RECOMMENDED PRACTICE
DNV-RP-F106

FACTORY APPLIED EXTERNAL PIPELINE COATINGS FOR CORROSION CONTROL

MAY 2011

DET NORSKE VERITAS

FOREWORD

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CHANGES

• General

This issue replaces the October 2010 edition of the document. The revision has been done to obtain compliance with ISO 21809-1 (FDIS issued 2011-03-31, publication expected in summer of 2011) and ISO 21809-2 (2007). As a consequence of this, reference to ASTM, DIN and NF standards for testing of coating properties have largely been replaced by references to testing standards contained or referenced in ISO 21809-1 and ISO 21809-2. Some terminology has further been changed for compliance with these standards.

Incorporation of DNV experience from the use of the preceding 2003 revision.

• Main changes

— Inclusion of a new section (Sec.5) dedicated to the specification of linepipe coating in inquiry and contract for coating work.
— Inclusion of a new section (Sec.7) for coating system specific requirements referring to ISO 21809-1 and ISO 21809-2 when applicable.
— Multi-layer polypropylene coating, coal tar enamel coating and multi-layer polychloroprene coating have been deleted from the scope of this document.
— Format for specification of amendments and deviations has been deleted.
— An Inspection and Testing Plan (ITP) format has been added (Annex 2).

CONTENTS

1. General

1.1 Introduction

1.1.1 A primary objective of external coatings on submarine pipelines is corrosion control. In addition, coating systems for corrosion control can be designed to provide mechanical protection during installation and operation. A corrosion protective coating (sometimes referred to as 'corrosion coating') may be combined with a concrete weight coating (for anti-buoyancy and/or mechanical protection) or a coating for thermal insulation.

1.1.2 Coatings for external corrosion control of pipelines are applied to individual pipe lengths at a dedicated coating plant. This coating is referred to as "linepipe coating" (sometimes also as "factory coating", "plant applied coating" or "parent coating"). In order to facilitate girth welding, areas at each end of the individual pipe length are left uncoated. These areas are normally coated after welding, by applying a "field joint coating system" (ref. DNV-RP-F102). Repair of linepipe coating after discharge from the coating factory is referred to as "coating field repair" (ref. DNV-RP-F102).

Guidance note:

In its widest sense, the term "pipeline coating" includes linepipe coating, field joint coating (FJC) and coating field repair (CFR). FJC and CFR are typically performed under the same contract issued to the installation contractor (sometimes subcontracted to another party), whilst linepipe coating is mostly carried out by another coating applicator contracted by the pipeline operator, installation contractor or linepipe manufacturer.

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1.1.3 Submarine pipelines are almost invariably designed with a cathodic protection (CP) system, mostly based on galvanic (or "sacrificial") anodes. The CP system serves as a back-up for any deficiencies of the pipeline coating, including defects during application and damage during transportation/installation, in addition to any assumed environmental degradation of coating properties and mechanical damage during operation. Hence, CP design for submarine pipelines is closely related to the design and quality control of pipeline coatings, including FJC and CFR. For submarine pipelines, maintenance of coating and cathodic protection systems is largely impractical. Moreover, cost and schedule impacts of deficient coating during installation of offshore pipelines are typically higher than for pipelines on land. This is reflected by high requirements to the quality control of coating application. Submarine pipeline installation by reeling may further impose special requirements to both selection of coating type and the quality control of application.

1.2 Scope

1.2.1 This Recommended Practice (RP) has been prepared to facilitate the specification and execution of coating application work. The RP covers the application of specific types of linepipe coating systems as referred to below. The use of this RP implies the involvement of Purchaser in quality control aspects, including review of procedures and inspection/testing plans for coating application, witnessing of qualification tests (PQT) for coating and acceptance of documentation of quality control (Daily Log formats and index for Final Documentation) prior to start of production in order to ensure that the produced coating meets all requirements of this RP and ISO 21809-1.

Guidance note:

The requirements to design and quality control are in compliance with ISO 21809-1, but with some additions. This means that compliance with this RP ensures full compliance with ISO 21809-1.

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1.2.2 This RP covers the process of applying external coating systems for corrosion control of submarine pipelines at the coating plant, and includes the qualification, implementation and documentation of this process. The following coating systems are covered:

1) Single layer fusion bonded epoxy*).
2) 3-layer coating based on an inner layer of fusion bonded epoxy (FBE) applied by spraying, an intermediate adhesive layer applied by spraying or extrusion, and an outer jacket of polyethylene (PE) applied by extrusion*).
3) 3-layer coating based on an inner layer of FBE applied by spraying, an intermediate adhesive layer applied by spraying or extrusion, and an outer jacket of polypropylene (PP) applied by extrusion.
4) Glass fibre reinforced asphalt enamel coating*).
5) Polychloroprene (vulcanised rubber) coating (sometimes applied for thermal insulation in addition to corrosion control and mechanical protection).

*) Primarily for use in combination with a concrete weight coating.

Guidance note:

Pipeline operators (and installation contractors if applicable) should consider the need to carry out qualification of

generic coating systems for specially demanding applications; e.g. resistance to bending during installation by reeling and/or long term (>10.000 hrs) thermal degradation of critical coating properties associated with high operating temperatures. Purchasers of linepipe coating should further consider pre-qualification of the coating manufacturers prior to the issue of "Purchase Document" (see definition in Sec. 3).

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1.2.3 This RP covers primarily the process of applying coating to ordinary straight pipe joints (including any joints designed as buckle arrestors). It may also be used for coating of certain pipeline components (e.g. bends, tees and reducers), or for coating of linepipe for onshore pipelines, using the same or similar coating systems. The user shall then duly consider the needs for amendments and deviations for such applications.

Guidance note:
Some of the coating systems for field joints as defined in DNV-RP-F102 may be better suited for coating of pipeline components than those covered by this RP.

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1.2.4 The following activities associated with linepipe coating are not covered in this recommended practice:

— requirements for the qualification of Manufacturer specific coating materials and Applicator specific coating systems for general purposes (i.e. not project specific, see Guidance Note to 6.6.3)
— application of internal coating
— application of thermally insulating coating
— application of concrete weight coating.

Guidance note:
The coating systems as defined in CDS 1, 2 and 3 are applicable as substrate to a thermally insulating coating or concrete weight coating.

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1.2.5 Considerations related to safety and environmental hazards associated with either pipe coating work or properties of the coating in the 'as applied' condition (reflected by national and multi-national regulations) are beyond the scope of this document.

1.3 Objectives and use

1.3.1 DNV-RP-F106 has been prepared for compliance with general and coating system specific requirements in published standards of the ISO 21809 series. This RP focuses on the execution and documentation of quality control, including detailed guidance to the specification of coating work. The requirements to testing and inspection are basically the same as in the ISO 21809-1 standard. The RP includes more stringent requirements and detailed recommendations to ensure a consistent quality of the coated pipes and to avoid ambiguous and incomplete coating specifications in submarine pipeline projects.

1.3.2 The cathodic protection design for submarine pipelines in DNV-RP-F103 recognises the importance of (i) design and (ii) quality control of pipeline coatings. To account for this, specific 'coating breakdown factors' are defined for linepipe and FJC/CFR coating systems. These factors assume that the quality control of linepipe coating application is in compliance with this RP, and with DNV-RP-F102 for FJC/CFR.

1.3.3 This Recommended Practice (RP) may either be used as a guideline for the preparation of purchase specifications for external pipeline coating systems as defined in 1.2.2 above or as an attachment to an inquiry or purchase order for such coatings. If a Purchaser has chosen to refer to this RP in a purchase document, then Applicator shall consider all requirements in this RP as mandatory unless superseded by amendments and deviations in the specific contract

Guidance note:
When this RP is used as the governing standard for purchase of linepipe coating, any amendments or revisions should be made with reference to the relevant paragraph of the RP. Requirements that are adequately covered in the RP should not be repeated.

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1.3.4 If reference is made to this RP in a Purchaser document, the project specific information and requirements listed in Section 5 shall always be specified.

1.4 Structure of document

1.4.1 Sec. 5 gives requirements and recommendations for purchase of linepipe coating. Requirements that are common to all types of external linepipe coating systems are given in Sec. 6 whilst those applicable to a specific system are contained in Sec. 7 and in individual 'Coating Data Sheets' (CDS) in ANNEX 1. ANNEX 2 gives an example of an ITP format meeting the requirements in 6.2 of this RP.

1.5 Relation to DNV-OS-F101 and other DNV documents on pipeline corrosion control

1.5.1 DNV-OS-F101 "Submarine Pipeline Systems", Sec. 6 (Design – Materials Engineering), gives some guidelines to the selection of coating systems for external corrosion protection of pipelines (linepipe coating and field joint coatings), and general requirements to their application. This document (DNV-RP-F106) is an extension of these general guidelines and requirements, and provides detailed requirements for the application of linepipe coating.

1.5.2 DNV-RP-F102 "Pipeline Field Joint Coating and Field Repair of Linepipe External Coating" gives detailed requirements to the application of such coating.

1.5.3 Cathodic protection of coated submarine pipelines is covered in DNV-RP-F103 "Cathodic Protection of Submarine Pipelines by Galvanic Anodes".

Guidance note:
DNV-RP-F103 offers CP design parameters that are based on the requirements to pipeline coatings in DNV-RP-F102 and in DNV-RP-F106 (i.e. present RP), reducing the need for arbitrary conservatism in CP design due to potential deficiencies associated with pipeline coating design and/or quality control of coating application.

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2. References

The following standards are referred to in this document. The latest editions apply unless otherwise indicated.

2.1 AS (Australian Standard)

AS 3894.6	Site Testing of Protective Coatings – Determination of Residual Contaminants

2.2 ASTM (American Society for Testing and Materials)

ASTM C518	Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D256	Test Method for Determining the Izod Pendulum Impact Resistance of Notched Specimens of Plastics
ASTM D257	Test Method for D-C Resistance or Conductance of Insulating Materials
ASTM D570	Test Method for Water Absorption of –Plastics
ASTM D790	Test Method for Flexural Properties of –Unreinforced and Reinforced Plastics and Electrically Insulating Materials
ASTM D373-96	Test Method for Air Permability of Textile Fabrics
ASTM D2084	Standard Test Method for Rubber Property – Vulcanization Using Oscillating Disc Cure Meter
ASTM D3895	Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning – Calorimetry
ASTM D4060	Test Method for Abrasion Resistance of –Organic Coatings by the Taber Abrader
ASTM D4285	Test Method for Indicating Oil or Water in Compressed Air
ASTM D4940	Standard Practice for Inspection of Marine Surface Preparation and Coating application
ASTM E96	Test Methods for Water Vapour Transmission of Materials
ASTM E797	Practice for Measuring Thickness by Manual –Ultrasonic Pulse-Echo Contact Method
ASTM G17	Test Method for Penetration Resistance of Pipeline Coatings
ASTM G21	Practice for Determining Resistance of –Synthetic Polymeric Materials to Fungi
ASTM G22	Practice for Determining Resistance of –Plastics to Bacteria

2.3 BS (British Standards)

BS 410 Part 1	Test Sieves Technical Requirements and Testing. Test Sieves of Metal Wire Cloth
BS 410 Part 2	Test Sieves. Technical Requirements and Testing. Test Sieves of Perforated Metal Plate
BS 3900 Part F4	Methods of Tests for Paint; Resistance to Continuous Salt Spray
BS 4147	Specification for Bitumen-Based Hot-Applied Coating Materials for Protecting Iron And Steel, Including Suitable Primers Where Required

2.4 DIN (Deutsche Industrie Normen)

DIN 53516	Testing of Rubber and Elastomers; Determination of Abrasion Resistance

2.5 DNV (Det Norske Veritas)

DNV-OS-F101	Submarine Pipeline Systems
DNV-RP-F102	Pipeline Field Joint Coating and Field Repair of Linepipe External Coating
DNV-RP-F103	Cathodic Protection of Submarine Pipeline by Galvanic Anodes

2.6 EN (European Standards)

EN 1426	Bitumen and bituminous binders – Determination of needle penetration
EN 1427	Bitumen and bituminous binders – Determination of softening point – Ring and ball method
EN 1849-1	Flexible sheets for waterproofing – Determination of thickness and mass per unit area – Part 1: Bitumen sheets for roof waterproofing
EN 10204	Metallic Products – Types of Inspection Documents
EN 10300	Steel Tubes and Fittings for Onshore and Offshore Pipelines - Bituminous Hot Applied Materials for External Coating
EN 12311-1	Flexible sheets for waterproofing – Part 1: Bitumen sheets for roof waterproofing - Determination of tensile properties

2.7 ISO (International Organization for –Standardization)

ISO 34	Rubber, Vulcanised or Thermoplastic – Determination of Tear Strength
ISO 37	Rubber, Vulcanised or Thermoplastic – Determination of Tensile Stress - Strain Properties
ISO 178	Plastics, Determination of Flexural Properties
ISO 188	Rubber, Vulcanised or Thermoplastic – Accelerated Ageing and Heat-Resistance Tests
ISO 306	Plastics-Thermoplastic Materials – Determining of Vicat Softening Temperature
ISO 527	Plastics – Determination of Tensile Properties. Part 1 and 2.
ISO 719	Testing of Glass; Determination of Water Resistance (Grain Titration Method) and Classification of Glass in Hydrolytic Classes
ISO 815	Physical Testing of Rubber. Method for Determination of Compression Set at Ambient, Elevated and Low Temperatures
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 1183	Plastics – Methods for Determining the Density and Relative Density of Non-Cellular Plastics
ISO 1817	Vulcanised Rubber. Determination of the Effects of Liquids
ISO 2187	Non-Magnetic Coatings on Magnetic Substrates – Measurements of Coating Thickness-Magnetic Method
ISO 2431	Paints and Varnishes – Determination of Flow Time by Use of Flow Cups
ISO 2591-1	Test sieving – Part 1: Methods using test sieves of woven wire cloth and perforated metal plate
ISO 2592	Determination of flash and fire points – Cleveland open cup method
ISO 2655	Plastics – Resins in the Liquid State or as Emulsions or Dispersions – Determining of Apparent Viscosity by the Brookfield Test
ISO 2781	Rubber Vulcanised – Determination of Density
ISO 2808	Paints and Varnishes – Determination of Film Thickness

