



BSI Standards Publication

Petroleum and natural gas industries – External coatings for buried or submerged pipelines used in pipeline transportation systems

Part 3: Field joint coatings

National foreword

This British Standard is the UK implementation of EN ISO 21809-3:2016+A1:2020. It is identical to ISO 21809-3:2016, incorporating amendment 1:2020. It supersedes BS EN ISO 21809-3:2016, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by **A1** **A1**.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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for buried or submerged pipelines used in pipeline
transportation systems - Part 3: Field joint coatings (ISO
21809-3:2016)

Industries du pétrole et du gaz naturel - Revêtements
externes des conduites enterrées ou immergées
utilisées dans les systèmes de transport par conduites -
Partie 3: Revêtements des joints soudés sur site (ISO
21809-3:2016)

Erdöl- und Erdgasindustrie - Umhüllungen für erd- und
wasserverlegte Rohrleitungen in Transportsystemen -
Teil 3: Nachumhüllungen (ISO 21809-3:2016)

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European foreword

This document (EN ISO 21809-3:2016) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee ECISS/TC 110 "Steel tubes, and iron and steel fittings" the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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Endorsement notice

The text of ISO 21809-3:2016 has been approved by CEN as EN ISO 21809-3:2016 without any modification.

Foreword to amendment A1

This document (EN ISO 21809-3:2016/A1:2020) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 459/SC 10 "Steel tubes, and iron and steel fittings" the secretariat of which is held by UNI.

This Amendment to the European Standard EN ISO 21809-3:2016 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2020, and conflicting national standards shall be withdrawn at the latest by October 2020.

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The text of ISO 21809-3:2016/Amd 1:2020 has been approved by CEN as EN ISO 21809-3:2016/A1:2020 without any modification.

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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).

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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 21809-3:2008), which has been technically revised. It also incorporates the Amendment ISO 21809-3:2008/Amd 1:2011.

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*

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

Coating repairs on rehabilitation is to form the subject of future part 11.

Introduction

Users of this part of ISO 21809 are to be aware that further or differing requirements can 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 where there is innovative or developing technology. Where an alternative is offered, the vendor is to identify any variations from this part of ISO 21809 and provide details.

Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems —

Part 3: Field joint coatings

1 Scope

This part of ISO 21809 specifies requirements for field joint coating of seamless or welded steel pipes for buried and submerged sections of pipeline transportation systems used in the petroleum, petrochemical and natural gas industries as defined in ISO 13623. This part of ISO 21809 specifies the qualification, application and testing of the corrosion protection coatings applied to steel surfaces left bare after the joining of pipes and fittings (components) by welding.

This part of ISO 21809 defines and codifies in [Table 1](#) the different types of field joint coatings for pipelines.

This part of ISO 21809 does not address requirements for additional mechanical protection, for thermal insulation or for joint infills of concrete weight-coated pipes.

NOTE Field joints of pipes and fittings coated in accordance with this part of ISO 21809 are considered suitable for further 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 34-1, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces*

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 62, *Plastics — Determination of water absorption*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

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 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

ISO 1523, *Determination of flash point — Closed cup equilibrium method*

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

ISO 2781, *Rubber, vulcanized or thermoplastic — Determination of density*

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

ISO 2811-1, *Paints and varnishes — Determination of density — Part 1: Pyknometer method*

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

ISO 3303-1, *Rubber- or plastics-coated fabrics — Determination of bursting strength — Part 1: Steel-ball method*

ISO 3417, *Rubber — Measurement of vulcanization characteristics with the oscillating disc curemeter*

ISO 3801, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area*

ISO 4591, *Plastics — Film and sheeting — Determination of average thickness of a sample, and average thickness and yield of a roll, by gravimetric techniques (gravimetric thickness)*

ISO 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*

ISO 4624, *Paint and varnishes — Pull-off test for adhesion*

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

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 7619-1, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 1: Durometer method (Shore hardness)*

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 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 conductometric determination of water-soluble salts*

ISO 8503-1, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces*

ISO 8503-2, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure*

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 8504-2, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 2: Abrasive blast-cleaning*

ISO 8504-3, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 3: Hand- and power-tool cleaning*

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

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

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

ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization*

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

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

ASTM D70¹⁾, *Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method)*

ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*

ASTM D127, *Standard Test Method for Drop Melting Point of Petroleum Wax, Including Petrolatum*

ASTM D149, *Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies*

ASTM D257, *Standard Test Methods for DC Resistance or Conductance of Insulating Materials*

ASTM D695, *Standard Test Method for Compressive Properties of Rigid Plastics*

ASTM D937, *Standard Test Method for Cone Penetration of Petrolatum*

ASTM D938, *Standard Test Method for Congealing Point of Petroleum Waxes, Including Petrolatum*

ASTM D1000, *Standard Test Methods for Pressure — Sensitive Adhesive — Coated Tapes Used for Electrical and Electronic Applications*

1) American Society for Testing and Materials, 100 Harbour Drive, West Conshohocken, PA 19380-2999

ASTM D1141, *Standard Practice for the Preparation of Substitute Ocean Water*

ASTM D1321, *Standard Test Method for Needle Penetration of Petroleum Waxes*

ASTM D2084, *Standard Test Method for Rubber Property — Vulcanization Using Oscillating Disk Cure Meter*

ASTM D4285, *Standard Test Method for Indicating Oil or Water in Compressed Air*

ASTM D4541, *Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers*

AWS C2.25/C2.25M²⁾, *Specification for Thermal Spray Feedstock Solid and Composite Wire and Ceramic Rods*

SSPC-SP1³⁾, *Surface preparation specification No.1 — Solvent cleaning*

SSPC CS 23.00, *Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminium, Zinc and Their Alloys and Composites for the Corrosion Protection of Steel*

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 field joint coating application

3.2 applicator

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

3.3 batch

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

3.4 batch certificate

certificate of analysis issued by the manufacturer for a given batch

3.5 bonding agent

material applied as a film to the primed steel surface in order to ensure adhesion of the subsequent protective coating

3.6 inspection document

document issued in accordance with ISO 10474 (or EN 10204) stating compliance with the requirements given in the purchase order

3.7 coating operative

individual undertaking coating activity on the work site, including surface preparation

3.8 cutback

length of pipe left uncoated at each end for joining purposes (e.g. welding)

2) America Welding Society, 550 N.W. Le Jeune Road, Miami, Florida 33126, USA.

3) The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4656, USA.

3.9

end user

company that owns and/or operates the pipeline system

3.10

field joint area

uncoated area that results when two pipe sections or a pipe section and a fitting with coating cutbacks are assembled by welding in the field

3.11

holiday

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

3.12

inspection and testing plan

ITP

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

3.13

inspector

end user and/or purchaser's representative responsible for one or more of the inspections specified in this part of ISO 21809

3.14

layer of tape

single wrap of tape without overlap

Note 1 to entry: Wrapping of a tape with 50 % overlap constitutes a two-layer coating.

