
**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)**

*Industries du pétrole et du gaz naturel — Revêtements externes
des conduites enterrées ou immergées utilisées dans les systèmes de
transport par conduites —*

*Partie 1: Revêtements à base de polyoléfines (PE tricouche et PP
tricouche)*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

This second edition cancels and replaces the first edition (ISO 21809-1:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

- adoption of qualification processes ([Clause 8](#));
- added prescriptions for coating application on pipes made by corrosion resistant alloys (CRA) or lined/clad internally with a CRA;
- cathodic disbondment test conditions revised.

A list of all parts in the ISO 21809 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

It is necessary that users of this document be aware that further or differing requirements can be required for individual applications. This document is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the vendor to identify any variations from this document and provide details.

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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)

1 Scope

This document specifies requirements for plant-applied external three-layer polyethylene and polypropylene based coatings for corrosion protection of welded and seamless steel pipes for pipeline transportation systems in the petroleum and natural gas industries in accordance with ISO 13623.

NOTE Pipes coated in accordance with this document are considered suitable for further protection by means of cathodic protection.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1183 (all parts), *Plastics — Methods for determining the density of non-cellular plastics*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 2811 (all parts), *Paint and varnishes — Determination of density*

ISO 3183, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

ISO 3251, *Paints, varnishes and plastics — Determination of non-volatile-matter content*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 6964, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method and basic specification*

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ISO 8130-2, *Coating powders — Part 2: Determination of density by gas comparison pyknometer (referee method)*

ISO 8130-3, *Coating powders — Part 3: Determination of density by liquid displacement pyknometer*

ISO 8130-7, *Coating powders — Part 7: Determination of loss of mass on stoving*

ISO 8501-1:2007, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 8502-3, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)*

ISO 8502-6, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 6: Extraction of soluble contaminants for analysis — The Bresle method*

ISO 8502-9, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 9: Field method for the conductometric determination of water-soluble salts*

ISO 8503-4, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile — Stylus instrument procedure*

ISO 8503-5, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 5: Replica tape method for the determination of the surface profile*

ISO 10350-1, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

ISO 10474:2013, *Steel and steel products — Inspection documents*

ISO 11124 (all parts), *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives*

ISO 11126 (all parts), *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives*

ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and glass transition step height*

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 15512, *Plastics — Determination of water content*

ISO 17855-2, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

ISO 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

ISO 19069-2, *Plastics — Polypropylene (PP) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

ISO 21809-2, *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*

ISO 80000-1, *Quantities and units – Part 1: General*

EN 10204:2004, *Metallic materials — Types of inspection documents*

ASTM D792, *Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*

ASTM D1505, *Standard Test Method for Density of Plastics by the Density-Gradient Technique*

ASTM D1693, *Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*

ASTM D4940, *Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives*

SSPC-AB 1,¹⁾ *Mineral and Slag Abrasives*

SSPC-AB 2, *Cleanliness of Recycled Ferrous Metallic Abrasives*

SSPC-AB 3, *Ferrous Metallic Abrasive*

SSPC-SP 1, *Solvent Cleaning*

SSPC-Guide 15, *Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

adhesion

bond between coating and substrate

3.2

applicator

company that undertakes the coating application in accordance with the provisions of this document

Note 1 to entry: If the compounding of the top layer is done prior to or during the application process by the applicator, then the applicator is regarded as the manufacturer (see 3.16).

3.3

application procedure specification

APS

document describing procedures, methods, equipment and tools used for coating application

3.4

batch

quantity of material produced in a continuous manufacturing operation using raw materials of the same source and grade

3.5

batch certificate

certificate of analysis issued by the manufacturer

1) Society for Protective Coating, 40 24th Street, 6th floor, Pittsburg; PA 15222-4656, USA.