ISO 2811	Paints and Varnishes – Determination of Density
ISO 2815	Paint and Varnishes – Buchholz Indentation Test
ISO 3146	Plastics- Determination of Melting Behaviour (Melting Temperature) of Semi-Crystalline Polymers by Capillary Tube and Polarizing-Microscope Methods
ISO 3251	Plastics – Unsaturated Polyesters and Epoxy Resins-Determination of Overall Volume Shrinkage
ISO 7253	Paints and Varnishes-Determination of Resistance to Neutral Salt Spray
ISO 8501-1	Preparation of Steel Substrate Before Application of Paint and Related Products – Visual Assessment of Surface Cleanliness. – Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates After Overall Removal of Previous Coatings.
ISO 8502-2	– Part 2: Laboratory Determination of Chloride on Cleaned Surfaces
ISO 8502-3	– Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
ISO 8502-6	– Part 6: Sampling of Soluble Impurities on Surfaces to be Painted – the Bresle Method.
ISO 8502-9	– Part 9: Field Method for the Conductometric Determination of Water-Soluble Salts
ISO 8503-2	Preparation of Steel Substrates Before Application of Paints and Related Products – Surface Roughness Characteristics of Blast Cleaned Substrates. – Part 2: Method for the Grading of Surface Profile of Abrasive Blast-Cleaned Steel – Comparator Procedure
ISO 8503-4	– Part 4: Method for the Calibration of ISO Surface Profile Comparators and for the Determination of Surface Profile – Stylus –Instrument Procedure
ISO 10474	Steel and Steel Products – Inspection Documents
ISO 11124	Preparation of Steel Substrates before Application of Paints and Related Products - Specifications for Metallic Blast-cleaning Abrasives
ISO 11126	Preparation of Steel Substrates before Application of Paints and Related Products - Specifications for Non-Metallic Blast Cleaning Abrasives
ISO 13736	Petroleum products and other liquids – Determination of flash point – Abel closed cup method
ISO 21809-1 (2011)	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
ISO 21809-2 (2007)	Petroleum and Natural Gas Industries –External Coatings for Buried or Submerged Pipelines Used in Pipeline Transportation Systems – Part 2: Fusion-bonded Epoxy Coatings
ISO 21809-3 (2008)	Petroleum and Natural Gas Industries –External Coatings for Buried or Submerged Pipelines Used in Pipeline Transportation Systems – Part 3: Field Joint Coatings

2.8 NACE (National Association of Corrosion -Engineers)

NACE RP0274 High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

3. Terminology and Definitions

Owner	party legally responsible for design, construction and operation of the pipeline
Purchaser	party (Owner or main contractor acting on his behalf) issuing inquiry or contract for coating work, or nominated representative
Applicator	party to whom the coating application work has been contracted
Manufacturer	manufacturer of coating materials purchased by Applicator
shall	indicates a mandatory requirement
should	indicates a preferred course of action (recommendation)
may	indicates a permissible course of action (option)
agreed agreement	refers to a written arrangement between *Purchaser* and *Applicator* (e.g. as stated in a contract)
report and *notify*	refers to an action by *Applicator* in writing
accepted acceptance	refers to a confirmation by *Purchaser* in writing
certificate certified	refers to the confirmation of specified properties issued by *Applicator* or *Manufacturer* according to ISO 10474;3.1B or equivalent (e.g. EN 10204;3.1)
Purchase Documents	refers to an inquiry/tender, or to purchase/contract specification, as relevant

For definition of coating terms associated with submarine pipeline systems, reference is made to 1.1.2 above.

4. Abbreviations

APS	Application Procedure Specification (Sec. 6.1)
CDS	Coating Data Sheet
CFR	Coating Field Repair
CP	Cathodic Protection
CR	Concession Request
FBE	Fusion Bonded Epoxy
FJC	Field Joint Coating
ITP	Inspection and Testing Plan (see 6.2)
LE	Liquid Epoxy
MDS	Material Data Sheet (see 6.6.4)
MS	Manufacturer Specification (see 6.6.4)
NC	Non-Conformance
PE	Polyethylene (polyethene)
PP	Polypropylene (polypropene)
PQT	Procedure Qualification Trial (see 6.4)
RP	Recommended Practice
SMYS	Specified Minimum Yield Strength

5. Specification of linepipe coating

5.1 General

5.1.1 This section contains requirements and guidance to Purchaser's specification of linepipe coating in order to meet the needs for adequate quality for a specific project and to avoid delays in production schedule.

5.1.2 If reference is made to this RP in a purchase document (see definition in Sec. 3), the following additional information (5.2) and requirements (5.3 and 5.4) shall always be specified, if applicable and relevant to the specific coating system as defined in the Coating Data Sheet (CDS) of ANNEX 1. (5.4 is intended as a check list for optional requirements).

5.2 Information to Applicator

5.2.1 The following information shall be provided in inquiry, as relevant for the actual project:

— Pipe material (reference to standard or purchaser's specification, including grade designation).

— Pipe dimensions, including nominal inner diameter, wall thickness and length (with tolerances).
— Longitudinal seam weld dimensions if considered relevant for the specified coating system.
— Number of pipes to be coated for each pipe material grade and dimension.
— Any temporary external coating (e.g. varnish type) or permanent internal coating on pipes to be supplied for external coating, or any supply of pipes with rust grade exceeding A/B according to ISO 8501-1 which may interfere with Applicator's surface preparation.
— Any long term storage of pipe joints requiring special protection.
— Pipeline maximum and minimum design temperature.
— Type of field joint coating to be applied.
— Any other relevant parameters related to pipeline installation and operation with potential impact on the selection of specific coating materials.

5.3 Mandatory requirements to be specified by Purchaser

5.3.1 The following requirements to the design and quality of the coating shall always be specified by Purchaser:

— Coating design; i.e. type of coating system (reference to ISO 21809 if applicable), max./min. thickness of individual coating layers (6.8.5).
— External surface colour and roughness/profile, if applicable
— Coating configuration at pipe ends such as length of cut-back and coating chamfer angle, including tolerances (6.8.6).
— Specific requirements for procedure qualification trial (PQT) such as number of pipes of each pipe dimension and number/type of coating defects to be coated, and schedule for notification and supply of documentation associated with the PQT (6.4).
— Methods and acceptance criteria for any testing indicated by "to be agreed" in the applicable CDS of ANNEX 1 (see 6.5.3)
— Requirements to pipe tracking and marking (6.11).
— Requirements to documentation, e.g. schedule for supply and format of documentation (6.13).

5.4 Optional requirements for specification by Purchaser

5.4.1 The following items may be included in Purchase Documents, as applicable and relevant.:

— Additional testing indicated as "by agreement" in the CDS (see 6.5.3), and any special conditions for testing (e.g. above and/or below ambient temperature).
— Testing of compatibility with FJC system to be verified during PQT.
— Requirements to Applicator's quality system (e.g. certification to ISO 9000).
— Specific coating materials to be used (e.g. Manufacturer specific products, see 6.6.3).
— Qualification of personnel carrying out coating repairs (6.4.5).
— Specific requirements to the ITP (6.2.3).
— Facilities needed for the Purchaser's quality surveillance.
— Regulatory authorities or Owner's requirements to the control of health and environmental hazards associated with coating work (1.2.5).
— Applicator's management of non-conformities (6.7.12, 6.1.3) and concession requests (6.7.1).
— Additional pipe receipt inspection, e.g. checking of dimensions or weight (6.7.3).
— Criteria for surface defects to be removed by grinding (6.7.11).
— Cleanliness of coated pipe ends and internal surfaces (6.7.7 and 6.8.7).
— Pipe end protection (e.g. temporary corrosion protective coating and use of end caps, see 6.12.4).
— Permissible coating repairs, e.g. maximum number per meter length or pipe, maximum size and permissible methods of repair (if different from those specified in 6.10.3 and for specific systems in Sec. 7).
— Special requirements to cutting of pipe for testing (7.1.9).
— Special requirements to handling and storage of pipes (6.12.1).
— Special requirements to shipping of coated pipes (6.12.4), including final inspection (6.9.8).
— Waiver of items in final documentation (6.13.4).
— Further deviations or amendments to this document.

5.4.2 As far as practical, test methods and acceptance criteria for testing indicated in the applicable CDS as "to be agreed or "by agreement" (see 6.5.3) shall be specified by Purchaser already in the inquiry.

6. Common Requirements

6.1 Application Procedure Specification (APS)

6.1.1 All work associated with coating application (including its qualification by a "PQT", see 6.4) shall be described in procedures which shall be compiled in an 'application procedure specification' (APS). This APS shall be submitted to the Purchaser prior to the PQT and/or start of production. A schedule for supply of the

APS shall preferably be specified in Purchase Documents.

6.1.2 The APS shall as a minimum include the following data sheets, process descriptions, procedures and other information:

— material data sheets (MDS) for coating and blasting materials (6.6.3-6.6.9)
— procedure for receipt, handling and storage of materials for surface preparation and coating (6.6.10 – 6.6.13)
— coating plant lay-out sketch or flow diagram
— procedure for receipt inspection of pipes
— procedure for surface preparation (6.7)
— MDSs for chemical pre-treatment products (6.7.14), if applicable
— procedure for coating application (including control of essential process parameters, see 6.8.3)
— procedures for inspection and testing (6.7, 6.9)
— procedure for coating repairs and stripping of unrepairable coating (6.10)
— procedure for preparation of pipe ends after coating (6.8.6, 6.8.7 and 6.9.4)
— procedure for pipe tracking (6.7.2, 6.11)
— procedure for marking and documentation, including a Daily Log format (6.3, 6.7.2, 6.11 and 6.13)
— procedure for handling, storage and loading of coated and uncoated pipes (6.12).

Procedures for the last five items are subject to acceptance by Purchaser and should be considered for issue as separate document.

Guidance note:
For "*accepted/"acceptance*", and "*agreed"/"agreement*", see definitions in Sec. 3

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6.1.3 Purchaser may specify (see 5.3.1, 5.4.1) that other additional detailed information is included in the APS, e.g. QA/QC responsibilities, management of non-conformities and concession requests.

6.2 Inspection and Testing Plan (ITP)

6.2.1 All work associated with coating application (including its qualification by a "PQT", see 6.4), shall be referred to in a project specific 'Inspection and Testing Plan' (ITP), sometimes called "quality inspection plan", "quality control plan" or "quality plan" only. The ITP shall be in tabular form and shall be issued as a separate project document (i.e. not to be included in the APS). An ITP covering the qualification work shall be issued to Purchaser in due time prior to the PQT. This document shall also contain and indicate all ITP activities which will apply for production. Following the successful completion of the PQT, Applicator shall issue an ITP dedicated for production, updated as required based on the results of the PQT.

6.2.2 The ITPs shall be submitted to Purchaser for acceptance in a timely manner (as per Purchase Documents, see 5.3.1) prior to PQT and start of production, respectively. Purchaser shall identify any hold points for witnessing (see 6.9.1) in the ITP and inform Applicator accordingly.

6.2.3 The ITP shall list all activities with any relevance to quality control, including receipt of coating materials, inspection and marking of incoming pipe, surface preparation, coating application (including monitoring of essential process parameters), inspection/testing, repairs and marking of the applied coating. Each activity shall be assigned a unique number and shall be listed in consecutive order. For each activity the following shall be specified:

— reference to the applicable clause/paragraph of the purchase specification
— reference to the applicable standard, procedure or equipment to be used (e.g. contact thermometer) if a procedure/standard is not required
— frequency/extent of testing, inspection and recording of essential process parameters
— acceptance criterion/criteria and any special conditions for testing (e.g. temperature, testing environment, duration)
— reporting document
— inspection code (e.g. inspection, witnessing and hold points) for the individual parties to be involved. Applicator's involvement of QA/QC personnel and operators shall further be indicated in the ITP.

6.2.4 The ITP shall contain a list of references to all relevant project documents issued by Purchaser.

6.2.5 Test methods and acceptance criteria in the ITP shall be in accordance with the applicable CDS in ANNEX 1 of this document. The agreed/specified frequency and extent of testing for properties with a frequency/extent of testing noted as "by agreement" in the CDS and specified in Purchase Documents shall be included in the ITP (see 5.4.1).

6.2.6 ANNEX 2 shows an example of an ITP format meeting the requirements above.

6.3 Daily Log

6.3.1 All data from inspection and testing of coated pipes, essential operating parameters (e.g. application temperature, line speed, etc.) and calibration of testing and monitoring equipment, shall be noted in a 'Daily Log' (also referred to as e.g. 'Daily Report'). Repairs and rejections of applied coating shall further be noted.

6.3.2 For pipe specific inspection and testing data, reference shall be made to the unique pipe number (see 6.7.2). The Daily Log shall further ensure traceability of coated pipes (including repairs) to individual coating material batches/lots.

