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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 21809-4

Oil and gas industries including lower carbon energy — External coatings for buried or submerged pipelines used in pipeline transportation systems —

Part 4: Polyethylene coatings (2-layer PE)

ICS: 75.200

ISO/TC 67/SC 2

Secretariat: **UNI**

Voting begins on:
2024-09-06

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This document is circulated as received from the committee secretariat.

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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 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, *Oil and gas industries including lower carbon energy*, Subcommittee SC 2, *Pipeline transportation systems*.

This second edition cancels and replaces the first edition (ISO 21809-4:2009), which was reviewed and confirmed in 2021 and has been technically revised.

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: Fusion-bonded epoxy coatings*
- *Part 3: Field joint coatings*
- *Part 4: Polyethylene coatings (2-layer PE)*
- *Part 5: External concrete coatings*
- *Part 11: Coatings for in-field application, coating repairs and rehabilitation*

Multilayer fusion bonded epoxy coatings is to form the subject of future part 6.

Introduction

It is necessary that users of this document be aware that further or differing requirements can be needed 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 document and provide details.

Oil and gas industries including lower carbon energy — External coatings for buried or submerged pipelines used in pipeline transportation systems —

Part 4: Polyethylene coatings (2-layer PE)

1 Scope

This document specifies the requirements for qualification, application, inspection, testing, handling and storage of materials for plant application of two-layer polyethylene coatings (2-layer PE) 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 document are considered suitable for additional protection by means of cathodic protection.

2 Normative references

The following referenced documents are indispensable for the application 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 80000-1, *Quantities and units — Part 1: General*

ISO 62, *Plastics — Determination of water absorption*

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

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

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

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

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

ISO 1872-2, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

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

ISO 4625-1, *Binders for paints and varnishes — Determination of softening point — Part 1: Ring-and-ball method*

ISO 4892-2, *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*

ISO 8501-1, *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 8501-3, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness - Part 3: Preparation grades of welds, edges and other areas with surface imperfections*

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 water soluble contaminants for analysis (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, *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 11125 (all parts), *Preparation of steel substrates before application of paints and related products — Test methods 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 surfaces*

ISO 11127 (all parts), *Preparation of steel substrates before application of paints and related products — Test methods for non-metallic blast-cleaning abrasives*

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

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

ISO 15512, *Plastics — Determination of water content*

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

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

ASTM D3236, *Standard Test Method for Apparent Viscosity of Hot Melt Adhesives and Coating Materials*

EN 10204, *Metallic products - Types of inspection documents*

SSPC-SP1, *Solvent Cleaning*

SSPC Guide 15, *Field Methods for Retrieval 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.

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 he is considered as manufacturer (see [3.7](#)).

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 raw material manufacturer for a given batch

3.6

certificate of analysis

document provided by the manufacturer which indicates results of specific tests or analysis, including test methodology, performed on a defined lot of the manufacturer's product and corresponding conformity ranges

3.7

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

3.8

coating

electrically insulating covering bonded to a metal surface for protection against corrosion by preventing contact between the electrolyte and the metal surface

3.9

coating disbondment

the loss of adhesion between the protective coating and the structure surface as a result of adhesive failure, chemical attack, mechanical damage, hydrogen concentrations, etc. coating disbondment may or may not be associated with a coating holiday

3.10

coating qualification (CQ)

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

3.11

coating system qualification (CSQ)

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

3.12

coating repair

(coating) activities dedicated to restore the integrity of the coating when the damage are localized on small areas

Note 1 to entry: Typically these activities are performed manually

3.13

coating resistance (R_c)

resistance of the resistor representing the electrical resistance of the coating in the equivalent circuit

Note 1 to entry: The coating resistance is usually expressed in giga-ohms. The specific coating resistance is usually expressed in gigaohms times square centimetres.

3.14

corrosion

Deterioration of a material, usually a metal that results from an electrochemical reaction with its environment

3.15

cutback

length of pipe left uncoated at each end for joining purposes

3.16

design temperature

temperature that can be endured by a pipeline (component) and/or pipeline system during operation, including maximum and minimum temperatures, likely to be reached during transport, storage, handling, installation, upset conditions and operation.

