SPECIFICATION FOR 3 LAYER POLYETHYLENE COATING

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1.0 SCOPE

This specification covers the minimum requirements for supply / arrangement of all materials, plant, equipment, plant sites, consumables, utilities and application including all labour, supervision, inspection and tests etc. for application of external anti-corrosion coating of pipes by using 3 Layer Side Extruded Polyethylene Coating conforming to DIN-30670, 1991, 'Polyethylene Coating of Steel Pipes and Fittings' and the requirements of this specification.

2.0 REFERENCE DOCUMENTS

Reference has also been made to the latest edition of the following standards, codes and specifications. The edition enforce at the time of floating the enquiry shall be termed as latest edition.

Sl.	Code		Description
1.	ASTM D-149	:	Standard Test Methods of Dielectric Breakdown voltage and Dielectric strength of solid electrical insulating materials at commercial frequencies.
2.	ASTM D-257	:	Standard Test Methods for D-C Resistance or conductance of insulating materials.
3.	ASTM D-543	:	Standard Method of Test for Ressistance of lastics to Chemical Reagents.
4.	ASTM D-570	:	Standard Method of Test for Water Absorption of Plastics.
5.	ASTM D-638	:	Standard Test Method for Tensile Properties of Plastics.
6.	ASTM D-792	:	Standard Test Method of Specific Gravity and Density of Plastics by Displacement.
7.	ASTM D-1238	:	Test Method for Low Rate of Thermoplastics by Extrusion.
8.	ASTM D-1525	:	Test Method for Vicat Softening Temperature of Plastics
9.	ASTM D-1603	:	Test Method for Carbon Black in Olefin Plastics

10.	ASTM D-1693	:	Test Method for Environmental Stress Cracking of Ethylene Plastics
11.	ASTM D-2240	:	Test Method for Rubber Property – Durometer Hardness
12.	ASTM D-3895	:	Test Method for Oxidative – Induction Time of Polyolefins by Differential Scanning calorimetry
13.	ASTM G-42	:	Tentative Methods for Cathodic disbonding of Pipeline Coatings Subjected to Elevated or Cyclic Temperatures.
14.	API RP 5L1	:	Recommended Practice for Railroad Transportation of Line pipe.
15.	API RP 5LW	:	Transportation of Line Pipe on barges and marine vessels
16.	DIN EN 10204	:	Metallic Products – Types of Inspection Documents
17.	DN 53735	:	Testing of Plastics : Determination of Melt Index of Thermoplastics.
18.	ISO 8502-3	:	Preparation of Steel Stubstrates before Applic application of Paints and Related Products – Part-3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
19.	ISO 9002	:	Quality Systems : Specification of Production and Installation
20.	ISO 11124	:	Preparation of Steel Substrates Before Application of Paints and Related Products
21.	SIS 055900	:	Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness.
22.	APL 5L	:	Specification for Line Pipe
23.	ASME B 31.8	:	Gas Transmission and Distribution Piping Systems
24.	ASME B 31.4	:	Liquid Transportation systems for Hydrocarbons, Liquid petroleum Gas Anhydrous ammonia, and Alcohols
25.	CSA Z245.20-98	:	External Fusion Bond Epoxy Coating for Steel Pipe

The Contractor shall be familiar with the requirements of these documents and shall make them readily available at the coating plant to persons concerned while carrying out the works specified in this specification.

3.0 PLANT SCALE AND INSTALLATION

3.1 The Contractor shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works. Coating plant(s), shall be installed into a yard whose geometry and dimensions are such as to allow the execution of a continuous work schedule. For this purpose the Contractor shall ensure non stop work execution owing to prohibitive adverse weather conditions and when required the Contractor shall install requisite equipment and plant in roofed and adequately weather protected areas.

3.2 Plant equipment, machinery and other facilities shall be in first class operating condition to at least meet the job requirements of quality and production.

3.3 The Contractor shall at his own responsibility provide and prepare all necessary area for the storage of bare and coated pipe and all other materials, for coating yard, stock-piling and other temporary installation. For each area, the Contractor shall provide to stipulate servitude agreements as required with the relevant Authorities, and, on work completion, to clean, restore and pay servitude and claims for damages, as applicable.

3.4 The Contractor shall at its own responsibility provide for water and power supply and other utilities and consumables and obtain authorisation regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing authorities.