3.15

manufacturer

company responsible for the manufacture of coating material

3.16

maximum service temperature of field joint coating

$T_{\max}$

maximum continuous temperature that the field joint coating can resist during operation

3.17

maximum and minimum design temperature of pipeline

maximum and minimum operating temperature for which the pipeline has been designed

3.18

minimum service temperature of field joint coating

minimum temperature that the field joint coating can resist during operation and installation

3.19

overlap

length of the field joint coating over the plant-applied coating including the coating bevel

3.20

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]

3.21

pipeline system

pipeline with compressor or pump stations, pressure control stations, flow control stations, metering, tankage, 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]

3.22

pre-production trial

PPT

application of coating and inspection/testing of its properties immediately prior to start of production, to confirm that the APS is able to produce field joint coatings with the specified properties

3.23

primer

material applied as a film on substrate (steel and/or plant coating) to ensure adhesion of the subsequent protective coating

3.24

procedure qualification trial

PQT

application of a field joint coating and subsequent inspection/testing of its properties, to confirm that the APS is able to produce a coating with the specified properties, carried out at the premises of the applicator or any other agreed location

3.25

purchaser

company responsible for providing the product order requirements

3.26

wraparound sleeve

sleeve wrapped circumferentially around the steel pipe area being coated

4 Symbols and abbreviated terms

4.1 Symbols

c	bursting strength without heat ageing
B_{70}	bursting strength after heat ageing for 70 days
B_{100}	bursting strength after heat ageing for 100 days
C	percentage of conversion of FBE coating
ΔH	exothermic heat of reaction
ΔT_g	variation of glass transition temperature between two or more successive thermal analysis scans
E_0	elongation at break without heat ageing
E_{70}	elongation at break after heat ageing for 70 days
E_{100}	elongation at break after heat ageing for 100 days
P_0	peel strength to pipe surface without heat ageing

P_{70}	peel strength to pipe surface after heat ageing for 70 days
P_{100}	peel strength to pipe surface after heat ageing for 100 days
P'_0	peel strength between layers without heat ageing
P'_{70}	peel strength between layers after heat ageing for 70 days
P'_{100}	peel strength between layers after heat ageing for 100 days
R_S	specific electrical resistance of a coating
R_{S70}	specific electrical resistance after 70 days
R_{S100}	specific electrical resistance after 100 days
$T_{\max}$	maximum service temperature of field joint coating

4.2 Abbreviated terms

APS	application procedure specification
DFT	dry film thickness
DSC	differential scanning calorimetry
EP	epoxy
EPDM	ethylene propylene diene monomer
FBE	fusion-bonded epoxy
FJC	field joint coating
HSS	heat-shrink sleeve
ITP	inspection and testing plan
MSDS	material safety data sheet
PE	polyethylene
PP	polypropylene
PPT	pre-production trial
PQT	procedure qualification trial
PU	polyurethane
PVC	polyvinylchloride
TSA	thermal spray aluminium
2LPE	two-layer polyethylene coating
3LPE	three-layer polyethylene coating
3LPP	three-layer polypropylene coating

5 General requirements

5.1 Responsibility of the end user

The end user shall be responsible for making or approving the appropriate selection of the FJC in accordance with the specified service conditions. He shall validate the information to be supplied by the purchaser as listed in [Clause 6](#).

5.2 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.

5.3 Compliance, testing and quality

Systems for quality and environmental management, and good laboratory practices, should be applied to assist compliance with the requirements of this part of ISO 21809.

NOTE 1 ISO/TS 29001 gives sector-specific guidance on quality management systems

NOTE 2 ISO 14001 gives guidance on the selection and use of an environmental management system.

NOTE 3 ISO/IEC 17025 gives guidance for testing laboratories.

6 Information to be supplied by the purchaser

6.1 General information

The purchase order shall include the following information:

- designation of this part of ISO 21809;
- type of field joint coating system in accordance with [Table 1](#);
- minimum and maximum thickness of the field joint coating (if applicable);
- minimum and maximum design temperature of the pipeline;
- cutback length (or length of the field joint being coated), including tolerances;
- pipe material/grade;
- pipe nominal outer diameter and wall thickness;
- plant-applied coating system, including thickness;
- number of field joints to be coated;
- type and frequency of inspection document in accordance with ISO 10474 or EN 10204 (see [7.7](#)).

6.2 Additional information

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

- permissible field joint coating repairs (see [9.5](#));

- acceptable level of soluble salts (see [9.1.2.2](#));
- any special requirement with regard to FJC overall thickness and/or thickness of individual layers (see [10.5.2](#), [11.5.2](#), [12.5.2](#), [13.5.2](#), [16.5.3](#), [17.5.3](#), [18.5.2](#), [19.5.2](#));
- overlap on the parent (i.e. “plant-applied”) coating or detailed drawing of the field joint coating with dimensional tolerances (see [17.5.3](#));
- requirements for traceability and marking;
- requirements for documentation and schedule of supply of documentation (see [7.7](#));
- qualification of the applicator’s personnel who apply and/or inspect the coating (see [7.5](#));
- purchaser’s approval of the application procedure specification (APS) (see [7.1](#));
- use of specific proprietary coating materials (see [7.2](#));
- procedure qualification trial (PQT) (see [7.3](#));
- pre-production trial (PPT) (see [7.4](#));
- subsequent coating (or infill) being applied;
- temperature range during installation;
- method of installation of the pipeline;
- time constraints for application and number and dimensions of working stations, if relevant;
- specific testing conditions and minimum requirements when applicable (e.g. cathodic disbondment or flexibility) (see [17.5.8](#), [17.5.10](#), etc.).

7 Application procedures and qualification

7.1 Application procedure specification (APS)

The applicator shall prepare an APS to be approved by the end user and/or purchaser prior to the start of production and prior to any agreed PQT and/or PPT (see [7.3](#) and [7.4](#)). The responsibilities shall be clearly defined between all parties. Once approved, the APS shall not be changed without prior written authorization of the parties.

The APS shall include the following:

- identification of the coating;
- manufacturer’s instructions for application, including the acceptable temperature range during installation;
- preparation of steel surface and plant-applied coating, including inspection (see [9.1](#));
- data sheets defining coating and abrasive blasting material properties, including all health and safety data (see [7.2](#) and [9.1.2.2](#));
- maximum service temperature, $T_{\max}$, of field joint coating;
- receipt, handling and storage of coating and abrasive blasting materials (see [7.2](#) and [9.1.2.2](#));
- coating application procedure, tools and equipment;
- overlap (with tolerances) of FJC over plant coating (a drawing should be considered for certain types of FJC);

- time required for coating application;
- inspection and testing of applied FJC;
- repair and testing of defective FJC;
- stripping of defective FJC;
- marking, traceability and documentation.

The APS shall cover all items associated with quality control as defined in this part of ISO 21809 and any agreed options for the specific FJC.