6.3.3 The Daily Log shall contain the actual physical/mechanical parameters being recorded (not to be replaced by e.g. "passed" only). It shall be updated on a daily basis and shall be available for Purchaser's review at any time during coating application.

6.3.4 A Daily Log format shall be accepted by Purchaser prior to start of production and a draft format shall be submitted prior to the PQT (see 6.4). Unless waived by Purchaser, Daily Logs covering all coated pipes shall be included in the final documentation (see 6.13.4)

6.4 Procedure Qualification Trial (PQT)

6.4.1 For compliance with this RP, a project specific 'procedure qualification trial' (PQT, also referred to as a 'procedure qualification test') is mandatory. The primary objective of the PQT is to verify that the APS and ITP are adequate to achieve the specified as-applied coating properties. Of particular interest are those aspects that require destructive testing and hence cannot be frequently verified during regular production. The PQT shall utilise the specific coating materials, equipment, procedures and key personnel to be used during ordinary production. Furthermore, it shall establish that specified dimensions/tolerances for cut-back preparation (and external surface roughening of the coating, if applicable) can be met. The PQT shall also include any receipt testing of the actual coating materials supplied for the specific assignment. Coating of pipeline components, if applicable, shall also be covered by a PQT.

Guidance note:

Applicator should duly consider the needs to carry out internal tests prior to the execution of the PQT.

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6.4.2 Coating application procedures (including repairs) and equipment for coating shall be qualified prior to production through the execution of a PQT. The PQT shall be scheduled taking into account the time needed to complete and report the testing. For certain coating systems, Purchaser may specify or agree that the PQT is carried out at start of production, see Sec. 7.

6.4.3 Specific requirements for a PQT, including e.g. number of pipes to be coated, number and type of repairs to be qualified plus schedule for notification and reporting of PQT, shall be specified in Purchase Documents (see Sec. 5 and definition of "Purchase Documents" in Sec. 3).

6.4.4 For pipes with internal coating, the PQT shall confirm no detrimental effects resulting from the external coating process.

Guidance note:

This should include e.g. visual examination of internal coating for discolouration, cracking or blistering, and testing of adhesion.

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6.4.5 Purchaser may require that the PQT shall include qualification of individual coating applicators/ operators to carry out more complex repairs of coating during production.

6.4.6 An APS and ITP specific for the PQT shall be submitted to Purchaser in a timely manner (as per Purchase Documents) prior to start-up of the qualification activities. Applicator shall further submit a PQT schedule referring to the individual pipes to be coated and the testing to be performed on each of these pipes. Furthermore, a PQT reporting index/format shall be submitted.

6.4.7 Coating application temperature, drying or curing conditions as specified in the APS/ITP shall be according to Manufacturer's recommendations. Calibration certificates for instruments essential to quality control (e.g. temperature sensors, thickness gauges) shall be available for Purchaser's review during the PQT.

6.4.8 The pipes to be coating during the PQT shall have identical geometry (diameter, wall thickness and seam weld if applicable) as the pipes to be coated during production. If practical, the pipes to be coated for PQT shall be of the same supply as that used for production.

Guidance note:

Purchaser should duly consider the need to verify linepipe coating's compatibility with the planned FJC application; e.g. by using a simulated heat treatment to verify that any heat input associated with FJC does not deteriorate essential

coating properties of the linepipe coating properties.

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6.4.9 The PQT shall cover all dimensions of pipe to be coated for the specific project. For pipes with identical diameter but with small variations in thickness (< 10%), the scope of the PQT may be reduced (to be agreed and specified in Purchase Documents)

6.4.10 Purchaser shall supply pipes for the PQT and any internal trials as requested by Applicator to meet the PQT schedule (preferably to be agreed in Purchase Documents). Unless otherwise agreed, minimum three pipes shall be coated with a full coating system and subjected to testing.

6.4.11 Qualification of coating repairs shall be performed to verify the properties of maximum allowable repair size as specified in Purchase Documents. Unless otherwise agreed, three repairs shall be carried out for each repair procedure to be used for production. Testing shall as a minimum include holiday detection and adhesion to steel surface and/or parent coating. It shall further be demonstrated that the repair does not deteriorate the properties of the adjacent parent coating (e.g. adhesion to steel substrate).

Guidance note:

If testing of adhesion according to Annex C of ISO 21809-1 is not practical, testing shall be performed according to an agreed method to demonstrate 'cohesive failure' (i.e. no adhesive failure of repair to steel substrate or repair to parent coating).

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6.4.12 Results from all inspection, testing and calibrations, recordings of essential process parameters for coating (including e.g. line speed and parameters relevant to temperature control for linepipe and coating materials), and coating material certificates shall be compiled in a PQT report. The report shall contain the actually recorded values during testing (i.e. not only "passed"/"failed".). Unless otherwise agreed, the report and the PQT results shall be accepted by Purchaser prior to start of production.

Guidance note:

Cathodic disbondment tests last normally 30 days, so that it may not always be practical to await the completion of the test prior to start of production.

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6.5 Documentation for quality control of production

6.5.1 Prior to start-up of regular production, Applicator shall submit the following documents to Purchaser for acceptance:

- an APS in accordance with 6.1.2, amended/revised based on results from the PQT (if needed)
- a project-specific ITP in accordance with 6.2, updated based on the results from the PQT and reflecting the essential process parameters applied for the PQT (see 6.2.3)
- a Daily Log Format, amended/revised based on results from the PQT as needed (see 6.3).

6.5.2 The APS, ITP, and Daily Log shall be in English, unless otherwise agreed.

6.5.3 Unless otherwise agreed (see Sec. 5 and Sec.7), methods and frequency of inspection and testing, as well as acceptance criteria shall be in accordance with the applicable CDS in ANNEX 1 of this document. The following notes apply to all CDSs:

- "*according to APS/ITP*" means that testing method and/or acceptance criteria are optional to Applicator but shall be defined in the APS/ITP
- "*to be included*" under "*frequency / qualification*" means that testing shall be performed
- "*to be agreed*" means that testing shall be carried out, and that test method and/or acceptance criteria (as applicable) are subject to agreement. (A tentative test method and acceptance criterion should be specified by Purchaser during the tender/enquiry phase and the agreed method/criterion shall be stated in the contract)
- "*by agreement*" and "*agreed*" testing method or acceptance criterion means that Purchaser may require testing, and/or that methods and acceptance criteria are subject to agreement (to be specified by Purchaser in inquiry and confirmed in contract).

6.5.4 Standards, procedures and work instructions referenced in the ITP shall be available to all persons concerned with the associated work and in a language of which they have a working knowledge.

6.5.5 Purchaser shall have the right to inspect any activity associated with coating work throughout production and to carry out audits of Applicator's QA/QC system.

6.6 Coating and blasting materials

6.6.1 In this sub-section, the term "coating materials" covers materials for coating repairs as well as for linepipe coating.

6.6.2 The selection of coating materials for a particular project, and the specification of properties to be verified during PQT and production, shall take into account the maximum and minimum operating temperature of the pipelines, and any special conditions during installation and operation.

Guidance note:

Unless included in Applicator's scope of work, the selection of generic types of coating materials (e.g. high density PE or PP) shall be specified by Purchaser. (This selection is typically carried out during a conceptual design phase in the project).

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6.6.3 The manufacturer of specific coating materials shall be specified by Applicator in the APS (see 6.1). Purchaser may specify in tender/inquiry any preferences for Manufacturer specific coating materials.

Guidance note:

Prior to the issue of a specific purchase order, Purchaser or Applicator may choose to qualify specific coating material formulations according to their own requirements for linepipe coating (which need not be project specific). Such coating material qualification should be specific to a production facility, and a defined range of production process parameters.

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6.6.4 Coating materials shall be described by Manufacturer in specific 'material data sheets' (MDS), which shall list relevant properties of raw materials and processed (as-applied) materials, recommendations for surface preparation, application temperature range, conditions for curing/drying, detailed instruction for storage and handling. The MDSs (including those for materials to be used for repairs) shall be contained in the APS.

Guidance note:

Coating material data in MDSs are often referred to as "typical/indicative". The Coating Data Sheets in Annex 1 therefore refer to "Manufacturer Specification" ("MS") stating maximum/minimum values for coating material properties as-specified in e.g. batch certificates (ISO 10474, Type 3.1.B or equivalent).

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6.6.5 Testing and certification of coating material properties may relate to properties of either raw materials (as-delivered) or processed (as-applied) materials. In the latter case, test coupons with applied coating, or specially prepared coating layers (i.e. without substrate) are used.

6.6.6 Certain properties related to raw materials (as-delivered) for coating shall be certified per batch / lot (i.e. by an "inspection certificate" type 3.1.B according to ISO 10474 or equivalent), in accordance with section 2, column "Production", of the relevant 'Coating Data Sheet' (CDS) in ANNEX 1. Purchaser (or Applicator) may specify further properties for batch-wise certification indicated "by agreement" in the CDS (see 6.5.3).

Guidance note:

In the case of continuous production of raw materials, "batches" will not apply and a "lot" is defined based on e.g. hours or weight/volume of production.

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6.6.7 Applicator shall verify that all coating materials and abrasives received are in accordance with the specified requirements in the APS/ITP by review of batch/lot certificates. Requirements to raw materials are specified in Section 2 in the relevant CDS in ANNEX 1. Review of certificates and any verification testing to be performed by Applicator shall be included as separate items in the ITP.

6.6.8 For properties of processed (as-applied) coating materials, and in particular those related to long-term environmental degradation resistance, data for a representative product specification (i.e. not batch/lot specific) will normally apply and a "test report" based on non-specific testing is issued (ISO 10474 type 2.2 or equivalent). For certain coating systems, mandatory requirements for certification of such processed properties apply as indicated by "to be included" in section 2 of the CDS. Purchaser may specify further properties for certification as indicated "by agreement" in the CDS (see 6.5.3). Test reports covering as-applied properties specified in the CDSs shall be included in the PQT report.

Guidance note:

Data on as-applied coating properties that are much dependent on surface preparation and/or coating application (e.g. adhesion and resistance to bending, blistering and cathodic disbonding) should be considered as indicative only and

cannot replace any PQT data as specified in sub-section 3.2 of the applicable CDS.

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6.6.9 Properties of blasting materials shall comply with ISO 11124 or ISO 11126 for carbon-steel and stainless steel linepipe, respectively and shall be documented in MDSs for inclusion in the APS. For stainless steel linepipe, stainless steel grit (not covered by ISO 11126) is also applicable.

6.6.10 Until compliance with specified requirements has been confirmed, the coating and blasting materials received by Applicator shall be kept physically separated from checked materials. Any materials checked and found non-conforming shall be marked and quarantined.

6.6.11 All materials to be used for surface preparation and coating of pipes shall be contained in their original packing until use and shall be adequately marked, including:

— manufacturer's name and place of manufacture
— material type and product designation
— batch/lot number
— weight (for materials in drums, bags or similar)
— size (for materials in rolls or similar)
— date of manufacturing (and shelf life, if applicable)
— manufacturing standard (if applicable)
— short instruction for storage (including max/min temperature and humidity) and handling (including health and safety notes).

6.6.12 Applicator shall ensure that all materials for coating and surface preparation are stored and handled so as to avoid damage by environment or other effects. Manufacturer's recommendations for storage and use shall be readily available for Purchaser's review.

6.6.13 Any mixing of coating material batches/lots to be used for production or additions made by Applicator to purchased products shall be described in the APS (see 6.1).

6.6.14 Recycled coating materials may be used if detailed in the APS, stating e.g. requirements to cleaning and maximum ratio of recycled to virgin coating material. Purchaser may require documentation that such recycling does not affect the specified properties.

6.6.15 All coated pipes shall be traceable to individual batches/lots of coating materials.

6.7 Incoming inspection of pipes and surface preparation

6.7.1 All surface preparation and associated inspection and monitoring activities shall be carried out according to the qualified APS (see 6.1) and ITP (see 6.2). Methods, acceptance criteria and frequency/extent of inspection and testing shall comply with the requirements given in the relevant CDS in ANNEX 1, and/or amendments in Purchase Documents (see Sec. 5) as applicable. Once qualified, any changes in the APS/ITP shall be formally accepted by Purchaser through a Concession Request (CR).

6.7.2 At delivery, every pipe will be identified by a unique number (i.e. as applied by pipe manufacturer) and any additional marking made by Applicator to maintain identity shall be performed as specified or accepted by Purchaser (6.11.1). Intermediate storage of pipes shall be according to 6.12.

6.7.3 Each pipe shall be subject to an initial visual examination of the pipe external surface. Particular emphasis shall be paid to examination of pipe ends. Pipes with damage such as dents, ovality, cuts and other defects that cannot be corrected by light surface dressing shall be removed and Purchaser shall be promptly notified. Any requirements to additional checking of pipe dimensions and/or weight shall be specified in Purchase Documents.

6.7.4 Salts, soils and other loose contamination detected during visual examination shall be removed from the pipe surface using a suitable water-based cleaning method (e.g. high-pressure fresh water or brushing). Organic contaminants like oil and grease shall be removed by using suitable hydrocarbon solvents or detergents (type to be specified in APS). Purchaser shall be notified promptly if the surface condition of the received pipes (surface contamination or rust grade according to ISO 8501-1) is deemed to affect the quality of the coating. For any grinding of surface defects prior to blast cleaning, the conditions in 6.7.11 shall apply.

Guidance note:

Unless otherwise specified by Purchaser, the initial condition of the pipes received shall be according to Rust Grade A or B of ISO 8501-1.

