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European Assessment Document for

Three-layer polyethylene-based coating for corrosion protection of steel pipes

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

The EAD applies to the plant-applied external three-layer polyethylene-based (PE [1]) coating for corrosion protection of steel pipes[2] according to EN ISO 21809-1[3] (subsequently three-layer PE coating) on steel pipes according to EN 10217-1, EN 10217-3, EN 10217-5, EN 10219-1, EN 10224, EN 10255 or EN ISO 3183 for natural gas and petroleum industry. Complete three-layer PE coating is produced in manufacturing plant by form of application of continual strip of hot melted polymer on pre-prepared surface of pipe under spiral rotation of pipe. Continual spiral closed joint in applied coating creates its integral part.

The complete coating covered by this EAD contains three layers, as specified below, and it is based on polyethylene (PE) of specified apparent density according to intended temperature range, of specified thickness in dependence on intended type of installation of coated pipe and according to linear pipe weight P_m according to Table 1.1.1:

- the first layer: continuously applied epoxy covering on surface of steel;
- the second layer: adhesive applied by extrusion or by powder spray on epoxy covering;
- the third layer: top layer made of polyethylene (PE) of specified type and nominal apparent density as given below, applied by extrusion.

Type of polyethylene (PE) in the scope of this EAD used on top layer of coating is:

- low-density polyethylene (PE-LD) with minimum nominal apparent density 930 kg/m^3;
- medium-density polyethylene (PE-MD) with minimum nominal apparent density 940 kg/m^3
- high-density polyethylene (PE-HD) with minimum nominal apparent density 941 [4] kg/m^3.

Dependence between the minimum coating thickness to be applied on coated pipes in relation to material type of PE coating, intended temperature range, type of installation of coated pipes and to linear pipe weight $P_{m,}$ covered by this EAD, is given in Table 1.1.1.

Table 1.1.1 Total thickness of three-layer PE coating

Material of the top layer of PE coating	PE-LD with minimum nominal apparent density 930 kg/m^3			PE-MD with minimum nominal apparent density 940 kg/m^3 or PE-HD with minimum nominal apparent density 941 kg/m^3		
Intended temperature range	From -20 °C up to +60 °C			From -40 °C up to +80 °C		
Intended application of coated pipes [1])	Lighter installation / laying conditions	Standard conditions	More severe environments and installation / laying conditions	Lighter installation / laying conditions	Standard conditions	More severe environments and installation / laying conditions
Linear pipe weight P_m [2]) [kg/m] (see 1.3.1)	Total thickness of the three-layer PE coating [mm]					
$P_m \leq 15$	1,8	2,1	2,6	1,3	1,8	2,3
$15 < P_m \leq 50$	2,0	2,4	3,0	1,5	2,1	2,7
$50 < P_m \leq 130$	2,4	2,8	3,5	1,8	2,5	3,1
$130 < P_m \leq 300$	2,6	3,2	3,9	2,2	2,8	3,5
$P_m > 300$	3,2	3,8	4,7	2,5	3,3	4,2

1 For symbols for plastics, please see EN ISO 1043-1.

Notes:

[1]) Examples of intended application of coated pipes are given in 1.2.1.

[2]) Procedure of determination of the linear pipe weight P_m is given in 2.2.2.

The product is not covered by a harmonised European standard (hEN).

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.

It is assumed that the product will be installed according to the Manufacturer's Product Installation Instructions (MPII), or (in absence of such instructions) according to the usual practice of the building professionals.

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.

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

1.2.1 Intended use(s)

The three-layer PE coating is intended to be used for corrosion protection of welded or seamless steel pipes for pipeline transportation systems in petroleum or natural gas industries, laid in a ground or on surface of ground or offshore.

The three-layer PE coating covered by this EAD is intended to be used in the temperature range:

A. Coating with top layer made of PE-LD with minimum nominal apparent density 930 kg/m^3, determined for application in the temperature range from -20 °C up to +60 °C

B. Coating with top layer made of PE-MD with minimum nominal apparent density 940 kg/m^3 or of PE-HD with minimum nominal apparent density 941 kg/m^3, both are determined for application in the temperature range from -40 °C up to +80 °C

Different coating thicknesses, as given in 1.1, Table 1.1.1, are intended to be used in following conditions for example:

1. Lighter installation / laying conditions: sandy soils or prepared backfill with selected materials;
2. Standard conditions: clay soils, backfill made by native soil or not coarse materials;
3. More severe environments and installation / laying conditions: offshore applications or rocky soils.

Transversal welds of pipes, performed on construction site, and/or fittings shall be coated by pre-made narrow supplementary strips of insulation, placed on a surface pre-prepared by layers of the epoxy covering and the adhesive according to MPII.

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2 EN ISO 21809-1 uses the term "pipe" while European standards, mentioned in Chapter 4, use the term "tube" in titles. Due to continuity, in the content of the EAD term "pipe" is preferred, except of standard titles.

3 All undated references to standards or to EADs in this EAD are to be understood as references to the dated versions listed in chapter 4.

4 PE-HD is specified in the Clause 2.1370 of EN ISO 472 as material with "density greater than 0,940 g/cm^3".

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 three-layer PE coating for corrosion protection of steel pipes for the intended use of 25 years when installed in the works (provided that the three-layer PE coating on steel pipes is subject to appropriate installation (see 1.2.1)). 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[5].

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.

1.3 Specific terms used in this EAD

For the purposes of this document, the following terms and definitions apply.

1.3.1 Linear pipe weight P_m

Mass per metre of length of a steel pipe without coating, expressed in kilograms per metre of length and determined as described in 2.2.2.

1.3.2 Holiday

Coating discontinuity according to Clause 3.13 of EN ISO 21809-1.

1.3.3 Peel strength

Force according to Clause 3.19 of EN ISO 21809-1.