3.17

end user

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

3.18

holiday

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

3.19

impact resistance

mechanical resistance of a coating that it can withstand without damage under shock force

3.20

Inspection certificate

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

3.21

Inspection and testing plan (ITP)

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

3.22

inspector

end user and/or purchaser's representative responsible for one or more of the inspections specified in this document

3.23

manufacturer

company responsible for the manufacture of coating material(s)

3.24

manufacturer's specification

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

3.25

operating temperature

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

3.26

parties

stakeholders (end-user, purchaser, applicator, manufacturer, etc.) with a vested interest in the decision-making

3.27

peel strength

force required for peeling the coating from the substrate

3.28

pipe diameter length

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

3.29

pipeline

those facilities through which fluids are conveyed, including pipe, pig traps, components and appurtenances, up to and including the isolating valves

[SOURCE: ISO 13623]

3.30

pipeline transportation 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]

3.31

pre-production trial (PPT)

application of a coating and subsequent inspection/testing of its properties, to confirm that the coatings produced in accordance with the APS and ITP are acceptable within the specified properties, carried out in the coating plant at a specific coating line, immediately prior to start of production and to verify that the plant's equipment is adequate to consistently adhere to the APS requirements

3.32

procedure qualification trial (PQT)

application of a coating and subsequent inspection/testing of its properties, to confirm that the coatings produced in accordance with the APS and ITP are acceptable within the specified properties, carried out in the coating plant at a specific coating line and to verify that the plant's equipment is adequate to consistently adhere to the APS requirements

3.33

purchaser

company responsible for providing the purchase order requirements

3.34

qualification test

a process of inspection and evaluation of product/component compliance test performed on a component to verify the requirements of the manufacturing procedure specification and to demonstrate that components that meet the specified requirements can be produced

3.35

safety data sheet (SDS)

document intended to provide procedures for handling and working with the material in a safe manner including physical data such as flash point, toxicity, first aid treatment

Note 1 to entry: Physical data can include flash point and toxicity.

3.36

start up

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

3.37

steel grade

term that defines the chemical, physical and mechanical properties of steel used for manufacture of pipe or component

3.38

Shift

The time period when a crew of workers is at work

3.39

substrate

surface on which a repair is carried out

Note 1 to entry: The surface may belong to original pipework, pipework component, pipeline, tank, or vessel.

3.40

surface cleanliness

level of contamination on a significant surface

3.41

test report

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

3.42

test ring

sample taken from production coated pipe ([3.32](#))

3.43

test sample

sample from a batch of raw material or field joint coating that represents the properties of the complete batch.

3.44

test specimen

an object prepared for the purpose of testing specific properties. The Test Specimens may be as follows: the coating material; a simulated field joint, flat panel or similar prepared specifically for testing; a coupon, ring or similar that has been cut from a field joint; a field joint that has been coated in production or otherwise, in laboratory or field conditions.

3.45

water dew point

temperature at a specified pressure at which water vapour condensation initiates

3.46

total coating thickness

sum of layers with the exclusion of rough coat, if applicable

4 Abbreviated terms

BST black standard temperature

ESCR environmental stress cracking resistance

MFR melt flow rate; designated as symbol q_{MFR} for use in mathematical expressions and equations

HDPE high density polyethylene

ppd per pipe diameter

SAW submerged arc welding

UV ultraviolet

2LPE 2-layer polyethylene coating

5 General requirements

5.1 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.