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6.7.5 Pipe surfaces shall be prepared for coating using blast cleaning to provide a surface cleanliness and surface roughness (anchor pattern) to meet the requirements in the applicable CDS of ANNEX 1. Any

relaxation of these requirements based on Manufacturer's recommendations shall be accepted by Purchaser.

6.7.6 Relevant properties of blasting materials shall be documented (e.g. in a MDS). Receipt, storage and marking of purchased materials shall be as defined in 6.6.7 - 6.6.13. The blasting material and pressurised air system shall be kept dry and free from injurious contaminants, including salts, oil and grease. Recycled blasting material shall be checked for cleanliness at regular intervals and recorded in the Daily Log. Checking of oil contamination and water soluble contaminants shall be carried out according to ASTM D4285 and ASTM D4940, respectively for inclusion in the Daily Log. Conditioning of grit during production shall be described in the APS/ITP.

6.7.7 Requirements to special protection of machined bevels and/or internal surfaces (e.g. by use of end caps) during cleaning may apply (to be specified in Purchase Documents). Precautions shall be taken to avoid contamination of stainless steel linepipe by carbon steel particles, carbon steel tools and handling equipment.

6.7.8 During blast cleaning the pipe surface shall be at least 3°C above the dew point temperature. Pre-heating of pipes is required if the initial temperature of the pipe surface is less than 3°C above the dew temperature.

6.7.9 After the blast cleaning, the pipes shall be thoroughly checked by visual inspection, e.g. by survey alongside a rotating pipe so that the entire pipe surface is easily accessible for inspection.

6.7.10 Marking of defects (if applicable) shall be carried out using a method that leaves no contamination or residual materials. "French chalk" or similar is recommended.

6.7.11 Criteria for removal of surface defects (e.g. slivers, swabs, burns, gouges pits, etc) on pipes delivered for coating should be stated in Purchase Documents, and finally agreed in the APS/ITP after the PQT. The criteria should take into account the condition of the pipes and the type of coating system to be applied. For defects requiring more than superficial grinding (i.e. dressing), the residual wall thickness shall be checked by UT (ASTM E797) for compliance with the linepipe material specification and the results recorded. Pipes not meeting these requirements shall be quarantined and Purchaser notified. Pipes with grinding exceeding 10 cm^2 per linear meter of pipe or 0.5% of the total pipe surface area shall be re-blasted.

6.7.12 Dust or abrasive residue shall be removed from the pipe surface using dry clean air, vacuum cleaning, brushing or an equivalent technique. Compressed air quality shall be controlled (control method and acceptance criteria to be specified in APS/ITP). Verification of surface cleanliness and roughness shall be detailed in the ITP for compliance with the applicable CDS in ANNEX 1. Measurements of residual salt contamination may be performed using special proprietary equipment if specified in the ITP, and provided that compliance with the referenced standard can be demonstrated. Pipes not meeting specified requirements shall be subject to new blast cleaning or rejection. In the case of repeated failures, surface preparation shall be discontinued and Applicator shall issue a "non-conformance report" suggesting measures to improve the efficiency of the associated process.

6.7.13 Precautions shall be taken to avoid contamination or other damage to the pipe surface (including pipe ends and bevels) after completed surface preparation (e.g. by conveyor rollers) and/or superficial rusting during intermittent storage. Such precautions, including requirements for maximum duration (in hours) between blasting and coating, and maximum relative humidity shall be specified in the APS/ITP.

6.7.14 Mechanical surface preparation may be followed by a chemical treatment (to be stated in the APS/ITP) if specified or accepted by Purchaser. Purchaser or Applicator may further specify washing with deionised water prior to coating application. Any associated pre-heating of pipes, checking of chemicals and control of application shall then be specified in APS/ITP. Subject to acceptance by Purchaser, testing of residual salt contamination may be waived if the pipes are subject to chemical treatment or washing with deionised water following completed blasting and immediately prior to coating.

6.8 Coating application

6.8.1 All coating application work shall be carried out according to the qualified APS and ITP. Once these documents have been qualified, any changes of materials, equipment and essential process parameters (including change in line speed) shall be formally accepted by Purchaser through a CR.

6.8.2 If pre-heating is applied, temperature control shall ensure that no pipe is heated above 275°C (for linepipe with SMYS > 465 MPa a lower temperature may apply). Powder application on linepipe shall be by automatic electrostatic spraying with control of compressed air quality. For use of re-cycled coating materials, see 6.6.14.

Guidance note:

A lower maximum temperature may apply for pipes with internal coating and special grades of high strength linepipe.

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6.8.3 Throughout coating application, essential process parameters affecting the quality of the coating (e.g.

application temperature of linepipe and coating materials, line speed) shall be monitored continuously. For certain coating systems, the application temperature shall be recorded in the Daily Log as specified in the applicable pipeline Coating Data Sheet in ANNEX 1 and included in the ITP. Equipment for monitoring shall be calibrated at scheduled intervals as specified in the ITP (see 6.2).

6.8.4 Any use of temporary coatings or tapes to mask coating application at pipe ends shall be described in the APS (MDSs to be included if relevant). Purchaser may require documentation that materials used for this purpose does not affect subsequent welding and FJC.

6.8.5 Coating thickness (nominal and minimum values of individual layers, maximum value if applicable) shall be as defined in Purchase Documents (see Sec. 5).

Guidance note:

Thickness measurements during production are made on a spot check basis and are primarily intended to verify nominal coating thickness (or minimum/maximum average thickness), not an absolute minimum thickness for individual pipes. The capability to produce uniform coating thickness for individual pipes is to be verified during the PQT (see 6.4).

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6.8.6 The length and surface condition of pipe ends to be left uncoated (or "cut-back") and any chamfering of edges of coating shall be performed in accordance with the requirements in Purchase Documents and in the MPS/ITP. Any use of temporary protective coating at pipe ends shall be specified or accepted by Purchaser.

Guidance note:

Temporary coatings at pipe ends may interfere with subsequent welding and FJC operations.

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6.8.7 Any residue of coating or blasting materials on the internal pipe surface shall be removed by an appropriate method (to be specified in APS/ITP). Special requirements to cleanliness of internal surfaces may apply if specified in Purchase Documents. Unless otherwise accepted by Purchaser, any end caps supplied with the pipes shall be refitted soon after coating has been completed.

6.9 Inspection and testing of coated pipes

6.9.1 Coated pipes shall be inspected and tested according to the ITP (see 6.2) and APS (see 6.1). Any changes in methods or frequency of inspection/testing shall be formally accepted by Purchaser through a CR. Purchaser shall be allowed to witness all inspection and testing. Applicator shall give adequate notice for Purchaser to arrange for witnessing of hold points in the ITP (see 6.5.5).

Guidance note:

Purchaser should duly consider the needs and benefits of carrying out quality surveillance during production, either as an audit or by continuous presence by trained and qualified inspectors.

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6.9.2 The CDS may specify or Purchaser may require testing of specified coating properties during production, for which it is necessary to cut off a part of the pipe wall (e.g. cathodic disbondment testing and hot water soak test). Such testing may then be specified to be performed on a special (dummy) test pipe if all other conditions are the same as for regular production.

6.9.3 Visual inspection of completed coating shall ensure that the entire pipe surface is covered, e.g. by survey alongside a rotating pipe. Characterisation of damage to the linepipe coating shall distinguish between:

a) superficial defects that can be repaired by light surface dressing
b) defects with major reduction in coating thickness but without exposure of bare metal (or no indication by holiday detector), and
c) damage that extends down to the pipe material or an inner coating layer (or indication by holiday detector).

Guidance note:

Acceptance criteria for visual coating defects should be quantitative as far as practical. Photographs of non-acceptable defects may be helpful.

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6.9.4 Inspection shall verify specified dimensions for coating cut-backs and any requirements for cleanliness of pipe ends (to be included in ITP), the procedure being subject to acceptance by Purchaser (see 6.1.2). For pipes with internal coating applied prior to external coating, inspection shall further include the condition of the internal coating at the pipe ends.

6.9.5 Failures during testing which are obviously due to defective sampling or operational errors of testing

equipment may be disregarded and testing repeated on the same pipe.

6.9.6 Individual pipes not meeting specified criteria shall be stripped and re-coated, or if possible (see 6.10), repaired. In case of failure of a pipe coating during fractional testing (e.g. each 20th pipe or twice per shift), the preceding and following pipes shall be tested individually until at least 3 successively coated pipes show adequate properties. In the case of repeated failures to meet specified acceptance criteria, Purchaser shall have the right to require the testing frequency to be increased. Similarly, subject to acceptance by Purchaser, testing frequency may be reduced as a result of repeated successful testing.

6.9.7 In case of repeated failures to meet specified requirements, production shall be discontinued and Purchaser promptly informed. Applicator shall then carry out an investigation and review of the cause(s) of the failures and issue a "non-conformance report". Non-conforming pipes (individual or lots) shall be marked and quarantined.

6.9.8 Purchaser may specify (to be included in Purchase Documents) a final inspection of the pipe coating prior to discharge.

6.10 Repairs and stripping of coating

6.10.1 Coating repair may apply to coating holidays associated with production irregularities or damage to the coating during handling and storage at Applicator's facilities. (For repairs of linepipe coating in the field, reference is made to DNV-RP-F102).

6.10.2 Coating repairs shall be included in the APS (see 6.1) and ITP (see 6.2), the procedure being subject to acceptance by Purchaser (see 6.1.2). The repairs shall be carried out and inspected according to a qualified procedure (see 6.4). Requirements to coating repair materials in 6.6 apply.

6.10.3 Permissible repairs (e.g. maximum surface area of individual repair, maximum repairs per pipe and maximum number of pipes with repairs) are specified for the actual coating system in Sec 7. Any alternative acceptance criteria and repair methods shall be specified in Purchase Documents (see Sec. 5) and included in the APS/ITP.

6.10.4 Inspection of repairs shall as a minimum include visual examination, checking of thickness and holiday detection.

6.10.5 All major repairs (e.g. coating damage down to pipe surface) shall be noted in the Daily Log and shall be traceable to individual batches of coating repair materials.

6.10.6 Any damage to internal coating caused by Applicator shall be repaired according to an agreed procedure.

6.10.7 Stripping of unrepairable coating for re-coating of pipe shall be carried out according to a procedure accepted by Purchaser. Temperature control shall ensure that no pipe is heated above 275°C. Multiple stripping of coating (i.e. for the same pipe) shall be subject to a CR.

6.10.8 Any cutting of pipes shall be carried out according to a procedure specified or accepted by Purchaser. Cutting of individual pipes shall be subject to a CR.

6.11 Pipe tracking and marking

6.11.1 Specific requirements to pipe tracking (e.g. electronic format) and marking shall be specified in Purchase Documents (see 5.3.1). In case Purchase Documents refer to a specific part of ISO 21809, the requirements to marking in that standard shall apply. Applicator's marking and pipe tracking shall be described in a procedure subject to acceptance by Purchaser (see 6.1.2) and marking included as a specific activity in the ITP (see 6.2).

6.11.2 At delivery of pipes for coating, every pipe shall be identified by a unique number (i.e. as applied by pipe manufacturer). Any additional marking made by Applicator to maintain identity shall be performed as specified or accepted by Purchaser. Storage of pipes shall be according to 6.12.

6.11.3 All results from inspection and testing during qualification and production shall be documented and be traceable to a unique pipe number and individual coating material batches / lots. Recordings of essential process parameters and inspection of repairs (other than surface dressing) shall be included. For specific requirements to a Daily Log, see 6.3.

6.12 Handling and storage of pipes

6.12.1 Pipes shall be handled and stored in a manner that damage to coated and uncoated surfaces is avoided and in accordance with any special requirements in Purchase Documents. A procedure shall be prepared and is subject to acceptance by Purchaser (see 6.1.2).

6.12.2 Equipment to be used, e.g. conveyors, rollers, pipe racks, fork padding and hooks, and that contacts the external/internal pipe surface shall be specified in APS. Stainless steel pipes require special considerations to avoid surface contamination (e.g. from use of carbon steel tools and handling equipment). Purchaser may require documentation (e.g. by calculations) that a specified maximum stack height cannot cause any damage to large diameter pipes.

6.12.3 Damage to coatings during handling or storage shall be repaired according to 6.10, whilst any damage to linepipe material shall be reported to Purchaser. (Pipes with damage to linepipe material shall be separated and quarantined).

6.12.4 Any specific requirements for packaging or other means of protection of coated pipes for shipping (including use of end-caps) shall be defined in Purchase Documents (see 5.4.1).

6.13 Documentation

6.13.1 Minimum time for supply of documentation prior to PQT (see 6.4) and start of production shall be specified in Purchase Documents (see 5.3.1).

6.13.2 Prior to PQT (see 6.4), Applicator shall submit the following documents to Purchaser:

— APS (see 6.1) covering PQT and production (Purchaser acceptance is required for special items, see 6.1.2)
— ITP (see 6.2) covering PQT
— tentative Daily Log format (see 6.3).

6.13.3 Prior to start of production, Applicator shall submit the following documents to Purchaser for acceptance:

— PQT report (see 6.4.12)
— APS for production
— ITP for production
— Daily Log format
— Final Documentation index (see 6.13.4).

6.13.4 Applicator shall issue as Final Documentation (also referred to as “as-built documentation” or “final data book”) a compilation of inspection document meeting the requirements in ISO 10474, inspection certificate 3.1.B or equivalent. This document shall include:

— Procedure Qualification Test (PQT) report (see 6.4.12)
— Application Procedure Specification (APS) for production (see 6.1.2)
— Inspection and Testing Plan (ITP) for production (see 6.2.3)
— Approved CRs (see 6.7.1)
— Material data sheets (see 6.6.4)
— Coating material certificates (see 6.6.6 and 6.6.8)
— Daily Logs (see 6.3)
— Coating repair reports (see 6.10.5)
— NC reports (see 6.9.7).

