



RECOMMENDED PRACTICE DNV-RP-F106

FACTORY APPLIED EXTERNAL PIPELINE COATINGS FOR CORROSION CONTROL

OCTOBER 2003

*Since issued in print (October 2003), this booklet has been amended, latest in April 2006.
See the reference to “Amendments and Corrections” on the next page.*

DET NORSKE VERITAS

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Amendments and Corrections

This document is valid until superseded by a new revision. Minor amendments and corrections will be published in a separate document normally updated twice per year (April and October).

For a complete listing of the changes, see the "Amendments and Corrections" document located at: <http://www.dnv.com/technologyservices/>, "Offshore Rules & Standards", "Viewing Area".

The electronic web-versions of the DNV Offshore Codes will be regularly updated to include these amendments and corrections.

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1. General

1.1 Introduction

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

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"). 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 by the installation contractor, whilst linepipe coating is mostly carried out by another coating manufacturer 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 manufacturing and damage during transportation/installation, in addition to any assumed degradation of coating materials 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.

1.2 Scope

1.2.1 This Recommended Practice (RP) has been prepared to facilitate the specification and execution of coating work. While the requirements and recommendations are general, the document contains advice on how amendments can be made to include project specific requirements and requirements/guidelines by a regulating authority, or to reflect the pipeline operator's general philosophy on pipeline corrosion control.

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 and implementation of this process. The following coating systems are covered:

- 1) Single or dual 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) Multi-layer PP coatings with the 3 innermost layers as for 3) above and a relatively thick layer of foamed or syntactic PP for the purpose of thermal insulation plus an outer jacket in PP.

- 5) Glass fibre reinforced asphalt enamel coating*).
- 6) Glass fibre reinforced coal tar enamel coating*).
- 7) Polychloroprene (vulcanised rubber) coating (sometimes applied for thermal insulation in addition to corrosion control and mechanical protection).
- 8) Multi-layer polychloroprene (vulcanised rubber) coating (primarily for heat/thermal insulation).

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

Guidance note:

Pipeline operators (and installation contractors if applicable) should consider the needs to carry out qualification of generic coating systems for specially demanding applications; e.g. resistance to bending during installation by reeling and 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.

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1.2.3 This RP covers primarily the process of coating of ordinary pipe joints, and pipe joints with a buckle arrestor. It may also be used for coating of 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 consider the needs for amendments and deviations for such applications.

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

- Requirements for the qualification of supplier specific coating materials for general purposes (i.e. not project specific), see Guidance Note to 5.4.3.
- Detailed design of linepipe coating systems for project specific purposes (e.g. heat insulation, anti-buoyancy; see also Guidance Note to 5.4.2).
- Application of concrete weight coating.

1.2.5 Although 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 of great importance, such are never-the-less beyond the scope of this document.

1.3 Objectives and use

1.3.1 This Recommended Practice (RP) has two major objectives; it may either be used as a guideline for the preparation of manufacturing specifications for external pipeline coating systems as defined in 1.2.2 above, or it may be used as an attachment to an inquiry or purchase order for such coatings. If Purchaser has chosen to refer to this RP in a purchase document (see definition in Sec. 3, then Contractor shall consider all requirements in this RP as mandatory (see Sec. 3), unless superseded by amendments and deviations in the specific contract (see 1.3.4).

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

Information:

- Pipe material (reference to selected standard or purchaser's specification), nominal inner diameter, wall thickness and length.
- Seam weld dimensions, including tolerances, if relevant for the specified coating system.
- Any temporary external coating (e.g. varnish type) or per-

manent internal coating on pipes to be supplied for external coating.

Requirements:

- Coating design; i.e. type of coating system, max./min. thickness of individual coating layers (5.6.5), surface roughness/profile and colour.
- Coating configuration at pipe ends such as length of cut-back and coating chamfer angle (5.6.6).
- Project specific requirements to the detailed design of coating system (e.g. heat insulation capacity, maximum fluid temperature, maximum water depth), if included in the scope of work.
- Specific requirements for pre-production qualification testing (PQT) such as number of pipes to be coated, qualification of repairs (type and number) and schedule for notification and supply of documentation (5.2).
- Methods and acceptance criteria for any testing indicated “to be agreed” in the applicable CDS of ANNEX 1 (see 5.3.3).
- Permissible coating repairs, e.g. maximum number per pipe and maximum size (5.8.3).
- Requirements to pipe tracking (5.5.2) and marking (5.9.1).
- Requirements to documentation, e.g. schedule for supply of documentation and format (5.9).

1.3.3 The following items, intended as a check list, may be included in purchase documents, as applicable and relevant. (For specification of amendments and deviations in purchase documents, see 1.3.4 below.):

- Additional testing indicated “by agreement” in the CDS (see 5.3.3), and any special conditions for testing (e.g. above and/or below ambient temperature).
- Specific coating materials to be used (e.g. supplier proprietary products, see 5.4.3).
- Verification of thermal insulation capacity by testing (5.2.6).
- Qualification of personnel carrying out coating repairs (5.2.7).
- Specific requirements to the ITP (5.3.2).
- Facilities needed for the Purchaser’s quality surveillance.
- Regulatory-, or Contractor’s requirements to the control of health and environmental hazards associated with coating work.
- Contractor’s management of non-conformities (5.5.12, 5.7.8) and concession requests (5.5.1).
- Additional pipe receipt inspection, e.g. checking of dimensions or weight (5.5.3).
- Surface preparation of pipes other than “cosmetic” grinding (5.5.11).
- Cleanliness of coated pipe ends and internal surfaces (5.5.7 and 5.6.7).
- Pipe end protection (e.g. temporary corrosion protective

coating and use of end caps, see 5.10.4).

- Special requirements to handling and storage of pipes (5.10.1).
- Special requirements to shipping of coated pipes (5.10.4), including final inspection (5.7.9).
- Further deviations or amendments to this document.

1.3.4 As far as practical, tentative test methods and acceptance criteria for testing indicated in the CDS as “to be agreed” (see 1.3.2) or “by agreement” (see 1.3.3) shall be specified by Purchaser in the inquiry. Purchaser may also specify any preference for a specific test method in case more than one method is specified for mandatory testing (“to be included”). If alternative methods are given in the CDS and no specific method has been specified by Purchaser, the method to be used is optional to Contractor.

1.3.5 ANNEX 2, Tables 1 and 2 show examples of how deviations and amendments to the common requirements in Sec. 5 and to a specific CDS, respectively, may be specified in a purchase document.

1.4 Structure of document

1.4.1 Requirements that are common to all types of external linepipe coating systems are given in Sec. 5 whilst those applicable to a specific system or application are contained in individual ‘Coating Data Sheets’ (CDS) in ANNEX 1.

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. 8, gives some guidelines to the selection of pipeline external corrosion protective coatings, field joint coatings and concrete coatings, and general requirements to their manufacturing. This document (DNV-RP-F106) provides detailed requirements for the manufacturing of factory applied external coating of linepipe.

1.5.2 DNV-RP-F102 “Pipeline Field Joint Coating and Field Repair of Linepipe External Coating” gives detailed requirements to the manufacturing 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:

This document 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 manufacturing..

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2. References

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

2.1 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 D149	Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electric Insulating Materials at Commercial Power Frequencies
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 D638	Test Method for Tensile Properties of Plastics
ASTM D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D785	Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials
ASTM D790	Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrically Insulating Materials
ASTM D870	Practice for Testing Water Resistance of Coatings Using Water Immersion
ASTM D1149	Test Method for Rubber Deterioration – Surface Ozone Cracking in a Chamber
ASTM D1238	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1525	Test Method for Vicat Softening Temperature of Plastics
ASTM D1921	Test Method for Particle Size (Sieve Analysis) of Plastic Materials
ASTM D2084	Standard Test Method for Rubber Property – Vulcanization Using Oscillating Disc Cure Meter
ASTM D2240	Test Method for Rubber Property-Durometer Hardness
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 E96	Test Methods for Water Vapour Transmission of Materials
ASTM E797	Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method
ASTM G8	Test Method for Cathodic Disbonding of Pipeline Coating
ASTM G14	Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
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

2.2 BS (British Standards)

BS410 Part 1	Test Sieves Technical Requirements and Testing. Test Sieves of Metal Wire Cloth
BS410 Part 2	Test Sieves. Technical Requirements and Testing. Test Sieves of Perforated Metal Plate
BS903 PartA1	Physical Testing of Rubber. Determination of Density
BS3900 Part F4	Methods of Tests for Paint; Resistance to Continuous Salt Spray
BS4147	Specification for Bitumen-Based Hot-Applied Coating Materials for Protecting Iron And Steel, Including Suitable Primers Where Required
BS4164	Specification for Coal-Tar-Based Hot-Applied Coating Materials for Protecting Iron And Steel, Including a Suitable Primer
BS6374 Part 5	Lining of Equipment with Polymeric Materials for the Process Industries Part 5. Specification for Lining with Rubbers

2.3 CSA (Canadian Standards Association)

CAN/CSA-Z245.20/21	External Fusion Bond Epoxy Coating for Steel Pipe-External Polyethylene Coating for Pipe
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2.4 DIN (Deutsche Industrie Normen)

DIN 30670	Polyethylene Coatings of Steel Pipes and Fittings; Requirements and Testing
DIN 30671	Thermoses Plastic Coatings for Buried Steel Pipes
DIN 30678	Polypropylene Coatings for Steel Pipes
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	Methods for Determination of Softening Point of Bitumen (Ring and Ball)
EN 10204	Metallic Products – Types of Inspection Documents