1.3.4 Total thickness of coating

Thickness of the complete three-layer PE coating according to Clause 3.28 of EN ISO 21809-1.

1.3.5 Composition of the three-layer PE coating

Unique combination of the type of epoxy covering, of the type of adhesive and of the type of the material of the top layer (PE-LD or PE-MD or PE-HD), as specified in Table 1.1.1.

5 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.

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 the three-layer PE coating 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, Description
Basic Works Requirement 4: Safety and accessibility in use			
2	Corrosion protection: Total thickness of coating	2.2.2	Description, Level
3	Corrosion protection: Apparent density of the PE coating	2.2.3	Description, Level
4	Corrosion protection: Continuity of applied coating	2.2.4	Description, Level
Aspects of durability			
5	Impact strength at (23 ± 3) °C	2.2.5	Description, Level
6	Indentation at (23 ± 3) °C and at maximum design temperature	2.2.6	Description, Level
7	Stress at yield and strain at break at (23 ± 3) °C	2.2.7	Description, Level
8	Peel strength	2.2.8	Description, Level
9	Difference in the glass transition temperature ΔT_g of the epoxy material	2.2.9	Description, Level
10	Product stability during application of the PE top layer process	2.2.10	Description, Level
11	Cathodic disbondment	2.2.11	Description, Level
12	Flexibility	2.2.12	Description, Level
13	Resistance to hot water immersion	2.2.13	Description, Level
14	Vicat softening temperature	2.2.14	Description, Level
15	UV resistance	2.2.15	Description, Level
16	Thermal ageing	2.2.16	Description, 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.

All tests shall be performed at normal laboratory environment (+23 ± 2) °C and RH (50 ± 10) % according to EN ISO 21809-1, if relevant test procedure does not specify different conditions. Test specimens shall be conditioned in relevant environment for 24 hours before the test, if test procedure does not specify otherwise.

2.2.1 Reaction to fire

The three-layer PE coating shall be tested using the method(s) relevant for the corresponding reaction to fire class according to EN 13501-1. The three-layer PE coating shall be classified according to the Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1.

Details of tests are specified in the Annex A.

The following information shall be given in the ETA, preferably in form of a table:

- The classified composition of the three-layer PE coating according to 1.3.5;
- The class of reaction to fire relevant to this composition of the three-layer PE coating.

2.2.2 Corrosion protection: Total thickness of the coating

The total thickness of the coating (see 1.3.4) shall be determined according to Clause 4.3 of EN ISO 2178.

Each composition of the three-layer PE coating (see 1.3.5) shall be tested. Number of tested linear pipe weights P_m (see 1.3.1) for each composition of the three-layer PE coating (see 1.3.5) covered by the ETA, shall be determined as follows:

- If only one up to three different linear pipe weights P_m, situated in the Table 1.1.1 behind each to other, are specified in the scope of the product covered by the ETA, only one linear pipe weight, preferably the minimum one, shall be selected for the test;
- In any different case, at least two different linear pipe weights P_m shall be selected for the test, with difference between them at least one (if possible two) intermediate pipe weight(s). Preferably the minimum and the maximum linear pipe weights from specified scope of the product, covered by the ETA, shall be selected.

The linear pipe weight P_m shall be determined from the nominal diameter of a pipe and from the nominal thickness of a pipe wall, generally for the density of steel 7850 kg/m^3, if the manufacturer does not specify a different density.

At least ten test points selected by random on the tested specimen (pipe) shall be measured.

The average value of the total thickness of the coating, given in [mm], shall be calculated for each tested pipe and rounded for one decimal place downwards.

The following information shall be given in the ETA for each tested pipe, preferably in form of a table:

- The tested composition of the three-layer PE coating according to 1.3.5;
- The linear pipe weight P_m in [kg/m] of tested pipe according to 1.1;
- The individual measured values of the total thickness of the three-layer PE coating in [mm];
- The average value of the total thickness of the three-layer PE coating in [mm].

2.2.3 Corrosion protection: Apparent density of the PE coating

The apparent density of the PE coating shall be determined according to Clause 5.2, Method B, of EN ISO 1183-1, on at least one test specimen, prepared from the amount about 500 g of granules, taken from a bag with PE granules ready for manufacturing of coating. Mass of the test specimen shall be at least 50 g.

Instead of provisions of EN ISO 1183-1, the apparent density shall be expressed in [kg/m^3]. Calculated value shall be rounded in integer downwards.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The value of the apparent density of the PE coating in [kg/m^3].

2.2.4 Corrosion protection: Continuity of applied coating

The continuity of applied coating shall be determined by the test with a high-voltage holiday detector according to Annex B of EN ISO 21809-1. At least one separate pipe of length at least 4 metres with the applied three-layer PE coating, covered by the ETA, for each composition of the three-layer PE coating (see 1.3.5) shall be tested.

The test of the total thickness of coating according to 2.2.2 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the continuity of applied coating, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Total thickness of coating” according to 2.2.2. Measured thickness of the coating shall be recorded and its average value according to 2.2.2 shall be calculated.

For the test, the tested pipe shall be positioned on a base, allowing rotation of the pipe. The upper part of surface of the tested pipe shall be controlled for presence of holidays in an angle of about +/- 60° from the top. When this control is finished, the pipe shall be rotated for 90° and process of control shall be repeated, until the complete surface of the tested pipe is controlled. Overlapping of tested surface in rotated positions shall be held during the test.

If any holiday in the three-layer PE coating during the test is detected, it shall be marked by appropriate marker on the tested surface. After completing of the test of the all surface of the pipe, all detected holidays are recorded or, if no holidays were identified, record “Pipe without defects” is performed.

Before the test, the control of correct function of used high-voltage holiday detector shall be performed on separate test specimen with pre-prepared artificial defect in applied coating, as specified in Clause H.4.2, Annex H, of EN ISO 21809-1. Record about the control shall be performed and documented in the test report.