5.2 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 of the applicable requirements of this document. It shall be permissible for the purchaser to make any investigation necessary in order to be assured 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) the number of this document and year of publication (ISO 21809-4:..);
- b) number of pipes to be coated
- c) requested schedule of delivery
- d) requested documentation and schedule for supply of documentation
- e) requirements on test reports and (daily) log
- f) type and frequency of inspection document in accordance with ISO 10474 or EN 10204
- g) requirements for traceability of coating system, repairs and marking of repairs
- h) pipe quantity, outside diameter, minimum wall thickness, minimum, maximum and nominal length; grade of steel;
- i) bare pipe standard or specification designation, e.g. ISO 3183;
- j) coating system classification and thickness;
- k) cutback length and tolerances for both ends of pipe;
- l) pipeline design and/or operating temperatures, in degrees Celsius;
- m) test temperature for flexibility;
- n) CSQ requirements

6.2 Additional information

If applicable, purchase orders shall include the following information:

- a) additional surface treatments;
- b) plant inspection by the purchaser;
- c) increased test-ring length;
- d) test-ring location;
- e) test frequency for additional test rings;
- f) additional markings;
- g) additional handling procedures;
- h) additional storage procedures;
- i) waiver of test reports;
- j) other special requirements.
- k) Additional or deviating CQ, PQT, PPT and/or production test requirements
- l) Maximum temperature the steel can endure during the coating process if this exceeds 275 °C

Pertinent information on application to be provided by the pipe coating applicator.

7 Coating classification

7.1 General

The coating shall consist of two layers:

- a) 1st layer, composed of one of the following:
 - asphaltic modified rubber,
 - non-asphaltic-modified rubber (e.g. butyl based),
 - hot melt or polymeric
- b) 2nd layer, consisting of the **HDPE** top layer.

7.2 Coating systems

The coating system shall be classified in accordance with [Table 1](#).

Table 1 — Coating systems

Coating systems	A	B	C
1st layer	Asphaltic-modified rubber adhesive	non-asphaltic-modified rubber adhesive	hot melt or polymeric adhesive
2nd layer	HDPE	HDPE	HDPE

NOTE Temperature resistance of coating systems varies based on the polyethylene and adhesive systems specified.

7.3 Coating thickness classes

The total thickness of the coating shall be in accordance with [Table 2](#).

Table 2 — Minimum total coating thickness

Nominal pipe diameter mm	P_m kg/m	Coating thickness ^{a,b} mm		
		A minimum adhesive: 0,15	B minimum adhesive: 0,2	C minimum adhesive: 0,25
< 115	≤ 15	0,75	0,95	1,25
115 to 275	$15 < P_m \leq 50$	0,85	1,00	1,40
276 to 510	$50 < P_m \leq 130$	1,00	1,20	1,60
511 to 760	$130 < P_m \leq 300$	1,25	1,40	1,80
> 760	$P_m > 300$	1,35	1,75	2,00

^a The total thickness may be reduced by a maximum of 10 % on the weld seam for SAW welded pipes.

^b The choice of coating thickness is dependent on the condition of the soil or ground, laying method onshore and offshore, service constraints and pipe dimensions. These are minimum values and can be changed according to country or project specific requirements.

The applicator shall identify the materials and shall confirm that the certificates comply and relate to the specified materials.

The applicator and/or end user shall determine the suitability of the system in its environment with respect to coating system in cooperation with the manufacturer of the coating. When necessary additional measures may be implemented such as reinforcements within the coating, additional mechanical protection or other suitable solutions transport, laying of pipe, storage, soil stresses or other factors influencing the performance of the coating before service.

8 Materials

8.1 Pipe

The pipe being coated shall conform to the pipe standard or specification that is specified in the purchase order.

CAUTION — Pipe conforming to such standards or specifications does not necessarily have a surface condition that is appropriate for the application of coating, e. g. temporary coating, salt contamination, slivers.

8.2 Coating materials

8.2.1 Adhesive

Each batch of adhesive shall be tested by the manufacturer in accordance with the requirements of [Table 3](#) or [Table 4](#).