2.7 GBE (Gas Business Engineering/British Gas)

GBE/CW6	Technical Specification for the External Protection of Steel Linepipe and Fittings Using Fusion Bonded Powder and Associated Coating Systems
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2.8 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 813	Rubber, Vulcanised or Thermoplastic-Determination of Adhesion to Rigid Substrate- 90 Degree Peel Method
ISO 815	Physical Testing of Rubber. Method for Determination of Compression Set at Ambient, Elevated and Low Temperatures
ISO 845	Cellular Plastics and Rubbers – Determination of Apparent (Bulk) Density
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 1306	Rubber Compounding Ingredients-Carbon Black (Pelletized)-Determination of Pour Density
ISO 1431-3	Rubber, Vulcanised or Thermoplastic-Resistance to Ozone Cracking- Part 1: Static Strain Test
ISO 1515	Paints and Varnishes – Determination of Volatile and Non-Volatile Matter
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 2409	Paints and Varnishes – Cross-Cut Test
ISO 2431	Paints and Varnishes – Determination of Flow Time by Use of Flow Cups
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 3001	Plastics-Epoxy Compounds-Determination of Epoxy Equivalent

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 4624	Paints and Varnishes – Pull-Off Test for Adhesion
ISO 4892-2	Plastics – Methods of Exposure to Laboratory; Light Sources
ISO 7253	Paints and Varnishes-Determination of Resistance to Neutral Salt Spray
ISO 8130-6	Determination of Gel Time of Thermosetting Coating Powders at a Given Temperature
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 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 10005	Quality Management- Guidelines for Quality Plans
ISO 10474	Steel and Steel Products – Inspection Documents
ISO 13736	Methods for Determination of the Flash Point by the Abeles Apparatus

2.9 NACE (National Association of Corrosion Engineers)

NACE RP0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation
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2.10 NF (Normes Francaise)

NF A 49-710	External 3- Layer Polyethylene Based Coating. Application by Extrusion
NF A 49-711	External 3- Layer Polypropylene Based Coating. Application by Extrusion

3. Terminology and Definitions

<i>Owner</i>	party legally responsible for design, construction and operation of the pipeline
<i>Purchaser</i>	party (Owner or main contractor) issuing inquiry or contract for coating work, or nominated representative
<i>Contractor</i>	party to whom the coating work has been contracted
<i>manufacture/manufacturing</i>	“manufacture/manufacturing” relates to the processes associated with the qualification of linepipe coating (PQT), and the subsequent production of such coatings. The producer of coating materials is referred to as “coating material supplier” or “supplier”
<i>shall</i>	indicates a mandatory requirement
<i>should</i>	indicates a preferred course of action
<i>may</i>	indicates a permissible course of action
<i>agreed/agreement</i>	refers to a written arrangement between <i>Purchaser</i> and <i>Contractor</i> (e.g. as stated in a contract)
<i>report and notify</i>	refers to an action by <i>Contractor</i> in writing
<i>accepted/acceptance</i>	refers to a confirmation by <i>Purchaser</i> in writing
<i>certificate/certified</i>	refers to the confirmation of specified properties issued by <i>Contractor</i> or supplier of coating materials according to EN 10204:3.1.B, ISO 10475:5.1-B or equivalent
<i>purchase document(s)</i>	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

CDS	Coating Data Sheet
CP	Cathodic Protection
CR	Concession Request
FBE	Fusion Bonded Epoxy
ITP	Inspection and Testing Plan (see 5.3.2)
LE	Liquid Epoxy (“two-pack” type)
MIP	Manufacturing and Inspection Plan (see 5.3.3)
MPS	(Coating) Manufacturing Procedure Specification (see 5.1)
NC	Non-Conformance
PDS	(Coating material) Product Data Sheet (see 5.4.4)
PE	Polyethylene (polyethene)
PP	Polypropylene (polypropene)
PQT	(Coating) Pre-Production Qualification Testing (see 5.2)
RP	Recommended Practice

5. Common Requirements

5.1 Manufacturing procedure specification

5.1.1 All work associated with coating manufacturing (including its qualification; “PQT”, see 5.2) shall be described in procedures which shall be compiled in a ‘manufacturing procedure specification’ (MPS). This MPS shall be submitted

to the Purchaser prior to the PQT and/or start of production.

5.1.2 The MPS shall as a minimum include the following data sheets, procedures and other information:

- coating material properties, including supplier’s product data sheets (PDS) and/or certificates (5.4.3 - 5.4.9)
- receipt, handling and storage of materials for surface preparation and coating (5.4.10 - 5.4.12)
- coating plant lay-out sketch or flow diagram
- surface preparation (5.5)
- data sheets for chemical pre-treatment products (5.5.14) and masking tape (5.6.4), if applicable
- coating application (including control of essential process parameters, see 5.6.6)
- inspection and testing (5.5, 5.7)
- coating repairs and stripping of unrepairable coating (5.8)
- preparation of pipe ends after coating (5.6.6, 5.6.7 and 5.7.5)
- pipe tracking (5.5.2, 5.9.1)
- marking and documentation (5.5.2 and 5.9)
- handling and storage of coated and uncoated pipes (5.10).

Procedures for the last five items are subject to acceptance by Purchaser. Some detailed requirements for items to be included in the coating manufacturing specification are given in 5.4 - 5.10.

Guidance note:

For “accepted/“acceptance”, and “agreed/“agreement”, see definitions in Sec .3

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5.1.3 Purchaser may specify (see 1.3.3) that other additional detailed information is included in the MPS, e.g. procedures for testing and inspection, Contractor’s management of non-conformities and concession requests (see 1.3.3).

5.2 Pre-production qualification testing (PQT)

5.2.1 The primary objective of the ‘pre-production qualification testing’ (PQT) is to verify that the MPS is 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 use the specific coating materials, equipment and key personnel to be used during ordinary production. Furthermore, it shall establish that specified dimensions/tolerances for cut-back preparation and 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 pipe joints with buckle arrestor and pipeline components, if applicable, shall be included in the PQT.

5.2.2 Coating manufacturing procedures (including repairs) and equipment for coating shall be qualified prior to production, or alternatively (if contractually agreed) during the manufacturing start-up phase of the plant (normally referred to as “first day production test”).

Guidance note:

For more complex coating systems, it is recommended that the PQT is carried out in due time prior to start-up of production.

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5.2.3 Purchaser may choose to accept results from a previous qualification using identical coating materials and process parameters, and similar pipe dimensions (to be confirmed in contract). However, significant changes of essential process parameters (e.g. application temperature for pipe material and coating materials, line speed, etc.), coating material formulation or pipe dimension require re-qualification.

Guidance note:

In case of any doubt whether changes of process parameters are “significant”, a new PQT should always be carried out. For certain coating systems, in particular those that are dependant on curing of an innermost epoxy layer by induction heating, the quality of the coating is dependant on a combination of parameters, including coil arrangement and applied power, line speed and pipe wall thickness that are unique for each specific project. The PQT shall demonstrate proper application temperature by direct temperature recordings at the location where FBE shall be applied. Furthermore, it is essential for coating configuration at pipe ends i.e. length of cut-back and coating chamfer angle, that the capability of the equipment to apply a uniform thickness of the individual layers is verified prior to start of production. It is recommended that a previous PQT of such coating systems is not accepted, and that the PQT is witnessed by a competent person representing Purchaser.

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5.2.4 Specific requirements for pre-production qualification testing, including e.g. number of pipes to be coated and repaired, schedule for notification and reporting, shall be specified in the purchase document (see 1.3.2 -1.3.4 and definition of “purchase document” in Sec. 3).

5.2.5 For pipes with internal coating, the PQT shall confirm no detrimental effects of 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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5.2.6 For linepipe coating intended for thermal insulation, Purchaser may require verification of insulating capacity by testing (to be specified in the purchase document).

5.2.7 Purchaser may require that the PQT shall include qualification of individual coating applicators to carry out more complex repairs of coating.

5.2.8 An MPS and an ‘inspection and test plan’ (ITP, see 5.3.2) specific for the PQT, together with a detailed schedule for coating application, inspection/testing and reporting shall be submitted to Purchaser in a timely manner (as per purchase document) prior to start-up of the qualification activities.

5.2.9 Coating application temperature, drying or curing conditions, shall be according to coating material supplier’s recommendations. Data sheets and calibration certificates for instruments essential to quality control (e.g. temperature sensors) shall be available for Purchaser’s review during the PQT.

5.2.10 If practical, the pipes to be coated for PQT should be of the same supply as that used for production. As a minimum, 3 pipes shall be coated with a full coating system. For 3- and multi-layer systems with an innermost layer of FBE, minimum one pipe shall be coated without adhesive to allow easy stripping of the outer PE/PP layer for verification of FBE thickness, curing of FBE and PE/PP as-applied tensile properties. The number of personnel involved in coating application during the PQT, including any supervisor, should be the same as that used for normal production.

5.2.11 Purchaser shall have the right to select or accept pipe(s) for inspection and testing during the PQT. Unless otherwise agreed, test methods and acceptance criteria shall be in accordance with the applicable CDS in ANNEX 1 of this document. The frequency and extent of testing for properties with a frequency/extent of testing noted as “by agreement” in the CDS shall be specified in purchase document (1.3.3).

5.2.12 Qualification of coating repairs shall be performed to verify the properties of maximum allowable repair size as specified in purchase document. Minimum 3 repairs shall be

carried out for each repair procedure to be used for repairs. 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).

5.2.13 Results from all inspection, testing and calibrations during qualification, recordings of essential operational 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. Unless otherwise agreed, the report shall be accepted by Purchaser prior to start of production.

5.3 Quality control of production

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

- a project specific MPS updated to reflect the process parameters used during the completed and accepted PQT
- a project specific ‘inspection and testing plan’ (ITP) updated to reflect the process parameters used during the completed and accepted PQT (see 5.3.2)
- a daily log format (see 5.7.10)
- a description of responsibilities of personnel involved in quality control.