All coating work, testing and inspection shall be carried out according to the APS.

7.2 Coating materials

The applicator shall provide the data sheets specified in [Clauses 10](#) to [20](#) for each coating material from the manufacturer.

In addition to the coating-material data sheets, the applicator shall provide the following information from the manufacturer:

- batch certificates certifying that the coating materials delivered meet the coating characteristics as set forth in the coating data sheets;
- any agreed optional requirements, if applied according to the manufacturer's instructions;
- packaging, transport and storage requirements of coating materials;
- range of application conditions including minimum and maximum application temperatures (for materials and substrate) and relative humidity;
- material safety data sheet (MSDS).

Marking on each shipment of coating materials shall contain the following information:

- manufacturer's name;
- name and complete identification of material, including plant of origin;
- reference to applicable coating-material standards, if any;
- production batch number;
- mass/size;
- date of production;
- expiry date.

7.3 Procedure qualification trial (PQT)

If specified by the purchaser or otherwise required by this part of ISO 21809, the APS shall be qualified by a PQT. Test methods and frequencies for PQT are specified in [Annex A](#). Acceptance criteria are given in the relevant clauses referred to in [Annex A](#).

The applicator may request the manufacturer(s) to assist during the PQT to ensure the correct use of the coating material(s) and to train applicator personnel.

PQT may be carried out independently of any project. In this case, representative pipes having the diameter, thickness and plant-coating as agreed upon between manufacturer, applicator, end user and purchaser, if any, shall be used.

For a PQT related to a specific project, tests shall be carried out on test zones distributed along a pipe coated with the actual plant-applied coating. The length of the test zones shall be equivalent to the field joint coating length. The test points shall be defined in the PQT programme.

If not present, a circumferential cap weld shall be added at the centre of each of the test zones to simulate the field weld.

If heating of the area to be coated is specified in the APS, it shall be demonstrated that there is no visual detrimental effect such as blistering or disbondment of the plant-applied coating.

All tools and equipment (e.g. for induction heating, abrasive blasting, coating application and inspection) being used for PQT shall be of the same type as those being used for the actual field joint coating.

Unless otherwise specified, at least three test zones shall be coated.

Coating repairs and stripping of defective FJC shall be included in PQT if they are allowed.

The time for coating application during PQT shall be consistent with the estimated field joint coating time in the field. Any significant differences in the PQT environment compared to actual production conditions should be considered, e.g. number of work stations, lifting equipment.

For pipelines that experience deformations above 0,3 % during handling or installation (e.g. reeling), the PQT shall include relevant tests carried out after pipe deformation. The test temperature shall be at least 5 °C below minimum deformation temperature.

The applicator shall submit a complete report of the qualification test results to the purchaser for approval.

7.4 Pre-production trial (PPT)

If specified by the purchaser or otherwise required by this part of ISO 21809, a PPT shall be performed on site to verify the following:

- surface condition and adhesion of the plant-applied coating on steel in the vicinity of the cut-backs;
- field joint coating materials;
- application procedure;
- equipment being used for surface preparation and coating application;
- heating equipment (when used);
- application of the coating system;
- qualification of the coating operatives and purchaser's inspectors that will actually be used in the field;
- properties of the applied FJC.

The above shall comply with the requirements of this part of ISO 21809 and the results of any previous PQT.

Test methods and frequencies for PPT are specified in [Annex A](#). Acceptance criteria are given in the relevant clauses to which reference is made in [Annex A](#).

The PPT shall be carried out in presence of the end user and/or purchaser (or their representative) at the start of operations when equipment and personnel are mobilized on site. The PPT shall be performed on the first joints to be coated or, if agreed, on a dummy pipe.

The applicator shall submit a complete report of the tests containing the values and other results obtained in the PPT.

7.5 Qualification of coating and inspection personnel

The coating operatives shall be qualified to undertake the coating application procedure and repair work. The qualification may be obtained by demonstration during PQT, during PPT, through a certification organization or as agreed with the end user.

The applicator shall request the manufacturer of the coating material(s) and equipment to provide technical assistance to the coating operatives if necessary.

Inspectors and applicator personnel carrying out the coating inspection shall be trained and qualified. Proof of successful qualification shall be documented.

7.6 Production testing and inspection

The applicator shall perform inspection and testing during production in accordance with an ITP to verify the surface preparation, coating application and the specified properties of the applied FJC.

The ITP shall be prepared by the applicator and shall be approved by the purchaser prior to the start of the coating work and prior to the start of any PQT and/or PPT. The ITP shall identify all inspection activities and tests, their frequency and the relevant inspection authorities.

Test methods and frequencies are specified in [Annex A](#). Acceptance criteria are given in the relevant clauses to which reference is made in [Annex A](#).

7.7 Inspection documents and traceability

The inspection documents shall be in accordance with ISO 10474 or EN 10204. The type of certificate of compliance shall be defined in the purchase order.

FJC reports shall identify each field joint by a unique number for identification purposes and shall record the material batch number for traceability. Test results shall be linked to the field joint number or repair on which they were performed. Records shall be maintained on a shift and daily basis and shall be available for inspection by the purchaser and/or end user.

The inspection documents signed by the applicator (and the inspector, if applicable) shall be transmitted to the purchaser at a frequency defined in the purchase order. Cumulative production records shall be maintained daily.

8 Classification of field joint coatings

The FJC types covered by this part of ISO 21809 are classified in [Table 1](#).

Table 1 — FJC types

Clause	Code	Type of field joint coating
10	10	Hot-applied bituminous tape coatings
11	11A	Petrolatum tape coatings
	11B	Wax-based tape coatings
12	12A	Cold-applied tape coatings with a polymeric continuous backing
	12B	Cold-applied tape coatings with a polymeric mesh backing ^{A1}
13	13A	Non-crystalline low-viscosity polyolefin based coatings with polymeric tape outer wrap
	13B	Non-crystalline low-viscosity polyolefin based coatings with heat shrinkable material outer wrap

Table 1 (continued)

Clause	Code	Type of field joint coating
14	14A	Coatings based on heat-shrinkable materials, polyethylene-base, applied without primer
	14B	Coatings based on heat-shrinkable materials, polyethylene-based, applied over a liquid epoxy, fusion-bonded epoxy, or other compatible primer layer
	14C	Coatings based on heat-shrinkable materials, polyolefin-based, with reinforced backing (hybrid), applied over a liquid epoxy, fusion-bonded epoxy, or other compatible primer layer
	14D	Coatings based on heat-shrinkable materials, polypropylene-based, applied over a liquid epoxy, fusion-bonded epoxy, or other compatible primer layer
15	15	Hot-applied microcrystalline wax coatings
16	16A	Elastomeric coatings, polychloroprene-based
	16B	Elastomeric coatings, EPDM-based
17	17A	Single-layer fusion-bonded epoxy powder coatings
	17B	Two-layer fusion-bonded epoxy powder coatings
18	18A	Liquid applied epoxy based coatings
	18B	Liquid applied polyurethane based coatings
	18C	Fibre-reinforced epoxy based coatings
	18D	Fibre-reinforced vinylester based coatings
	18E	Cast solid polyurethane based coatings
19	19A	Coatings based on flame-sprayed polypropylene powder applied over an epoxy layer
	19B	Coatings based on polypropylene tapes/sheets hot-applied over an epoxy layer
	19C	Coatings based on injection-moulded polypropylene over an epoxy layer
	19D	Coatings based on flame-sprayed polyethylene powder applied over an epoxy layer
	19E	Coatings based on polyethylene tapes/sheets hot-applied over an epoxy layer
20	20	Thermal spray aluminium (TSA) coatings

The FJC shall be compatible with the plant-applied coating and ensure continuity of corrosion protection.

