

DEP SPECIFICATION

**ELASTOMER COATINGS AND MONEL SHEATHING FOR
OFFSHORE RISER PROTECTION**

DEP 31.40.30.36-Gen.

February 2015

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for elastomer coating and Monel sheathing for the external protection of risers of offshore facilities such as fixed-leg production platforms. It includes the minimum requirements with respect to surface preparation, coating materials, application, welding, testing, repair, handling and storage and inspection for:

- Chlorinated rubber (CR) [polychloroprene (also known by the trade name Neoprene)] elastomer coating systems for carbon steel and duplex stainless steel risers.
- Ethylene propylene diene monomer (EPDM) elastomer coatings for carbon steel and duplex stainless steel risers.
- Monel sheathing for risers.

This DEP also covers the application of anti-fouling protection onto the elastomer coating, the protection of elastomer coated risers at riser clamp positions, unique cases of elastomer coated subsea line pipe, and field joint coating. Additionally, anti-corrosion coatings under elastomer coatings are addressed.

This DEP also covers the elastomer lining of the internal surface of riser clamps and guides, and may also be used for the elastomer lining of line pipe externally. However, the Principal may specify additional requirements above those specified in this DEP for the elastomer lining of clamps or, line pipe.

External Monel cladding of riser pipe by either roll bonding or welding is not covered in this DEP.

DEP 30.48.00.31-Gen. applies to the parts of the riser above those where the special riser protection in accordance with this DEP has been applied, and also applies to riser clamp surfaces not receiving elastomer coating systems.

Anti-corrosion coating systems to be placed under elastomer coating systems are covered by either DEP 31.40.30.32-Gen. or DEP 30.48.00.31-Gen. and as additionally specified within this DEP.

Additional information on elastomer materials and their characteristics are found in DEP 30.10.02.13-Gen.

This is a revision of the DEP of the same number dated February 2013; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended to be used in offshore oil and gas production facilities and, where specified, other marine facilities. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could 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 regards to the 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, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

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

Note: The Contractor may also be the Applicator or the Applicator may be a separate entity, either of which has been approved by the Principal to apply the Manufacturer's/Supplier's material/product. Each of the coating systems to be applied under this DEP is a specialized coating system requiring specialized Applicators.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor. Note: The Manufacturer/Supplier may also be the Applicator or the Applicator may be a separate entity, either of which has been approved by the Principal to apply the Manufacturer's/Supplier's material/product.

The **Applicator** is each party in each case that applies any of the coating systems defined within this DEP within a coating plant or other specialized coating application facility.

The **Principal** is the party that initiates the project and ultimately pays for it. 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

Term	Definition
abrasive blast cleaning	Impingement of a high kinetic energy stream of blast cleaning abrasive onto the surface to be prepared.
anchor profile	Contour of a blast-cleaned surface on a plane perpendicular to the surface.
anti-corrosion coating	Fusion-bonded epoxy or liquid-applied (paint system) corrosion barrier coating system applied to metal substrate surface before elastomer coating system application, in order to enhance corrosion mitigation properties of elastomer coating.
batch	With regard to priming/bonding agents - Amount of materials produced within one uninterrupted production run of maximum 8 hours under constant production conditions. With regard to anti-corrosion system coatings and also elastomer system coatings – One complete mixing cycle of base material and compounding materials. For anti-corrosion coatings, each batch is designated with a specific batch number, which is formally assigned, documented and provided by the coating Manufacturer/Supplier.
bonding agent	Material applied to the primed metal surface or prepared anti-corrosion coating, in order to ensure proper adhesion of the elastomer coating. Also, known as the adhesive.
cure	Vulcanization of thermo-set elastomeric coatings, crosslinked thermoset cure of FBE coatings, or crosslinked chemical cure of liquid (paint) applied coatings.
dew point	Temperature of a given air/water-vapour mixture at which, under atmospheric pressure, condensation begins to form.

Term	Definition
offshore	Open sea, subsea and coastal waters areas.
primer	Liquid material applied to the metal substrate to ensure proper adhesion of the subsequent bonding agent, adhesive, or coating layer.
shift	Production run in 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.
splash zone	Vertical zone from approximately 3 m (10 ft) below LAT up to 4.3 m (14 ft) above HAT – further and more specifically defined as the astronomical tidal range plus in each direction a percentage of a wave height having a probability of exceedance of 0.01 (i.e., 1 in 100), where the upper limit of the splash zone is determined by assuming 65 % of this wave height above HAT and the lower limit by assuming 45 % of this wave height below LAT, which may as calculated each modify the approximate values provided above..