Table 3 — Minimum requirements for adhesive material in systems A and B

Properties	Requirements		Test method
	A	B	
Viscosity	Within 10 % of manufacturer's specification, expressed in millipascal-seconds	N/A	ASTM D3236
Specific gravity at (25 ± 3) °C	0,9 to 1,2	0,95 to 1,5	ISO 1183
Melt flow rate	N/A	Within 10 % of manufacturer's specification, expressed in grams per 10 min	ISO 1133
Ring and ball softening point	At least 20 °C above maximum design temperature	N/A	ISO 4625-1

Table 4 — Minimum requirements for adhesive material in system C

Properties	Requirements (hot melt)	Requirements (polymeric)	Test method
Viscosity	Within 20 % of manufacturer's specification, expressed in millipascal-seconds	N/A	ASTM D3236
Water absorption	< 0,1 %	N/A	ISO 62
Ring and ball softening point	At least 20 °C above maximum design temperature	N/A	ISO 4625-1
Melt flow rate	N/A	Within 20 % of manufacturer's specification, expressed in grams per 10 min	ISO 1133
Moisture content	N/A	< 0,1 %	ISO 15512
Vicat softening temperature A/50 (9,8 N)	N/A	W 85 °C	ISO 306

8.2.2 Polyethylene material

8.2.2.1 General

The applicator shall use high density polyethylene material that is in compliance with [Table 5](#).

Table 5 — Minimum requirements for polyethylene top layer

Properties	Requirements	Test method
Density of base resin ^a	> 0,930 g/cm ³	ISO 1183
Melt flow rate at 190 °C: 2,16 kg	Within 20 % of manufacturer's specification	ISO 1133
Elongation at break at 23 °C: ±3 °C	> 600 %	ISO 527-2, ISO 527-3
Tensile yield strength at 23 °C: ±3 °C ^b	> 15 MPa	ISO 527-2, ISO 527-3
Vicat softening temperature A/50 (9,8 N)	> 95 °C	ISO 306
Water absorption	< 0,05 %	ISO 62
Hardness Shore D	>55	ISO 868
ESCR (50 °C, F50, Cond. B, 100 % Igepal CO 630)	> 300 h	ASTM D 1693
Oxidation induction time (intercept in the tangent method) ^c	> 30 min at 210 °C, or > 10 min at 220 °C	ISO 11357-6

Table 5 (continued)

Properties	Requirements	Test method
UV resistance and thermal ageing, 2 400 hours ^a	$\Delta q_{\text{MFR}} > < 35 \%$	Annex A
Carbon black content	in the range of 2-3 %	ISO 6964
Carbon black dispersion	max. grade 3	ISO 18553
^a The test specimen shall be a compression-moulded or injection moulded sheet pr annealed for 30 min at 100 °C ^b The test specimen shall be a 2 mm thick compression-moulded or injection moulded sheet prepared in accordance with ISO 527-2, strained at 50 mm/min. The specimen may also be prepared according to ISO 1872-2. ^c Manufacturer shall select one test condition only.		

If the compounding is performed during the application process, the applicator shall perform the qualification tests for the product in accordance with [Table 5](#).

The carbon black used in the production of black compound shall be P type.

NOTE The applicator sometimes performs compounding with additives against UV and thermal ageing or other purposes.

8.2.2.2 Compounding during processing

The polyethylene shall be compounded and stabilized by additives against UV and thermal ageing.

If the compounding is done by the applicator during the coating process, the applicator shall qualify the process, conduct all the relevant tests versus the requirements of this document, and shall certify that the compounded polyethylene is in compliance with this document.

8.3 Packaging

The coating materials shall be contained in packaging that is clearly labelled to identify the items specified in [9.2.1 b](#)).

For bulk shipments, where the container is not specifically marked for that product (e.g. railcars), the manufacturer shall provide documentation to ensure traceability in accordance with the requirements of this clause. The manufacturer's specification for adhesive and PE materials shall include the following:

- trade name;
- description of the adhesive (if applicable);
- colour;
- maximum and minimum storage temperatures, expressed in degrees Celsius;
- shelf-life at storage temperature, expressed in months;
- physical properties, in accordance with [Tables 3,4](#) and [5](#).

8.4 Storage and handling of coating materials

Storage and handling of coating materials shall be in accordance with the manufacturer's specification.

9 Qualification processes

The Purchaser is either the end user or the representative of the end user.

The Qualification scheme shall be performed per coating line, coating material and application procedure.