Purchaser may waive the inclusion of detailed process and inspection data, specifying in Purchase Documents that the documentation shall be retained by Applicator for a certain period of time.

7. Coating System Specific Requirements

7.1 Single layer FBE (CDS no. 1)

7.1.1 For offshore pipelines, FBE pipeline coatings are almost invariably used in combination with a concrete coating or a thermally insulating coating. Such applications require that the two coating systems are compatible, taking into account the application of the outermost layer, pipeline installation and operation. Adhesion between the layers is a primary parameter for both concrete coating and a thermally insulating coating. Purchaser shall duly consider the needs for additional requirements and modifications of those properties defined in this sub-section (e.g. increased minimum thickness or surface roughness) for inclusion in Purchase Documents. Special testing of coated pipes may be required, involving other coating contractors and/or the installation contractor, to verify that the coating systems are compatible and meet the requirements for installation and operation. (see 1.1.3); however, the requirements to such testing is beyond the scope of this document and may have to be developed on a project-specific basis.

7.1.2 The general requirements in Sec 6 of this RP and the FBE specific requirements in this sub-section and in CDS 1 cover the requirements to FBE application in ISO 21809-2. If Purchaser has specified compliance with both DNV-RP-F106 and ISO 21809-2, the additional requirements of this RP shall apply. Some

requirements to FBE application in this RP exceed those of the ISO standard whilst some requirements in the standard are replaced by other requirements in the RP. These are detailed below.

7.1.3 The required information to be supplied by Purchaser (Sec 6 of the ISO standard) is covered and amended by the general requirements in Sec. 5 of this RP.

7.1.4 The requirement to "qualification of manufacturer" in Sec. 8.1 of ISO 21809-2 is covered by the requirement for a test report 'type 2.2' according to ISO 10474 (or equivalent) of as-applied coating properties specified in of CDS 1 (Annex 1) of this RP.

7.1.5 Use of recycled material (see 6.6.14) shall not exceed 15% (unless otherwise agreed in Purchase Documents).

7.1.6 ISO 21809-2 does not mention APS, ITP or Daily Log for quality control of coating application. Nevertheless, for compliance with this RP these documents are mandatory for FBE application work (see 6.1, 6.2 and 6.3).

7.1.7 Although not specified as a requirement or option in ISO 21809-2, a PQT shall be performed in accordance with Sec. 6.4 of this RP. If specified or agreed by Purchaser, the PQT may be carried out at start of production; i.e. Purchaser's acceptance of a PQT report prior to start of production is then not required. The execution of a PQT shall otherwise meet all requirements in Sec. 6 and CDS 1 of this RP. The PQT replaces the requirement for non-project specific qualification by Applicator in Sub-Sec. 8.2 of ISO 21809-2.

Guidance note:

For compliance with the requirements to FBE FJC in ISO-21809-3, a 28 days cathodic disbondment test at ambient temperature has been included for PQT in CDS no.1.

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7.1.8 Applicator's batch-wise testing of raw materials and as-applied coating properties as specified in CDS 1 meet the requirements in ISO 21809-2, par. 10.2.2. Purchaser may specify or accept review of batch certificates and test reports from Manufacturer and waive the requirement of testing by Applicator (preferably to be specified in Purchase Documents).

7.1.9 ISO 21809-2, 10.2.4.3 specifies testing during production to be performed on test rings cut from pipe during production. For offshore pipelines, such testing is sometimes impractical since variations in pipe length may interfere with offshore installation procedures. For pipes with an internal lining or cladding in corrosion resistant alloy, cutting is excluded. Unless otherwise specified or agreed by Purchaser, cutting shall only be performed on dummy pipes; e.g. end of lead pipes used for start up after interrupted coating application.

7.1.10 For re-tests of as-applied coating properties, the requirements in 10.2.4.4 in the standard overrule those specified in 6.9 of this RP.

7.1.11 Unless otherwise specified by Purchaser (see 5.4.1), the requirements for repair of coated pipe in Sec. 11 of ISO 21809-2 shall apply.

7.1.12 If compliance with ISO 21809-2 is specified in Purchase Documents the requirements to marking in Sec. 11 of the standard shall apply.

7.1.13 For compliance with this RP, Purchaser's option for waiver of an inspection certificate type 3.1B (ISO10474 or equivalent) in ISO 21809-2, Sec. 14, shall not apply.

7.1.14 For compliance with this RP the requirements for pipe tracking and marking in Section 6.11 and requirements for documentation in Section 6.13 of this RP shall apply.

7.2 3LPE (CDS no. 2) and 3LPP (CDS no. 3)

7.2.1 For offshore pipelines, 3LPE and 3LPP pipeline coatings may be used alone or in combination with a concrete coating or thermally insulating coating. The latter applications require that the two coating systems are compatible taking into account the procedures for application of the additional layer and for pipeline installation and operation. Adhesion between the layers is then a primary parameter being dependant on the application procedures in addition to the overall design of the coating systems. Purchaser shall duly consider the needs for additional requirements and modifications of those defined in this sub-section (e.g. increased minimum thickness or surface roughness) for inclusion in Purchase Documents. Special testing of coated pipes may be required involving other coating contractors and/or the installation contractor to verify that the coating systems are compatible and meet the requirements for installation and operation. (see 1.1.3); however, the requirements to such testing is beyond the scope of this document and may have to be developed on a project specific basis.

Guidance note:

Sec. 7.3 of ISO 21809-1 defines minimum total thickness for "Coating Thickness Classes". These have been defined

for onshore pipelines and may not be adequate for offshore pipelines where 3LPE/3LPP coatings are to be used with or without an additional thermally insulating coating or a concrete weight coating.

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7.2.2 The general requirements in Sec 6 of this RP and the specific requirements in this sub-section and in CDS 2 and CDS 3 cover the requirements to 3LPE and 3LPP application in ISO 21809-1. If Purchaser has specified compliance with both DNV-RP-F106 and ISO 21809-1, the additional requirements of this RP shall apply. Some requirements to 3LPE/3LPP application in this RP exceed those of the ISO standard whilst some requirements in the standard are replaced by other requirements in the RP. These are detailed below.

7.2.3 In ISO 21809-1 Daily Log and ITP are only optional for documentation of quality control of coating application. Never-the-less, for compliance with this RP these documents are mandatory for the application work (see 6.2 and 6.3)

7.2.4 Although specified as an option in ISO 21809-1, a PQT is mandatory and shall be performed in accordance with Sec. 6.4 of this RP. If specified or agreed by Purchaser, the PQT may be carried out at start of production; i.e. Purchaser's acceptance of a PQT report prior to start of production is then not required. The execution of a PQT shall otherwise meet all requirements in Sec. 6 and CDS 2/3 of this RP. The PQT replaces the requirement for non-project specific qualification of Applicator's coating system in Sec. 8.2 of ISO 21809-1.

Guidance note:

For compliance with the requirements to 3LPE/3LPP FJC in ISO-21809-3, a 28 days cathodic disbondment test at ambient temperature has been included for PQT in CDS no.2 and 3.

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7.2.5 The required information to be supplied by Purchaser (Sec 6 of the ISO standard) is covered and amended by the general requirements in Sec. 5 of this RP.

7.2.6 Unless otherwise agreed, the glass transition temperature of the FBE shall exceed the maximum operating temperature of the pipeline by minimum 5ºC (to be specified in MDS). Requirements to pigment type and dispersion shall be specified or agreed by Purchaser (CDS 2/3, Item 2.3.1). Additions made to purchased PE/PP materials by Applicator are subject to acceptance by Purchaser (to be specified in APS). Applicator's testing of raw materials and as-applied coating properties as specified in CDS 2 and 3 in this RP (Annex 1) meets the requirements in ISO 21809-1, Section 8 "Coating materials".

7.2.7 ISO 21809-1 specifies that qualitative testing of chloride contamination according to AS 3894.6: "Site testing of Protective Coatings –Determination of Residual Contaminants" may be performed to judge the needs for quantitative testing. However, for compliance with this RP, testing shall be performed according to ISO 8502-9 and ISO 11127-6 unless Purchaser has agreed to a waiver (see 6.7.14)

7.2.8 For compliance with this RP, the epoxy layer shall be Fusion Bonded Epoxy (FBE) with a nominal thickness in the range 250-400 μm (minimum 200 μm actual thickness). This coating is considered as the primary corrosion protective coating with PE/PP providing mechanical protection. Liquid Epoxy (LE) with a minimum thickness of 25 μm as specified in Table 9 in ISO 21809-1 is considered as a 'primer' only and cannot replace the FBE layer as specified above. Max/min thickness shall be specified in Purchase Documents (see 5.3.1).

Guidance note:

For high temperature grades of FBE (≥130ºC) to be used on pipelines with installation by reeling, a lower thickness range may be required to avoid cracking and shall then be agreed.

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7.2.9 ISO 21809-1, Sec. 11 specifies testing of cathodic disbondment and hot water immersion test to be performed once per day during production. For offshore pipelines, destructive testing is sometimes impractical since variations in pipe length may interfere with offshore installation procedures. For pipes with an internal lining or cladding in corrosion resistant alloy, cutting is excluded. Unless otherwise specified or agreed by Purchaser, cutting shall only be performed on dummy pipes; e.g. end of lead pipes used for start up after interrupted coating application.

7.2.10 For the PQT, one pipe shall be coated without adhesive to allow easy stripping of the outer PE/PP layer for verification of FBE thickness and curing of FBE and PE/PP. For the PQT, thickness of the adhesive layer shall be recorded on a section of a pipe joint without subsequent application of outer PE/PP layer. During production, recordings of FBE layer thickness sampling of FBE and dry adhesion test may be performed in an area at the cutback with a heat resistant paper introduced prior to the application of the adhesive by extrusion. FBE and adhesive thickness may also be recorded on lead pipes for start up of coating process after interrupted coating. Testing of PE/PP tensile properties is preferably to be performed on PE/PP applied on pipe joint or part of lead pipe without adhesive. If this is not practical, testing of PE/PP sampled directly from extruder may be agreed.

7.2.11 The PQT shall provide evidence (e.g. by visual examination and local thickness recordings if deemed necessary) that the coating is adequately water cooled to avoid damage by e.g. rollers and conveyors.

7.2.12 Use of recycled FBE material shall not exceed 15% unless otherwise agreed in Purchase Documents. Provisions to prevent thermal degradation of PE/PP by prolonged retention in the extruder system shall be described in the APS.

7.2.13 Measures to avoid a) contamination of equipment handling coating materials (e.g. by cleaning) and b) excessive heating of PE/PP in the extruder during start-up and interruption of coating shall be described in the APS.

7.2.14 ISO 21809-1, Sec. 11 specifies testing of cathodic disbondment and hot water immersion test to be performed once per day during production. For offshore pipelines, destructive testing is sometimes impractical since variations in pipe length may interfere with offshore installation procedures. For pipes with an internal lining or cladding in corrosion resistant alloy, cutting is excluded. Unless otherwise specified or agreed by Purchaser, cutting shall only be performed on dummy pipes; e.g. end of lead pipes used for start up after interrupted coating application.

7.2.15 For compliance with ISO 21809-1, the temperature of each pipe shall be continuously monitored and recorded by use of optical pyrometers or contact thermometers, unless otherwise agreed with Purchaser. Pipe temperature shall be recorded in Daily Log at intervals not exceeding 0.5 hrs.

7.2.16 For compliance with this RP, essential process parameters for monitoring and recording shall include pipe feed rate, induction coil current and frequency (recordings minimum once per shift)

7.2.17 Unless otherwise specified or agreed by Purchaser, the outer PE/PP layer at the cutback shall be removed to expose a tail of FBE with a length of 2.0 to 5.0 mm (or as specified by Purchaser). The tail shall be prepared to remove adhesive to the extent practical without causing excessive damage to the FBE layer.

Guidance note:

The primary purpose of the FBE tail is to provide an overlap to the field joint coating. The tail further retards disbonding of the coating by corrosion during outdoor storage

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7.2.18 Unless otherwise specified by Purchaser (see Sec. 5), the following applies to maximum permissible repair:

— The size of individual defect areas shall not exceed 10 cm^2
— The total number of defects to be repaired shall not exceed 1 defect per metre length of pipe.

7.2.19 For compliance with this RP the requirements for pipe tracking and marking in Section 6.11 and requirements for documentation in Section 6.13 shall apply.

7.3 Asphalt Enamel (CDS no. 4)

7.3.1 The requirements of this RP meet or exceed the requirements in EN 10300. Surface preparation, inspection and testing of coated pipes during qualification and production shall be carried out according to the applicable methods, acceptance criteria and frequencies specified in CDS no. 4 (Annex 1), any amendments made in Purchase Documents (see Sec. 5) and this section. If alternative test methods are given in the CDS and Purchaser has not specified any preference in Purchase Documents (see Sec. 5), then the selection of method is optional to Applicator.

7.3.2 Unless otherwise specified by Purchaser, the following applies to maximum permissible repair:

— 0.1 m^2 for defects connected to bonding or adhesion
— Up to 10% of the surface can be repaired for other defects
— Pinholes shall be filled with hot enamel.

7.4 Polychloroprene Coating (CDS no. 5)

7.4.1 Surface preparation, inspection and testing of coated pipes during qualification and production shall be carried out according to the applicable methods, acceptance criteria and frequencies specified in CDS no. 5 (Annex 1), any amendments made in Purchase Documents (see Sec. 5) and this section. If alternative test methods are given in the CDS and Purchaser has not specified any preference in Purchase Documents (see Sec. 5), then the selection of method is optional to Applicator.