5.3.2 The ITP shall meet the general requirements of ISO 10005, Sec. 5.10. It shall be in tabular form, defining all quality control activities associated with receipt of coating materials, inspection and marking of incoming pipe, surface preparation, coating application and inspection/testing of the applied coating. The activities shall be listed in consecutive order, with each activity assigned a unique number and with reference to the applicable code(s), standard(s) and Contractor’s procedure(s) or work instruction(s) that shall apply for the specific project. Furthermore, frequency / extent of inspection and testing, acceptance criteria and actions in the case of non-conformances shall be defined in the plan. The ITP shall further contain a column for inspection codes, (e.g. inspection, witnessing and hold points) indicating the involvement of Contractor, Purchaser and any 3rd party. It is good practice to include a reference to the applicable reporting form/document and to refer to the specific equipment or tools to be used for verification.

Guidance note:

It is recommended that the ITP also reflects the relevant manufacturing steps, in addition to the inspection and testing activities, all in the consecutive order they occur during production. Such a document is sometimes referred to as a ‘manufacturing and inspection plan’ (MIP).

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5.3.3 Unless otherwise agreed (see 1.3.3), 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 MPS / ITP” means that testing method and/or acceptance criteria are optional to Contractor but shall be defined in the MPS / ITP
- “to be included” under “frequency / qualification” means that testing shall be included during PQT
- “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 is preferably to be specified by Purchaser in inquiry and the agreed method / criterion shall be included 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).

For specification of amendments and deviations to the data sheets, see 1.3.5.

5.3.4 The MPS, ITP, and 'daily log' shall be in English, unless otherwise agreed.

5.3.5 Procedures and work instructions referenced in the ITP, and applicable acceptance criteria, shall be available to all persons concerned with the associated work and in their normal language.

5.3.6 Purchaser shall have the right to inspect any activity associated with coating work throughout production and to carry out audits of Contractor's QA / QC system. Purchaser shall identify any hold points for witnessing (see 5.7.1) in the ITP and inform Contractor accordingly.

5.4 Coating and blasting materials

5.4.1 In this sub-section, "coating materials" cover materials for coating repairs as well as for linepipe coating.

5.4.2 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 Contractor'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 conceptual design).

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5.4.3 Supplier specific coating materials shall be specified by Contractor in the MPS (see 5.1.2). Purchaser may specify in inquiry any preferences for supplier specific coating materials.

Guidance note:

Prior to the issue of a specific purchase order, Purchaser or Contractor may choose to qualify specific coating material formulations according to their own requirements for linepipe coating (which need not be project specific). Such coating qualification should be specific to a production facility, and a defined range of production process parameters. Purchaser and/or Contractor may require witnessing of the coating material qualification testing, either by himself or by a third party, or that the qualification testing shall be performed by a third party.

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5.4.4 Coating materials shall be described by supplier in specific 'product data sheets' (PDS), including 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 PDSs (including those to be used for repairs) shall be contained in the MPS.

5.4.5 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 panels with applied coating, or specially prepared coating layers (i.e. without substrate) are used.

5.4.6 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 EN 10204 or ISO 10474), in accordance with section 2, column "Production", of the relevant 'coating data sheet' (CDS) in ANNEX 1.

Contractor may specify further properties for batch wise certification as indicated "by agreement" in the CDS.

Guidance note:

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

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5.4.7 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 (EN 10204, type 2.2 or ISO 10474). For certain coating systems, mandatory requirements for certification of such processed properties apply as indicated by "to be included" or "to be agreed" in section 2 of the CDS, column "Coating Material Qualification" (see 1.3.2). Contractor may specify further properties for certification as indicated "by agreement" in the CDS (see 1.3.3).

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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5.4.8 Properties of blasting materials shall be documented (e.g. in a product data sheet for inclusion in the MPS). Abrasives for stainless steel linepipe shall be based on fused aluminium oxide, stainless steel shot or non-ferrous garnet according to an appropriate standard.

5.4.9 Contractor shall verify that all coating materials and abrasives received are in accordance with the specified requirements in the MPS. The verification may include testing - by Contractor himself (or by a third party) -, and/or review of supplier's certificates. Review of certificates and any verification testing to be performed by Contractor shall be included in the ITP.

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

5.4.11 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 and handling (including health and safety notes).

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

5.4.13 Any mixing of coating material batches/lots to be used for production shall be described in the MPS.

5.4.14 Recycled coating materials may be used if detailed in the MPS, stating e.g. requirements to cleaning and maximum addition to virgin coating material. Purchaser may require documentation that such use does not affect the specified properties. For FBE powder, the maximum amount of recycled material shall not exceed 15%.

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

5.5 Receipt inspection of pipes and surface preparation

5.5.1 All surface preparation and associated inspection and monitoring activities shall be carried out according to the qualified MPS and ITP (5.3.2). Methods, acceptance criteria and frequency or extent of inspection and testing shall comply with requirements given in the relevant CDS in ANNEX 1, and/or amendments in purchase documents (see 1.3.2 and 1.3.3) as applicable. Once qualified, any changes from the MPS / ITP shall be formally accepted by Purchaser through a "concession request" (CR).

5.5.2 On receipt, every pipe shall be identified by a unique number (i.e. as applied by pipe manufacturer) and any additional marking made by Contractor to maintain identity shall be performed as specified or accepted by Purchaser (5.9.1). Intermediate storage of pipes shall be according to 5.10.

5.5.3 Each pipe shall be subject to an initial visual examination. Particular emphasis shall be paid to examination of pipe ends. Pipes with severe damage such as dents, ovality, cuts and other defects that cannot be corrected by surface dressing shall be removed and Purchaser notified accordingly. Any requirements to additional checking of pipe dimensions and/or weight shall be specified in purchase document.

5.5.4 Salts, soils and other loose contamination 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 MPS). Purchaser shall be notified promptly if the surface condition of the received pipes is deemed to affect the quality of the coating.

5.5.5 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 coating supplier's recommendations shall be accepted by Purchaser. Materials and equipment to be used shall be described in the MPS.

5.5.6 Relevant properties of blasting materials shall be documented (e.g. in a product data sheet). Receipt, storage and marking of purchased products shall be as defined in 5.4.9 - 5.4.13. 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 (to be specified in the ITP and recorded in the 'daily log'). Checking of oil contamination shall be carried out according to ASTM D4285. Conditioning of grit during production shall be described in the MPS. Special precautions shall be taken to avoid contamination of blasting materials for stainless steel linepipe (to be described in MPS).

5.5.7 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 C-steel particles, C-steel tools and handling equipment.

5.5.8 During blast cleaning, the pipe surface shall be at least 3°C above the dew point temperature and the ambient relative humidity should not exceed 85%. Pre-heating of pipes is required if humidity is higher.

5.5.9 After the blast cleaning, the pipes shall be thoroughly checked, e.g. by survey alongside a rotating pipe so that the entire pipe surface is covered.

5.5.10 Marking of defects (if applicable) shall be carried out using "French chalk" only.

5.5.11 Slivers, swabs, burns, laminations or gouges shall be removed by cosmetic grinding. (Any needs for, and specific requirements to, more excessive grinding required by Purchaser shall be specified in purchase documents). The remaining wall thickness shall comply with the applicable linepipe specification. (Checking of remaining wall thickness by ultrasonic testing shall be according to ASTM E797 or equivalent). Pipes with any dressed area larger than 10 cm² shall be completely re-blasted. Unrepairable pipes shall be quarantined and Purchaser notified accordingly.

5.5.12 Dust or abrasive remains shall be removed from the pipe surface using dry clean air, vacuum cleaning, brushing or an equivalent technique. Compressed air quality shall be controlled (to be specified in MPS / ITP). Surface cleanliness and roughness shall be verified as detailed in 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 Contractor shall issue a 'non-conformance report' suggesting measures to improve the efficiency of the associated process.

5.5.13 Precautions shall be taken to avoid contamination or other damage to the pipe surface after completed surface preparation (e.g. by conveyor rollers) and/or superficial rusting. Requirements for maximum duration (in hours) between blasting and coating, and/or maximum relative humidity shall be specified in the MPS / ITP.

5.5.14 Mechanical surface preparation may be followed by a chemical treatment (to be stated in the MPS / ITP) if accepted by Purchaser. Any associated pre-heating of pipes, checking of chemicals and control of application shall be specified in MPS / ITP.

5.6 Coating application

5.6.1 All coating work shall be carried out according to the qualified MPS. Once the MPS has been qualified, any changes of materials, equipment and essential process parameters (including e.g. change in line speed) shall be formally accepted by Purchaser through a CR.

5.6.2 If pre-heating is applied, temperature control shall ensure that no pipe is heated above 270°C. Powder application on linepipe shall be by automatic electrostatic spraying with control of compressed air quality. For use of re-cycled coating materials, see 5.4.14.

5.6.3 Throughout coating application, essential parameters affecting the quality of the coating (e.g. application temperature of linepipe and coating materials, line speed, relative humidity, etc) shall be monitored on-line and recordings noted in the 'daily log' (5.7.10). For certain coating systems, the application temperature shall be continuously monitored and recorded on-line as specified in the applicable pipeline 'coating data sheet' in ANNEX 1. Equipment for monitoring shall be calibrated at scheduled intervals as specified in the ITP (5.3.2).

5.6.4 Any use of temporary coatings or tapes to mask coating application at pipe ends shall be described in the MPS (material data sheets to be included).

5.6.5 Coating thickness (nominal and minimum values of individual layers, maximum value if applicable) shall be defined in purchase document (i.e. unless thicknesses stated in the CDS shall apply).

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.

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5.6.6 The length and surface condition of pipe ends to be left uncoated (or "cut-back"), and any chamfering of edges, shall be performed in accordance with the requirements in purchase documents and in the MPS. Any use of temporary protective coating on pipe ends shall be specified or accepted by Purchaser.

5.6.7 Any remainders of coating or blasting materials on the internal pipe surface shall be removed by an appropriate method. Special requirements to cleanliness of internal surfaces may apply as 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.