1.3.3 Abbreviations

Term	Definition
CR	Chlorinated Rubber [polychloroprene (also known by the trade name neoprene)]
DFT	Dry Film Thickness
EPDM	Ethylene Propylene Diene Monomer, a synthetic elastomer (rubber), also known as epm
FBE	Fusion-Bonded Epoxy
HAT	Highest Astronomical Tide Level
ITP	Inspection and Test Plan
LAT	Lowest Astronomical Tide Level
MSDS	Material Safety Data Sheet
PTFE	Polytetrafluoroethylene, also known by the trade name Teflon
PPT	Pre-production Test
PQR	Procedure Qualification Test Record
PQT	Pre-qualification Test

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced in this DEP are listed in (8).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2013. The changes in this revision are too numerous and extensive to summarise here.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://sww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL REQUIREMENTS AND SURFACE PREPARATION

2.1 GENERAL

1. Chlorinated rubber (CR) elastomer coatings [polychloroprene (also known by the trade name Neoprene)] shall be suitable for use in seawater, ambient air temperatures down to -35°C (-31°F) and service temperatures of maximum $+90^{\circ}\text{C}$ ($+194^{\circ}\text{F}$), with approved high temperature or specialized FBE anti-corrosion coating systems, or approved high temperature liquid-applied (paint) anti-corrosion coating systems, able to achieve the same maximum temperature rating.
2. For lower maximum riser (splash zone) temperature requirements normally below $+80^{\circ}\text{C}$ ($+176^{\circ}\text{F}$) [and lower maximum subsea pipe temperature requirements normally below $+85^{\circ}\text{C}$ ($+185^{\circ}\text{F}$)], the normal temperature (i.e., standard) approved FBE anti-corrosion coating systems will generally be applied. FBE is considered to be the standard anti-corrosion coating system for these applications.
3. Ethylene propylene diene monomer (EPDM) elastomer coatings shall be suitable for use in seawater, ambient air temperatures down to -35°C (-31°F) and service temperatures of maximum $+120^{\circ}\text{C}$ ($+248^{\circ}\text{F}$), with approved high temperature liquid-applied (paint) anti-corrosion coating systems able to achieve the same maximum temperature rating or with approved high temperature FBE anti-corrosion coating systems able to achieve a significant but potentially reduced portion of the maximum temperature level of the EPDM material, as determined to be appropriate in each case.
4. Monel sheathing shall be considered for application on risers with a design life >25 years in seawater, ambient air temperatures down to -35°C (-31°F) and service temperatures up to $+120^{\circ}\text{C}$ ($+248^{\circ}\text{F}$). Monel sheathing shall not be selected if the riser will be installed by pulling it through a J-tube or a conductor.
5. DEP 30.48.00.31-Gen. shall apply to the portion of the riser above the upper limit of the special riser protection applied in accordance with this DEP, and also to riser clamp surface areas that will not receive an elastomer coating application.
6. An anti-corrosion coating system shall be applied underneath elastomer riser coating.
 - a. In the case of riser clamps, elastomer coating systems will normally be applied without an underlying anti-corrosion coating system.
 - b. Anti-corrosion coating systems to be placed under elastomer coating systems are covered by either DEP 31.40.30.32-Gen. or DEP 30.48.00.31-Gen. and as additionally specified within this DEP.
 - c. Appropriate temperature limits must be addressed for anti-corrosion coating systems under elastomer coating systems. This is to be achieved taking into consideration the maximum temperature defined for the specific elastomer coating system (i.e., liner) or as may be required in order to address the defined maximum design/operating temperature of the riser (not to exceed the maximum allowable design temperature of the elastomer liner).
 - d. Normally under elastomer coating systems, FBE anti-corrosion coating systems will be comprised of a single layer FBE application. In those unique cases involving high temperature liquid-applied (paint) anti-corrosion coating systems, those coating systems will normally be 3-coat systems unless otherwise specifically approved by the Principal's coatings subject matter expert.
7. All surface preparations, coating applications and pipe handling shall be performed in a safe manner and in accordance with the principles of good workmanship.

