

BITUMINOUS ENAMEL COATING OF STEEL LINEPIPE

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(DEP Circulars 75/03 and 54/04 have been incorporated)

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies the minimum requirements and the test procedures for the factory application of hot-applied, external, bituminous enamel coating to linepipe and includes the material, application, inspection, repair, handling and storage requirements. Bituminous enamel coatings may be based on conventional "oxidised bitumen" or "modified bitumen".

Bituminous enamel coatings may be used for the corrosion protection of subsea steel pipelines that are to be concrete weight-coated, for buried landfall sections of a pipeline, and for onshore buried pipelines.

Oxidised bitumen enamel is suitable for use when the design temperature of a subsea pipeline does not exceed 70 °C. It may also be used for buried landfall sections of a pipeline provided that the pipeline temperature does not exceed 60 °C. It is suitable for use at temperatures down to -10 °C.

Modified bitumen enamel is suitable for use when the design temperature of the line does not exceed 90 °C. It is suitable for use at temperatures down to -20 °C.

Bituminous enamel coatings are not suitable for pipelines that pass through locations that have been or are likely to be contaminated by fuel spillages, e.g. aviation fuel. Bituminous enamel coatings are not suitable for pipelines that are to be laid by reelbarge.

This DEP is based on the European Standard prEN 10300 and Shell Expro ERD ES/092.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F", as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in onshore and offshore pipelines.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with respect to safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Coating Contractor	The party ultimately responsible for the coating operation, which may include supply of coating materials, application of the coating, and transport of uncoated and coated linepipe as specified in the relevant contract. The Coating Contractor may be the Coating Applicator, the Linepipe Manufacturer or the Pipeline Construction Contractor.
Coating Manufacturer	The party that manufactures or supplies materials, equipment and/or services to perform the duties specified by the Coating Contractor.
Coating Applicator	The party that applies the bituminous enamel coating system in the coating plant.
Batch	The amount of materials produced during one uninterrupted production run of maximum 8 hours under constant production conditions.
Shift	A set of pipes coated in one production run of which the beginning and end coincide with a change in personnel. In the context of the quality control procedures of this DEP, the maximum duration of a shift is 10 hours.
Primer	A material applied as a thin film to metal in order to ensure adhesion of the subsequent protective coating.
Bitumen	A very viscous liquid or a solid, consisting of hydrocarbons and their derivatives, which is soluble in carbon disulphide or trichloroethylene. It is substantially non-volatile and softens gradually when heated. It is black or brown in colour and possesses waterproofing and adhesive properties. It is obtained by refinery processes from petroleum.
Oxidised bitumen	Bitumen which has been rheologically changed by the action of blowing air through it.
Modified bitumen	Bitumen which has been rheologically changed by the addition of a polymer or polymers.
Inert filler	Finely divided mineral powder, which is not hygroscopic, is not electrically conductive, and does not react with other ingredients of the coating material or with the environment in which it will be used.
Bituminous enamel	A coating material which comprises oxidised or modified bitumen and filler (formerly also called "asphalt enamel").
Non-woven glass fabric	A continuous sheet of randomly arranged glass fibres in an open porous structure bonded by a suitable resin and reinforced by continuous longitudinal glass yarns.
Woven glass fabric	A regular woven glass fabric made from glass yarns held together by a binder.
Composite glass fabric	One layer of glass fibre tissue and one layer of woven or lock welded glass mesh held together by a binder.
Composite polyester/glass fabric	A woven polyester/glass mesh with a layer of glass fibre tissue held together by a binder.
Innerwrap	An inert porous reinforcement which is intended to be saturated and buried within the bituminous enamel coating in order to improve its mechanical performance.
Outerwrap	A continuous sheet of reinforced glass fibre fabric or glass

fibre/polyester composite fabric impregnated by a suitable bituminous material which is compatible with the bituminous enamel coating and fused into the outer surface to improve its mechanical performance.

Bleed through

The process that allows bitumen enamel to pass through the outerwrap to form a mechanical bond between glass fabric and the enamel.

1.4 ABBREVIATIONS

DFT	Dry film thickness
IR	Infra-red
HSE	Health, Safety and Environment
WFT	Wet film thickness

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section is shown in brackets. Other documents referenced in this DEP are listed in (9).

2. GENERAL INFORMATION

2.1 COATING SYSTEM DESCRIPTION

The bituminous enamel coating system described in this DEP shall comprise a number of layers or components as follows:

1. a primer: which must be compatible with the bituminous enamel coating;
2. an enamel: comprising a bitumen containing an inert filler;
3. innerwrap: reinforcing glass fabric wrap (oxidised bituminous enamel only);
4. outerwrap: glass or composite fabric wrap impregnated with oxidised bitumen;
5. solar protection: weather-resistant material to protect the coating from sunlight;
6. other: in special cases (for example, for onshore use due to the nature of backfill material or for offshore use) additional mechanical protection or a concrete weight coat may be applied by agreement. The type and grade of outerwrap may be influenced by the presence or absence of the additional mechanical protection.

