
**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**

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

*Partie 2: Revêtements monocouche à base de résine époxydique
appliquée par fusion*

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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. 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. 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is 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 21809-2:2007), which has been technically revised. It also includes the Technical corrigendum ISO 21809-2:2007/Cor.1:2008.

ISO 21809 consists of the following parts, under the general title *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)*
- *Part 2: Single layer fusion-bonded epoxy coatings*
- *Part 3: Field joint coatings*
- *Part 4: Polyethylene coatings (2-layer PE)*
- *Part 5: External concrete coatings*

The following parts are under preparation:

- *Part 6: Multilayer fusion-bonded epoxy coatings (FBE)*

Introduction

Users of this part of ISO 21809 should be aware that further or differing requirements might be needed for individual applications. This part of ISO 21809 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 if there is innovative or developing technology. If an alternative is offered, the vendor should identify any variations from this part of ISO 21809 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 2: Single layer fusion-bonded epoxy coatings

1 Scope

This part of ISO 21809 specifies the requirements for qualification, application, testing and handling of materials for plant application of single layer fusion-bonded epoxy (FBE) coatings applied externally for the corrosion protection of bare steel pipe for use in pipeline transportation systems for the petroleum and natural gas industries as defined in ISO 13623.

NOTE Pipes coated in accordance with this part of ISO 21809 are considered suitable for additional protection by means of cathodic protection.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2815, *Paints and varnishes — Buchholz indentation test*

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 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 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 11127-6, *Preparation of steel substrates before application of paints and related products — Test methods for non-metallic blast-cleaning abrasives — Part 6: Determination of water-soluble contaminants by conductivity measurement*

ISO 11357-1, *Plastics — Differential scanning calorimetry (DSC) — Part 1: General principles*

ISO 13623, *Petroleum and natural gas industries — Pipeline transportation systems*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

EN 10204:2004,¹⁾ *Metallic products — Types of inspection documents*

AS 3894.6,²⁾ *Site testing of protective coatings — Determination of residual contaminants*

ASTM D4060,³⁾ *Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser*

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

SSPC-AB 1,⁴⁾ *Mineral and Slag Abrasives*

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

SSPC-AB 3, *Ferrous Metallic Abrasive*

SSPC-SP 1, *Solvent cleaning*

3 Terms and definitions

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

3.1 application procedure specification

APS

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

3.2 applicator

company that undertakes the coating application in accordance with this part of ISO 21809

3.3 batch

quantity of epoxy powder produced using the same formulation and raw materials of the same source during a continuous production run of not more than 8 h

3.4 batch certificate

certificate of analysis issued by the manufacturer

1) European Committee for Standardization, Management Centre, Avenue Marnix 17, B-1000, Brussels, Belgium.

2) Standards Australia, GPO Box 476, Sydney, NSW 2001, Australia.

3) American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

4) SSPC: The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburg. PA 15222-4656, USA.

3.5**cutback**

length of pipe left uncoated at each end for joining purposes

3.6**glass transition**

reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one

[SOURCE: ISO 11357-2:2013, 3.1]

3.7**glass transition temperature**

T_g

characteristic value of the temperature range over which the glass transition takes place

Note 1 to entry: Note to entry: The assigned glass transition temperature, T_g , can vary, depending on the specific property and on the method and conditions selected to measure it.

[SOURCE: ISO 11357-2:2013, 3.2]

3.8**holiday**

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

3.9**laboratory-coated test specimen**

specimen taken from a laboratory-prepared panel

3.10**manufacturer**

company responsible for the manufacture of coating material(s)

3.11**manufacturer's specification**

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

3.12**powder shipment**

amount of powder transported in one container

3.13**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 prior to the start of production

3.14**purchaser**

company responsible for providing the product order requirements

3.15**test report**

document that provides the quantitative test results for tests conducted in accordance with the requirements of this part of ISO 21809

3.16**test ring**

sample taken from production-coated pipe

4 Symbols and abbreviated terms

4.1 Symbols

C	percentage conversion of FBE coating, expressed as a percentage
d	thickness, expressed in millimetres
ΔH	exothermic heat of reaction, expressed in joule per grams
M	mass, expressed in grams
R	mandrel radius, expressed in millimetres
T_g	glass transition temperature, expressed in degrees Celsius
ΔT_g	variation of the glass transition temperature, expressed in degrees Celsius
w_{ep}	mass fraction of the epoxy powder retained on a sieve, expressed as a percentage of total sample
w_m	mass fraction of moisture, expressed as a percentage

4.2 Abbreviated terms

d.c.	direct current
DSC	differential scanning calorimetry
FBE	fusion-bonded epoxy
HRC	Rockwell C scale hardness
ID	inner diameter
ITP	inspection and testing plan
NPS	nominal pipe size
OD	outer diameter
ppd	per pipe diameter

5 General requirements

5.1 Rounding

Unless otherwise stated in this part of ISO 21809, 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 80000-1:2009, Annex B, Rule A.

NOTE For the purposes of this provision, the rounding method of ASTM E29 is equivalent to ISO 80000-1:2009, Annex B, Rule A.

5.2 Compliance to standard

A quality system and an environmental management system should be applied to assist compliance with the requirements of this part of ISO 21809.