7.4.2 The requirements to testing items, methods, and acceptance criteria are largely based on those for polychloroprene field joint coatings in ISO 21809-3.

Unless otherwise specified by Purchaser, the following applies to maximum permissible repair:

— Single defect area shall not exceed 40 cm^2
— Accumulation of defects of any individual size, separated from each other by not more than 50 mm, distributed over an area larger than 0.2 m^2.

7.4.3 The data in CDS 5 applies to single layer or upper layer of dual/multilayer systems. For inner layers in dual/multilayer coatings reduced mechanical properties may be agreed.

8. ANNEX 1: Coating Data Sheets

Coating Data Sheet No.1: Single Layer Fusion Bonded Epoxy Coating				
1 Coating Configuration				
Thickness epoxy layer	FBE: Nominal 350-500 μm (min 300μm) (max/min to be specified in purchase document for inclusion in ITP)			
2 Coating Materials				
Item/Property	*Test method*	*Acceptance criteria*	*Type of Manufacturer inspection document according to ISO10474*	*Testing required by Applicator*[1)]
2.1.1 FBE material, raw material property				
Cure time	ISO 21809-2 Annex. A.2	according to MS	3.1.B	NA
Gel time	ISO 21809-2 Annex. A.3	according to MS		each batch
Total volatile/moisture content by mass	ISO 21809-2 Annex. A.5	≤ 0.6% by mass		NA
Particle size	ISO 21809-2 Annex. A.6	maximum retained on 150 μm and 250 μm sieves according to MDS		
Density	ISO 21809-2 Annex. A.7	according to MS		
Thermal characteristic	ISO 21809-2 Annex. A.8	according to MS		
Infrared scan (by agreement)	by agreement	by agreement	3.1.B	
2.1.2 FBE material, processed (as-applied) property				
Minimum glass transition temperature	ISO 21809-2 Annex A.8	≥ 5ºC above maximum pipeline design temperature and within MS	2.2	NA
Cathodic disbondment: 24h, 65 ± 3ºC, -3.5 V	ISO 21809-2 Annex A.9	≤ 8 mm disbondment		1 specimen each batch
24 h hot-water adhesion, 65 ± 3ºC	ISO 21809-2 Annex A.15	rating of ≤ 2		
28 day hot-water adhesion, 65 ± 3ºC	ISO 21809-2 Annex A.15	rating of ≤ 3		NA
Cathodic disbondment: 28day, 20 ± 3ºC, -1.5 V	ISO 21809-2 Annex A.9	≤ 8 mm disbondment		
Cathodic disbondment: 28day, 65 ± 3ºC, -1.5 V	ISO 21809-2 Annex A.9	≤ 15 mm disbondment		
Cross-section porosity	ISO 21809-2 Annex A.11	according to ISO 21809-2 Figure A.10		1 specimen each batch
Interface porosity	ISO 21809-2 Annex A.11	according to ISO 21809-2 Figure A.11		
Flexibility at 0ºC	ISO 21809-2 Annex A.12	no cracking at bending of 2.0º per pipe diameter		3 specimens each batch
Impact	ISO 21809-2 Annex A.13	≥ 1.5 J		NA
Cathodic disbondment of strained coating: 28 days, 20 ± 3ºC, -1.5 V	ISO 21809-2 Annex A.14	no cracking		
Salt spray test (by agreement)	ISO 7253, 4000 hrs or BS 3900, Part F4	no rusting, no blistering	2.2	NA
2.2.1 LE material, raw material property (for coating repairs only)				
Density	ISO 2811	according to MS	NA	NA
Solid content of base and hardener	ISO 3251	according to MS		
Gel time at 205 ± 3ºC	according to MDS	according to MS		
Minimum glass transition temperature (DSC analysis)	ISO 11357	≥ 5ºC above maximum pipeline design temperature and within MS		
3 Surface Preparation, Coating Application and Final Inspection/Testing				
3.1 Surface Preparation				
Item/Property	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
Initial surface condition	visual examination	dry and free from contamination (oil, grease, etc.) and surface defects	each pipe	each pipe
Pipe temperature	according to ITP	pipe temperature min. 3°C above dew point	each pipe	every 1h

Coating Data Sheet No.1: Single Layer Fusion Bonded Epoxy Coating (Continued)				
Size, shape and properties of abrasive	Visual + certification ISO 11124 (metallic) ISO 11126 (non metallic)	Conformity to certificate	once	1/day
Water soluble contamination of abrasives	ASTM D 4940	Conductivity ≤ 60 mS/cm	once	1/shift
Salt contamination after blast cleaning	ISO 8502-9	≤ 20 mg/m^2 (as NaCl)	each pipe	every 2h
Visual inspection of blasted surface	ISO 8501-1	A/B ≥ Sa 2 ½.	each pipe	each pipe
Presence of dust after dust removal	ISO 8502-3	rating max. 2	each pipe	every 2h
Surface roughness	ISO 8503-4	R_Z/R_{y5}: 50-100 μm	each pipe	every 4h
Final surface condition	visual examination	free from surface defects	each pipe	each pipe
3.2 Coating Application and Final Inspection/Testing				
Item/Property	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
Pipe temperature	according to ITP	according to ITP	each pipe	continuous monitoring; recording 1/ shift
Pipe feed rate	according to ITP	according to ITP	each pipe	continuous monitoring recording 1/ shift
Water quenching	according to ITP	according to ITP	each pipe	continuous monitoring
Induction coil settings	according to ITP	according to ITP	each pipe	continuous monitoring; recording 1/ shift
Appearance of coating	visual	according to ITP	each pipe, 100% surface area	each pipe, 100% surface area
Pipe end configuration	according to ITP	according to ITP	each pipe	each pipe, both pipe ends
Holiday detection	ISO 21809-2 Section 10.2.3.6	no holidays	each pipe, 100% surface area	each pipe, 100% surface area
Thickness	ISO 2808 or by agreement	according to ITP	each pipe	Three random locations along each pipe length
Degree of cure	ISO 21809-2 Annex A.8	according to MS	3 pipes	1/shift
Porosity	ISO 21809-2 Annex A.11	Less than or equal to that illustrated in Fig. A.10 and A.11	3 pipes	1/shift on a test ring[2)]
Dry Adhesion	ISO 21809-2 Annex A.4	Rating of ≤ 2	3 pipes	1/shift
Impact resistance	ISO 21809-2 Annex A.13	≤ 1.5 J	3 pipes	1/shift on a test ring
Flexibility at 0ºC for coating thickness of 350 to 500 μm	ISO 21809-2 Annex A.12	no cracking at 2.0º per pipe diameter length	one pipe	3/shift on a test ring [2)]
Hot water adhesion	ISO 21809-2 Annex A.15	rating 1 to 3	one pipe	1/shift on a test ring[2)]
Cathodic disbonding 24 h, 65°C ± 3°C, -3.5 V	ISO 21809-2 Annex A.9	≤ 8 mm disbondment	one pipe	1/shift on a test ring[2)]
Cathodic disbonding 28 days, 20°C ± 3°C, -1.5 V	ISO 21809-2 Annex A.9	≤ 8 mm disbondment	one pipe	NA
Cathodic disbonding 28 days, Max. operating temperature ± 3°C, -1.5 V	ISO 21809-2 Annex A.9	≤ 15 mm disbondment	one pipe	NA
Interface contamination	ISO 21809-2 Annex A.10	30% maximum	one pipe	1/shift on a test ring [2)]
Hardness	ISO 2815	by agreement	by agreement	by agreement
Residual magnetism of linepipe	by agreement	by agreement	by agreement	by agreement
1) Purchaser may choose to accept Applicator's review of batch certificates and waive the requirements of testing by Manufacturer, see Sec. 7.1.8. 2) Unless otherwise specified or agreed by Purchaser, cutting shall only be performed on dummy pipes, see Section 7.1.9.				
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 6.5.3				

Coating Data Sheet No.2: 3-Layer Polyethylene Coating			
1 Coating Configuration			
Thickness Fusion bonded epoxy	Nominal value: 250-400 μm (min. thickness 200 μm) (max/min to be specified in purchase document)		
Thickness Polyethylene adhesive	According to ITP (min. thickness 150 μm)		
Thickness Polyethylene outer sheath	According to ITP (min. thickness 2.2 mm)		
Total thickness	Nominal value: 3.0 to 4.0 mm (min thickness 2.5 mm) (max/min to be specified in purchase document)		
2 Coating Materials			
Item/Property	*Test method*	*Acceptance criteria*	*Type of Manufacturer inspection documents according to ISO10474*[1)]
2.1.1 FBE material, raw material property			
Density	ISO 21809-1 Annex N	according to MS ± 0.05	3.1.B
Gel time at 205 ± 3ºC	ISO 21809-1 Annex. J	according to MS ± 20%	
Particle size	ISO 21809-2 Annex. A.6	according to MS	
Moisture/water content	ISO 21809-1 Annex K	≤ 0.6% by mass	
Thermal characteristic	ISO 21809-1Annex. D	≥ 95ºC and within MS	
Infrared scan (by agreement)	by agreement	by agreement	3.1.B
2.1.2 FBE material, processed (as-applied) property			
Hot water adhesion (by agreement)	ISO 21809-2 Annex. A.15	Rating of <2 (24 h, 65ºC), Rating of <3 (28 days, 65ºC)	2.2
Flexibility at 0ºC (by agreement)	ISO 21809-2 Annex. A.12	no cracking at 2.0º per pipe diameter length	
Impact resistance (by agreement)	ISO 21809-2 Annex. A.13	≥ 1.5 J	
Salt spray test (by agreement)	ISO 7253, 4000 hrs or BS 3900, Part F4	no rusting, no blistering	
2.2.1 PE adhesive material, raw material property			
Density	ISO 1183	according to MS	3.1.B
Melt flow index/rate	ISO 1133	according to MS	
Moisture/water content	ISO 15512	≤ 0.1%	
Reactive site content	according to MS	according to MS	
2.2.2 PE adhesive material, processed (as applied) property			
Elongation at break at 23 ± 2ºC	ISO 527	≥ 600%	2.2
Tensile yield strength at 23 ± 2ºC	ISO 527	≥ 8 MPa	
Vicat softening temperature A/50 (9.8N)	ISO 306	≥ 85ºC	
Flexural modulus (by agreement)	ASTM D790	≥450 MPa	2.2
2.3.1 PE material, raw material property			
Density	ISO 1183	≥ 0.93 kg/dm^3	3.1.B
Melt flow index/rate	ISO 1133	according to MS	
Moisture/water content	ISO 15512	≤ 0.05%	
Pigment type and dispersion	to be agreed	to be agreed	
Carbon black content (if applicable)	to be agreed	to be agreed	
Melting point (by agreement)	ISO 3146	≥ 120°C	3.1.B
Thermo stabilisation (by agreement)	ASTM D3895	by agreement	

Coating Data Sheet No.2: 3-Layer Polyethylene Coating (Continued)			
2.3.2 PE material, processed (as-applied) property			
Hardness	ISO 868	≥ 55 Shore D	2.2
Elongation at break at 23 ± 2ºC	ISO 527	≥ 600%	
Tensile yield strength at 23 ± 2ºC	ISO 527	≥ 15 MPa	
Vicat softening temperature A/50 (9.8 N)	ISO 306	≥ 110ºC	
ESCR (50ºC, F50, 10% Igepal CO630 or 100% Igepal CO630)	ASTM D1693	≥ 1000 H cond. A or ≥ 300 H cond. B if density > 0.955 g/cm^3	
Oxidation induction time (intercept in the tangent method)	ISO 11357	≥ 30 min. at 210ºC or ≥ 10 min. at 220ºC	
UV and thermal degradation	ISO 21809-1 Annex. G	ΔMFR ≤ 35%	
Indentation (by agreement)	ISO 21809-1 Annex. F, mass 2.5 kg	≤ 0.2 mm, 20°C ≤ 0.4 mm, max. temp.	2.2
Impact resistance (by agreement)	ISO 21809-1 Annex. E	≥ 7 J/mm	
2.4.1 LE material, raw material property (for coating repairs)			
Density	ISO 2811	according to MS	NA
Solid content of base and hardener	ISO 3251	according to MS	
Gel time at 205 ± 3ºC	According to MS	according MS	
Minimum glass transition temperature (DSC analysis)	ISO 11357	> 95ºC and according to MS	

3 Surface Preparation, Coating Application and Final Inspection/Testing				
3.1 Surface Preparation				
Item/Property	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
Initial surface condition	visual examination	dry and free from contamination (oil, grease, etc.) and surface defects	each pipe	each pipe
Pipe temperature and relative humidity	according to ITP	pipe temperature min. 3°C above dew point	each pipe	every 4h
Size, shape and properties of abrasive	Visual + certification ISO 11124 (metallic) ISO 11126 (non metallic)	Conformity to certificate	once	every batch
Water soluble contamination of abrasives	ASTM D 4940	Conductivity ≤ 60 mS/cm	once	1/shift
Salt contamination after blast cleaning	ISO 8502-9	≤ 20 mg/m^2 (as NaCl)	each pipe	every 4h
Visual inspection of blasted surface	ISO 8501-1	A/B ≥ Sa 2 ½.	each pipe	each pipe
Presence of dust after dust removal	ISO 8502-3	rating max. 2	each pipe	every 1h
Surface roughness	ISO 8503-4 ISO 8503-5	R_Z/R_{y5}: 50 to 100 μm 50-100 μm	each pipe each pipe	1/shift every 1h
Final surface condition	visual examination	free from surface defects	each pipe	each pipe
Pipe temperature prior to chemical treatment (if specified in MPS)	according to ITP	according to ITP	each pipe	continuous monitoring
3.2 Coating Application and Final Inspection/Testing				
Item/Property:	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
3.2.1 Epoxy layer				
Pipe feed rate	according to MPS/ ITP	according to ITP	each pipe	continuous monitoring, recording 1/shift