With suitable surface preparation and application techniques, this coating system shall produce coating properties required for the intended installation and operating conditions of the pipeline, see (5.2) and (5.7).

2.2 INFORMATION TO BE SUBMITTED BY THE PRINCIPAL

The Principal shall submit all technical information to the Coating Contractor regarding the project, in particular the installation and operating conditions.

This information shall include as a minimum:

1. project name;
2. the type of coating required;
3. the minimum and maximum operating temperature of the pipeline;
4. the pipeline diameter and wall thickness including minimum required wall thickness;
5. the applicable linepipe specification;
6. the geographical area (offshore/onshore);
7. expected ambient temperatures during installation;
8. installation method;
9. soil and backfill conditions for land pipelines;
10. seabed trenching, laying and burial conditions for sub-sea pipelines;
11. subsequent coatings to be applied (e.g. weight coating);
12. requirements for temporary protection of pipe ends;
13. type(s) of cathodic protection.

The Principal shall indicate whether, and to what extent, he intends to witness coating application and quality control.

2.3 INFORMATION TO BE SUBMITTED BY THE COATING CONTRACTOR

The Coating Contractor shall submit all data specified in (2.3.1), (2.3.2) and, if required by the Principal, (2.4).

2.3.1 System identification

The Coating Contractor shall submit all necessary details to identify the coating system, which shall include:

1. system designation or trade name;
2. name of Manufacturers of the primer, bitumen enamel, inner and outer wraps;
3. nominal total coating thickness;
4. recommended Coating Applicators;

5. relevant international and national coating standard approvals;
6. approvals for previous projects for Shell Group Companies;
7. recommended storage and shelf life of coating materials;
8. HSE data sheets.

2.3.2 Coating system application

2.3.2.1 Coating plant

The Coating Contractor shall submit to the Principal details of the coating plant, including:

1. layout diagram of the coating plant and pipe routing scheme;
2. general description of the equipment available to carry out the coating process;
3. details of process control and inspection equipment, required for the coating process such as temperature control, thickness control, holiday testers, laboratory equipment;
4. details of the pipe handling and transport equipment and procedures;
5. quality assurance and control procedures.

2.3.2.2 Coating process

The Coating Contractor shall submit to the Principal information on the required coating process. The information shall include:

1. description of the coating process;
2. pipe cleaning procedure and pipe surface preparation;
3. pipe heating and temperature control;
4. method of bituminous enamel application;
5. minimum and maximum coating application temperature;
6. coating repair procedures.

2.4 ACCEPTANCE BY THE PRINCIPAL OF THE PROPOSED COATING SYSTEM

The Coating Contractor shall show that samples of the proposed coating system applied on pipes of the same material and nominal wall thickness as the pipes to be coated under the contract will meet the requirements of this DEP as defined in (5.2) and (5.7).

With the approval of the Principal, tests carried out in accordance with other coating standards may be used insofar as their procedures are the same as or more stringent than the procedures in this DEP. Such information shall include full reports on test procedures and results and be signed by the laboratory representatives.

Based on the information provided, the Principal may require the proposed coating system to be qualified via a pre-production trial. The results of this pre-production trial shall be reported to the Principal 6 (six) weeks before the scheduled start of production.

3. COATING SYSTEM REQUIREMENTS

3.1 GENERAL

The coating system shall be suitable for the installation and operating conditions of the pipeline as specified by the Principal (2.2).

Any modification of a proposed coating system shall require the Contractor to submit the technical properties of the modified system to the Principal, prior to application of the modified coating system.

3.2 COATING MATERIALS

3.2.1 Primer

All primer shall be supplied in sealed containers with the following information clearly marked on the container:

1. name of Manufacturer;
1. material designation;
2. date of manufacture;
3. batch number/letter(s);
4. relevant manufacturing standard (e.g. BS 4147).

Any primer without the required identification shall be rejected and replaced with approved material.

The primer shall be fast drying, it shall be compatible with the bituminous enamel coating to be used by the Coating Contractor, and it shall be supplied by the Coating Manufacturer of the bitumen.

Material that is not traceable to satisfactory test certificates shall not be used.

3.2.1.1 Primer for oxidized bitumen enamel

Primers for use with oxidized bitumen shall contain chlorinated rubber, plasticiser, and when required, colouring pigment, together with solvents needed to give a consistency suitable for application by spray, brush or other approved method. The primer shall conform to the requirements of Table 1 in section 5.2.2.

3.2.1.2 Primer for modified bitumen enamel

Primers for use with modified bitumen shall contain hydrocarbon resin, plasticiser, and when required, colouring pigment, together with solvents needed to give a consistency suitable for application by spray, brush or other approved method. The primer shall conform to the requirements of Table 1 in section 5.2.2.

3.2.2 Inert filler

The inert filler shall be physically and chemically stable at the maximum application temperature of the coating material. Powdered slate and talc are typical examples of suitable filler types.