The following information shall be given in the ETA, preferably in form of a table:

- The tested composition of the three-layer PE coating according to 1.3.5;
- The tested linear pipe weight P_m according to 1.1;
- The tested average total thickness t_m of the three-layer PE coating;
- The number and description of identified defects (holidays) in tested pipe(s). Additionally, sketch of tested pipe with position(s) of identified defect(s) can be added.

The test result is valid for all total thicknesses of the specified composition of the three-layer PE coating from the range of the tested thicknesses of the product according to 2.2.2.

2.2.5 Impact strength at (23 ± 3) °C

The impact strength at (23 ± 3) °C shall be determined according to Annex E of EN ISO 21809-1, on one test specimen, created by one pipe of length about 1 metre, with applied specified composition of the three-layer PE coating (see 1.3.5). At least ten test points for the test of the impact strength at (23 ± 3) °C shall be selected on the test specimen by random, in mutual distance according to E.3.4, Annex E, of EN ISO 21809-1.

The tests of the total thickness of coating according to 2.2.2, of the apparent density of the PE coating according to 2.2.3 and of the continuity of applied coating according to 2.2.4 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the impact strength at (23 ± 3) °C, even in case the manufacturer does not wish to declare the performance for the essential characteristics "Total thickness of coating" according to 2.2.2, "Apparent density of the PE coating" according to 2.2.3 and "Continuity of applied coating" according to 2.2.4.

Only a test specimen without defects of continuity of applied coating according to 2.2.4 shall be used for the test of impact strength at (23 ± 3) °C.

For the assessment of the pipes with linear pipe weight $P_m \leq 15$ kg/m, the pipes of diameter higher than 50 mm and of thickness of wall corresponding to maximal linear pipe weight P_m (see 1.3.1) equal to 15 kg/m shall be used. The pipes with diameter equal to or lower than 50 mm shall not be tested.

For the thickness of pipe wall equal to or lower than 2,5 mm, interior of tested specimen shall be supported by appropriate insert to reduce elastic response. This insert can be created by steel circular segment of height at least 5 mm, of external diameter at least 50 mm and of length at least 50 mm, mechanically pressed to the internal side of the tested pipe in the point of impact.

Each test impact shall be performed on the new test point, in the distance of at least of 100 mm outside of any possible defects, identified according to 2.2.4 during previous tests.

During the test, additional loads shall be added one by one on impact hard steel punch until creation of defect of continuity is detected on the tested place after performed impact. Then the last added load is removed from hard steel punch and ten impacts with such loaded punch shall be performed on new test points on the test specimen, with detection of continuity of applied coating after each impact. If during any of following ten impacts defect of continuity is detected, load of hard steel punch is decreased as previously and new at least ten impacts shall be performed.

To simplify the test, it is recommended to start the test with total weight of hard steel punch with additional load(s) at least on level calculated as:

$$m = \frac{t_c \times i}{9{,}81}$$

where: m is weight of hard steel punch with additional load(s), used for test, in [kg];

i expected level of impact strength at (23 ± 3) °C given in [J/mm] according to material of the top layer, for PE-LD: i = 5 J/mm, for PE-MD and PE-HD: i = 7 J/mm;

t_c average value of thickness of tested three-layer PE coating in [mm], determined according to 2.2.2.

To increase or to decrease impact energy, it is recommended to use additional loads of weight 102 g (equal to 1.0 N), 204 g (equal to 2.0 N) and/or 51 g (equal to 0.5 N).

After the tests, impact strength at (23 ± 3) °C *"I_j"* shall be calculated at least for series "*j*" of tests, which does not cause any defects after ten impacts, as follows:

$$I_j = \frac{m_j \times 9{,}81}{t_m}$$

where: I_j is impact strength at (23 ± 3) °C of the test series *"j"*, given in [J/mm];

m_j	weight of hard steel punch with additional load(s), used for assessed test series *"j"* of impacts, in [kg];
t_m	average value of the thickness of tested three-layer PE coating in [mm], determined according to 2.2.2.

For further test series of impacts, which cause any defect(s) within performed ten impacts, the impact energy *"I_j"* can be calculated in the same way.

The following information shall be given in the ETA, preferably in form of a table:

- The tested composition of the three-layer PE coating according to 1.3.5;
- The tested linear pipe weight P_m according to 1.1;
- The tested total thickness t_m of the three-layer PE coating;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The calculated impact strength at (23 ± 3) °C "I_j", which does not cause any defects after ten impacts, given in [J/mm].

2.2.6 Indentation at (23 ± 3) °C and at maximum design temperature

The indentation at (23 ± 3) °C and at maximum design temperature shall be determined according to Annex F of EN ISO 21809-1, on test specimen, created by one pipe with applied three-layer PE coating of specified material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1. At least three measurements on the test specimen shall be performed at the temperatures as follows:

- On the top layer made of PE-LD with minimum nominal apparent density 930 kg/m^3:

  at (23 ± 3) °C and at (60 ± 3) °C;

- On the top layer made of PE-MD with minimum nominal apparent density 940 kg/m^3 or of PE-HD with minimum nominal apparent density 941 kg/m^3:

  at (23 ± 3) °C and at (80 ± 3) °C.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to tested for assessing the indentation at (23 ± 3) °C and at maximum design temperature, even in case the manufacturer does not wish to declare the performance for the essential characteristic "Apparent density of the PE coating" according to 2.2.3.

The indentation at (23 ± 3) °C and at maximum design temperature of the tested places shall be calculated separately according to Clause F.4, Annex F, of EN ISO 21809-1. Then the average values of the indentation at (23 ± 3) °C and at maximum design temperature shall be calculated separately for each tested material of the top layer of the three-layer PE coating according to 1.1. All calculations shall be performed with accuracy ±0.01 mm.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The average values of the indentation at (23 ± 3) °C and at maximum design temperature in [mm].