Coating Data Sheet No.2: 3-Layer Polyethylene Coating (Continued)				
Induction coil settings	according to MPS/ITP	according to ITP	each pipe	continuous monitoring, recording 1/shift
Pipe temperature	according to MPS/ITP	according to ITP	each pipe	continuous monitoring, recording of pipe temperature every 0.5 h.
Minimum thickness	ISO 2808 (location to be detailed in APS/ ITP)	200 μm or as agreed	one pipe	1/shift (lead pipe if applicable)
Degree of cure	ISO 21809-1 Annex. D	according to ITP and $\Delta T_G \leq 5$°C	one pipe	1/shift (lead pipe if applicable)
Porosity	ISO 21809-2 Annex. A11	according to standard	one pipe	by agreement
Dry Adhesion	ISO 21809-2 Annex A.4	Rating max. 2	one pipe	1/shift (lead pipe if applicable)
3.2.2 PE Adhesive Layer				
Minimum thickness	ISO 2808 (location to be detailed in APS/ ITP)	150 μm or according to ITP	one pipe	1/shift (lead pipe if applicable)
3.2.3 PE layer and full layer				
PE extrusion temperature	according to MPS/ITP	according to ITP	each pipe	continuous monitoring, recording of PE extrusion temperature every 1h
Water quenching	according to ITP	according to ITP	each pipe	continuous monitoring
Appearance of coating	visual	according to ITP	each pipe, 100% surface area	each pipe, 100% surface area
Pipe end configuration	according to MPS/ ITP	according to ITP	each pipe	each pipe, both pipe ends; recording once per hour
Continuity / Holiday detection	ISO 21809-1, Annex B	no holidays	each pipe, 100% surface area	each pipe, 100% surface area (visual/acoustic alarm function)
Total thickness	ISO 21809-1, Annex A	according to purchase order and ITP	each pipe	every 10 pipes
Adhesion (peel strength), at 20°C ± 3°C	ISO 21809-1 Annex. C Use of hanging mass method by agreement only. Heating of pipe to be described in APS	≥ 15 N/mm, no peeling of FBE layer (see notes to Table 7 of ISO 21809-1)	each pipe, both ends	every 4h, both ends
at 80°C ± 3°C		≥ 3 N/mm, no peeling of FBE layer (see notes to Table 7 of ISO 21809-1)	each pipe, both ends	every 4h, both ends
In process degradation of PE	ISO 1133	Δ MFR ≤ 20%	one pipe	1st pipe per shift
Impact resistance, at room temperature	ISO 21809-1 Annex E	≥ 7 J/mm	3 pipes	each PE batch
Indentation resistance, at room temperature and at max. design temperature	ISO 21809-1 Annex F, mass 2.5 kg	≤ 0.2 mm, 20° C ≤ 0.4 mm, max. temp.	one pipe	each PE batch
Elongation at break	ISO 527-3	≥ 400%	one pipe	each PE batch

Coating Data Sheet No.2: 3-Layer Polyethylene Coating (Continued)				
Cathodic disbonding, 65°C/24 hrs, -3.5 V and 23°C/28 days; -1.5 V	ISO 21809-1 Annex H	≤ 7 mm disbonding,		
			one pipe	1/day[2)]
			one pipe	NA
at max. operating temperature, if higher than 65°C/28 days; -1.5 V		≤ 15 mm disbonding,	one pipe	NA
Hot water immersion test	ISO 21809-1 Annex M	Average ≤ 2 mm disbonding and maximum ≤ 3 mm, 48 hours	one pipe	1/day[2)]
Flexibility	ISO 21809-1 Annex I	No cracking at an angle of 2.0º per pipe diameter length	one pipe	NA
Hardness	ISO 868	≥50 Shore D	by agreement	NA
Tensile yield strength at 23 ± 2ºC	ISO 527	≥ 15 MPa	by agreement	NA
Residual magnetism of linepipe material	by agreement	by agreement	by agreement	by agreement
1) See 6.6.6 for definition of Type 3.1.B certificate and 6.6.8 for definition of Type 2.2 certificate 2) Unless otherwise specified or agreed by Purchaser, cutting shall only be performed on dummy pipes, see Section 7.2.14.				
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 6.5.3				

Coating Data Sheet No.3: 3-Layer Polypropylene Coating			
1 Coating Configuration			
Fusion bonded epoxy	Nominal value: 250-400μm (min. thickness 200 μm) (max/min to be specified in purchase document)		
Polypropylene adhesive	According to ITP (min. thickness 150 μm)		
Polypropylene outer sheath	According to ITP (min. thickness 2.2 mm)		
Total thickness	Nominal value: 3.0 - 4.0 mm. (min thickness 2.5 mm) (max/min to be specified in purchase document)		
2 Coating Materials			
Item/Property	*Test method*	*Acceptance criteria*	*Type of Manufacturer inspection documents according to ISO10474*[1)]
2.1.1 FBE material, raw material property			
Density	ISO 21809-1 Annex N	according to MS ± 0.05	3.1.B
Gel time at 205 ± 3ºC	ISO 21809-1 Annex J	according to MS ± 20%	
Particle size (by agreement)	ISO 21809-2 Annex. A.6	according to MS	
Moisture/water content	ISO 21809-1 Annex K	≤ 0.6% by mass	
Thermal characteristic	ISO 21809-1 Annex D	≥ 5ºC above maximum pipeline design temperature and within MS	
Infrared scan (by agreement)	by agreement	by agreement	3.1.B
2.1.2 FBE material, processed (as-applied) property			
Hot water adhesion (by agreement)	ISO 21809-2 Annex. A.15	rating ≤ 2 (24 h, 65ºC), rating ≤ 3 (28 days, 65ºC)	2.2
Flexibility at 0ºC (by agreement)	ISO 21809-2 Annex. A.12	no cracking at 2.0º per pipe diameter length	
Impact resistance (by agreement)	ISO 21809-2 Annex. A.13	≥ 1.5 J	
Salt spray test (by agreement)	ISO 7253, 4000 hrs or BS 3900, Part F4	no rusting, no blistering	
2.2.1 PP adhesive material, raw material property			
Density	ISO 1183	according to MS.	3.1.B
Melt flow index/rate	ISO 1133	according to MS	
Moisture/water content	ISO 15512	≤ 0.1%	
Reactive site content	according to MDS	according to MS.	
2.2.2 PP adhesive material, processed (as-applied) property			
Elongation at break at 23 ± 2ºC	ISO 527	≥ 400%	2.2
Tensile yield strength at 23 ± 2ºC	ISO 527	≥ 12 MPa	
Notched impact strength at 23 ± 2ºC	ISO 179	≥ 3 kJ/m^2	
Vicat softening temperature A/50 (9.8 N)	ISO 306	≥ 110ºC	
Flexural modulus at 23 ± 2ºC (by agreement)	ASTM D790	≥ 450 MPa	2.2
2.3.1 PP material, raw material property			
Density	ISO 1183	> 0.89 kg/dm^3	3.1.B
Melt flow index/rate	ISO 1133	according to MS	
Moisture/water content	ISO 15512	≤ 0.05%	
Pigment type and dispersion	to be agreed	to be agreed	
Melting point (by agreement)	ISO 3146	≥ 150°C	3.1.B
Thermo stabilisation (by agreement)	ASTM D3895	by agreement	

Coating Data Sheet No.3: 3-Layer Polypropylene Coating (Continued)				
2.3.2 PP material, processed (as-applied) property				
Hardness	ISO 868	≥ 60 Shore D	2.2	
Elongation at break at 23 ± 2ºC	ISO 527	≥ 400%		
Tensile yield strength at 23 ± 2ºC	ISO 527	≥ 20 MPa		
Notched impact strength at min. temperature	ISO 179-1	≥ 3 kJ/m^2		
Vicat softening temperature A/50 (9.8 N)	ISO 306	≥ 130ºC		
Oxidation induction time (intercept in the tangent method)	ISO 11357	≥ 30 min. at 220ºC		
UV resistance and thermal ageing	ISO 21809-1 Annex G	Δ MFR ≤ 35%		
Indentation (by agreement)	ISO 21809-3 Annex. H, mass 2.5 kg	max. 0.1 mm at 20°C max. 0.4 mm at max. temp.	2.2	
Impact resistance (by agreement)	ISO 21809-3 Annex. G	≥ 10 J/mm		
2.4.1 LE material, raw material property (for coating repairs)				
Density	ISO 2811	according to MS.	NA	
Solid content of base and hardener	ISO 3251	according to MS.		
Gel time at 205 ± 3ºC	According to MS	according to MS.		
Minimum glass transition temperature (DSC analysis)	ISO 11357	> 95ºC and within MS		
Viscosity of base and hardener (by agreement)	ISO 2655	according to MS	NA	
3 Coating Application and Final Inspection/Testing				
3.1 Surface Preparation				
Item/Property	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
Initial surface condition	visual examination	dry and free from contamination (oil, grease, etc.) and surface defects	each pipe	each pipe
Pipe temperature and relative humidity	according to ITP	pipe temperature min. 3°C above dew point	each pipe	every 4h
Size, shape and properties of abrasive	visual + certification ISO 11124 (metallic) ISO 11126 (non metallic)	conformity to certificate	once	every batch
Water soluble contamination of abrasives	ASTM D 4940	conductivity ≤ 60 mS/cm	once	1/shift
Salt contamination after blast cleaning	ISO 8502-9	≤ 20 mg/m^2 (as NaCl)	each pipe	every 4h
Visual inspection of blasted surface	ISO 8501-1	A/B ≥ Sa 2 ½.	each pipe	each pipe
Presence of dust after dust removal	ISO 8502-3	rating max. 2	each pipe	every 1h
Surface roughness	ISO 8503-4 ISO 8503-5	R_Z/R_{y5}: 50 to 100 μm 50 to 100 μm	each pipe each pipe	1/shift every 1h
Final surface condition	visual examination	free from surface defects	each pipe	each pipe
Pipe temperature prior to chemical treatment (if specified in MPS)	according to ITP	according to ITP	each pipe	continuous monitoring
3.2 Coating Application and Final Inspection/Testing				
Item/Property:	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
3.2.1 Epoxy layer				
Pipe feed rate	according to MPS/ ITP	according to ITP	each pipe	continuous monitoring, recording 1/ shift

Coating Data Sheet No.3: 3-Layer Polypropylene Coating (Continued)				
Induction coil settings	according to MPS/ITP	according to ITP	each pipe	continuous monitoring, recording 1/ shift
Pipe temperature	according to MPS/ITP	according to ITP	each pipe	continuous monitoring, recording of pipe temperature every 0.5 h
Minimum thickness	ISO 2808 (location to be detailed in APS/ ITP)	200 μm or higher as agreed	one pipe	1/shift (lead pipe if applicable)
Degree of cure	ISO 21809-1 Annex D	according to ITP and $\Delta T_G \leq 5$ºC	one pipe	1/shift (lead pipe if applicable)
Porosity	ISO 21809-2 Annex. A11	according to standard	one pipe	by agreement
Dry Adhesion	ISO 21809-2 Annex A.4	Rating max. 2	one pipe	1/shift (lead pipe if applicable)
3.2.2 PP Adhesive Layer				
Minimum thickness	ISO 2808 (location to be detailed in APS/ ITP)	150 μm or higher as agreed	one pipe	1/shift (lead pipe if applicable)
3.2.3 PP layer and full layer				
PP extrusion temperature	according to MPS/ITP	according to ITP	each pipe	continuous monitoring, recording of PP extrusion temperature every 1h.
Water quenching	according to ITP	according to ITP	each pipe	continuous monitoring
Appearance of coating	visual	according to ITP	each pipe, 100% surface area	each pipe, 100% surface area
Pipe end configuration	according to MPS/ ITP	according to ITP	each pipe	each pipe, both pipe ends, recording once per hour
Continuity / Holiday detection	ISO 21809.-1 Annex B	no holidays	each pipe, 100% surface area	each pipe, 100% surface area (visual/acoustic alarm function)
Total thickness	ISO 21809.-1 Annex A	according to purchase order and ITP	each pipe,	every 10 pipes
Adhesion (peel strength), at 20°C ± 3°C	ISO 21809-1 Annex. C Use of hanging mass method by agreement only. Heating of pipe to be described in APS	≥ 25 N/mm, no peeling of FBE layer (see notes to Table 7 of ISO 21809-1)	each pipe, both ends	every 4h, both ends
at 90°C ± 3° or at max. operating temperature if above 90°C (max. temperature range applies to PQT only)		≥ 4 N/mm, no peeling of FBE layer (see notes to Table 7 of ISO 21809-1)	each pipe, both ends	every 4h, both ends
In process degradation of PP	ISO 1133	Δ MFR ≤ 35%	one pipe	1st pipe per shift
Impact resistance, at room temperature	ISO 21809-1 Annex E	≥ 10 J/mm	3 pipes	Once per PP batch
Indentation resistance, at room temperature and at max. design temperature	ISO 21809-1 Annex F, mass 2.5 kg	≤ 0.1 mm, 20°C ≤ 0.4 mm, max. temp.	one pipe	Each PP batch