5.7 Inspection and testing of coated pipes

5.7.1 Coated pipes shall be inspected and tested according to the ITP (5.3.2). Any changes shall be formally accepted by Purchaser through a 'concession request'. Purchaser shall be allowed to witness all inspection and testing. Contractor shall give adequate notice for Purchaser to arrange for witnessing of special hold points indicated in the ITP (see 5.3.6).

Guidance note:

Purchaser should 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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5.7.2 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 the applicable CDS and any amendments made in purchase documents (see 1.3.2 and 3.3). If alternative test methods are given in the CDS and Purchaser has not specified any preference in purchase document (see 1.3.4), then the selection of method is optional to Contractor.

5.7.3 Purchaser may specify testing of specified coating properties during production requiring cutting of pipe wall (e.g. cathodic disbondment testing and hot water soak test). Such testing may then be carried out on a special (dummy) test pipe if all other conditions are the same as for regular production.

5.7.4 Visual inspection of completed coating shall ensure that the entire pipe surface is covered, e.g. by survey alongside a rotating pipe.

Guidance note:

Acceptance criteria for visual coating defects should be quantitative as far as practical. Photographs of non-acceptable defects may be helpful. Characterisation of damage to the linepipe coating should distinguish between, e.g.

- 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).

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5.7.5 Inspection shall verify specified dimensions for coating cut-backs and any requirements for cleanliness of pipe ends.

5.7.6 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.

5.7.7 Individual pipes not meeting specified criteria shall be re-coated, or if possible (see 5.8), 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 testing frequency to be increased. Similarly, subject to acceptance by Purchaser, testing frequency may be reduced as a result of repeated successful testing.

5.7.8 In case of repeated failures to meet specified requirements, production shall be discontinued. Contractor shall then carry out an examination of the cause(s) of the failure and issue a 'non-conformance report'. Non-conforming pipes (individual or lots) shall be marked and quarantined.

5.7.9 Purchaser may specify a final inspection of the pipe coating prior to discharge.

5.7.10 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 the 'daily log'. For pipe specific data, reference shall be made to the unique pipe number 5.5.2). The log shall be up-dated on a daily basis and is to be available for Purchaser's review at any time during manufacturing.

5.8 Repairs and stripping

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

5.8.2 Coating repairs shall also be carried out and inspected according to a qualified procedure (see 5.2). Requirements to coating repair materials in 5.4 apply.

5.8.3 Maximum permissible repairs (e.g. maximum surface area of individual repair, maximum repairs per pipe and maximum number of pipes with repairs) shall be specified in purchase documents (1.3.2 and 1.3.3) and in MPS. Inspection of repairs shall as a minimum include visual examination, checking of thickness and holiday detection.

5.8.4 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 material.

5.8.5 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 270°C. Multiple stripping of coating (i.e. for the same pipe) shall be subject to a CR.

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

5.9 Documentation and marking

5.9.1 Specific requirements to pipe tracking (e.g. electronic format), marking and documentation format shall be specified in purchase documents (1.3.2). Contractor's marking and pipe tracking shall be described in the MPS and included as a specific activity in the ITP.

5.9.2 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 5.7.10.

5.9.3 Documentation, including coating material certificates, shall be retained by Contractor for minimum 5 years, or as agreed upon.

5.9.4 Contractor shall issue an inspection document corresponding to the requirements given in EN 10204 or ISO 10474, inspection certificate 3.1.B.

5.10 Handling and storage of pipes

5.10.1 Pipes shall be handled and stored such that damage to coated and uncoated surfaces is avoided and in accordance with any special requirements in purchase documents. A procedure shall be contained in the MPS and is subject to acceptance by Purchaser.

5.10.2 Materials to be used on e.g. conveyors, rollers, pipe racks, fork padding and hooks contacting the external/internal pipe surface shall be specified in MPS. Stainless steel pipes require special considerations to avoid surface contamination (e.g. from use of C-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.

5.10.3 Damage to coatings during handling or storage shall be repaired according to 5.8, whilst any damage to linepipe material shall be reported to Purchaser. (Pipes with damage to linepipe material shall be separated and quarantined).

5.10.4 Any specific requirements for packaging or other means of protection of coated pipes for shipping (including use of end-caps) shall be defined in the purchase documents (1.3.3).

6. ANNEX 1 Coating Data Sheets

Coating Data Sheet No.1: Single or Dual Layer Fusion Bonded Epoxy Coating				
1 Coating Configuration				
Epoxy layer		FBE: Typical nominal value 400 μm to 600 μm (min/max value and test method/frequency to be agreed for inclusion in ITP)		
2 Coating Materials				
Item/Property	Test method	Acceptance criteria	Frequency	
			Coating Material Qualification and PQT	Production
2.1.1 FBE material, raw material property				
Density	ISO 2811	according to PDS	not applicable	every batch/lot
Particle size	according to PDS	according to PDS	not applicable	every batch/lot
Max. moisture content	according to PDS	according to PDS	not applicable	every batch/lot
Gel time	ISO 8130-6	according to PDS	not applicable	every batch/lot
Thermal analysis	NF A 49-711 or GBE/CW6 part 1, App. A	according to PDS	not applicable	by agreement
Infrared scan	by agreement	by agreement	by agreement	by agreement
2.1.2 FBE material, processed (as-applied) property				
Glass transition temperature	by agreement	min. 95°C and min. 5°C above pipeline max. operating temperature	to be included	not applicable
Water resistance	ASTM D870, 3000 hrs at 85°C or GBE/CW6 part 1, App. E	no blistering, loss of hardness <10% according to standard	to be included	not applicable
Flexibility (bending) test	GBE-CW6 Part 1 or CAN/CSA 245.20	according to standard or by agreement	to be included	not applicable
Impact resistance	ASTM G14 or GBE/CW6 part 1, App. D	>13 Joules acc. to standard	by agreement	not applicable
Salt spray test	ISO 7253, 4000 hrs or BS 3900, Part F4	no rusting, no blistering	by agreement	not applicable
Cathodic disbonding	ASTM G8 or GBE/CW6, part 1, App. F or or other agreed procedure	by agreement	by agreement	not applicable
Abrasion resistance	ASTM D4060	<0.050 g/1000 cycles	by agreement	not applicable
2.2.1 LE material, raw material property (for coating repairs)				
Epoxy equivalent in the base	ISO 3001			
Volume solids of the base and hardener	ISO 3251	according to PDS	not applicable	every batch
Viscosity of base and hardener	ISO 2655	according to PDS	not applicable	every batch
2.2.2 LE material, processed material property (for coating repairs)				
not applicable				
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	to be included	every pipe
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 8501-2 and ISO 8502 -6 or agreed method	max. 10 mg NaCl/m ²	to be included	first 5, then 1/30 both pipe ends

Coating Data Sheet No.1: Single or Dual Layer Fusion Bonded Epoxy Coating (Continued)				
Initial/ intermediate washing by water or phosphoric acid	according to MPS/ITP	not applicable	by agreement	by agreement
Surface cleanliness	ISO 8501-1	A/B \geq Sa 2 ½.	to be included	every pipe
Surface cleanliness	ISO 8502-3	rating max. 2	to be included	first 5, then 1/30 both pipe ends
Surface roughness	ISO 8503-4	R _Z min. 40 µm; max. 100 µm	to be included	first 5, then 1/30 both pipe ends
Final surface condition	visual examination	free from surface defects	to be included	every pipe
Pipe temperature prior to chemical treatment (if specified in MPS)	according to ITP	according to ITP	to be included	continuous monitoring

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	to be included	continuous monitoring
Coating material and pipe temperatures	according to ITP	according to ITP	to be included	continuous monitoring
Pipe feed rate	according to ITP	according to ITP	to be included	continuous monitoring
Water quenching	according to ITP	according to ITP	to be included	continuous monitoring
Appearance of coating	visual	according to ITP	to be included, 100% surface area	every pipe, 100% surface area
Pipe end configuration	according to ITP	according to ITP	to be included	every pipe, both pipe ends
Holiday detection	GBE/CW6 part 1, App. C or by agreement	no holidays	to be included, 100% surface area	every pipe, 100% surface area (visual/acoustic alarm function)
Thickness	ISO 2808 or by agreement	according to ITP	to be included	first pipe and start/lead pipe ¹⁾ , then one pipe every shift 4 recordings (90°) at both pipe ends and mid section
Degree of cure	FBE: differential thermal analysis according to GBE/CW6 or by agreement	FBE: $\Delta T_G = \max. 5^\circ\text{C}$	to be included	first pipe, start/lead pipe ¹⁾ then one pipe every shift
Adhesion	ISO 2409 or ISO 4624 or DIN 30671 or by agreement	classification: 0 (ISO 2409) min. 34 MPa (ISO 4624) no detachment (DIN 30671)	to be included	by agreement
Impact resistance	GBE/CW6 part 1, App. D or ASTM G14	according to standard	to be included	not applicable
Hardness	ISO 2815	by agreement	by agreement	by agreement
Porosity	CAN/CSA-Z245.20	by agreement	by agreement	by agreement
Bending resistance (specimen) at room temperature	GBE/CW6, Appendix B (min. 2% strain)	no cracking or disbondment	to be included	by agreement
Cathodic disbonding	ASTM G8 or GBE/CW6, part 1, App. E or other agreed procedure	max. 7 mm disbonding, 48 hrs at 65°C, or 28 days at room temperature	to be included	by agreement
Hot water soak test	GBE/CW6 Part 1, App. E or agreed procedure	according to standard	to be included	by agreement
Residual magnetism	by agreement	by agreement	by agreement	by agreement