The weld geometry and structure shall be taken into consideration during the selection of the FJC system.

The maximum service temperature, $T_{\max}$, of the FJC shall be equal to or greater than the maximum design temperature of the pipeline.

The FJC shall be compatible with the minimum operating temperature of the pipeline and the minimum ambient temperature during transportation and handling during the construction of the pipeline.

9 General requirements for surface preparation, coating application, testing and repair

9.1 Surface preparation

9.1.1 General

Surface preparation shall be carried out in accordance with the APS and as detailed below.

9.1.2 Preparation of the steel substrate

9.1.2.1 General

Prior to the coating application, the surface shall be dry and free of any contamination (such as detritus, dust, non-adhering particles, grease, oil, soluble salts) detrimental to surface preparation or to adhesion of the coating on the steel.

Oil, grease and wax shall be removed by solvent cleaning in accordance with SSPC-SP1.

All visible surface imperfections of substrate caused by the girth welding operation, such as welding slag and spatter, sharp edges or burrs that could damage the coating, detected before or during surface preparation shall be removed by an approved grinding method or filing techniques according to the following grades:

- P3 of standard ISO 8501-3 for components and fittings to be used in submerged conditions (permanent or intermittent);
- P2 of standard ISO 8501-3 for components and fittings to be used in buried conditions.

Grinding of steel defects shall not reduce the wall thickness below the specified minimum wall thickness of the pipe.

Areas of rust or scaling shall be removed by spot abrasive blast-cleaning or wire brushing as specified in the APS.

9.1.2.2 Abrasive blast-cleaning

Abrasives used in the preparation of field joints shall comply with ISO 11124 or ISO 11126.

Compressed air for blast-cleaning shall be free of oil, condensed moisture and any other contaminants, and shall conform to the requirements of ASTM D4285.

Reclaimed abrasive blast materials shall not be used unless automatic reclaiming equipment is used. Blasting equipment that includes devices to recycle abrasives shall have equipment that ensures removal of dust, fines, corrosion products and other contaminants.

The cleanliness shall be checked in accordance with the requirements of ISO 8501-1. Acceptance criteria are given for each system in [Clauses 10](#) to [20](#).

NOTE

- Sa 3 is approximately equivalent to NACE No.1/SSPC-SP5 (White metal blast cleaning).
- Sa 21/2 is approximately equivalent to NACE No.2/SSPC-SP10 (Near-white metal blast cleaning).
- Sa 2 is approximately equivalent to NACE No.3/SSPC-SP6 (Commercial blast cleaning).

The profile/roughness shall be checked in accordance with the requirements of ISO 8503-5. Acceptance criteria are given for each system in [Clauses 10](#) to [20](#). Other methods (see ISO 8503-1, ISO 8503-2, ISO 8503-3 and ISO 8503-4) may be used if correlated with ISO 8503-5. The profile shall be of an angular and dense nature.

In areas where the roughness of the profile does not meet these requirements, the surface shall be reblasted.

The level of soluble salts measured in accordance with the requirements of ISO 8502-6 or ISO 8502-9 shall be ≤ 20 mg/m² for coating types 14B, 14C, 14D, 16, 17, 18, 19 and 20. It is not necessary to measure the level of soluble salts on the steel surface for the other coating types.

Testing of the soluble-salt level during production may be reduced or omitted by agreement between applicator and end user or purchaser, if the PPT has demonstrated that the application procedure ensures a salt level below these requirements.

9.1.2.3 Wire-brush cleaning

If wire-brush cleaning is permissible (see 9.1.1), it shall be performed in accordance with ISO 8504-3. The surface preparation shall be in accordance with ISO 8501-1 grade St 3 using a power tool.

Manual wire-brush cleaning shall be allowed only if the manufacturer of the FJC requires a degree of cleanliness of ISO 8501-1 grade St 2 and if defined in the APS.

NOTE

- St 2 is approximately equivalent to SSPC-SP2 (Hand tool cleaning).
- St 3 is approximately equivalent to SSPC-SP3 (Power tool cleaning) or SSPC-SP11 (Power tool cleaning down to bare metal).

9.1.2.4 Final check and preparation of the steel surface

Dust contamination shall be measured in accordance with ISO 8502-3. Acceptance criteria are given for each FJC type in [Clauses 10](#) to [20](#).

Chemical treatment of the steel may be used by agreement between the applicator and the purchaser and/or end user, subject to the manufacturer's recommendation.

9.1.3 Preparation of the adjacent plant-applied coating

The plant-coated area adjacent to the cutback shall be prepared to ensure the adhesion of the field joint coating in accordance with [Clauses 10](#) to [20](#) for each of the different FJC types.

9.2 Application of the coating

The temperature of the substrate shall be at least 3 °C above the dew point.

The coating shall be applied by qualified personnel and in accordance with the APS. The coating shall be applied symmetrically and with approximately equal overlaps onto the plant-applied coating on either side.

Following surface preparation, the surface being coated shall not be exposed for a length of time that can result in flash rust detrimental to the quality of the coating.

At the time of application of the coating, the temperature of the substrate shall be within the temperature range specified in the APS. The temperature of the field joint shall be monitored to ensure that the application conditions are fully satisfied and are uniform across the steel substrate and the plant-applied coating. The methods of monitoring and recording shall be defined in the APS.

During adverse weather conditions, cleaning and coating operations shall be stopped unless protective enclosures are installed that maintain the field joint area in a clean and dry condition as specified in the APS throughout the surface preparation and coating application and curing.

9.3 Visual inspection of the applied coating

The applied coating shall be free of anomalies, contain no surface defects detrimental to the quality of the coating (grit, foreign particles, fish eyes, blisters, etc.) and have approximately equal overlaps onto the plant coating on either side.

9.4 Testing of the field joint coating

Inspection and testing shall be carried out during production in accordance with the agreed ITP. Test procedures and acceptance criteria are defined in [Clauses 10](#) to [20](#) for different FJC types. Testing frequencies are given in [Annex A](#).

Damaged areas created by testing shall be repaired in accordance with [9.5](#).