2.2 PROJECT INFORMATION

1. The Principal shall submit technical information to the Contractor regarding the project. This information shall include as a minimum:
 - a. Project name;
 - b. Design life;
 - c. Clamp positions (sliding or fixed/anchor clamps);
 - d. Corrosion protection requirements for riser, clamps, J-tubes, unique cases of subsea line pipe, etc. (including internal elastomer lining of clamps and, under normal applications, riser external anti-corrosion coating system combined with overlying outer elastomer lining – also, for unique subsea line pipe applications of the same type);
 - e. Anti-fouling requirements for the riser (or subsea line pipe);
 - f. Maximum operating temperature of the riser (or subsea line pipe);
 - g. Riser pipe including bend (or subsea line pipe) material, diameter, length and wall thickness;
 - h. Expected ambient temperatures during installation;
 - i. Riser (or subsea line pipe) installation method and field joint coating requirements;
 - j. Requirements for temporary protection of riser (or subsea line pipe) ends;
 - k. Qualification requirements of inspectors;
 - l. Qualification requirements for each individual applicator/operator, each individual coating system and the various aspects of each system's surface preparation, application and cure;
 - m. External and internal markings on the coated pipes.

2.3 CONTRACTOR AND APPLICATOR RESPONSIBILITIES

2.3.1 General

1. The Contractor, in addition to the responsibilities under the general conditions of the contract, is responsible for the quality of the work which shall be performed in accordance with this DEP and all other relevant documents, such as site regulations, safety rules and requirements, product data sheets, referenced standards and codes.
2. The Contractor is fully responsible for all quality assurance and quality control, and for the associated formal, complete, and detailed documentation including signatures and dates in each specific case.
3. The Contractor shall schedule a pre-job meeting to ensure that job and quality requirements are fully understood. Attendees shall include a representative of the Principal, the Contractor's job superintendent and supervisor, the inspector and the applicator of the elastomer coating or Monel sheathing.
4. For all work, the Contractor shall submit appropriate work planning and a quality plan for implementing the requirements of this DEP for review by the Principal.
5. Copies of this DEP, the work planning and the quality plan shall be made available to the coating Contractor at the site.
6. The obligations of the Contractor are explained in more detail further on in this DEP.

2.3.2 Safety and environment

1. The Contractor/Applicator shall be responsible for all aspects of safety and personal protection related to the work to be done. Environmental regulations and rules shall be met.

2. All personnel shall be provided with approved personnel protection e.g., protective clothing, safety glasses, safety shoes, hard hats, goggles, respirators, earplugs, fresh-air-fed hood and any other necessary safety equipment. All safety equipment shall be maintained in a good working condition.
3. Handling and disposal of hazardous waste resulting from the Contractor's/Applicator's activities shall comply with regulations and specific contract requirements.
4. Unless otherwise agreed, the Contractor/Applicator shall ensure that coating system and blasting material comply with any local and/or regional standards or regulations on banned materials.

2.3.3 Quality assurance

1. Both the Applicator and the Manufacturer of the coating materials shall operate under an ISO 9001 quality management system.
2. A detailed inspection and test plan (ITP), or in the case of liquid applied (paint) coating systems, a detailed procedure, shall be developed for each coating system and its associated qualifications, preparations, applications, curing, repairs, inspections and testing and shall be approved by the Principal prior to the qualifications and commencement of the work.

An example of an ITP is given in DEP 30.48.00.31-Gen, or an example ITP may be acquired from the Principal's designated coatings specialist.

2.3.4 Quality Plan

1. For all coatings work, the Contractor/Applicator shall submit Quality Plan(s) for implementing the requirements of this DEP.
2. The Principal shall review and approve the quality plan, in order to verify the coatings work is understood by the Applicator and executed in accordance with this DEP.
3. Copies of this DEP, applicable work plans and the quality plan(s) shall be made available to the coating Contractor's/Applicator's representative at the site. The Contractor/Applicator shall be completely familiar with their contents.
4. Well before commencing any qualifications or production work, the project-specific quality plan(s) shall be submitted to the Principal for approval. ITP(s) or procedure(s) for the coating system(s) to be applied are to be primary component(s) of the quality plan(s). The quality plan(s) shall, as a minimum, include the following:
 - a. Work plan and method statement(s) covering the various activities;
 - b. Detailed scope of the work including each item or area to be coated, the required surface preparations, the coating system(s), its (their) required application(s), and the associated complete curing of each;
 - c. Full details for the blast, coating, and curing equipment, materials, methods, practices, qualifications, inspections, testing and repairs, including provisions for appropriate environmental conditions controls such as dehumidification, temperature controls and other measures, with the inclusion of the coverage of methods of access and other aspects for providing assurance of the work, product(s) of the work, quality assurance and quality controls measures, safety and environmental stewardship;
 - d. Names and complete information covering the personnel involved in the work together with clear definitions of their responsibilities and lines of communication;
 - e. Detailed preparation, application, curing, and repair procedures, as well as associated plans for all qualifications, testing and inspections. In each of these areas the Quality Plan documents are to include: the methods to be employed; specifics of inspection and testing equipment, instruments and devices to be used; all steps and associated sequence(s); all frequencies; each of the applicable reference documents and standards to be applied for