NOTE ISO/TS 29001 gives sector-specific 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 of the applicable requirements of this part of ISO 21809. It shall be permissible for the purchaser to make any investigation necessary in order to be ensured of compliance by the applicator and to reject any material and/or coating that does not comply.

6 Information supplied by the purchaser

6.1 General information

The purchase order shall include the following information:

- a) reference to this part of ISO 21809 and year of publication, i.e. ISO 21809-2:2014;
- b) pipe quantity, outside diameter, minimum wall thickness, minimum, maximum and nominal length, steel grade;
- c) bare pipe standard or specification designation, e.g. ISO 3183;
- d) minimum thickness and maximum permissible thickness of the coating;
- e) cutback and tolerances for both ends of pipe;
- f) minimum and maximum pipeline design temperatures (°C);
- g) type of certificate of compliance;
- h) pipe line installation methods for offshore (e.g. reel lay, S-lay, J-lay).

6.2 Additional information

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

- a) additional surface treatments;
- b) plant and process inspection by the purchaser;
- c) increased test ring length;
- d) test ring location;
- e) test frequency for additional test rings;
- f) additional markings;
- g) handling procedures;
- h) storage procedures;
- i) waiver of test reports;
- j) maximum allowable preheating temperature;
- k) applicator qualification requirements;
- l) other special requirements;

- m) pipe tracking and traceability of pipes to coating materials;
- n) permissible number coating repairs if different from [Clause 11](#);
- o) documentation and schedule for supply of documents;
- p) purchaser approval of APS;
- q) inspection and testing plan and/or daily log;
- r) inspection of incoming pipe;
- s) pipe end protection;
- t) surface pretreatments if any;
- u) PQT requirements;
- v) protection against adverse weather conditions during storage.

7 Coating materials

7.1 Epoxy powder

7.1.1 General

The applicator shall use epoxy powder that is

- a) certified by the manufacturer to be in accordance with the requirements of [7.1.2](#) and [8.1](#), and compatible with the requirements of [9.2](#), [9.3](#) and [9.4](#),
- b) identified by the manufacturer on each package with the following:
 - manufacturer's name;
 - product number/description;
 - product temperature range (maximum and minimum);
 - mass of material;
 - batch number/manufacturing identification number;
 - location of manufacture;
 - temperature requirements for transportation and storage;
 - year, month and day of manufacture;
 - expiry date, and
- c) handled, transported, and stored in accordance with the manufacturer's recommendations.

7.1.2 Properties

As a minimum, each batch of epoxy powder shall be tested by the manufacturer in accordance with the requirements of [Table 1](#). Test results shall be reported in accordance with ISO 10474 and a batch certificate with the test results shall be provided by the manufacturer to the applicator.

Table 1 — Minimum requirements for epoxy powder

Property	Unit	Test method	Requirements
Cure time	s	Clause A.2	Within the manufacturer's specification
Gel time	s	Clause A.3	Within the manufacturer's specification
Total volatile/moisture content mass fraction	%	Clause A.5	≤ 0,6 %
Particle size	%	Clause A.6	Maximum retained on 150 µm and 250 µm sieves within the manufacturer's specification
Density	g/cm ³	Clause A.7	Within the manufacturer's specification
Thermal characteristics	T_{g1} (°C) T_{g2} (°C) ΔH (J/g)	Clause A.8	Within the manufacturer's specification

7.1.3 Packaging

The powder shall be contained in packaging that is labelled to identify the items specified in [7.1.1 b\)](#).

7.2 Repair materials

The applicator shall use repair materials that are certified by the powder manufacturer to be compatible with the epoxy powder.

Repair material batches shall be identified by the product manufacturer with the following:

- manufacturer's name;
- product number/description;
- product temperature range (maximum and minimum);
- mass of material;
- batch number/manufacturing identification number;
- location of manufacture;
- temperature requirements for transportation and storage;
- year, month and day of manufacture;
- expiry date.

Repair materials shall be handled, transported, and stored in accordance with the material manufacturer's recommendations.

8 Coating qualification

8.1 Qualification by manufacturer

8.1.1 Epoxy powder

8.1.1.1 General

The manufacturer shall qualify the epoxy powder in accordance with this part of ISO 21809. The qualification shall be repeated in case of changes in the material composition, changes in the production process which influence the material processing behaviour and change in production facility.

The manufacturer shall carry out the tests in accordance with the requirements of [8.1.1](#). Coatings designed for up to 95°C shall be qualified by the manufacturer through laboratory coated test specimens or plant applied coating for each of the applicable tests. The test results shall meet the acceptance criteria in [Table 2](#).

For coatings designed for services above 95°C, in addition to the requirements in [Table 2](#), the tests for flexibility, impact resistance, cathodic disbondment, hot water adhesion, tabor abrasion and thermal characteristics shall be repeated using samples that have been conditioned in an oven at a temperature of 5°C below T_g , for a minimum of 30 d followed by ambient temperature for 24 h before testing. Cathodic disbondment testing shall be performed using the method in [Clause A.10](#). Acceptance criteria for these tests shall be agreed between the manufacturer and the purchaser. Other temperature exposure conditions may be agreed based on the pipeline service conditions.

Laboratory test specimens shall be prepared in accordance with [8.1.1.2](#).

These test results shall be reported in accordance with ISO 10474 and shall be available to the applicator upon request.

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