2.2.7 Stress at yield and strain at break at (23 ± 3) °C

The stress at yield and the strain at break at (23 ± 3) °C of PE coating material shall be determined according to EN ISO 527-2 on at least one specimen of PE coating material manufactured into form of foil of applied thickness(es), of area at least 1 m^2 and of width at least 200 mm. Five test specimens of shape 1B according to Clause 6.1, Table 1 and Figure 1 of EN ISO 527-2, shall be taken from foil for each type of the material of the top layer according to 1.1 separately for longitudinal and for transversal direction.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the stress at yield and strain at break at (23 ± 3) °C, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Apparent density of the PE coating” according to 2.2.3.

The average values of stress at yield f_m in [MPa] and of strain at break ε_m in [%] of PE coating of the tested specimen shall be calculated according to Clause 10 of EN ISO 527-1 and rounded downwards, separately for longitudinal and for transversal direction for each type of the material of the top layer according to 1.1.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The average values of the stress at yield f_m in [MPa] and of the strain at break ε_m in [%] for longitudinal direction;
- The average values of the stress at yield f_m in [MPa] and of the strain at break ε_m in [%] for transversal direction.

2.2.8 Peel strength

The peel strength shall be determined according to Annex C of EN ISO 21809-1, on at least three test specimens prepared from the pipe with an external diameter of at least 60 mm with applied specified composition of the three-layer PE coating according to 1.3.5, taken from production line. Preferably the minimum total thickness t_m of the specified composition of the three-layer PE coating should be tested.

The tests of the total thickness of coating according to 2.2.2 and of the continuity of applied coating according to 2.2.4 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the of peel strength, even in case the manufacturer does not wish to declare the performances for the essential characteristics “Total thickness of coating” according to 2.2.2 and “Continuity of applied coating” according to 2.2.4.

The test shall be performed for the each following test temperature:

- at the temperature (23 ± 3) ºC for all types of the material of the top layer according to 1.1;

and consequently

- at the temperature (60 ± 3) ºC for the top layer made of PE-LD with minimum nominal apparent density 930 kg/m^3;

or

- at the temperature (80 ± 3) ºC for the top layer made of PE-MD with minimum nominal apparent density 940 kg/m^3 or of PE-HD with minimum nominal apparent density 941 kg/m^3.

Type of break of each test specimen (e.g., break of tested layer, exfoliation between steel and epoxy covering, peeling of full length of test specimen) after the test of the peel strength shall be recorded.

In case of break of tested layer of the PE material at temperature (23 ± 3) ºC on any test specimen, the maximum achieved force shall be recorded and the peel strength shall be calculated from this force.

The peel strength shall be determined in [N/mm] separately for each test specimen according to Clause C.4, Annex C of EN ISO 21809-1. Than the average values of the peel strength shall be calculated in [N/mm] for each test temperature separately and rounded downwards for three valid places.

The following information shall be given in the ETA, preferably in form of a table:

- The tested composition of the three-layer PE coating according to 1.3.5;
- The tested total thickness t_m of the three-layer PE coating;
- The individual values of the peel strength of all tested specimens and the average value of the peel strength, separately for each test temperature;
- The type of break after the test of the peel strength separately for each test specimen and test temperature.

In extended application, the test result is valid for all thicknesses of the same composition of the three-layer PE coating.

2.2.9 Difference in the glass transition temperature ΔT_g of the epoxy material

The difference in the glass transition temperature ΔT_g of the epoxy material shall be determined according to Annex D of EN ISO 21809-1, on one test specimen for each used composition of the epoxy material.

The test specimen of a two-component epoxy liquid shall be prepared by procedure described in Clause D.5.1.1 of EN ISO 21809-1, the test specimen of a one-component epoxy liquid according to Clause D.5.1.2 of EN ISO 21809-1. Any alternative method of sampling directly from the pipe is not allowed for these types of epoxy. The test specimen of an epoxy powder shall be prepared according to Clause D.5.1.3 of EN ISO 21809-1.

The following information shall be given in the ETA, preferably in form of a table:

- The tested composition of the epoxy covering according to 1.1;
- The value of difference in the glass transition temperature ΔT_g of the epoxy material for each used composition of the epoxy covering.

2.2.10 Product stability during application of the PE top layer process

The product stability during application of the PE top layer process shall be determined by the method of melt-flow rate (MFR) according to Method A, Clause 8 of EN ISO 1133-1, on at least one test specimen for each type of the material of the top layer according to 1.1, at least for one test specimen taken from the batch of raw material.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the product stability during application of the PE top layer process, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Apparent density of the PE coating” according to 2.2.3.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The individual values of the product stability during application of the PE top layer process.

2.2.11 Cathodic disbondment

The cathodic disbondment shall be determined according to Annex H of EN ISO 21809-1, on at least one test specimen, prepared from the pipe coated by the specified composition of the three-layer PE coating (see 1.3.5), taken from production line, separately for each type of the material of the top layer according to 1.1 after conditioning as follows:

- for all types of the top layer:

  at 23 °C/28 days; -1,38 V;

  at 65 °C/24 h; -3,38 V;

and consequently

- for the top layer made of PE-LD with minimum nominal apparent density 930 kg/m^3:

  at 60 °C/28 days; -1,38 V;

or

- for the top layer made of PE-MD with minimum nominal apparent density 940 kg/m^3 or of PE-HD with minimum nominal apparent density 941 kg/m^3:

  at 80 °C/28 days; -1,38 V.

The tests of the apparent density of the PE coating according to 2.2.3 and of continuity of applied coating according to 2.2.4 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the cathodic disbondment, even in case the manufacturer does not wish to declare the performance for the essential characteristics “Apparent density of the PE coating” according to 2.2.3 and “Continuity of applied coating” according to 2.2.4.