each case; all associated individual inspections and tests acceptance criteria; and all the same types of provisions to be applied to repairs and repair methods/systems;

- f. Descriptions of calibration methods, certification calibration documentation, and specifics of calibration checks for the required inspection and testing instruments, devices and equipment;
 - g. Provisions for project-specific qualification of personnel, supervision, materials, equipment, procedures, methods, surface preparations, coating applications, repairs, curing, inspections and testing; and
 - h. Materials and applied coating(s) protection, handling and storage provisions.
5. Following review and approval by the Principal, the project Quality Plan may be updated and/or revised, as a result of potential needed changes identified and documented during the qualifications, with updates and revisions then approved by the Principal. The Quality Plan shall be reviewed by the Principal's coatings specialist or that individual's designated representative.

2.3.5 Reporting

1. The Contractor/Applicator shall submit all completed, detailed, signed, and dated inspection forms and reports for each shift not more than each week. These forms and reports shall include details of every inspection and test performed, as well as all repairs and other resolutions. If required by the Principal, the reports shall also detail the progress of the work versus the approved programme.
2. All areas and items that have been inspected and accepted or rejected shall be clearly identified and fully documented.

2.3.6 Contractor's/Applicator's inspections and tests

1. Contractor's/Applicator's inspection personnel shall be individually currently certified by a recognized organisation (NACE International or approved equivalent) and shall be approved by the Principal.
2. Normally, a currently certified NACE Certified Coating Inspector – Level III (or at the least and at the Principal's discretion a NACE Coating Inspector – Level II Certified) or other approved equivalent coating inspector will be required to be present and performing each quality control measure throughout the preparations, applications, repairs, curing, inspections, testing, and handling activities.
3. The Contractor/Applicator shall provide and use all inspection and testing instruments, equipment, devices and materials necessary to ensure that the specified conditions, quality requirements and acceptance criteria are achieved and fully documented.
4. All the instruments, equipment and devices used for inspection and testing shall have valid calibrations that are formally certified, signed and dated within the 12 months prior to the coating work being performed.
5. All instruments, equipment and devices that can be calibration checked on site shall have such checks performed at least at the beginning of each shift (i.e., before the shift's work begins) or as otherwise required by this DEP or referenced DEP(s) and all such checks shall be in accordance with the Manufacturer's operation manual and/or calibration or calibration check recommendations, or shall be in accordance with industry standard practices where the Manufacturer does not provide that information.

2.4 SURFACE PREPARATION

2.4.1 General

1. Unless otherwise specified in this DEP, the surface preparation requirements as specified in (2.4) are applicable to all protective systems as specified in this DEP.
2. Surface preparations of steel substrates in preparation for anti-corrosion coating system applications, or of surfaces of anti-corrosion coating systems in preparation for

elastomer coating system applications, are to be in accordance with the respective applicable DEP as referenced within this DEP document (i.e., either DEP 31.40.30.32-Gen. or DEP 30.48.00.31-Gen.) and as additionally specifically required within this DEP document.

3. Complete pipe lengths (overall surface areas) shall be prepared even if the areas indicated for coating are of a lesser extent.
4. External and internal markings of pipes and clamps shall be preserved before blast cleaning.
5. Open ends shall be closed and kept closed during all surface preparations to protect the interior of the risers (or pipes) and to prevent the accumulation of debris within those interior areas.

2.4.2 Inspection prior to surface preparation

1. Prior to the actual surface preparations, the riser pipes and clamps shall be visually inspected for fabrication defects, dents, laps, defective bevels, weld spatter, contamination and preservation coating. Welded areas and appurtenances shall be given special attention for the removal of welding flux in crevices.
2. Surface defects such as slivers, weld spatter, laminations and gouges shall be removed with proper tools. Weld seams shall be ground to remove surface irregularities, which may affect coating applications.
3. After grinding or the completion of other mechanical or hand tool preparations or repairs, the remaining wall thickness shall be checked and compared with the minimum requirements of the riser (or line pipe) specification. Risers (or pipes) not meeting the minimum wall thickness requirements shall be rejected.
4. If defects and damages are too severe to repair, the Principal shall be notified.
5. Each remedial method requires the approval of the Principal before that work in each case is started.