3.5 The Contractor shall provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for the procedure qualification and during regular production. Outside testing for qualification and regular production is not acceptable to the Company.

3.6 The Contractor shall be fully responsible for adherence to all statutory regulations applicable for handling and disposal of the hazardous chemicals during the coating works.

3.7 The Contractor shall be responsible for obtaining all statutory approvals/ clearances from relevant Authorities including Pollution Control Board, as applicable for the coating plant(s).

4.0 MATERIALS

4.1 The three layer coating system shall comprise of a powder epoxy primer, polyethylene adhesive and a polyethylene top coat. Coating materials shall be suitable for the service conditions and the pipe sizes involved. The coating materials i.e. epoxy powder, adhesive and polyethylene compound shall have proven compatibility. The coating system and materials shall be pre-qualified

and approved by the Company. The Contractor shall obtain prior approval from the Company for the coating system and coating of all materials.

4.2 All the tests for all properties specified in para 5.3.1 and 5.3.2 for each batch of epoxy, adhesive and polyethylene compound including Infra-red Scan for each batch of epoxy powder shall be carried out. The Contractor shall furnish test certificates as per DIN EN 10204, 3.1B issued by the manufacturer for Company's approval prior to their use.

4.3 Samples from each batch of epoxy, adhesive and polyethylene shall be drawn in the presence of the Company Representative and test for the following properties at the coating yard at least one week prior to its use, to establish compliance with the Manufacturer's certificates.

a) **Epoxy Powder**

i. Gel Time
ii. Cure Time
iii. Moisture Content
iv. Thermal Characteristics (Tgl, Tg2, .H)

b) **Adhesive**

i. Specific Gravity
ii. Melt Flow Rate
iii. Vicat Softening Point

c) **Polyethylene**

i. Melt Flow Rate
ii. Specific Gravity
iii. Vicat Softening Point
iv. Moisture Content
v. Oxidative Induction Time

In case of failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required as per para 5.3.1 and 5.3.2 including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

4.4 All materials to be used shall be supplied in sealed, damage free containers and shall be suitably marked and identifiable with the following minimum information:

a. Name of the manufacturer
b. Type of material
c. Batch Number
d. Place and Date of Manufacture
e. Shelf Life/ Expiry Date (if applicable)
f. Quantity

All materials noted to be without above identification shall be deemed/ suspect and shall be rejected by the Company. Such materials shall not be used for coating and shall be removed from site and replaced by the Contractor.

4.5 The Contractor shall ensure that all coating materials properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.

4.6 The Contractor shall be required to use all materials on a date received rotation basis, i.e. first in-first used basis.

5.0 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING

5.1 The coating must be able to withstand a maximum in service operating temperature of +65°C and shall conform to 'S' Type of coating as per DIN 30670. In addition, in open storage the coating must be able to withstand a temperature of at least +80°C, without impairing its serviceability and properties specified.

5.2 The top coat polyethylene used shall be black readymade compound, fully stabilized against influence of ultraviolet radiation (.e. sunlight), oxygen in air and heat (due to environmental temperature as specified above). No appreciable changes shall occur during exposure to such environments up to at least a period of 6000 hours.

The Contractor shall submit certificate from Manufacturer in this regard.

5.3 Properties

Properties of coating system and coating material shall comply the requirements indicated in subsequent paragraph. In case the coating/ material properties are tested as per test methods/ standards other than specified herein below, the same may be accepted provided the test procedures and test conditions are same or more stringent than the specified.

5.3.1 Properties of Epoxy Powder and Adhesive

The Contractor shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirements and properties of coating system as specified in para 5.1 and 5.3.3 of this specification respectively. Epoxy powder properties shall be as per CSA Z245.20.98.

Copolymer grafted adhesive shall have the following properties.