At least three test specimens for each test condition shall be prepared from the tested pipe according to Clause H.3, Annex H of EN ISO 21809-1. Tested pipe shall be without defects, identified by the test of continuity of applied coating according to 2.2.4.

Before the test, artificial defect according to H.4.2, Annex H of EN ISO 21809-1 shall be prepared intentionally in each tested specimen.

The following information shall be given in the ETA, preferably in form of a table:

- The tested composition of the three-layer PE coating according to 1.3.5;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The individual values and the average value of the cathodic disbondment for specified test conditions.

2.2.12 Flexibility

The flexibility shall be determined according to Annex I of EN ISO 21809-1, on at least one test specimen for each type of the material of the top layer according to 1.1. At least three test specimens shall be prepared from the tested pipe coated by the three-layer PE coating, taken from production line.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the flexibility, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Apparent density of the PE coating” according to 2.2.3.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The description of presence of detected cracks on the test specimen or the statement “Without cracks”.

2.2.13 Resistance to hot water immersion

The resistance to hot water immersion shall be determined for each type of the material of the top layer (see 1.1) according to Annex L of EN ISO 21809-1, three test specimens shall be prepared from the pipe coated by the specified composition of the three-layer PE coating, taken from production line. Tested pipe shall be without defects, detected eventually by previous test of continuity of applied coating according to 2.2.4.

The test of the continuity of applied coating according to 2.2.4 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the the resistance to hot water immersion, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Continuity of applied coating” according to 2.2.4.

At least three test specimens shall be prepared by cold-cut (for example by water jet cutting) from the pipe coated by three-layer PE coating, taken from production line, according to outer diameter of coated pipe in accordance with Clauses L.3.1 or L.3.2, Annex L of EN ISO 21809-1. Testing on a coated pipe without cutting of test specimens is not allowed.

The test specimens shall be conditioned according to Clause L.4.2, Annex L of EN ISO 21809-1, then adjusted according to Clause L.4.3, Annex L of EN ISO 21809-1 and after it visually and manually examined according to Clause L.4.4, Annex L of EN ISO 21809-1 for presence of any defects. Eventual defects consisting in loss of adhesion, as total or partial unsticking of PE layer, disbonding of edges or corners or creating of bulges, shall be measured and recorded.

The resistance to hot water immersion shall be expressed in [mm] as the average value of loss of adhesion of the coating after adjusting of conditioned test specimens by cooling for 1 hour and after 24 hours. These values shall be rounded in integer upwards. Maximum value of loss of adhesion shall be recorded separately and rounded in integer upwards.

The following information shall be given in the ETA, preferably in form of a table:

- The composition of the three-layer PE coating according to 1.3.5;
- The maximum value of the loss of adhesion of the three-layer PE coating after the test of the resistance to hot water immersion;
- The description of determined loss of adhesion during the test of the resistance to hot water immersion.

2.2.14 Vicat softening temperature

The Vicat softening temperature shall be determined according to Clause 1, Method A/50 of EN ISO 306, on one specimen for each type of the material of the top layer according to 1.1. Three test specimens shall be prepared from tested pipe coated by three-layer PE coating, taken from production line, by careful removing of the top layer from the coated pipe by sharp knife, chisel or scalpel.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the Vicat softening temperature, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Apparent density of the PE coating” according to 2.2.3.

After the test, the average value of Vicat softening temperature according to Clause 9.6 of EN ISO 306 shall be calculated in [°C] and rounded for one nearest decimal place.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The average value of the Vicat softening temperature in [°C].

2.2.15 UV resistance

The UV resistance shall be tested in accordance with Clause G.1.4.2, Annex G of EN ISO 21809-1 according to EN ISO 4892-2, Table 3, Method A, cycle type 1, for a period of 2150 hours via tensile strain at break ε_b, determined by test according to 2.2.7. Specific conditions for ageing are given in Clause G.1.4.1, Annex G of EN ISO 21809-1.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the UV resistance, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Apparent density of the PE coating” according to 2.2.3.

At least five test specimens of the shape 1B according to Clause 6.1, Table 1 and Figure 1 of EN ISO 527-2, shall be prepared from the test specimen, created by one pipe coated by the three-layer PE coating, and tested separately for longitudinal and for transversal direction of coating for each type of the material of the top layer according to 1.1.

The *MOR* [6] values after the test of UV resistance shall be calculated in accordance with Clauses G.1.4.3 and G.1.4.4, Annex G of EN ISO 21809-1 separately for each type of the material of the top layer according to 1.1 and for longitudinal and for transversal direction of the coating.

The ΔMOR [6] values after the test of UV resistance shall be calculated in accordance with Clause G.1.5, Annex G of EN ISO 21809-1 separately for each type of the material of the top layer according to 1.1 and for longitudinal and for transversal direction of the coating.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating;
- The ΔMOR [6] values after the test of UV resistance separately for longitudinal and for transversal direction of the three-layer PE coating.

2.2.16 Thermal ageing

The thermal ageing shall be tested according to Clause G.2.1, Annex G of EN ISO 21809-1 according to EN ISO 527-2 via the variation in the tensile strain at break ε_b, determined by the test according to 2.2.7. Each type of the material of the top layer according to 1.1 shall be aged and tested separately for longitudinal and for transversal direction of coating.

The test of the apparent density of the PE coating according to 2.2.3 shall be performed every time as preliminary preparation of the specimen to be tested for assessing the thermal ageing, even in case the manufacturer does not wish to declare the performance for the essential characteristic “Apparent density of the PE coating” according to 2.2.3.