The inert filler shall be supplied dry in bulk or in sacks and shall be accompanied by documentation detailing the Manufacturer's name, material designation, date of manufacture and batch number.

3.2.3 Bituminous enamels

The bituminous enamel shall comprise either oxidised or modified bitumen with inert filler.

Bituminous enamel may be supplied either hot in bulk or cold in drums or kegs. Supplies shall be accompanied by a delivery note clearly marked with the Manufacturer's name, material designation, date of manufacture and batch number.

3.2.4 Innerwrap (oxidised bitumen only)

The innerwrap shall be a non-woven glass fibre tissue that comprises a continuous sheet of randomly arranged glass fibres in an open porous structure bonded by a suitable resin and shall be reinforced by continuous longitudinal glass yarns that are spaced evenly across the width. It shall have a uniform appearance and be undamaged. It shall be compatible with the bituminous enamel coating material with which it is used and it shall have a texture such that it may be embedded completely within the coating material.

All innerwrap shall be supplied in sealed polyethylene bags and shall be clearly marked with the Manufacturer's name, material designation, date of manufacture and batch number.

3.2.5 Outerwrap

The outerwrap shall be a continuous sheet of reinforced glass fibre for oxidised bitumen or glass fibre/polyester composite fabric for modified bitumen impregnated by a suitable bituminous material that is compatible with the bituminous enamel coating.

The outerwrap shall have a uniform porosity to allow air and fumes to escape and to allow the hot coating to bleed through to ensure fusion of the outerwrap within the outer surface.

All outerwrap shall be supplied in sealed polyethylene bags and shall be clearly marked with the Manufacturer's name, material designation, date of manufacture and batch number.

When unrolled at ambient temperature, the successive layers of outerwrap shall not stick to each other.

3.2.6 Sample retention

A 1 kg sample shall be taken from each batch of enamel. Samples shall be marked and stored by the Coating Applicator under conditions such that the enamel does not deteriorate. The Principal may request tests on these samples up to one year after delivery of the last coated pipe of the order.

4. COATING OPERATIONS

4.1 PIPE SURFACE PREPARATION

The pipes shall be inspected for surface contamination prior to blast-cleaning. Oil, grease and other contaminants shall be removed by a suitable solvent (e.g. Xylene) or detergent. Salt contamination, chemical cleaning agents and remaining detergents shall be washed off using potable water. The pipe surface shall be dry before blast-cleaning.

End plugs shall be placed inside ends of the pipe to prevent the inclusion of blasting abrasives.

All pipes shall be washed with potable water before blast-cleaning and pre-heated to a minimum of 30 °C in order to remove moisture and to prevent contamination of the abrasive media.

The pipe surface shall be cleaned of mill scale, rust and other foreign matter by blast-cleaning to achieve a minimum surface cleanliness of Sa 2 ½ in accordance with ISO 8501-1. The grade of abrasive shall give a blast peak-to-trough profile of $(75 \pm 25) \mu\text{m}$. During blast cleaning, the pipe surface temperature shall be at least 3 °C above the ambient dew point. The residual chloride salt content on blast cleaned steel pipes shall be measured once for every 100 pipes. The pipes with salt content higher than 30 mg/m² shall be re-blasted. The residual salt content on steel pipe surfaces shall be measured either by Elcometer 130 SCM 400 salt contaminator meter or other method approved by the Principal.

Abrasives shall be stored in dry condition and only dry abrasive shall be used. For carbon steel pipes the abrasive shall be steel grit or a mixture of steel grit and shot. The abrasive shall be kept free from dust, salts and other impurities. The abrasive shall be checked for salt contamination twice per shift. The salt contamination of the abrasive can be checked by conductivity measurement. The conductivity of the abrasive material extract shall be below 50 $\mu\text{mho/cm}$.

For stainless steel pipes, stainless steel or non-ferrous abrasives shall be used for blast-cleaning.

The use of sand is not permitted.

Before coating, the pipe surface shall be cleaned of all dust and foreign matter using clean, dry, oil-free, compressed air or vacuum cleaning.

To prevent dust and grit contamination of primed and coated surfaces, blast-cleaning shall not be done in areas close to coating operations.

Any pipe which has been rejected, repaired and subsequently re-accepted by the Principal under the provisions of section (5.4) and (5.5) and has not been coated within 4 hours of blast-cleaning shall be re-blasted.

Any pipe not meeting the specified surface preparation standard shall be re-cleaned as described above.

4.2 COATING APPLICATION

4.2.1 General

Blast-cleaned pipes shall be coated before showing any visible rust stains, otherwise pipes shall be blast cleaned again.

The application of the coating shall be in accordance with the Coating Manufacturer's application procedures.

The pipes and components shall be preheated so that the steel temperature is between 30 °C and 50 °C when the primer is applied. During coating the bevelled ends of the pipes and the pipe bore shall be protected against mechanical damage and from contamination with coating material.