9.5 Repairs

The acceptable size and frequency of field joint coating repairs and the repair procedures shall be subject to agreement between the purchaser and the applicator.

FJC materials and repair procedures shall be included in the APS.

9.6 Verification, handling and storage of coating materials

The applicator shall ensure that the materials used for surface preparation and the coating(s) comply with the material specification and that the manufacturer's handling and storage instructions are followed.

10 Hot-applied bituminous tape coatings

10.1 Coating identification

Hot-applied bituminous tape coatings (FJC Type 10) shall be identified in the APS in accordance with [Table 2](#) and shall meet the requirements of [Table 3](#).

Data sheets for the coating materials shall be in accordance with [Table 4](#) (primer) and [Table 5](#) (tape).

Application instructions shall be provided by the manufacturer in accordance with [Table 6](#).

10.2 Description of the coatings

Bituminous tape coatings consist of a single layer or multiple layers of fusible bituminous tape, hot-applied, with or without a primer. Maximum service temperature is 30 °C.

10.3 Surface preparation

Surface preparation shall be carried out in accordance with the APS. The edges of the plant coating shall be bevelled and the plant coating shall be roughened for the minimum length according to the overlap on the plant coating ([10.4.4](#)).

The area being coated shall be cleaned by mechanical rotary wire brush to a minimum of grade St 3 as defined in ISO 8501-1. Alternatively, surface preparation can be achieved by abrasive blast-cleaning to a minimum grade of Sa 2 as defined in ISO 8501-1.

Dust contamination shall be grade 3 or better, measured in accordance with ISO 8502-3.

10.4 Coating application

10.4.1 General

Application of the coating shall be carried out in accordance with the APS.

10.4.2 Application of the primer

If applicable, application of the primer shall be carried out in accordance with the APS.

10.4.3 Application of the bituminous tapes

Application shall be carried out in accordance with the APS. As a general guideline, the following procedure shall be followed.

- Clean the area being coated with the approved cleaning method.
- Pre-heat it to a temperature recommended by the manufacturer.
- Verify the temperature of the substrate using a temperature-measuring device (e.g. hand-held thermocouple).
- Apply a thin coat of compatible primer; allow the primer to dry.
- Cut a sufficient length of bituminous tape (circumference plus 50 mm for overlap).
- If necessary, pre-heat again the surface being coated.
- Heat the bituminous side of the tape until the bitumen becomes liquid and put it with this side down on the surface being coated.
- Heat additionally the outer side and smooth the overlap.
- Install the required number of pre-cut sheets side by side, with the prescribed overlap, including the required overlap on the plant-applied coating
- If it is necessary to install a second layer of bituminous tape, heat the surface of the first layer and smooth it until the anti-adhesive coat is incorporated.
- Install the second layer of bituminous tape.

10.4.4 Overlap

The minimum tape overlap shall be in accordance with [Table 7](#), or the manufacturer's required overlap ([Table 6](#)) if greater.

The overlap of tape on plant-applied coating shall be in accordance with the manufacturer's application instructions ([Table 6](#)) and shall be at least 50 mm.

The width of the tape used depends on the diameter of the pipes. For all types of manual application, an appropriate width shall be chosen to avoid wrinkling of the tape, which can occur if the tape is too wide.

10.5 Testing of the applied coatings

10.5.1 General

The tests in [10.5.2](#) to [10.5.10](#) shall be carried out for production quality control, and for PQT and PPT if required.

10.5.2 Thickness

The nominal thickness is the calculated sum of the thickness of all the layers of the coating before application. The minimum thickness of the coating on the body of the joint shall be not less than 90 % of the nominal value or as otherwise agreed to by the purchaser.

Unless otherwise agreed with the purchaser, the minimum thickness on the weld cap shall be not less than 0,6 mm.

NOTE The coating thickness on the weld cap is normally less than on the body because some of the polymeric adhesive flows from the weld cap to the body, both during and after the application. This is necessary to prevent voids in the coating and is not detrimental to the corrosion protection.

The coating thickness shall be measured using the method given in [Annex B](#).

10.5.3 Holiday detection

The entire surface of the coated joint shall be checked for holidays or other discontinuities according to the method defined in [Annex C](#) at a voltage of 5 kV/mm + 5 kV to a maximum of 25 kV. The voltage shall never exceed the acceptable voltage for the plant-applied coating.

Holidays shall be repaired in accordance with the APS.

10.5.4 Impact resistance

The impact resistance shall be measured using the method given in [Annex D](#) and shall meet the requirements of [Table 3](#).

10.5.5 Indentation resistance

The indentation resistance shall be measured using the method given in [Annex E](#) and shall meet the requirements of [Table 3](#).

10.5.6 Specific electrical insulation resistance

The specific electrical insulation resistance shall be measured using the method given in [Annex F](#) and shall meet the requirements of [Table 3](#).

10.5.7 Cathodic disbondment

The cathodic disbondment shall be measured using the method given in [Annex G](#).

The cathodic disbondment after 28 days at 23 °C shall meet the requirements of [Table 3](#).

10.5.8 Peel strength to pipe surface and plant coating

The minimum waiting period between application of the coating and the peel strength test shall be 24 h, unless specified otherwise by the manufacturer.

The peel strength shall be measured using the methods given in [Annex H](#) and shall meet the requirements of [Table 3](#). The method given in [H.1](#) should preferably be used for PQT. The method given in [H.2](#) can be used for PPT and production testing, as well as for PQT in agreement with purchaser.

Failure shall not occur at the interface between steel and adhesive, except for a peeling strength 50 % higher than the values listed in [Table 3](#).

10.5.9 Hot-water immersion test

A hot-water immersion test shall be carried out in accordance with [Annex I](#) with a duration of 28 days, the test temperature being the maximum service temperature of the joint coating, limited as specified in [Annex I](#).

The peel strength after the hot-water immersion test shall be measured using the method given in [H.1](#) and shall meet the requirements of [Table 3](#).

10.5.10 Lap shear strength

The lap shear strength resistance shall be measured using the method given in [Annex J](#) and shall meet the requirements of [Table 3](#).

Table 2 — Coating identification

Property
Coating trade name
FJC Type and code as per Table 1
Maximum and minimum service temperature
Primer trade name
Number of layers ^a
Trade names of all layers
Nominal thickness of the coating system
Compatible plant coatings ^b
^a Excluding primer.
^b State all types of plant coatings that have been tested successfully with the coating.