At least five test specimens of shape 1B according to Clause 6.1, Table 1 and Figure 1 of EN ISO 527-2, shall be prepared from the tested pipe coated by the three-layer PE coating, taken from production line, according to Clause G.2.3, Annex G of EN ISO 21809-1 and aged according to the material type of PE coating as follows:

- Coating made of PE-LD with minimum nominal apparent density 930 kg/m^3:

  2400 hours at temperature (100 ± 3) ºC

- Coating made of PE-MD with minimum nominal apparent density 940 kg/m^3:

  4800 hours at temperature (100 ± 3) ºC

6 Abbreviation *”MOR”* (“Modification of Resistance”) for change of tensile strain at break ε_b after specified conditioning is used in the context of 2.2.15 and 2.2.16 of this EAD in contrast to Annex G of EN ISO 21809-1.

- Coating made of PE-HD with minimum nominal apparent density 941 kg/m^3:

4800 hours at temperature (100 ± 3) ºC

After the thermal ageing, the test specimens shall be removed from a test chamber and conditioned at (23 ± 3) °C, (50 ± 5 %) RH at least for 24 hours. Then the test specimens shall be tested for the tensile strain at break ε_b according to 2.2.7.

The *MOR* [6] values after thermal ageing shall be calculated in accordance with Clauses G.2.4.3 and G.2.4.4, Annex G of EN ISO 21809-1 separately for each tested material type of PE coating and for longitudinal and for transversal direction of coating.

The *⊿MOR* [6] values after thermal ageing shall be calculated in accordance with Clause G.1.5, Annex G of EN ISO 21809-1 separately for each tested material type of PE coating and for longitudinal and for transversal direction of coating.

The following information shall be given in the ETA, preferably in form of a table:

- The tested type of the material of the top layer (PE-LD or PE-MD and/or PE-HD) according to 1.1;
- The apparent density of the tested material of the top layer of the three-layer PE coating given in kg/m^3;
- The *⊿MOR* [6] values after thermal ageing separately for longitudinal and for transversal direction of the three-layer PE coating.

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 (EU/EC) 1999/472/EC as amended by Commission Decision (EU/EC) 2001/596/EC.

The applicable AVCP system is 3 for any use except for uses subject to regulations on reaction to fire.

For uses subject to regulations on reaction to fire the applicable AVCP system regarding reaction to fire is 1 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 of the product itself, of input components and of continuous manufacturing of product are laid down in Table 3.2.1.

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]					
Product					
1	Input materials	Control plan and as specified in rows 18 to 43	Control plan	1	Once per each batch
2	Reaction to fire	2.2.1	Control plan	1	One per five years or at change of property of any component or at modification of product
	Non-combustibility test	A.2	Control plan	3	Each batch of each component, only if Classes of reaction to fire A1 or A2 are declared
	Gross heat of combustion Q_{pcs}	A.3	Control plan	3	One per five years or at change of property of any component or at modification of product
	Single-flame source test	A.4	Control plan	5	One per five years or at change of property of any component or at modification of product
	Density of components: - Two component epoxy - Epoxy powder - Adhesive material - Material of PE top layer	Table 3.2.1: Row 17 Row 21 Row 27 Rows 31, 32	Table 3.2.1: Row 17 Row 21 Row 27 Rows 31, 32	One per each component	One per batch
	SBI test	A.5	Control plan	1	One per five years or at change of property of any component or at modification of product

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
3	Corrosion protection: Total thickness of coating	2.2.2	Control plan	EN ISO 21809-1, Clause 12.1 and Table 9	EN ISO 21809-1, Clause 12.1 and Table 9
4	Corrosion protection: Apparent density of the PE coating	2.2.3	Control plan	1	Each batch of raw material for coating
5	Corrosion protection: Continuity of applied coating on pipe with artificial holiday	2.2.4	Artificial holiday shall be detected	Pipe with artificial holiday	On start of production or in change of manufactured pipe weight or once per five days of production of the same pipe weight
6	Corrosion protection: Continuity of applied coating on produced pipes	2.2.4	Control plan	Each pipe	Continuously, each pipe
7	Corrosion protection: Continuity of applied coating on repaired places	3.4.1	No holiday is identified after repair	Each identified holiday	Each repaired holiday
8	Impact strength at (23 ± 3) °C	2.2.5	Control plan	10	Once per each batch
9	Indentation at (23 ± 3) °C and at maximum design temperature	2.2.6	Control plan	3	Once per each batch
10	Stress at yield and strain at break at (23 ± 3) °C	2.2.7	Control plan	5	Once per each batch
11	Peel strength	2.2.8	Control plan	1	Every four hours of manufacturing process
12	Difference in the glass transition temperature ΔT_g of the epoxy material	2.2.9	Control plan	1	1st production pipe and 2nd per shift
13	Product stability during application of the PE top layer process	2.2.10	Control plan	1	1st pipe per shift
14	Cathodic disbondment - at 23 °C/28 d; -1,38 V - at 65 °C/24 h; -3,38 V - maximum operation temperature (max. 80 °C) / 28 d; -1,38 V	2.2.11	Control plan	Three per each test condition	Once per day
15	Flexibility	2.2.12	Control plan	3	At modification of product process or one per six months
16	Resistance to hot water immersion	2.2.13	Control plan	3	At change of property of any component or at modification of product
17	Vicat softening temperature	2.2.14	Control plan	3	Every batch of PE material for coating
18	UV resistance	2.2.15	Control plan	3	At change of property of any component or at modification of product or at least once per three years