3.6

certificate of compliance

document issued in accordance with ISO 10474 or EN 10204, stating compliance with the purchase order for coated pipes, but without mention of any test results, issued in accordance with the purchasing requirements

3.7

coating material qualification

qualification of the coating materials properties carried out by the manufacturer before the coating system qualification

3.8

coating system qualification

qualification of application method, applied coating system and subsequent inspection/testing of its properties, to confirm that the APS is adequate to produce a coating with the specified properties

Note 1 to entry: The coating system qualification is not project dependent.

3.9

cutback

length of pipe left uncoated at each end for joining purposes

3.10

design temperature range

temperature range, including maximum and minimum temperatures, likely to be reached during transport, storage, handling, installation and operation

Note 1 to entry: The design temperature range of the coating can be narrower than that specified for the steel pipe material and/or the pipeline system.

3.11

dummy pipe

pipe having the same outside diameter and wall thickness of the project pipes. Dummy pipes and coated dummy pipes shall be representative of the production and shall be coated in accordance with approved APS

3.12

end user

company (companies) that own(s) and/or operate(s) pipeline(s)

3.13

holiday

coating discontinuity that exhibits electrical conductivity when exposed to a specific voltage

3.14

inspection certificate 3.1

document in accordance with ISO 10474 or EN 10204 giving the results of the testing of coated pipes, supplied and signed by a representative of the applicator authorized to issue such documents

3.15

inspection and testing plan

ITP

document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures

3.16

manufacturer

company responsible for the manufacture of coating material(s)

3.17**manufacturer's specification**

document that specifies the characteristics, test requirements and application recommendations for the coating materials

3.18**operating temperature**

temperature that can be endured by a pipeline (component) and/or pipeline system during operation, within the design temperature range

3.19**peel strength**

force required for peeling the coating from the substrate

3.20**pipe diameter length**

length along the pipe axis equal to the specified outside diameter of the pipe

3.21**pipeline**

components of a pipeline system connected together to convey fluids between stations and/or plants, including pipe, pig traps, components, appurtenances, isolating valves, and sectionalizing valves

[SOURCE: ISO 13623:2017, 3.1.15, modified]

3.22**pipeline system**

pipelines, stations, supervisory control and data acquisition system (SCADA), safety systems, corrosion protection systems, and any other equipment, facility or building used in the transportation of fluids

[SOURCE: ISO 13623:2017, 3.1.16]

3.23**pre-production trial****PPT**

application of a coating and subsequent inspection/testing of its properties, to confirm that the APS is adequate to produce a coating with the specified properties, carried out in the coating plant immediately prior to start of production and to verify that the plant's equipment is adequate to consistently adhere to the APS requirements

3.24**procedure qualification trial****PQT**

application of a coating and subsequent inspection/testing of its properties, to confirm that the APS is adequate to produce a coating with the specified properties, carried out in correlation to a specific project

3.25**purchaser**

company responsible for providing the purchase order requirements

3.26**start up**

coating application activities re-start in case of modification of production parameters or unplanned stoppage or production interruption exceeding 12 h

3.27**test report**

document that provides the quantitative test results for tests conducted in accordance with the requirements of this document

3.28

total coating thickness

sum of all three layers, namely epoxy material, adhesive material and top layer, with the exclusion of rough coat, if applicable

4 Conformance

4.1 Rounding

Unless otherwise stated in this document, to determine conformance with the specified requirements, observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with ISO 80000-1.

NOTE For the purpose of this provision, the rounding method of ASTM E29 is equivalent to ISO 80000-1.

4.2 Compliance with this document

A quality system and an environmental management system should be applied to assist compliance with the requirements of this document.

NOTE ISO 9001 gives guidance on quality management systems and ISO 14001 gives guidance on the selection and use of an environmental management system.

The applicator shall be responsible for complying with all the applicable requirements of this document. The purchaser shall be allowed to make any investigations necessary to ensure compliance by the applicator and to reject any material and/or coating that does not comply.