1) "start/lead pipe" refers to first pipe after interrupted coating

"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 5.3.3

END OF CDS 1

Coating Data Sheet No.2: 3-Layer Polyethylene Coating				
1 Coating Configuration				
Fusion bonded epoxy	Typical nominal value 200 µm to 400 µm (min/max value and test method/frequency to be agreed for inclusion in ITP)			
Polyethylene adhesive	According to ITP			
Polyethylene outer sheath	According to ITP			
Total thickness	Min. 2.0 mm (to be agreed for inclusion in ITP)			
2 Coating Materials				
Item/Property	Test method	Acceptance criteria	Frequency	
			Coating Material Qualification and PQT	Production
2.1.1 FBE material, raw material property				
	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1
2.1.2 FBE material, processed (as-applied) property				
	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2
2.1.3 LE material, raw material property (for coating repairs)				
	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1
2.1.4 LE material, processed material property (for coating repairs)				
	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2
2.2.1 PE adhesive material, raw material property				
Density	ISO 1183	according to PDS	not applicable	every batch
Particle size (for spraying)	According to PDS	according to PDS	not applicable	every batch
Melt flow index/rate	ISO 1133 or ASTM D1238	according to PDS	not applicable	every batch
Softening point (Vicat)	ISO 1306 or ASTM D1525	according to PDS	not applicable	every batch
2.3.1 PE material, raw material property				
Density	ISO 1183	>0.94 kg/dm ³	not applicable	every batch/lot
Melt flow index/rate	ISO 1133 or ASTM D1238	according to PDS	not applicable	every batch/lot
Softening point (Vicat)	ISO 306 or ASTM D1525	≥110°C	not applicable	every batch/lot
Melting point	ISO 3146	≥120°C	not applicable	by agreement
Thermo stabilisation	ASTM D3895	by agreement	by agreement	by agreement
2.3.2 PE material, processed (as-applied) property				
Hardness	ISO 868 or ASTM D785	≥50 Shore D	to be included	by agreement
Impact resistance	NF A 49-710	according to standard	to be included	not applicable
Izod impact, room temperature	ASTM D256	by agreement	by agreement	by agreement
Tensile properties, room temperature	ISO 527 or ASTM D638	tensile strength at yield ≥20 MPa elongation at break ≥400%	to be included	by agreement
Indentation	NF A 49-710	max. 0.1 mm at 20°C max. 0.3 mm at 80°C	to be included	not applicable
Thermal degradation resistance	NF A 49-710	≥100 days	to be included	not applicable
Flexural modulus	ASTM D790 or ISO 178	≥700MPa	by agreement	not applicable
Brittleness temperature	ASTM D746	<-40°C	by agreement	not applicable
UV resistance	ISO 4892-2 or DIN 30670 or NF A 49-710	by agreement (ISO) or according to standard (NF)	by agreement	not applicable
Abrasion resistance	ASTM D4060 or DIN 53516	by agreement	by agreement	not applicable
Fungi resistance	ASTM G21	no growth	by agreement	not applicable
Bacteria resistance	ASTM G22	no growth	by agreement	not applicable

Coating Data Sheet No.2: 3-Layer Polyethylene Coating (Continued)				
Water absorption	ASTM D570	<0.5% per 24 hours	by agreement	not applicable
Water vapour permeability	ASTM E 96	<0.1g/m ² per 24 hours	by agreement	not applicable
Thermal conductivity	ASTM C518	by agreement	by agreement	not applicable
Volume resistivity	ASTM D 257	≥10 ¹³ ohm cm	by agreement	not applicable
Electrical insulation capacity	NF A 49 –710	≥10 ⁸ ohm cm ²	by agreement	not applicable
Dielectric strength	ASTM D 149	≥25 kV/mm	by agreement	not applicable
3 Surface Preparation, Coating Application and Final Inspection/Testing				
3.1 Surface Preparation				
<i>Item/Property</i>	<i>Test method</i>	<i>Acceptance criteria</i>	<i>Frequency</i>	
			<i>PQT</i>	<i>Production</i>
as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1
3.2 Coating Application and Final Inspection/Testing				
<i>Item/Property:</i>	<i>Test method</i>	<i>Acceptance criteria</i>	<i>Frequency</i>	
			<i>PQT</i>	<i>Production</i>
3.2.1 Epoxy layer				
3.2.2 PE Adhesive Layer				
Thickness	according to MPS/ITP	according to ITP	to be included	by agreement
3.2.3 PE layer and full layer				
Coating material and pipe temperatures	according to MPS/ITP	according to ITP	to be included	continuous monitoring (pipe temperature before FBE application)
Pipe feed rate	according to MPS/ ITP	according to ITP	to be included	continuous monitoring
Water quenching	according to ITP	according to ITP	to be included	continuous monitoring
Appearance of coating	visual	according to ITP	to be included, 100% surface area	every pipe, 100% surface area
Pipe end configuration	according to MPS/ ITP	according to ITP	to be included	every pipe, both pipe ends
Holiday detection	NACE RP0274, 10 kV/mm nominal thickness, max. 25 kV, 200-300 mm/s or NF A 49-711	no holidays	to be included, 100% surface area	every pipe, 100% surface area (visual/acoustic alarm function)
Thickness	according to MPS/ ITP (method to be agreed)	according to purchase order and ITP	to be included, coverage to be defined for PQT	according to ITP (frequency and location to be agreed)
Adhesion (peel strength), at 20°C ±5°C at 80°C ±5°C	NF A 49-711, E3 or DIN 30670/30678	min. 150 N/cm, no peeling of FBE layer	to be included	first pipe and start/lead pipe ¹⁾ , then one per shift, both pipe ends
		min. 40 N/cm, no peeling of FBE layer	to be included	not applicable
Hardness	ISO 868	≥50 Shore D	to be included	not applicable
Impact resistance, at room temperature	NF A 49-711 or DIN 30670/30678	according to standard	to be included	first pipe and start/lead pipe ¹⁾ , or by agreement
at max. operating temperature,		by agreement	by agreement	not applicable
Indentation resistance, at room temperature and at 80°C	NF A 49-711 or DIN 30670/30678	max. 0.10 mm, 20°C max. 0.3 mm, 80°C	to be included	first pipe for each PP batch
at max. operating temperature, if higher than 80°C		to be agreed	to be included	by agreement
Tensile properties, at room temperature at room temperature at max. operating temperature	ASTM D638 or ISO 527 or NF A 49-711	UTS ≥20 MPa, elongation ≥400%	to be included	first pipe for each PP batch
		by agreement	by agreement	not applicable
Cathodic disbonding, at room temperature or at 65°C	ASTM G8 or GBE/CW6 or other agreed procedure	max. 7 mm disbonding, 48 hrs at 65°C or 28 days at room temperature	to be included	by agreement
at max. operating temperature, if higher than 65°C		by agreement	by agreement	by agreement

Coating Data Sheet No.2: 3-Layer Polyethylene Coating (Continued)				
Hot water soak test	GBE/CW6 Part 1, App. E (modified, cut edges freely exposed) or agreed proce- dure	max. 2 mm disbonding, 7 days at 80°C	to be included	by agreement
Bending resistance (full scale testing), at room temperature	by agreement	by agreement; (e.g. no cracking or disbond- ing at strain exceeding max. strain during installation by 30%)	by agreement	not applicable
at min. installation temperature	by agreement	by agreement (e.g. no cracking or disbond- ing at strain exceeding max. strain during installation by 30% and at 5°C below min. installation temperature)	by agreement	not applicable
Residual magnetism	by agreement	by agreement	by agreement	by agreement
1) "start/lead pipe" refers to first pipe after interrupted coating				
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 5.3.3				

END OF CDS 2

Coating Data Sheet No.3: 3-Layer Polypropylene Coating				
1 Coating Configuration				
Fusion bonded epoxy		Typical nominal value 200 µm to 400 µm (min/max value and test method/frequency to be agreed for inclusion in ITP)		
Polypropylene adhesive		According to ITP		
Polypropylene outer sheath		According to ITP		
Total thickness		min. 2.5 mm (to be agreed for inclusion in ITP)		
2 Coating Materials				
Item/Property	Test method	Acceptance criteria	Frequency	
			Coating Material Qualification and PQT	Production
2.1.1 FBE material, raw material property				
	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1
2.1.2 FBE material, processed (as-applied) property				
	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2
2.1.4 LE material, raw material property (for coating repairs)				
	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1
2.1.3 LE material, processed material prop- erty (for coating repairs)				
	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2
2.2.1 PP adhesive materi- al, raw material property				
Density	ISO 1183	according to PDS	not applicable	every batch
Particle size (for spraying)	According to PDS	according to PDS	not applicable	every batch
Melt flow index/rate	ISO 1133 or ASTM D1238	according to PDS	not applicable	every batch
Softening point (Vicat)	ISO 1306 or ASTM D1525	according to PDS	not applicable	every batch
2.2.2 PP adhesive materi- al, processed (as-applied) property				
Tensile properties, room temperature	ISO 527 ASTM D638	Tensile strength ≥12 MPa elongation at break ≥500%	by agreement	not applicable
Flexural modulus	ASTM D790	≥450 MPa	by agreement	not applicable
2.3.1 PP material, raw material property				
Density	ISO 1183	>0.89 kg/dm3	not applicable	every batch/lot
Melt flow index/rate	ISO 1133 or ASTM D1238	according to PDS	not applicable	every batch/lot
Softening point (Vicat)	ISO 306 or ASTM D1525	≥120°C	not applicable	every batch/lot
Melting point	ISO 3146	≥150°C	not applicable	by agreement
Thermo stabilisation	ASTM D3895	by agreement	by agreement	by agreement
2.3.2 PP material, processed (as-applied) property				
Hardness	ASTM D785 or ISO 868	≥60 Shore D	to be included	by agreement
Impact resistance	NF A 49-711	according to standard	to be included	not applicable
Izod impact, room temperature	ASTM D256	by agreement	by agreement	by agreement
Tensile properties, room temperature	ASTM D638	tensile strength at yield ≥20 MPa elongation at break ≥400%	to be included	by agreement
Indentation	NF A 49-711	max. 0.3 mm at 20°C max. 0.5 mm at 110°C	to be included	not applicable
Flexural modulus	ASTM D790 or ISO 178	≥700MPa	by agreement	not applicable
Brittleness temperature	ASTM D746	<-20°C	by agreement	not applicable