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
19	Thermal ageing	2.2.16	Control plan	3	At change of property of any component or at modification of product or at least once per three years
Input components: Two component epoxy					
20	Density (only two component epoxy)	EN ISO 2811-1 EN ISO 2811-2 EN ISO 2811-3 EN ISO 2811-4	EN ISO 21809-1, Clause 9.2.2 and Table 3 and Control plan concerning reaction to fire (see 2.2.1)	1	One per batch
21	Solid content of resin and hardener	EN ISO 3251	EN ISO 21809-1, Clause 9.2.2 and Table 3	1	One per batch
22	Gel time at (205 ±3) °C (only two component epoxy)	Control plan	Control plan	1	One per batch
Input components: Epoxy powder					
23	Density	EN ISO 21809-1, Annex M	EN ISO 21809-1, Clause 9.2.2 and Table 3 and Control plan concerning reaction to fire (see 2.2.1)	1	One per batch
24	Moisture content	EN ISO 21809-1, Annex K	EN ISO 21809-1, Clause 9.2.2 and Table 3	1	One per batch
25	Particle size	EN ISO 21809-2	EN ISO 21809-1, Clause 9.2.2 and Table 3	1	One per batch
26	Gel time at (205 ±3) °C	EN ISO 21809-1, Annex J	EN ISO 21809-1, Clause 9.2.2 and Table 3	1	One per batch
Input components: Adhesive material (copolymeric or grafted adhesive in pellet or powder form)					
27	Stress at yield at (23 ±3) °C	2.2.7	EN ISO 21809-1, Clause 9.2.3 and Table 4	1	One per batch
28	Strain at break at (23 ±3) °C	2.2.7	EN ISO 21809-1, Clause 9.2.3 and Table 4	1	One per batch
29	Density	EN ISO 1183-1 EN ISO 1183-2 EN ISO 1183-3	Control plan, concerning reaction to fire (see 2.2.1)	1	One per batch
30	MFR	EN ISO 1133-1	Control plan	1	One per batch
31	Vicat softening temperature A/50	2.2.14	EN ISO 21809-1, Clause 9.2.3 and Table 4	1	One per batch
32	Water content	EN ISO 15512 (pellets or powder) EN ISO 8130-7 (powder)	EN ISO 21809-1, Clause 9.2.3 and Table 4	1	One per batch

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Input components: Material of PE top layer					
33	Density of black compound	EN ISO 1183-1 EN ISO 1183-2 EN ISO 1183-3	EN ISO 21809-1, Clause 9.2.4 and Table 5 and Control plan concerning reaction to fire (see 2.2.1)	1	One per batch
34	Density of the base resin (not black compound)	EN ISO 1183-1 EN ISO 1183-2 EN ISO 1183-3	EN ISO 21809-1, Clause 9.2.4 and Table 5 and Control plan concerning reaction to fire (see 2.2.1)	1	One per batch
35	Carbon black content	ISO 6964	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
36	Carbon black dispersion	ISO 18553	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
37	MFR	EN ISO 1133-1	Control plan	1	One per batch
38	Strain at break at (23 ±3) °C	2.2.7	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
39	Stress at yield at (23 ±3) °C	2.2.7	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
40	Vicat softening temperature A/50	2.2.14	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
41	Water content	EN ISO 15512 (pellets or powder) EN ISO 8130-7 (powder)	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
42	Hardness Shore D	EN ISO 868	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
43	Oxidation induction time	EN ISO 11357-6	EN ISO 21809-1, Clause 9.2.4 and Table 5	1	One per batch
Continuous manufacturing of product					
44	Surface preparation and coating application	EN ISO 21809-1, Clause 12.1 and Table 8	EN ISO 21809-1, Clause 12.1 and Table 8	EN ISO 21809-1, Clause 12.1 and Table 8	EN ISO 21809-1, Clause 12.1 and Table 8
45	Applied coating during and after manufacturing process	EN ISO 21809-1, Clause 12.1 and Table 9	EN ISO 21809-1, Clause 12.1 and Table 9	EN ISO 21809-1, Clause 12.1 and Table 9	EN ISO 21809-1, Clause 12.1 and Table 9
46	Repairs of applied three-layer PE coating	EN ISO 21809-1, Clause 13 and 2.2.4	EN ISO 21809-1, Clause 13	Each repaired holiday	Each repaired holiday

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 (for example as 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					
1	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 are fulfilled for reaction to fire, 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 complete FPC as described in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control					
2	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 in the Decisions regarding reaction to fire are fulfilled, 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 as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	Once per year

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

3.4.1 Control of repair of identified defects of continuity of applied coating

Defects in finished coating identified by test according to 3.2 and Table 3.2.1, row 8, shall be controlled by manual high-voltage holiday detector for correctness of repair, performed according to Clause 12 of EN ISO 21809-1 and MPII. Only correctly repaired pipes can be passed to further manipulation and package.

4 REFERENCE DOCUMENTS

EN 10217-1:2019	Welded steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties
EN 10217-3:2019	Welded steel tubes for pressure purposes - Technical delivery conditions - Part 3: Alloy fine grain steel tubes
EN 10217-5:2019	Welded steel tubes for pressure purposes - Technical delivery conditions - Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties
EN 10219-1:2006	Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 1: Technical delivery conditions
EN 10224:2002/A1:2005	Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids - Technical delivery conditions
EN 10255:2017	Non-Alloy steel tubes suitable for welding and threading - Technical delivery conditions
EN 13501-1:2018	Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests
EN 13238:2010	Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates
EN 13823:2020+A1:2022	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
EN ISO 306:2022	Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)
EN ISO 472:2013/A1:2018	Plastics - Vocabulary
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 868:2003	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
EN ISO 1043-1:2011/A1:2016	Plastics - Symbols and abbreviated terms - Part 1: Basic polymers and their special characteristics
EN ISO 1133-1:2022	Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 1: Standard method
EN ISO 1182:2020	Reaction to fire tests for products - Non-combustibility test
EN ISO 1183-1:2019	Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometer method and titration method
EN ISO 1183-2:2019	Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method
EN ISO 1183-3:1999	Plastics - Methods for determining the density of non-cellular plastics - Part 3: Gas pyknometer method
EN ISO 1716:2018	Reaction to fire tests for products - Determination of the gross heat of combustion (calorific value)