5 Symbols and abbreviated terms

5.1 Symbols

	ISO 21809-1:2018
<i>C</i>	percentage conversion of FBE coating
<i>d</i>	effective sample thickness, expressed in millimetres
<i>D</i>	outside diameter of the pipe, expressed in millimetres
ε_b	tensile strain at break, expressed in %
$\Delta\varepsilon_b$	difference in tensile strain at break between 2 tests, expressed in %
ΔH	exothermic heat of reaction, expressed in Joules per gram
<i>M</i>	mass, expressed in kilograms or grams
ΔMFR	difference in the MFR between two tests, expressed in %
P_m	mass of bare pipe per metre length, expressed in kilograms per metre
dQ/dt	differential heat flow, expressed in watts per square metre
<i>r</i>	mandrel radius, expressed in millimetres
T_g	glass transition temperature, expressed in degrees Celsius

ΔT_g	difference in the glass transition temperature between two successive thermal analysis scans, expressed in degrees Celsius
w_m	mass fraction of moisture, expressed as a percentage
ρ_p	density of the epoxy powder, expressed in grams per cubic centimetre

5.2 Abbreviations

APS	application procedure specification
Cr	chromium
CRA	corrosion resistant alloy
DSC	differential scanning calorimetry
ESCR	environmental stress cracking resistance
FBE	fusion-bonded epoxy
HDPE	high-density polyethylene
IR	infrared
ITP	inspection and testing plan
LDPE	low-density polyethylene
MDPE	medium-density polyethylene
MFR	melt flow rate
N.A.	not applicable
NPS	nominal pipe size
PDL	pipe diameter length
PE	polyethylene
PP	polypropylene
PPT	pre-production trial
PQT	procedure qualification trial
SAW	submerged arc welding
UV	ultraviolet

6 Information supplied by the purchaser

6.1 General information

The purchase order shall include the following information:

- a) number of this document and year of publication (ISO 21809-1:2018);

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- b) pipe quantity, outside diameter, minimum wall thickness, minimum, maximum and nominal length, grade of steel;
- c) bare pipe standard or specification designation, e.g. ISO 3183;
- d) design temperature range in accordance with [7.2](#);
- e) operating temperature;
- f) coating class and coating thickness class in accordance with [7.2](#) and [7.3](#);
- g) qualification scheme as defined in [8.1](#);
- h) minimum number of coated pipes to be used for PPT and PQT (if required);
- i) cutback configuration and finish (length, angle, visible epoxy, temporary protection, etc.) (see [11.4](#));
- j) type of certificate of compliance (see [16](#)).

6.2 Additional information

The purchase order shall specify which of the following provisions apply for the specific item ordered:

- a) pipe tracking and traceability of pipes to coating materials;
- b) different requirements for coating materials out of classification systems in accordance with [7.2](#);
- c) repair procedure qualification requirements and permissible number and size of coating repairs, if different from the one defined in [Clause 13](#);
- d) marking of pipes (see [14](#));
- e) handling procedures (see [15.1](#));
- f) storage procedures (see [15.2](#));
- g) documentation and schedule for supply of documentation;
- h) purchaser approval of APS/ITP;
- i) inspection and testing plan and/or daily log;
- j) inspection of incoming pipes;
- k) pipe end protection;
- l) use of different test methods for soluble salt contamination measurements;
- m) minimum thickness of epoxy layer and/or total coating thickness required, if exceeding those in [Table 9](#) and [Table 2](#), respectively;
- n) use of dummy pipe for destructive tests;
- o) rough coat application (e.g. prior to concrete weight coating or special laying methods) and acceptance criteria (see [11.3.5](#));
- p) surface pre-treatment and method to evaluate its effectiveness (see [11.2.4](#));
- q) special requirements relative to supply of coating materials (e.g. FBE or liquid, manufacturer-specific products and certification);
- r) methods, frequency and acceptance criteria for inspection and testing differing from this document;
- s) PQT (see [8.1](#));