60°C, 70°C or 80°C and 95°C an any change is done, it is necessary to perform reference curves again but just only at 95°C.

Table G1 - Conditions to lead to a change of material

Type of material change	Conditions
Change of the stress-designed layer(M1)	Any change of characteristic of effort layers (except color)
Change of non-stress- layer (M2)	Change of formulation and/or additives. Change of polymer type
Change of metal (M3)	Change of alloy/composition. Change of welding type
Change of construction type (M4)	Change of dimensions. Change of geometry of the components
Change of adhesive(M5)	Change of the formulation. Change of chemical nature

Table G2 - Pipes type M

Characteristic	Conditions requiring test					Type of sample to carry out the test
	M1	M2	M3	M4	M5	
Appearance	+	+	+	+	+	For dimensional group and pressure group
Dimensions	+	+	+	+	+	For dimensional group and pressure group
Reference curves	+	-	+	+	+(1)	For type of similar structure
Durability (inner layer)	+	-	-	+(2)	-	For type of similar structure
Durability (outer layer)	-	+	-	+	-	For type of similar structure
Strength of weld line (Internal Pressure)	-	-	+	+	-	For type of similar structure
Delamination	+	-	+	-	+	For type of similar structure
Physical and chemical characteristics	+	+	+	-	-	For type of similar structure

(1) Only validation (to realize internal pressure test 95°C 165h and 95°C 1000h)

(2) It will be realized to that of minor wall thickness

Table G3 - Pipes type P

Características	Conditions requiring test				Type of sample to carry out the test
	M1	M2	M4	M5	
Appearance	+	+	+	+	For dimensional group and pressure group
Opacity	+	+	+	+	On the dimension of minor thickness
Dimensions	+	+	+	+	For dimensional group and pressure group
Reference curves	+	-	+	+(3)	For type of similar structure
Durability	+	-	+(4)	-	For type of similar structure
Internal pressure	-	-	+	-	For type of similar structure
Delamination	+	+	-	+	For type of similar structure
Oxygen permeability	-	+	+(5)	-	For type of similar structure
Physical and chemical characteristics	+	+	-	-	For type of similar structure

(3) Only validation (carry out internal pressure test 95°C 165h and 95°C 1000h)

(4) It will be done over the minor wall thickness

(5) It will be done over the minor thickness of barrier layer

Whenever there is a change in design and material of fittings that affect to a functional part (nipple, shell, etc.) shall be sent to the secretary of the Committee new drawings. All functional tests system indicated in table 1 of point 3.2 and table 2 of point 4 must be repeated.

Annex H

Flexibility test

F.1 The method

Determination of the measure of the flexibility of pipes in which the pipe deformation is to be measured.

F.2 Test pieces and preparation

A one meter long piece of pipe is used as a specimen. The inside diameter- d - and outside diameter- D - are determined at a temperature of $23^{\circ} \pm 2^{\circ}\text{C}$ with the specimen in a longitudinal, horizontal, non-stressed position.

F.3 Equipment

The equipment shall consist of two guides A and B, the guide A fixed in a plane and the guide B movable in that plane and parallel to and aligned with the guide A

F.4 Procedure

The test is carried out according to the UNE-EN ISO 10619-1 Standard as shown in figure 5, placing the pipe between the two rulers and bringing the mobile one close to the fixed one up to a distance equal to $10d + D$, and then measuring the dimension - D' - of the bent section with a precision of 0.05 mm.

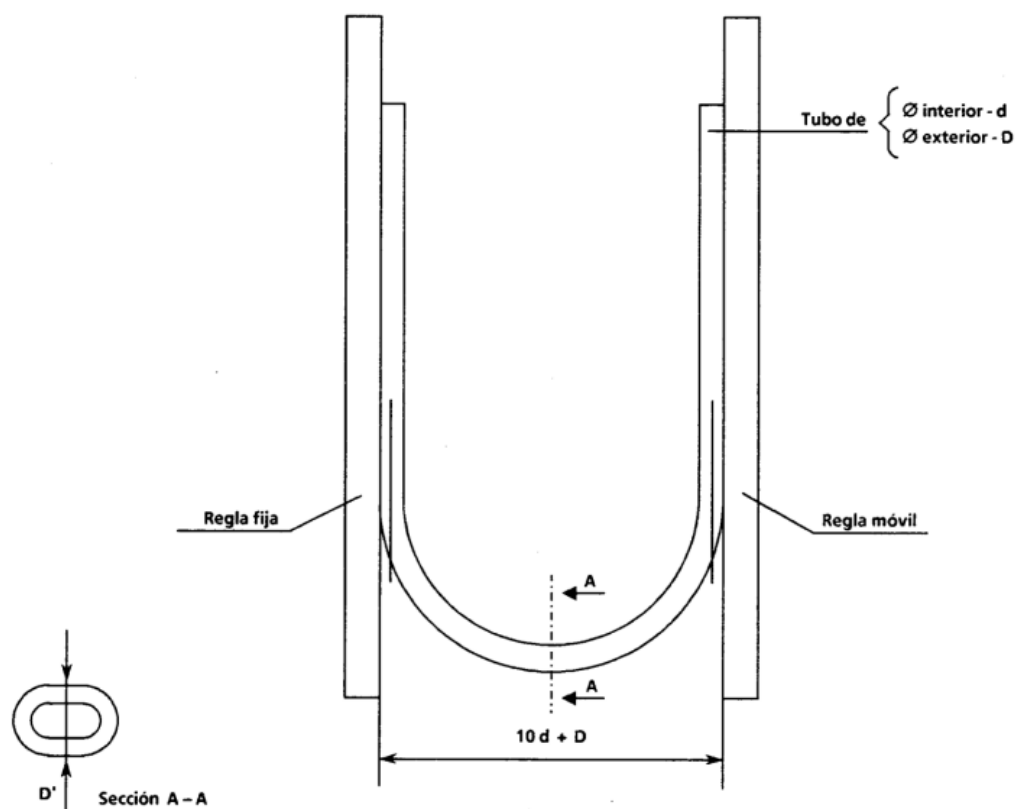


Figura 5

F.5 Results

The value of D'/D is calculated using the average values obtained. The results are compared with the allowable deflection.

F.6 Test requirement

Free of cracks and grooves

F.7 Test Report

- Test temperature
- Observation of any abrupt change(s) in pipe cross-section or irregularity in curvature caused by bending
- D , D' and D'/D value
- If D'/D is within the deformation tolerance

e) Reference to the test method of the Specific Rules

f) Date of test

Table of dimensions flexibility test for R=3

D	e	10d+D	10d+D values allowed for R=3
20	2,3	174	160-232
25	2,8	219	200-290
32	3,5	282	254-368
40	4,5	350	320-464
50	5,6	438	400-580
20	1,9	182	160-232
25	2,3	229	200-290
32	2,9	294	254-368