Coating Data Sheet No.3: 3-Layer Polypropylene Coating (Continued)				
Elongation at break	ISO 527-3	≥ 400%	one pipe	Each PP batch
Cathodic disbonding, 65°C/24 hrs, -3.5 V and 23°C/28 days; -1.5 V	ISO 21809-1 Annex H	≤ 7 mm disbonding,	one pipe	1/day
			one pipe	NA
at max. operating temperature, if higher than 65°C/28 days; -1.5 V		≤ 15 mm disbonding,	one pipe	NA
Hot water immersion test	ISO 21809-1 Annex M	Average ≤ 2 mm disbonding and maximum ≤ 3 mm, 48 hours	one pipe	1/day
Flexibility	ISO 21809-1 Annex I	No cracking at an angle of 2.0º per pipe diameter length	one pipe	NA
Hardness	ISO 868	≥ 60 Shore D	by agreement	NA
Tensile yield strength at 23 ± 2ºC	ISO 527	≥ 20 MPa	by agreement	NA
Residual magnetism of linepipe material	by agreement	by agreement	by agreement	by agreement
1) See 6.6.6 for definition of Type 3.1.B certificate and 6.6.8 for definition of Type 2.2 certificate 2) Unless otherwise specified or agreed by Purchaser, cutting shall only be performed on dummy pipes, see Section 7.2.14				
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 6.5.3				

Coating Data Sheet No. 4: Asphalt Enamel (or "Bitumen") Coating				
1 Coating Configuration				
Primer	Dry Film Thickness: min. 15 μm (20 ± 5 μm) Type: EN 10300, Type 2			
Asphalt Enamel	Thickness: 5-9 mm Type: EN 10300, Category I Grade b			
Inner wrapping	Thickness: min. 0.33 mm Type: Non woven fibre tissue consisting of uniformly porous mat of glass; Phenolic resin binder			
Outer wrapping	Thickness: According to EN 10300 Table 7 Type: Glass fibre, e.g. regular weaving of continuous glass filaments in the wrap and of glass filament or of single or double staple glass fibres in the wool, with small amounts of phenolic resin binder			
2 Coating Materials				
Item/Property	*Test method*	*Acceptance criteria*	*Type of Manufacturer inspection document required for review by Applicator*	*Testing required by Applicator*
2.1 Primer material				
Flow time (Flow cup nº 4 at 23ºC)	EN ISO 2431	according to EN 10300 Table 1	Batch certificates - to be included	No
Flash point (Abel closed cup)	EN ISO 13736	according to EN 10300 Table 1		
Volatile matter	EN 10300 Annex H	according to EN 10300 Table 1		
2.2 Filler material				
Filler fineness	ISO 2591-1	EN 10300 Section 4.2.3 ≥ 99% passing 250 μm sieve ≥ 93% passing 90 μm sieve	Batch certificates - to be included	No
2.3 Asphalt enamel material				
Flash point (Cleveland open cup)	EN ISO 2592	According to EN 10300 Table 2, Grade B	every batch/lot	
Filler content by ignition	EN 10300 Annex K	According to EN 10300 Table 2, Grade B	every batch/lot	Yes
Density at 25ºC	EN 10300 Annex L	According to EN 10300 Table 2, Grade B	every batch/lot	
Softening point (ring and ball)	EN 1427	According to EN 10300 Table 2, Grade B	every batch/lot	
Penetration at 25ºC	EN 1426	According to EN 10300 Table 2, Grade B	every batch/lot	
Sag test	EN 10300 Annex D	According to EN 10300 Table 3, Grade B	to be agreed	Yes
Impact test	EN 10300 Annex E	According to EN 10300 Table 3, Grade B	to be agreed	
Bend test	EN 10300 Annex G	According to EN 10300 Table 3, Grade B	to be agreed	
Peel test	EN 10300 Annex F, F.4.1	According to EN 10300 Table 3, Grade B	to be agreed	
Cathodic disbonding	EN 10300 Annex I	According to EN 10300 Table 3, Grade B	to be agreed	

Coating Data Sheet No. 4: Asphalt Enamel (or "Bitumen") Coating (Continued)				
2.4 Inner wrapping material				
Hydrolytic class	ISO 719	min. Class 3	every batch/lot	No
Weight	EN 10300 Annex M	According to EN 10300 Table 6	every batch/lot	
Loss of mass on ignition (binder content)	EN 10300 Annex M	According to EN 10300 Table 6	every batch/lot	
Tensile strength	EN 12311-1 modified as in EN 10300 Annex N	According to EN 10300 Table 6	every batch/lot	
Thickness	EN 1849-1 modified as in EN 10300 Table 6	According to EN 10300 Table 6	every batch/lot	
Porosity	ASTM D737-96 modified as in EN 10300 Annex O	According to EN 10300 Table 6	every batch/lot	
2.5 Outer wrapping material				
Hydrolytic class	same as for inner wrapping	min. Class 3	every batch/lot	No
Mass per area of base glass before impregnation	EN 10300 Annex M	According to EN 10300 Table 7	every batch/lot	
Mass per area	EN 10300 Annex M	According to EN 10300 Table 7	every batch/lot	
Thickness	EN 1849-1 modified as in EN 10300 Table 7	According to EN 10300 Table 7	every batch/lot	
Tensile strength	EN 12311-1 modified as in EN 10300 Annex N	According to EN 10300 Table 7	every batch/lot	
3. Surface Preparation, Coating Application and Final Testing				
3.1 Surface Preparation				
Properties	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
Initial surface condition	visual examination	free from surface contamination, temporary corrosion protection and defects	to be included	each pipe, 100% surface area
Pipe temperature and relative humidity	according to ITP	pipe temperature min. 3°C above dew point	to be included	minimum once per hour
Surface cleanliness	ISO 8501-1	A/B ≥ Sa 2 ½.	to be included	each pipe 100% surface area
Roughness	ISO 8503-2	75 μm ± 25 μm	to be included	4 pipes per shift, both ends
Presence of dust	ISO 8502-3	max. rating 2	to be included	one per shift, both ends
Final surface condition	visual examination	free from surface defects	to be included	each pipe 100% surface area
3.2 Coating Application and Final Testing (Inspection)				
Item/Property	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
3.2.1 Primer layer				
Application temperature	according to ITP (max. 50°C)	according to ITP	to be included	each pipe
Coating layer thickness	according to ITP	according to ITP	to be included	4 pipes per shift, 3x4 locations (90° apart)
3.2.2 Full layer				
Time duration from priming	according to ITP	Within 2 hours	to be included	each pipe
Enamel temperature	according to ITP	according to ITP	to be included	continuous monitoring
Pipe temperature	according to ITP	according to ITP	to be included	each pipe

Coating Data Sheet No. 4: Asphalt Enamel (or "Bitumen") Coating (Continued)				
Wrap and enamel configuration	according to ITP	according to ITP	to be included	according to ITP
Appearance of finished coating	visual examination	according to ITP	to be included	each pipe, 100% surface area
Total thickness	EN 10300 Annex T	according to ITP	to be included	first 10 pipes then every 5th pipe, 3x4 locations (90º apart)
Holiday detection	EN 10300 Annex R	no defects acceptable	to be included	each pipe, 100% surface area
Adhesion (Field bond test)	EN 10300 Annex S	coating shall be difficult to remove, causing cohesive failure of the coating.	to be included	first 5 pipes (one pipe end), then first pipe per shift or every 20th pipe, whatever gives the highest frequency
Pipe end configuration	according to ITP	according to ITP	to be included	each pipe, both pipe ends
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 6.5.3				

Coating Data Sheet No.5: Polychloroprene (or "Vulcanised Rubber") Coating (max. operating temperature 90°C for ordinary grades)				
1 Coating Configuration				
Primer and bonding agent)	Type and thickness according to ITP			
Polychloroprene	Thickness to be agreed			
2 Coating Materials				
Item/Property	*Test method*	*Acceptance criteria*	*Type of Manufacturer inspection document required for review by Applicator*	*Testing required by Applicator*
2.1 Primer material				
According to ITP	according to ITP	according to ITP	to be included	every batch/lot
2.2 Polychloroprene material, raw material and as-applied (processed) properties				
Rheometer curve	ASTM D2084	according to ITP	to be included	every batch/lot
Hardness	ISO 7619	60-70 Shore A	to be included	every batch/lot
Density	ISO 2781	1.40–1.70 kg/dm^3	to be included	every batch/lot
Tensile strength	ISO 37	> 14 MPa	to be included	1/20 batch/lot or by agreement
Elongation at break	ISO 37	> 350%	to be included	1/20 batch/lot or by agreement
Compression set	ISO 815	max. 20% at 60°C or max. 30% at 70°C	to be included	1/20 batch/lot or by agreement
Tear strength	ISO 34 -1	> 40 N/mm	to be included	1/20 batch/lot or by agreement
Accelerated ageing	ISO 188	according to ITP/ MPS	to be included	not applicable
Ozone resistance	ISO 1431-1 procedure A 0.5 ppm O_3, 72 h at 40ºC and 20% strain	no cracking or other visual degradation	by agreement	not applicable
Seawater resistance	ISO 1817	tensile strength ± 20% of unexposed value, max. 5% volume change	by agreement	not applicable
Abrasion resistance	DIN 53516	by agreement	by agreement	not applicable
Volume resistivity	ASTM D257	> 10 ^{11} ohm cm	by agreement	not applicable
Thermal conductivity	by agreement	by agreement	by agreement	not applicable
Penetration	ASTM G17	by agreement	by agreement	not applicable
3 Surface Preparation, Coating Application and Final Testing				
3.1 Surface preparation				
Properties	*Test method*	*Acceptance criteria*	*Frequency*	
			PQT	*Production*
Initial surface condition	visual examination	free from visual surface contamination, temporary corrosion protection and defects	to be included	each pipe, 100% surface area
Pipe temperature and relative humidity	according to ITP	pipe temperature min. 3°C above dew point	to be included	minimum once per hour
Salt contamination after blast cleaning	ISO 8502-6	max. 20 mg NaCl/ m^2	to be included	first pipe and every 10th pipe
Surface cleanliness	ISO 8501-1	A/B ≥ Sa 2 ½.	to be included	each pipe

Coating Data Sheet No.5: Polychloroprene (or "Vulcanised Rubber") Coating (max. operating temperature 90°C for ordinary grades) (Continued)				
Presence of dust after dust removal	ISO 8502-3	rating max. 2		
Roughness	ISO 8503-5	50-100 μm	to be included	each pipe
Final surface condition	visual examination	free from surface defects	to be included	each pipe 100% surface area
3.2 Coating Application and Final Testing				
FBE and Polychloroprene layer				
Max. duration from surface preparation to application of primer		according to ITP	to be included	each pipe
Ambient temperature and humidity	according to ITP	min. 15°C and max. 75% rel. humidity	to be included	every hour
Pipe temperature	according to ITP	min. 3°C above dew point	to be included	every hour
Surface appearance prior to primer application	according to ITP	according to ITP	to be included	each pipe
Primer/bonding agent drying time	according to ITP	according to ITP	to be included	each pipe
Primer/bonding agent appearance	visual inspection	according to ITP	to be included	each pipe
Primer/bonding agent thickness	ISO 2187	according to ITP	to be included	each pipe
Wrapping appearance (prior to vulcanising)	visual inspection	according to ITP	to be included	each pipe
Vulcanising temperature and pressure	according to ITP	according to ITP	to be included	every batch, continuous monitoring and recording
Vulcanised coating appearance	visual inspection	according to ITP	to be included	each pipe, 100% surface area
Coating layer thickness	ISO 2187	according to ITP	to be included	each pipe, 3x4 locations (90° apart)
Holiday detection	ISO 21809-3, Annex B	according to ITP	to be included	each pipe, 100% surface area
Cathodic disbondment at room temperature, 28 days	ISO 21809-3, Annex F	≤ 7 mm	to be included	not applicable
Cathodic disbondment at max operating temperature, 28 days (limited to 95ºC)	ISO 21809-3, Annex F	≤ 10 mm	to be included	not applicable
Adhesion (peel strength) at room temperature	ISO 21809-3, D.2	> 12 N/mm, cohesive failure	to be included	each pipe (at cutback or on test plate)
Adhesion (peel strength) after 28 day hot-water immersion test at max operating temperature	ISO 21809-3, D.2 (exposure according to ISO 21809-3, Annex I)	> 10 N/mm, cohesive failure	by agreement	by agreement
Hardness	ISO 7619 or ASTM D2240	according to ITP	to be included	each pipe
Pipe end configuration	according to ITP	according to ITP	to be included	each pipe, both pipe ends
Cathodic disbonding, at room temperature or at 65°C	ISO 21809-3, Annex F	max. 10 mm disbonding, 48 hrs at 65°C or 28 days at room temperature	to be included	by agreement
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 6.5.3				

9. ANNEX 2: Inspection and Testing Plan (ITP) Format (Applicable to PQT and Production)

Reference documents:		**Coating Specification (project specific doc. no)**							
		APS (project specific doc. no)							
Activity number	**General description**	**Ref. to Spec.**	**Ref. to Procedure or method/tool**	**Test frequency**	**Acceptance Criteria**	**Reporting document**	**Inspection code***		
							Applicator	**Purchaser**	**3rd party**
1 Receipt of coating and blasting materials									
1.1									
2 Inspection and marking of incoming pipes									
2.1									
3 Surface preparation and heating									
3.1									
4 Coating application									
4.1									
5 Inspection/Testing of applied coating									
5.1									
6 Repair									
6.1									
7. Marking of coating									

* R=Review, I=inspection, M=Monitoring, W=Witness, H=Hold,