Coating Data Sheet No.3: 3-Layer Polypropylene Coating (Continued)				
Thermal degradation resistance	NF A 49-711	≥100 days	to be included	not applicable
UV resistance	ISO 4892-2 or NF A 49-711	by agreement (ISO) or according to standard (NF)	by agreement	not applicable
Abrasion resistance	ASTM D4060 or DIN 53516	by agreement	by agreement	not applicable
Fungi resistance	ASTM G21	no growth	by agreement	not applicable
Bacteria resistance	ASTM G22	no growth	by agreement	not applicable
Water absorption	ASTM D570	<0.5% per 24 hours	by agreement	not applicable
Water vapour permeability	ASTM E96	<0.1g/m ² per 24 hours	by agreement	not applicable
Thermal conductivity	ASTM C518	by agreement	by agreement	not applicable
Volume resistivity	ASTM D257	≥10 ¹³ ohm cm	by agreement	not applicable
Electrical insulation capacity	NF A 49-711	≥10 ⁸ ohm cm ²	by agreement	not applicable
Dielectric strength	ASTM D149	≥25 kV/mm	by agreement	not applicable
3 Coating Application and Final Inspection/Testing				
3.1 Surface Preparation				
Item/Property	Test method	Acceptance criteria	Frequency	
			PQT	Production
as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1
3.2 Coating Application and Final Inspection/Testing				
Item/Property:	Test method	Acceptance criteria	Frequency	
			PQT	Production
3.2.1 Epoxy layer				
as for CDS 1, 3.2	as for CDS 1, 3.2	as for CDS 1, 3.2	as for CDS 1, 3.2	as for CDS 1, 3.2
3.2.2 PP Adhesive Layer				
Thickness	according to MPS/ITP	according to ITP	to be included	by agreement
3.2.3 PP layer and full layer				
Coating material and pipe temperatures	according to MPS/ITP	according to ITP	to be included	continuous monitoring (pipe temperature before FBE application)
Pipe feed rate	according to MPS/ ITP	according to ITP	to be included	continuous monitoring
Water quenching	according to ITP	according to ITP	to be included	continuous monitoring
Appearance of coating	visual	according to ITP	to be included, 100% surface area	every pipe, 100% surface area
Pipe end configuration	according to MPS/ ITP	according to ITP	to be included	every pipe, both pipe ends
Holiday detection	NACE RP0274, 10 kV/mm nominal thickness, max. 25 kV, 200-300 mm/s or NF A 49-711	no "holidays"	to be included, 100% surface area	every pipe, 100% surface area (visual/acoustic alarm function)
Thickness	according to MPS/ ITP (method to be agreed)	according to purchase order and ITP	to be included, coverage to be defined for PQT	according to ITP (frequency and location to be agreed)
Adhesion (peel strength), at 100°C ±5°C	NF A 49-711, E3 or DIN 30670/30678	min. 50 N/cm, no peeling of FBE layer	to be included	first pipe and start/lead pipe ¹⁾ , then one per shift, both pipe ends
at max. operating temperature, if higher than 100°C		to be agreed	to be included	not applicable
Hardness	ISO 868	≥60 Shore D	to be included	not applicable
Impact resistance, at room temperature	NF A 49-711 or DIN 30670/30678	according to standard	to be included	first pipe and start/lead pipe ¹⁾ , or by agreement
at max. operating temperature,		by agreement	by agreement	not applicable
Indentation resistance, at room temperature and at 110°C	NF A 49-711 or DIN 30670/30678	max. 0.10 mm, 20°C max. 0.3 mm, 110°C	to be included	first pipe for each PP batch
at max. operating temperature, if higher than 110°C		to be agreed	to be included	by agreement
Tensile properties, at room temperature	ASTM D638 or ISO 527 or NF A 49-711	tensile strength at yield ≥20 MPa elongation at break ≥400%	to be included	first pipe for each PP batch
at max. operating temperature		by agreement	by agreement	not applicable

Coating Data Sheet No.3: 3-Layer Polypropylene Coating (Continued)				
Cathodic disbonding, at room temperature or at 65°C at max. operating temperature, if higher than 65°C	ASTM G8 or GBE/CW6 or other agreed procedure	max. 7 mm disbonding, 48 hrs at 65°C or 28 days at room temperature by agreement	to be included by agreement	by agreement by agreement
Hot water soak test	GBE/CW6 Part 1, App. E (modified, cut edges freely exposed) or agreed procedure	max. 2 mm disbonding, 7 days at 80°C	to be included	by agreement
Bending resistance (full scale test), at room temperature at min. installation temperature	by agreement by agreement	by agreement (e.g. no cracking or disbonding, no loss of adhesion strength after bending at strain exceeding max. strain during installation by 30%) by agreement (e.g. no cracking or disbonding, no loss of adhesion strength after bending at strain exceeding max. strain during installation by 30% and at 5°C below min. installation temperature)	by agreement by agreement	not applicable not applicable
Residual magnetism	by agreement	by agreement	by agreement	by agreement
1) "start/lead pipe" refers to first pipe after interrupted coating				
"according to ITP", "to be included", "to be agreed" and "by agreement" are explained in 5.3.3				

END OF CDS 3

Coating Data Sheet No. 4: Multi-Layer Polypropylene Coating				
1 Coating Configuration (typical)				
Fusion bonded epoxy (FBE)	Typical nominal value 200 μm to 400 μm (min/max value and test method/frequency to be agreed for inclusion in ITP)			
Polypropylene adhesive	According to ITP			
Polypropylene intermediate layer	According to ITP			
Polypropylene foam or syntactic layer	To be agreed for inclusion in ITP			
Polypropylene outer layer	According to ITP			
Total thickness	To be agreed for inclusion in ITP			
2 Coating Materials				
Item/Property to be tested	Test method	Acceptance criteria	Frequency of testing	
			Coating Material Qualification and PQT	Production
2.1.1 FBE material, raw material property				
	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1	as for CDS 1, 2.1.1
2.1.2 FBE material, processed (as-applied) property				
	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2	as for CDS 1, 2.1.2
2.2.1 LE material, raw material property (for coating repairs)				
	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1	as for CDS 1, 2.2.1
2.2.2 LE material, (as-applied) material property (for coating repairs)				
	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2	as for CDS 1, 2.2.2
2.3 PP foam material, raw material and processed (as-applied) properties				
Density	according to PDS	according to PDS	to be included	every batch/lot
Melt index	ISO 1133	according to PDS	not applicable	every batch/lot
Softening point	ISO 306	according to PDS	not applicable	every batch/lot
Tensile properties	ISO 527-2	by agreement	by agreement	not applicable
Flexural modulus	ISO 178	by agreement	by agreement	not applicable
2.4 PP Sheathing Material raw material and processed (as-applied) properties				
	as for CDS 3, 2.3.1 and 2.3.2	as for CDS 3, 2.3.1 and 2.3.2	as for CDS 3, 2.3.1 and 2.3.2	as for CDS 3, 2.3.1 and 2.3.2
3. Surface Preparation, Coating Application and Final Inspection/Testing				
3.1 Surface Preparation				
Properties	Test method	Acceptance criteria	Frequency	
as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1	as for CDS 1, 3.1	
3.2 Coating Application and Final Inspection/Testing				
3.2.1 FBE layer	as for CDS 1, 3.2	as for CDS 1, 3.2	as for CDS 1, 3.2	as for CDS 1, 3.2
3.2.2 Adhesive layer	as for CDS 1, 3.2.2	as for CDS 1, 3.2.2	as for CDS 1, 3.2.2	as for CDS 1, 3.2.2
3.2.3 First 3 layers				
PP temperature	according to MPS/ITP	according to ITP	to be included	continuous monitoring
Pipe feed rate	according to MPS/ITP	according to ITP	to be included	continuous monitoring
Water quenching	according to ITP	according to ITP	to be included	continuous monitoring
Appearance of coating	visual	according to ITP	to be included, 100% surface area	every pipe, 100% surface area
Thickness	according to MPS/ITP (method to be agreed)	according to ITP	to be included, coverage to be defined in PQT	according to ITP
Adhesion (peel strength), at 100°C ±5°C at max. operating temperature, if higher than 100°C	NF A 49-711, E3	min. 50 N/cm, no peeling of FBE layer to be agreed	to be included to be included	first pipe and start/lead pipe, then one per shift, both pipe ends not applicable

Coating Data Sheet No. 4: Multi-Layer Polypropylene Coating (Continued)				
Cathodic disbonding, at room temperature or 65°C	ASTM G8 or GBE/CW6 or other agreed procedure	max. 7 mm disbonding, 48 hrs at 65°C or 28 days at room temperature	to be included	by agreement
at max. operating tempera- ture, if higher than 65°C		by agreement	by agreement	not applicable
Hot water soak test	GBE/CW6 Part 1, App. E (modified, cut edges freely exposed) or agreed proce- dure	max. 2 mm disbonding, 7 days at 80°C	to be included	by agreement
3.2.4 Full layer (Inner 3-layer + foam layer + outer PP layer)				
Condition of 3-layer coating	visual	according to ITP	to be included	every pipe
Pre-heating temperature	according to MPS/ITP	according to ITP	to be included	continuous monitoring
Pipe feed rate	according to MPS/ITP	according to ITP	to be included	continuous monitoring
Water quenching	according to ITP	according to ITP	to be included	continuous monitoring
Appearance of coating	visual	according to ITP	to be included, 100% surface area	every pipe, 100% surface area
Overall thickness	according to MPS/ITP (method to be agreed)	according to purchase order and ITP	to be included, coverage to be defined for PQT	according to ITP, (fre- quency and location to be agreed)
Foam specific density	according to MPS/ITP	according to ITP	to be included	according to ITP
Adhesion of foam layer to in- ner 3-layer, shear test	according to MPS/ITP	according to ITP	to be included	first pipe and start/lead pipe, then one per shift,
Verification of heat insula- tion	according to MPS/ITP (e.g. by weighing of ap- plied coating)	according to ITP	to be included	every pipe
Full scale bending test, at room temperature	by agreement	by agreement (e.g. no cracking or dis- bonding, no loss of adhe- sion strength after bending at strain exceeding max. strain during installation by 30%)	by agreement	not applicable
at installation temperature	by agreement	by agreement (e.g. no cracking or dis- bonding, no loss of adhe- sion strength after bending at strain exceeding max. strain during installation by 30% and at 5°C below min. installation temperature)	by agreement	not applicable
“according to ITP”, “to be included”, “to be agreed” and “by agreement” are explained in 5.3.3				