Table 3 — Requirements for Type 10 — Hot-applied bituminous tape

Property	Test temperature °C	Unit	Requirements	Test method
Thickness	—	mm	$\geq 0,9 \times$ nominal value	Annex B
Holiday detection at 5 kV/mm + 5 kV, max. 25 kV	—	—	no holiday	Annex C
Impact resistance	23	J/mm	≥ 2	Annex D
Indentation resistance, pressure		N/mm ²	1,0	Annex E
— Residual thickness	23	mm	$\geq 0,6$	
Specific electrical insulation resistance				Annex F
— R_{S100}	23	$\Omega \cdot m^2$	$\geq 10^6$	
— R_{S100}/R_{S70}		—	$\geq 0,8^a$	
Cathodic disbondment resistance, 28 days	23	mm	≤ 20	Annex G
Peel strength				Annex H Annex I
— to steel surface ^b	23	N/mm	$\geq 0,4$	
— to plant coating	23	N/mm	$\geq 0,2$	
— plant coating after 28-day hot-water immersion test at 30 °C	23	N/mm	$\geq 0,1$	
— steel surface after 28-day hot-water immersion test at 30 °C	23	N/mm	$\geq 0,2$	
Lap shear strength	23	N/mm ²	$\geq 0,05$	Annex J
^a This requirement is only applicable if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.				
^b If the result is less than 0,4 N/mm, residual thickness of bituminous compound on the pipe surface or plant coating shall be $\geq 0,25$ mm.				

Table 4 — Data sheet — Primer

Property	Unit	Test method
Primer trade name	—	—
Generic type	—	—
Solid content	%	ISO 3251
Type of solvent	—	—
Flash point	°C	ISO 1523
Density	g/cm ³	ISO 2811-1
Coverage area	m ² /l	—
Dry film thickness	µm	ISO 2808
Storage conditions		
— temperature, minimum	°C	—
— temperature, maximum	°C	—
Shelf life at storage temperature	month	—

Table 5 — Data sheet^a — Tape

Property	Unit	Test method
Trade name	—	—
Description of coating material	—	—
Colour	—	—
Minimum total thickness	mm	ISO 4591 and ISO 4593
or		
Surface density ^b	g/m ²	ISO 3801
Polymeric film/reinforcement		
— generic type of polymeric film	—	—
— generic type of reinforcement material	—	—
— nominal thickness, or	mm	ISO 4591 and ISO 4593
— surface density	g/m ²	ISO 3801
Adhesive		
— generic type	—	—
— nominal thickness or	mm	ISO 4591 and ISO 4593
— surface density	g/m ²	ISO 3801
— softening point ring and ball ^c	°C	ISO 4625-1
Mechanical properties		
— tape strength	N/mm	ISO 527-3
— modulus at 10 % elongation ^c	N/mm	
— elongation at break ^c	%	
Storage conditions		
— temperature, minimum	°C	—
— temperature, maximum	°C	—
^a Data according to this data sheet shall be supplied for each coating component.		
^b Also called “mass per unit area,” a deprecated designation.		
^c If applicable.		

Table 5 (continued)

Property	Unit	Test method
Shelf life at storage temperature	month	—
^a Data according to this data sheet shall be supplied for each coating component. ^b Also called “mass per unit area,” a deprecated designation. ^c If applicable.		

Table 6 — Application instructions

Property	Unit
Ambient conditions	
— minimum temperature	°C
— maximum temperature	°C
— relative humidity	%
Surface preparation — steel surface	
— cleanliness (ISO 8501-1)	—
— profile in case of abrasive blast-cleaning (ISO 8503-2)	—
— Surface preparation — plant coating	—
Application of primer	
— method	—
— minimum surface temperature	°C
— maximum surface temperature	°C
— pot life	h
— minimum overcoating time	h or min
— maximum overcoating time	days or h
— curing temperature	°C
Application of tape	
— method	—
— minimum material temperature	°C
— minimum overlap of tape	% or mm
General	
— minimum overlap on plant coating ^a	mm
— specific application instructions	—
— holiday detection voltage	kV
— repair procedure	—
^a It is necessary that this be given for each compatible plant coating.	

Table 7 — Overlap of tape

Tape width	Overlap
<50 mm	≥50 %
≥50 mm	≥25 mm

11 Petrolatum and wax-based tape coatings

11.1 Coating identification

Petrolatum and wax-based tape coatings (FJC Types 11A and 11B) shall be identified in the APS in accordance with [Table 2](#) and shall meet the requirements of [Table 8](#) for petrolatum tape coatings (Type 11A) or [Table 9](#) for wax tape coatings (Type 11B).

Data sheets for the coating materials shall be in accordance with [Table 4](#) (primer) and [Table 5](#) (tape).

Application instructions shall be provided by the manufacturer in accordance with [Table 6](#).

11.2 Description of the coatings

11.2.1 Petrolatum tapes (Type 11A)

Petrolatum tape coatings consist of a single layer or multiple layers of petrolatum tapes, with or without a primer.

The use of any outerwrap is possible if agreed by the manufacturer and the end user.

Maximum service temperature is 30 °C.

A $T_{\max}$ higher than 30 °C can be agreed between the end user and the manufacturer.

11.2.2 Wax-based tapes (Type 11B)

Wax-based tape coatings consist of a primer and a single layer or multiple layers of wax-based tapes.

The use of any outerwrap is possible if agreed by the manufacturer and the end user.

Maximum service temperature is 30 °C.

A $T_{\max}$ higher than 30 °C can be agreed between the end user and the manufacturer.

11.3 Surface preparation

Surface preparation shall be carried out in accordance with the APS. The edges of the plant coating shall be bevelled and the plant coating shall be roughened for the minimum length according to the overlap on the plant coating ([11.4.4](#)).

The area being coated shall be cleaned according to ISO 8501-1, grade St 2, by hand-tool cleaning as described in ISO 8504-3.

Alternatively, surface preparation can be achieved by abrasive blast-cleaning to a minimum grade of Sa 1 as defined in ISO 8501-1.

Dust contamination shall be grade 3 or better, measured in accordance with ISO 8502-3.

11.4 Coating application

11.4.1 General

Application of the coating shall be carried out in accordance with the APS.

11.4.2 Application of the primer

If applicable, application of the primer shall be carried out in accordance with the APS.

11.4.3 Application of petrolatum or wax-based tapes

Application shall be carried out in accordance with the APS. As a general guideline, the following application procedure shall be followed.

- Wipe the surface to remove visible moisture.
- Prepare the surface.
- Apply a thin coat of compatible primer (if any) by brush, by hand or using other applicable tools.
- Spirally wrap the area being coated with tapes of recommended width, employing the correct overlap and ensuring the complete coverage and adherence of the coating to the pipe surface.
- Apply any outerwrap if applicable.

11.4.4 Overlap

The minimum tape overlap shall be in accordance with [Table 7](#), or the manufacturer's required overlap ([Table 6](#)) if greater.

The overlap of tapes on plant-applied coating shall be in accordance with the manufacturer's application instructions ([Table 6](#)) and shall be at least 50 mm.

The width of the tape used depends on the diameter of the pipes. For all types of manual application, an appropriate width shall be chosen to avoid wrinkling of the tape, which can occur if the tape is too wide.

11.5 Testing of the applied coatings

11.5.1 General

The tests in [11.5.2](#) to [11.5.10](#) shall be carried out for production quality control, and for PQT and PPT if required.