EN ISO 2178:2016	Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method
EN ISO 2811-1:2023	Paints and varnishes - Determination of density - Part 1: Pycnometer method
EN ISO 2811-2:2011	Paints and varnishes - Determination of density - Part 2: Immersed body (plummet) method
EN ISO 2811-3:2011	Paints and varnishes - Determination of density - Part 3: Oscillation method
EN ISO 2811-4:2011	Paints and varnishes - Determination of density - Part 4: Pressure cup method
EN ISO 3183:2019	Petroleum and natural gas industries - Steel pipe for pipeline transportation systems
EN ISO 3251:2019	Paints, varnishes and plastics - Determination of non-volatile matter content
EN ISO 4892-2:2013/A1:2021	Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps
EN ISO 8130-7:2019	Coating powders - Part 7: Determination of loss of mass on stoving
EN ISO 11357-6:2018	Plastics - Differential scanning calorimetry (DSC) - Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)
EN ISO 11925-2:2020	Reaction to fire tests - Ignitability of building products subjected to direct impingement of flame - Part 2: Single-flame source test
EN ISO 15512:2019	Plastics - Determination of water content
EN ISO 21809-1:2018	Petroleum and natural gas industries – External coatings for buried or submerged pipelines used in pipeline transportation systems – Part 1: Polyolefin coatings (3-layer PE and 3-layer PP)
EN ISO 21809-2:2014	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 2: Single layer fusion-bonded epoxy coatings
EN ISO 80000-1:2013	Quantities and units – Part 1: General
ISO 6964:2019	Polyolefin pipes and fittings - Determination of carbon black content by calcination and pyrolysis - Test method
ISO 18553:2002/Amd.1:2007	Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds

ANNEX A Reaction to fire

A.1 General

This annex covers three-layer PE coating of steel pipes according to 1.1 for testing of reaction to fire according to EN 13501-1 and classification according to Regulation (EU) No. 2016/364.

The determination of reaction to fire of the three-layer PE coating is based on testing of the worst case, specified as configuration with the biggest Q_{PCS} value and the biggest thickness of all three layers in the same time. This test is valid for:

- For any combination of material of layers with Q_{PCS} value lower than tested
- For any combination of material of layers with thickness lower than tested
- For any combination of material of layers with Q_{PCS} value and/or thickness lower than tested.

A.2 Testing according to EN ISO 1182

This test method is relevant for the classes A1 and A2.

Using this test method, only the substantial components (see Clause 3.1.5 of EN 13501-1) of the three-layer PE coating need to be tested. Substantial components are defined by thickness ($\geq$ 1 mm) and/or of mass per unit area ($\geq$ 1 kg/m^2).

In the following, the third layer of three-layer PE coating made of PE material is identified as the most significant substantial component.

Differences concerning the apparent density of the third layer shall be considered by testing the lowest and the highest apparent density.

A.3 Testing according to EN ISO 1716

This test method shall be performed to for all components of the three-layer PE coating except for cases which are classified as A1 without testing.

Parameter relevant for this test method is composition when performing calculation of the Q_{PCS} value, apparent density or mass per unit area and thickness are relevant.

A.4 Testing according to EN ISO 11925-2

At least six test specimens shall be tested for one thickness and one composition (see 1.3.5) of the three-layer PE coating.

Test specimens of dimensions given in Clause 5.2 of EN ISO 11925-2 shall be cut by water jet cutting machine from the pipe coated by the three-layer PE coating, taken from production line.

If necessary due to external diameter of tested pipe, one or more longitudinal strip(s) can be prepared from the pipe. These strips shall have width at least 150 mm and total length (($n \times 250$) + 100) mm each, where "n" is number of test specimens to be prepared from one strip. Then the test specimens shall be cut by water jet cutting from these strips.

After water jet cutting, the test specimens shall be dried at laboratory conditions (23 $\pm$ 3) °C and (50 $\pm$ 5) % RH for 7 days at least before testing. Then the three-layer PE coating shall be tested using the test method given in EN ISO 11925-2 on at least six test specimens. For more details see Clause 5.4 of EN ISO 11925-2.

Due to the thickness of the three-layer PE coating used in practice, the low energy level of the ignition source and the short time of flame exposure, the influence of the end use condition can be considered as negligible when testing the specimens.

The product shall be tested with steel substrate behind. Testing of all test specimens shall be conducted with edge exposure according to Clause 7.3.3.2 of EN ISO 11925-2.

The following parameters shall be taken into account when preparing the specimens:

- each different basic chemical composition,
- the greatest and lowest thickness or mass per area unit,
- the lowest and highest apparent density,
- the lowest volume of inorganic components and
- the lowest volume of additionally dosed flame retardant.

The test results are valid for the variation tested and any variant of the product:

- with the same basic chemical composition,
- with densities between those assessed,
- with volume of inorganic components between those assessed,
- with higher volume of the same type of additionally dosed flame retardant as the one which has been tested and
- with thickness between those assessed.

A.5 Testing according to EN 13823 (SBI-test)

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

- In this test procedure the complete three-layer PE coating shall be tested. The three-layer PE coating shall be applied

  or

- the manufacturer builds the wall at the factory and carries it to the lab where it is put onto the trolley.

After preparation of the test specimens, they shall be conditioned according to EN 13238.

Parameters which are relevant:

- amount of the epoxy covering and of the adhesive;
- type, thickness and apparent density of the third layer made of PE;
- type and Q_{PCS} value of the epoxy covering and of the adhesive;
- amount of any flame retardant in each layer, if used.

In principle, it is desirable to find the test specimen configuration that gives the critical case concerning the reaction to fire test results. In the test procedure according to EN 13823, values for the rate of heat release, total heat release, lateral flame spread, rate of smoke release, total smoke release and burning droplets shall be determined.