2.4.3 Blasting equipment

1. The Contractor/Applicator shall demonstrate that the blasting equipment to be used is in good and fully functional working condition and has been consistently well maintained. Blasting equipment shall comply with all applicable local and/or regional regulations.
2. The compressed air shall be free of water and oil. Adequate separators and traps shall be provided, with those components installed in the coolest and greatest temperature drop locations of the system.
3. The absence of the presence of oil and water shall be confirmed for each compressor, in accordance with ASTM D 4285, at least 2 times per 10 hours (i.e., at least two times per any single shift period of 10 hours or less) and following every individual compressor start-up. In no case shall the temperature of the compressed air be allowed to exceed 110 °C (230 °F).
4. All blast cleaning, surface preparation, cleaning, and coating application air to be utilized, when blown through a white cloth or onto white paper for one minute, shall leave no visible moisture, oil or residue.

2.4.4 Pre-cleaning of surfaces

1. All pipe surfaces shall be free of surface contamination. Oil, grease and other similar contaminants shall be removed by solvent cleaning in accordance with SSPC-SP 1 or by using a biodegradable detergent, clean water rinse and clean drying process. Suitable solvents are MEK, Xylene and Toluene. Fatty (i.e., heavier) solvents such as kerosene, diesel fuel, white spirit and the like shall not be used.

2. Salt contamination, chemical cleaning agents and remaining detergents or their residues shall be washed off by means of clean, low-conductivity, and low-chlorides potable water. The pipe surface shall be fully clean dried prior to blast cleaning.
3. Wherever clean water washing or rinsing is employed at any time for cleaning pipe or coating surfaces (not applicable to acid washing and associated rinse associated with FBE coating applications), the clean water washing or rinsing shall be accomplished using water with a conductivity not exceeding 250 $\mu\text{S}/\text{cm}$ (635 $\mu\text{mhos}/\text{in}$) and a chloride content not exceeding 25 mg/L (i.e., 25 ppm) per ASTM D 1125 and ASTM D 512 respectively. In each case, all surfaces after such cleaning and after abrasive blasting (i.e., immediately prior to coating application) shall be demonstrated to have soluble salts levels not exceeding 2.0 $\mu\text{g}/\text{cm}^2$ (20 mg/m² or 1.86 mg/ft²).
4. Where detergents or other alkaline solutions are used to remove oil, grease or other contaminants, the final pH of the cleaned surfaces shall not exceed the pH of the rinse or wash water plus 0.5 (i.e., $\leq$ rinse water pH + 0.5) or shall not exceed a pH of 8.0 (i.e., pH $\leq$ 8.0), whichever upper limit is less (i.e., of a lower pH).
5. Where acids or other acidic solutions are used to remove contaminants, the final pH of the cleaned surfaces shall not be less than the pH of the rinse or wash water minus 0.5 (i.e., $\geq$ rinse water pH - 0.5) or shall not be less than a pH of 6.0 (i.e., pH $\geq$ 6.0), whichever lower limit is greatest (i.e., of a higher pH).
6. In all cases of surface contaminant removal using solvents, detergents, surfactant solutions, acidic solutions, caustic solutions, etc., the surfaces to be coated are to be thoroughly clean washed or rinsed such that no residual of the cleaning or solvent product remains.
7. No coatings of any type are to be applied to surfaces with a pH $\leq$ 6.0 or $\geq$ 8.0.
8. Some of the highly volatile (i.e., upper light end) solvents used for cleaning may fully evaporate to the point of not requiring a subsequent pressurized clean water wash/rinse. All others will require such provisions. Inspections utilizing water droplet beading, sheen methods and/or black light inspections may be required to ensure oil, grease, or solvent residues are not present.
9. Surface soluble salts levels shall be established by testing at least three separate surface areas of three separate pipes per shift, in accordance with ISO 8502-6 and ISO 8502-9 requirements (i.e. Bresle Method) and prior to any surface cleaning or blasting.
 - a. The only alternative suitable soluble salts test instrument/method shall be the utilization of the Elcometer 130, SCM 400 Salt Contamination Meter.
 - b. If any surface soluble salts levels are found to exceed 4.0 $\mu\text{g}/\text{cm}^2$ (40 mg/m² or 3.72 mg/ft²) prior to cleaning and/or abrasive blasting, all surfaces of the entire batch of pipe shall be clean water washed in their entirety.
 - c. In each case, the surfaces after cleaning and after abrasive blasting (i.e., immediately prior to coating application) shall be demonstrated to have soluble salts levels not exceeding 2.0 $\mu\text{g}/\text{cm}^2$ (20 mg/m² or 1.86 mg/ft²).
10. In all situations, no residue/contaminant shall remain on any surfaces to be coated or overcoated.