11.5.2 Thickness

The nominal thickness is the calculated sum of the thickness of all the layers of the coating before application. The minimum thickness of the coating on the body of the joint shall be not less than 90 % of the nominal value or as otherwise agreed to by the purchaser.

Unless otherwise agreed with the purchaser, the minimum thickness on the weld cap shall be not less than 0,6 mm.

NOTE The coating thickness on the weld cap is normally less than on the body because some of the polymeric adhesive flows from the weld cap to the body, both during and after the application. This is necessary to prevent voids in the coating and is not detrimental to the corrosion protection.

The coating thickness shall be measured using the method given in [Annex B](#).

11.5.3 Holiday detection

The entire surface of the coated joint shall be checked for holidays or other discontinuities at a voltage of 5 kV/mm to a maximum of 25 kV according to the method defined in [Annex C](#).

Holidays shall be repaired in accordance with the APS.

11.5.4 Impact resistance

The impact resistance shall be measured using the method given in [Annex D](#) and shall meet the requirements of [Table 8](#) or [9](#).

11.5.5 Indentation resistance

The indentation resistance shall be measured using the method given in [Annex E](#) and shall meet the requirements of [Table 8](#) or [9](#).

11.5.6 Specific electrical insulation resistance

The specific electrical insulation resistance shall be measured using the method given in [Annex F](#) and shall meet the requirements of [Table 8](#) or [9](#).

11.5.7 Cathodic disbondment

The cathodic disbondment shall be measured using the method given in [Annex G](#).

The cathodic disbondment after 28 days at 23 °C shall meet the requirements of [Table 8](#) or [9](#).

11.5.8 Peel strength to pipe surface and plant coating

The minimum waiting period between application of the coating and the peel strength test shall be 1 h, unless specified otherwise by the manufacturer.

Petrolatum and wax-based tapes shall leave a film of compound, visible without magnification, on the entire surface of the substrate when the coating is peeled off.

11.5.9 Hot-water immersion test

A hot-water immersion test shall be carried out in accordance with [Annex I](#) with a duration of 28 days, the test temperature being the maximum service temperature of the joint coating, limited as specified in [Annex I](#).

Petrolatum and wax-based tapes shall leave a film of compound on the substrate when peeled off after the hot-water immersion test.

11.5.10 Drip resistance

No dripping of the compound shall occur when the tape is tested in accordance with [Annex K](#) for types 11A and 11B as listed in [Table 8](#) or [9](#).

Table 8 — Requirements for Type 11A — Petrolatum tape

Property	Test temperature °C	Unit	Requirements	Test method
Thickness	—	mm	$\geq 0,9 \times \text{nominal value}$	Annex B
Holiday detection at 5 kV/mm max. 25 kV	—	—	no holiday	Annex C
Impact resistance	23	J/mm	$\geq 0,8$	Annex D
Indentation resistance, test pressure		N/mm ²	0,1	Annex E
— Residual thickness	23	mm	$\geq 0,6$	
Specific electrical insulation resistance				Annex F
— R_{S100}	23	$\Omega \cdot \text{m}^2$	$\geq 10^6$	
— R_{S100}/R_{S70}		—	$\geq 0,8^a$	
Cathodic disbondment resistance at 28 days	23	mm	≤ 20	Annex G

^a This requirement is only applicable if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.

Table 8 (continued)

Property	Test temperature °C	Unit	Requirements	Test method
Peel strength to pipe surface and plant coating	23	—	leave a film of compound on the substrate	—
Peel strength to steel and plant coating before and after 28-day hot-water immersion test at 30 °C	23	—	leave a film of compound on the substrate	Annex I
Drip resistance	45	—	no dripping of compound	Annex K
^a This requirement is only applicable if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.				

Table 9 — Requirements for Type 11B — Wax-based tape and primer

Property	Test temperature °C	Units	Requirements	Test method
Primer				
Congeval point	—	°C	>55	ASTM D938
Flash point	—	°C	≥65	ASTM D92
Density	25	g/cm ³	<1	ASTM D70
Cone penetration	25	mm	7,5 to 25	ASTM D937
Dielectric strength	—	V/μm	≥4	ASTM D149
Tape				
Congeval point of saturant	—	°C	>65	ASTM D938
Flash point of saturant	—	°C	≥60	ASTM D92
Thickness	—	mm	>1,75	ASTM D1000
Dielectric strength	—	V/μm	>6,6	ASTM D149
Drip resistance	45	—	No dripping of compound	Annex K
Complete coating				
Holiday detection at 5 kV/mm, max. 25 kV	—	—	no holiday	Annex C
Impact resistance	23	J/mm	≥0,8	Annex D
Indentation resistance, test pressure	23	N/mm ²	0,1	Annex E
— Residual thickness		mm	≥0,6	
Specific electrical insulation resistance	R_{S100}	—	$\Omega \cdot m^2$	Annex F
	R_{S100}/R_{S70}		—	
Cathodic disbondment resistance at 28 days	23	mm	<12	Annex G
Peel strength to pipe surface and plant coating	23	—	Leave a film of compound on the substrate	11.5.8
Peel strength to steel and plant coating before and after 28-day hot-water immersion test at 30 °C	23	—	Leave a film of compound on the substrate	Annex I and 11.5.8
^a This requirement is only applicable if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.				

A1 12 Cold-applied polymeric tape coatings

12.1 Coating identification

Cold-applied polymeric tape coatings (FJC Types 12A or 12B) shall be identified in the APS in accordance with Table 2 and shall meet the requirements of Table 10. Data sheets for the coating materials shall be in accordance with Table 4 (primer) and Table 5 (tape).

Application instructions shall be provided by the manufacturer in accordance with Table 6.

12.2 Description of the coatings

12.2.1 Cold-applied tape coatings with a polymeric continuous backing (Type 12A)

Cold-applied tape coatings with a polymeric continuous backing consist of several layers of one or more continuous polymeric tapes, with or without a primer.

This coating type can be further subdivided into the following:

- **12A-1:** with a $T_{\max}$ not greater than 50 °C;
- **12A-2:** with a $T_{\max}$ not greater than 80 °C;
- **12A-3:** with a $T_{\max}$ not greater than 120 °C.

The $T_{\max}$ shall be stated in brackets, e.g. FJC Type 12A-1(30) or FJC Type 12A-1(50).

A $T_{\max}$ higher than 120 °C can be agreed as long as the requirements of Table 10 are met.

12.2.2 Cold-applied tape coatings with a polymeric mesh backing (Type 12B)

Cold-applied tape coatings with a polymeric mesh backing consist of a single layer or multiple layers of one or more mesh-backed tapes, with or without a primer.

The mesh-backed tape shall be composed of rubber or polymeric based adhesive and a supporting woven fabric backing.

This coating type can be further subdivided into the following:

- **12B-1:** with a $T_{\max}$ not greater than 50 °C;
- **12B-2:** with a $T_{\max}$ not greater than 80 °C;

The $T_{\max}$ shall be stated in brackets, e.g. FJC Type 12B-1(30) or FJC Type 12B-1(50).