END OF CDS 4

Coating Data Sheet No. 5: Asphalt Enamel (or “Bitumen”) Coating				
1 Coating Configuration				
Primer	Dry Film Thickness: min. 15 µm (20 ±5 µm) Type: BS 4147, Type B			
Asphalt Enamel	Thickness: 5-9 mm Type: BS 4147, Type 2 Grade b			
Inner wrapping	Thickness: min. 0.3 mm Type: Non woven fibre tissue consisting of uniformly porous mat of glass; Phenolic resin binder			
Outer wrapping	Thickness: min. 0.6 mm 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	Frequency (applicable to PQT and production)	
2.1 Primer material				
Volatile matter	BS 4147 Appendix A	according to BS 4147 Table 3	every batch/lot	
Viscosity	ISO 2431	according to BS 4147 Table 3	every batch/lot	
2.2 Filler material				
Filler fineness	BS 410	≥99% passing 250 µm sieve ≥90% passing 250 µm sieve	every batch/lot	
2.3 Asphalt enamel material				
Flash point	ISO 13736	min. 260°C	every batch/lot	
Filler content	BS 4147 Appendix B	according to BS 4147 Table 6	every batch/lot	
Density	BS 4147 Appendix C	according to BS 4147 Table 6	every batch/lot	
Softening point	EN 1426	according to BS 4147 Table 6	every batch/lot	
Penetration	BS 4147 Appendix D	according to BS 4147 Table 6	every batch/lot, twice per shift	
Sag test	BS 4147 Appendix E	according to BS 4147 Table 7	first batch/lot, then every 10 th	
Impact test	BS 4147 Appendix G	according to BS 4147 Table 7	first batch/lot, then every 10 th	
Bend test	BS 4147 Appendix F	according to BS 4147 Table 7	first batch/lot, then every 10 th	
Peel test	BS 4147 Appendix H	according to BS4 147 Table 7	first batch/lot, then every 10 th	
2.4 Inner wrapping material				
Hydrolytic class	ISO 719	min. Class 3	every batch/lot	
Weight	according to ITP	min. 42 g/m ²	every batch/lot	
Glass content	According to ITP	min. 40 g/ m ²	every batch/lot	
Binder content	according to ITP	max. 15% of total weight	every batch/lot	
Thickness	according to ITP	min. 0.3 mm	every batch/lot	
Tensile strength	according to ITP	longitudinal: min. 100 N / 5 cm strip lateral: min. 25 N / 5 cm strip	every batch/lot	
2.5 Outer wrapping material				
Hydrolytic class	same as for inner wrapping		every batch/lot	
Weight	according to ITP	min. 250 g/m ²	every batch/lot	
Glass content	according to ITP	min. 170 g/m ²	every batch/lot	
Thickness	according to ITP	min. 0.6 mm	every batch/lot	
Tensile strength	according to ITP	longitudinal and lateral: min. 800 N/ 5 cm strip	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	every 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 8502-2, -6 or agreed method	max. 30 mg NaCl/m ²	to be included	one per shift, both ends
Surface cleanliness	ISO 8501-1	A/B ≥ Sa 2 ½.	to be included	every pipe 100% surface area
Roughness	ISO 8503-2	grade Medium (G)	to be included	one per shift, both ends
Final surface condition	visual examination	free from surface defects	to be included	every pipe 100% surface area

Coating Data Sheet No. 5: Asphalt Enamel (or “Bitumen”) Coating (Continued)				
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	every pipe
Coating layer thickness	according to ITP	according to ITP	to be included	first 10 pipes then every 10 th pipe, 3x4 locations (90° apart)
3.2.2 Full layer				
Time duration from priming	according to ITP	according to ITP	to be included	every 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	every pipe
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	every pipe, 100% surface area
Total thickness	according to ITP	5.0 mm minimum (incl. seam weld) 9.0 mm maximum	to be included	first 10 pipes then every 10 th pipe, 3x4 locations (90° apart)
Holiday detection	NACE RP0274 min. 15 kV Rate: 150-250 mm/s	no defects acceptable	to be included	every pipe, 100% surface area
Adhesion (Tapping/sounding test)	tapping by wooden stick (According to ITP)	according to ITP	to be included	first 10 pipes then every 10 th pipe, “100%” surface area
Adhesion (Peeling test)	cutting by knife through coating (e.g. 30x100 mm strip) and peeling by force (According to ITP)	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
Compactness test	examination of strip removed from coating for homogeneity and thickness of individual layers (acc. to ITP)	according to ITP	to be included	first 5 pipes (one pipe end), then first pipe per shift
Pipe end configuration	according to ITP	according to ITP	to be included	every pipe, both pipe ends
“according to ITP”, “to be included”, “to be agreed” and “by agreement” are explained in 5.3.3				

END OF CDS 5

Coating Data Sheet No. 6: Coal Tar Enamel Coating				
1. Coating Configuration				
Primer		Dry Film Thickness: min. 15 µm (20 ±5 µm) Type: BS 4164, grade B		
Coal Tar Enamel		Thickness: 5-9 mm Type: BS 4164, grade 120/5		
Inner wrapping		Thickness: min. 0.3 mm Type: 1 wrap of glass mat, non-woven glass fibre		
Outer wrapping		Thickness: min. 0.6 mm (when impregnated) Type: 1 wrap of saturated woven glass fibre		
2. Coating Materials				
Item/Property	Test method	Acceptance criteria	Frequency (applicable to PQT and production)	
2.1 Primer material				
Viscosity	ISO 2431	according to BS 4164 Table 1	every batch/lot	
Flash point	ISO 13736	according to BS 4164 Table 1	every batch/lot	
Volatile matter	BS 4164 Appendix A	according to BS 4164 Table 1	every batch/lot	
2.2 Filler material				
Filler fineness	BS 410	≥99% passing 250 µm sieve ≥90% passing 250 µm sieve	every batch/lot	
2.3 Coal tar enamel material				
Filler content	BS 4164 Appendix B	according to BS 4164 Table 2	every batch/lot, once per shift	
Density	BS 4164 Appendix C	according to BS 4164 Table 2	every batch/lot, once per shift	
Softening point	BS 4164 Appendix D	according to BS 4164 Table 2	every batch/lot, once per shift	
Penetration	BS 4164 Appendix E	according to BS 4164 Table 2	every batch/lot, once per shift	
Viscosity	BS 4164 Appendix F	according to BS 4164 Table 2	every batch/lot, once per shift	
Sag test	BS 4164 Appendix G	according to BS 4164 Table 3	first batch/lot, then every 10 th	
Impact test	BS 4164, Appendix K	according to BS 4164 Table 3	first batch/lot, then every 10 th	
Bend test	BS 4164, Appendix J	according to BS 4164 Table 3	first batch/lot, then every 10 th	
Low temperature test for cracking and disbonding	BS 4164, Appendix H	according to BS 4164 Table 3	first batch/lot, then every 10 th	
Peel test	BS 4164, Appendix L	according to BS 4164 Table 3	first batch/lot, then every 10 th	
Cathodic disbonding test	BS 4164, Appendix M	according to BS 4164 Table 3	by agreement	
2.4 Inner wrapping material				
Hydrolytic Class	ISO 719	class 3 or better	every batch/lot	
Weight	according to ITP	min. 42 g/m ²	every batch/lot	
Binder content	according to ITP	10-18%	every batch/lot	
Thickness	according to ITP	according to ITP	every batch/lot	
Tensile strength	according to ITP	min. 306 N/150 mm wide strip measured in the longitudinal direction	every batch/lot	
2.5 Outer wrapping material				
Hydrolytic class	ISO 719	Class 3 or better	every batch/lot	
Weight	according to ITP	min. 250 g/m ²	every batch/lot	
Binder content	according to ITP	according to ITP	every batch/lot	
Tensile strength	according to ITP	min. 535 N/150 mm wide strip	every batch/lot	
3. Surface Preparation, Coating Application and Final Testing/Inspection				
3.1 Surface Preparation				
Item/Property	Test method	Acceptance criteria	Frequency	
			PQT	Production
Initial surface condition	visual examination	free from surface contamination, temporary corrosion protection and defects	to be included	every 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 8502-2, -6 or agreed method	max. 30 mg NaCl/m ²	to be included	one per shift, both ends
Surface cleanliness	ISO 8501-1	A/B ≥ Sa 2 ½.	to be included	every pipe 100% surface area
Roughness	ISO 8503-2	grade Medium (G)	to be included	one per shift, both ends
Final surface condition	visual examination	free from surface defects	to be included	every pipe 100% surface area