2.4.5 Blast cleaning

1. Blast cleaning of surfaces shall, as a general rule, be achieved by dry abrasive blast cleaning (hereafter referred to as blast cleaning) as outlined in ISO 8504-2.
2. The surfaces of carbon and low alloy steelwork (i.e., bare steel substrates) to be coated with an elastomer coating system alone, or with a liquid-applied anti-corrosion coating system and elastomer coating system in combination, shall be blast cleaned to the visual standard of Sa 3 (white metal) in accordance with ISO 8501-1 or SSPC-SP 5, along with SSPC-VIS 1.

3. Where surfaces of carbon and low alloy steelwork (i.e., bare steel substrates) are to receive the normal elastomer application of an FBE anti-corrosion coating system and elastomer coating system in combination, or a Monel sheath system alone, the substrate shall be blast-cleaned to the visual standard of Sa 2-1/2 (near-white metal) in accordance with ISO 8501-1 or SSPC-SP 10, along with per SSPC-VIS 1.
4. In addition to the requirements of ISO 8501-1, blast-cleaned carbon steel surfaces shall be tested to be free of the presence of mill scale. Particular attention shall be given to shop blasted steel work (i.e., blast cleaning using centrifugal abrasive blast machines).
5. Stainless steel surfaces shall be blast cleaned using hard and inert blasting material that shall not harm stainless steel. This means the use of aluminium oxide or sufficiently hard, high-quality garnet abrasive, with full additional provisions to ensure no ferrous abrasives and abrasives components, or other carbon steel, low alloy steel or iron item, comes in contact with stainless steel surfaces at any time.
6. Any defect in the steel that becomes visible after the blasting shall be brought to the attention of the Principal and shall be removed or repaired as agreed. Any such treated surface shall be re-blasted to the requirements as specified in this section.
7. Blast cleaned steel surfaces to be coated, and all other surfaces to receive bonding agents, primers, adhesives or coatings of any type, shall not be touched by bare hands or by any other potentially contaminating items.
8. To prevent dust and grit contamination of blasted and cleaned substrates, bonding agents, primers, adhesives, coatings and all types of surfaces to be coated, or any such coating systems components in the process of curing, blast cleaning shall not be performed in areas close to coating operations.
9. Blasted surfaces profile (i.e., roughness) measurements shall be determined and documented utilizing replica tape in accordance with NACE RP0287.
 - a. For elastomer coating systems, the surface profiles and the anchor patterns shall be in accordance with the written recommendations of the elastomer coating system component (layer) Manufacturer.
 - b. Unless otherwise specified by the Manufacturer or within this DEP, bare steel surface profiles for elastomer coating systems alone shall be between 60 μm (2.4 mils) and 100 μm (4 mils).
 - c. For the associated anti-corrosion coating systems, the bare steel surface profile shall be in accordance with the specifically applicable DEP referenced herein.
 - d. A sharp angular profile is required for all types of coatings.
10. Blast cleaning of completed anti-corrosion coating system outer surfaces, in preparation for elastomer system applications, shall be performed utilizing fully measured controls and shall be achieved using a combination of finer abrasives, lower compressed air pressures and an oblique (i.e., not perpendicular) blast angle as it is directed to those surfaces.
 - a. The above blast cleaning is intended to fully abrade anti-corrosion coatings, without digging down into the anti-corrosion coating system, such that the system DFT is not reduced anywhere by more than 10% of the original completed system DFT or by no more than 2 mils (50 μm), whichever is less.
 - b. Such determinations shall be made utilizing DFT before and after measurements in accordance with ISO 2178 or SSPC-PA 2 and roughness uniformly controlled utilizing replica tape testing in accordance with NACE RP0287.
 - c. FBE will normally handle a more aggressive reduced blast than will liquid-applied (paint) coatings. Over thinning of the anti-corrosion coating system in