A $T_{\max}$ higher than 80 °C can be agreed as long as the requirements of Table 10 are met.

12.3 Surface preparation

Surface preparation shall be carried out in accordance with the APS. The edges of the plant coating shall be bevelled and the plant coating shall be roughened for the minimum length according to the overlap on the plant coating (12.4.4).

The area to be coated shall be cleaned by abrasive blast-cleaning as described in ISO 8504-2 to a minimum grade Sa 2 according to ISO 8501-1. The profile/roughness shall be in accordance with the manufacturer's application instructions.

For FJC Type 12A-1 and Type 12-B, surface preparation can be achieved by power tool cleaning as described in ISO 8504-3 to a minimum grade St 3 according to ISO 8501-1, by agreement of the end user.

Dust contamination shall be grade 3 or better, measured in accordance with ISO 8502-3.

12.4 Coating application

12.4.1 General

Application of the coating, including the primer if applicable, shall be carried out in accordance with the APS.

12.4.2 Application of the primer

If applicable, application of the primer shall be carried out in accordance with the APS.

12.4.3 Application of polymeric tapes with continuous or mesh baking

Application shall be carried out in accordance with the APS.

As a general guide, the following application procedure shall be followed.

- Prepare the surface according to the approved method.
- Apply a thin coat of compatible primer (if any); allow the primer to dry.
- Spirally wrap the area being coated with tapes of an adequate width, employing the right overlap and using sufficient tension to ensure a complete conformability of the coating. Any tenting effect shall be prevented. A manual application tool should be used to achieve these goals.

A single piece of wrapping wide enough to cover the required area may be used in certain circumstances (in particular, for offshore installation on a conventional barge).

12.4.4 Overlaps

The minimum tape overlap shall be in accordance with Table 7, or the manufacturer's required overlap (Table 6) if greater.

The overlap of tape on plant-applied coating shall be in accordance with the manufacturer's application instructions (Table 6) and shall be at least 50 mm.

12.5 Testing of the applied coatings

12.5.1 General

The tests in 12.5.2 to 12.5.11 shall be carried out for production quality control, and for PQT and PPT if required.

12.5.2 Thickness

The nominal thickness is the calculated sum of the thickness of all the layers of the coating before application. The minimum thickness of the coating on the body of the joint shall be not less than 90 % of the nominal value or as otherwise agreed to by the purchaser.

Unless otherwise agreed with the purchaser, the minimum thickness on the weld cap shall be not less than 0,6 mm.

NOTE The coating thickness on the weld cap is normally less than on the body because some of the polymeric adhesive flows from the weld cap to the body, both during and after the application. This is necessary to prevent voids in the coating and is not detrimental to the corrosion protection.

The coating thickness shall be measured using the method given in Annex B.

12.5.3 Holiday detection

The entire surface of the coated joint shall be checked for holidays or other discontinuities according to the method defined in Annex C.

The voltage of the holiday detector shall be set at the following values:

- 5 kV/mm + 5 kV at a maximum of 25 kV for cold-applied polymeric continuous tape coatings (Type 12A)
- 5 kV/mm at a maximum of 15 kV for cold-applied polymeric mesh-backed tape coatings (Type 12B).

Holidays shall be repaired in accordance with the APS.

12.5.4 Impact resistance

The impact resistance shall be measured using the method given in Annex D and shall meet the requirements of Table 10.

12.5.5 Indentation resistance

The indentation resistance shall be measured using the method given in Annex E and shall meet the requirements of Table 10.

12.5.6 Cathodic disbondment

The cathodic disbondment shall be measured using the method given in Annex G.

The cathodic disbondment after 28 days at 23 °C shall meet the requirements of Table 10. A test duration of 48 h instead of 28 days can be used for PPT provided that the test temperature is increased to 65 °C and a comparison of results is performed during PQT.

The maximum cathodic disbondment after 28 days at maximum service temperature shall meet the requirements of Table 10. It shall be agreed between the end user and the applicator for Type 12A.

12.5.7 Peel strength between tape layers

The peel strength between tape layers shall be measured using the method given in Annex L and shall meet the requirements of Table 10.

12.5.8 Peel strength to pipe surface and plant coating

Unless specified otherwise by the manufacturer, the minimum waiting period between application of the coating and the peel strength test shall be 120 h. This waiting period may be reduced to 24 h. However, if this test fails, it shall be carried out again after a waiting period of 120 h.

The peel strength shall be measured using the methods given in Annex H and shall meet the requirements of Table 10. The method given in H.1 shall be used for PQT. The method given in H.2 can be used for PPT and production testing.

Failure shall not occur at the interface between steel and adhesive, nor between adhesive and polyolefin or mesh backing, except for coatings with a peeling strength 50 % higher than the values listed in Table 10.

12.5.9 Hot-water immersion test

A hot-water immersion test shall be carried out in accordance with Annex I with a duration of 28 days, the test temperature being the maximum service temperature of the joint coating, limited as specified in Annex I.

The peel strength after the hot-water immersion test shall be measured using the method given in H.1 and shall meet the requirements of Table 10.

12.5.10 Lap shear strength

The lap shear strength resistance shall be measured using the method given in Annex J and shall meet the requirements of Table 10.

12.5.11 Thermal ageing resistance

The thermal ageing resistance shall be measured using the method given in Annex M and shall meet the requirements of Table 10.

Table 10 — Requirements for Type 12A (Polymeric continuous tapes) and Type 12B (Polymeric mesh-backed tapes)

Property	Test temp.	Unit	Type 12A-1 ($T_{\max} \leq 50\text{ °C}$)	Type 12A-2 ($T_{\max} \leq 80\text{ °C}$)	Type 12A-3 ($T_{\max} \leq 120\text{ °C}$)	Type 12B-1 ($T_{\max} \leq 50\text{ °C}$)	Type 12B-2 ($T_{\max} \leq 80\text{ °C}$)	Test method	
Thickness	—	mm	≥0,9 × nominal value						Annex B
Holiday detection: no holiday at:	—	—	5 kV/mm + 5 kV, max. 25 kV			5 kV/mm, max. 15 kV		Annex C	
Impact resistance	23 °C	J/mm	≥4			≥1,25		Annex D	
Indentation resistance, pressure	23 °C and	N/mm ²	10,0	1,0	1,0	0,1	0,1	Annex E	
— Residual thickness	$T_{\max}$	mm	≥0,6	≥0,6	≥0,6	≥0,6	≥0,6		
Cathodic disbondment resistance 28 days	23 °C $T_{\max}$	mm mm	≤15 a	≤15 a	≤15 a	≤10 ≤15	≤5 ≤10	Annex G	
Peel strength between tape layers								Annex L	
^a By agreement after qualification.									
^b The test is considered passed when the tape leaves a film of adhesive on the substrate.									