Coating Data Sheet No. 6: Coal Tar Enamel Coating (Continued)				
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	according to ITP	to be included	every pipe
Coating layer thickness	according to ITP	according to ITP	to be included	10 first pipe, then every 10 th pipe, 3x4 locations (90° apart)
3.2.2 Full layer				
Time duration from priming	according to ITP	according to ITP	to be included	every 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	every pipe
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	every pipe, 100% surface area
Total thickness	according to ITP	5.0 mm minimum (incl. seam weld) 9.0 mm maximum	to be included	first 10 pipes then every 10 th pipe, 3x4 locations (90° apart)
Holiday detection	NACE RP0274 min. 15 kV rate: 150-250 mm/s	no defects acceptable	to be included	every pipe, 100% surface area
Adhesion (Tapping/sounding test)	tapping by wooden stick (According to ITP)	according to ITP	to be included	first 10 pipes then every 10 th pipe, “100%” surface area.
Adhesion (Peeling test)	cutting by knife through coating (e.g. 30x100 mm strip) and peeling by force (according to ITP)	coating shall be difficult to remove, causing cohesive failure of the coating. Clean peeling from primer or the pipe surface is not acceptable	to be included	first 5 pipes (one pipe end), then first per shift
Compactness test	examination of strip removed from coating for homogeneity and thickness of individual layers (acc. to ITP)	according to ITP	to be included	first 5 pipes (one pipe end), then first per shift
“according to ITP”, “to be included”, “to be agreed” and “by agreement” are explained in 5.3.3				

END OF CDS 6

Coating Data Sheet No.7: Polychloroprene (or “Vulcanised Rubber”) Coating (max. operating temperature 90°C for ordinary grades)				
1 Coating Configuration				
Primer (bonding agent)		Type and thickness according to ITP		
Polychloroprene		Thickness to be agreed		
2 Coating Materials				
Item/Property	Test method	Acceptance criteria	Frequency	
2.1 Primer material			Coating Material Quali- fication	Production
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 or ASTM D2240	56-68 Shore A	to be included	every batch/lot
Density	ISO 2781 or BS 903 Part A1	1.40–1.70 kg/dm³	to be included	every batch/lot
Tensile strength	ISO 37	min. 11 MPa	to be included	1/20 batch/lot or by agreement
Elongation at break	ISO 37	min. 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	min. 20 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 or ASTM D1149	by agreement	by agreement	not applicable
Seawater absorption	ISO 1817	by agreement	by agreement	not applicable
Abrasion resistance	DIN 53516	by agreement	by agreement	not applicable
Volume resistivity	ASTM D257	by agreement	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	every 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/m²	to be included	first pipe and every 10 th pipe
Surface cleanliness	ISO 8501-1	A/B ≥ Sa 2 ½.	to be included	every pipe
Roughness	ISO 8503-2	grade Medium (G)	to be included	every pipe
Final surface condition	visual examination	free from surface defects	to be included	every pipe 100% surface area
3.2 Coating Application and Final Testing				
Primer and Polychloroprene layer				
Max. duration from surface preparation to application of primer		according to ITP	to be included	every 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	every pipe
Primer drying time	according to ITP	according to ITP	to be included	every pipe
Primer appearance	visual inspection	according to ITP	to be included	every pipe
Primer thickness	ISO 2187	according to ITP	to be included	every pipe
Wrapping appearance (prior to vulcanising)	visual inspection	according to ITP	to be included	every pipe

Coating Data Sheet No.7: Polychloroprene (or “Vulcanised Rubber”) Coating (max. operating temperature 90°C for ordinary grades) (Continued)				
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	every pipe, 100% surface area
Coating layer thickness	ISO 2187	according to ITP	to be included	every pipe, 3x4 locations (90° apart)
Holiday detection	BS 6374	according to ITP	to be included	every pipe, 100% surface area
Adhesion (peel strength) at room temperature	ISO 813 or BS 6374	by agreement	to be included	every pipe (at cutback or on test plate)
at max. operating temperature		by agreement	by agreement	by agreement
Hardness	ISO 7619 or ASTM D2240	according to ITP	to be included	every pipe
Pipe end configuration	according to ITP	according to ITP	to be included	every pipe, both pipe ends
Bending resistance (full scale test), at room temperature	by agreement	by agreement	by agreement	not applicable
at min. installation temperature	by agreement	by agreement	by agreement	not applicable
Cathodic disbonding, at room temperature or at 65°C	ASTM G8 or GBE/CW6 or other agreed procedure	max. 10 mm disbonding, 48 hrs at 65°C or 28 days at room temperature	to be included	by agreement
at max. operating temperature, if higher than 65°C		by agreement	by agreement	not applicable
“according to ITP”, “to be included”, “to be agreed” and “by agreement” are explained in 5.3.3				

END OF CDS 7

Coating Data Sheet No.8: Multi-Layer Polychloroprene (“Vulcanised Rubber”) Coating (primarily for heat insulation)				
1 Coating Configuration				
Primer (bonding agent)		Type and thickness according to ITP		
Inner layer		High temperature rubber grade (polychloroprene applicable up to 90°C), thickness to be agreed		
Mid layer		Insulation rubber grade, thickness to be agreed		
Outer layer		Polychloroprene, thickness to be agreed		
2 Coating Materials				
Item/Property	Test method	Acceptance criteria	Frequency	
2.1 Primer material			Coating Material Quali- fication	Production
as for CDS 7, 2.1	as for CDS 7, 2.1	as for CDS 7, 2.1	as for CDS 7, 2.1	as for CDS 7, 2.1
2.2 Rubber materials, raw material and as-applied (processed) properties				
2.2.1 Inner layer				
as for CDS 7, 2.2	as for CDS 7, 2.2	as for CDS 7, 2.2	as for CDS 7, 2.2	as for CDS 7, 2.2
2.2.2 Mid layer				
Rheometer curve	according to ITP	according to ITP	to be included	every batch/lot
Hardness	ASTM D2240	according to ITP	to be included	every batch/lot
Density	ISO 2781	according to ITP	to be included	every batch/lot
Tensile strength	ISO 37	according to ITP	to be included	1/20 batch/lot
Elongation at break	ISO 37	according to ITP	to be included	1/20 batch/lot
Compression set	ISO 815	according to ITP	to be included	1/20 batch/lot
Tear strength	ISO 34	according to ITP	to be included	1/20 batch/lot
Accelerated ageing	ISO 188	by agreement	by agreement	not applicable
Seawater absorption	ISO 1817	by agreement	by agreement	not applicable
Abrasion resistance	DIN 53516	by agreement	by agreement	not applicable
Thermal conductivity	by agreement	by agreement	by agreement	not applicable
2.2.3 Outer layer				
as for CDS 7, 2.2	as for CDS 7, 2.2	as for CDS 7, 2.2 or by agreement	as for CDS 7, 2.2	as for CDS 7, 2.2
3 Surface Preparation, Coating Application and Final Testing				
3.1 Surface preparation				
Properties	Test method	Acceptance criteria	Frequency	
			PQT	Production
as for CDS 7, 3.1	as for CDS 7, 3.1	as for CDS 7, 3.1	as for CDS 7, 3.1	as for CDS 7, 3.1
3.2 Coating Application and Final Testing				
Primer and full layer				
as for CDS 7, 3.2	as for CDS 7, 3.2	as for CDS 7, 3.2	as for CDS 7, 3.2	as for CDS 7, 3.2
“according to ITP”, “to be included”, “to be agreed” and “by agreement” are explained in 5.3.3				

END OF CDS 8

7. ANNEX 2 Specification of Amendments and Deviations

Table 1: Example of a Purchaser specification of amendments and/or deviations to “Common Requirements” in Sec.5 of this RP, see 1.3.5.

Sec. 5 ref.	Item/Property	Amendment or Deviation	Description
1.3.2	FBE layer thickness	Amendment	Min. thickness 250 µm, max. thickness 450 µm.
1.3.2	Full layer thickness	Amendment	Min. thickness 3.0 mm (2.7 mm allowed on seam weld), max. thickness 5.0 mm.
1.3.2	Cut-back design	Amendment	Cut-back to be prepared by brushing. Length: 120 ±10 mm, chamfer angle 20° ±2°
5.1.2	MPS	Amendment	Specification of management of non-conformities and concession requests to be included in MPS.
5.2.1	PQT	Amendment	Minimum 3 pipes shall be coated and tested successfully.

5.4.2	Coating materials	Amendment	Purchaser list of approved products shall apply.
5.7.7	Final inspection	Amendment	All pipes shall be subject to final visual inspection prior to discharge from stock.
5.8	Repairs	Amendment	Only one damage affecting FBE layer per pipe and max. 10 cm ² repair area is allowed. (Pipes with more damage to be stripped and re-coated).
5.9.3	Documentation	Deviation	Documentation shall be retained for 3 years.

Table 2: Example of a Purchaser specification of amendments and/or deviations to ‘coating data sheet’ (CDS) in ANNEX 1 of this RP, see 1.3.5.

Coating Data Sheet No. 3

<i>CDS ref.</i>	<i>Property or Test</i>	<i>Property/Test related to:</i>	<i>Amendment or Deviation</i>	<i>Description</i>
2.1.1	Thermal analysis	Coating material, quality control	Amendment	Testing of each lot/batch (EN 10204, 3.1.B) according to GBE/CW6 part 1, App. A to be included Each lot max. 10 tonnes.
2.1.2	Water resistance (FBE)	Coating material, qualification	Amendment	Compliance with GBE-CW6 Part 1, App. A to be certified (EN 10204, 2.2).
2.3.2	Tensile properties (PP)	Coating material quality control	Amendment	Testing of each batch/lot (EN 10204, 3.1.B) to be included. ISO 868; ≥60 Shore D
3.1	Salt contamination	Production	Deviation	One pipe per shift, both ends to be tested.
3.2.3	Bending test (full layer)	PQT	Amendment	One coated joint to be tested according to Purchaser procedure.
3.2.3	Full layer thickness	Production	Amendment	First pipe per shift and each 10 th pipe to be tested according to NF A 49-711 addendum B.
3.2.3	Adhesion at 100°C (full layer)	Production	Deviation and Amendment	Every 20 th pipe, one end to be tested acc. to NF A 49-711, min. 100 N/cm to be met.
3.2.3	Tensile properties	PQT and production	Amendment	Test method: ISO 527.