Sl	Properties	Unit	Requirement	Test Method
a	Melt Flow Rate (190°C / 2.16 kg)	g/10 minutes	1.0	ASTM D1238
b	Vicat Softening Point	°C	90 min.	ASTM D1525

c	Specific Gravity	-	0.926 min.	ASTM D792

5.3.2 Properties of Polyethylene Compound

Sl	Properties	Unit	Requirement	Test Method
a	Tensile Strength @+25°C	N/mm^2	17 min.	ASTM D 638
b	Melt Flow Rate (190°C / 2.16 kg)	g/10 minute	0.25 min.	ASTM D 1238 or DIN 53735
c	Specific Gravity @+25 °C	-	0.941 min. (HDPE)	ASTM D 792
d	Hardness@+25°C	Shore D	50 min.	ASTM D 2240
e	Water Absorption, 24 hours, @+25°C	%	0.05 max	ASTM D 570
f	Volume Resistivity @+25°C	Ohm-cm	10^{15} min	ASTM D 257
g	Dielectric withstand,1000 Volt/sec rise @+25°C	Volts/mm	30,000 min	ASTM D 149
h	Vicat Softening Point	°C	110 min.	ASTM D 1525
i	Elongation	%	600 min.	ASTM D 638
j	Oxidative Induction Time in Oxygen at 220°C, Aluminium pan, no screen	Min	10	ASTM D3895
k	Environmental Stress Crack Resistance (ESCR) (for F50) Medium Density, Condition "C" High Density, Condition "B"	Hours	 300 300	ASTM D1693
l	Carbon Black Content	%	2 min.	ASTM D1603

5.3.3 **Properties of Coating System**

Sl	Properties	Unit	Requirement	Test Method
a	Bond Strength (using Type 2 Test Assembly i.e. Dynamometer) @ 20±5°C @ 60±5°C	Kg/cm	 8.0 min 5.0 min.	DIN 30670
b	Impact Strength (min. of 30 impacts on body along the length. No breakdown allowed when tested at 25 kV)	Joules per mm of coating thickness	7 min	DIN 30670
c	Indentation Hardness @ 23±2°C @ 70±2°C	mm	 0.2 max 0.3 max	DIN 30670
d	Elongation at Failure	%	300 min.	DIN 30670
e	Coating Resistivity (*)	Ohm-m2	10^8 min.	DIN 30670
f	Heat Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value	DIN 30670
g	Light Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value	DIN 30670
h	Cathodic Disbondment @+65°C after 30 days @+65°C after 48 hrs	mm radius of dis-bondment (**)	 15 max. 7 max.	ASTM G42
i	Degree of Cure of Epoxy Percentage Cure, ΔH ΔTg	% °C	95 +3/ -2	CSA Z245.20-98(*)

(*) Test carried out in an independent laboratory of national/ international recognition on PE top coat is also acceptable.

(**) Disbondment shall be equivalent circle radius of total unsealed area as per ASTM G42.

(***) Temperature to which the test specimens are to be heated during cyclic heating shall however be as per the recommendations of epoxy powder manufacturer.

6.0 MEASUREMENT AND LOGGING

The Contractor shall maintain records of all the relevant data of individual pipe and pipe coating including heat number, diameter, length, wall thickness, defects, pipe number, batches of materials, materials balance, sampling, testing, damages, repairs, rejects and any other information that the Company considers to be relevant and required for all incoming bare pipes and the Company approved outgoing coated pipes as applicable. The Contractor shall submit this information in the form of a report at the agreed intervals. The above data shall also be provided in MS EXCEL format in Compact Disc (CD). The Contractor shall also submit the material balance details to the Company for information at the end of shift.

7.0 COATING PROCEDURE AND QUALIFICATION

7.1 The Contractor shall submit a detailed report for the Company's approval indicating but not limited to the following:

a. Details of plant(s), locations, layout, capacity and production rate(s).

b. Details of the equipment available to carry out the coating works including surface preparation, epoxy powder application and its recycling system, adhesive & polyethylene extrusion, moisture control facilities available for coating materials.

c. Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.

d. Details of chemicals pre-treatment facilities including process control and inspection equipment for phosphoric acid wash, de-ionised - ionised water wash and chromate wash.

e. Facilities in the yard for unloading, handling, transport, production, storage, stockpiling, loading of bare and coated pipes and warehouses for storage of other coating materials.

f Plant Organo-gram Chart and availability of manpower including coating specialist.

g Details of utilities /facilities such as water, power, fuel, access roads & communication etc. After approval has been given by the Company, no change in plant set-up shall be made. However, unavoidable changes shall be executed only after obtaining written approval from the Company.

7.2 At least four(4) weeks prior to the commencement of production coating, a detailed procedure of the Contractor 's methods, material proposed, etc., shall be formulated by the Contractor and submitted for the Company 's approval in the form of a bound manual. The procedure shall include, but not limited to the following information and proposals:

a. Pipe inspection at the time of bare pipe receipt.

b. Steel surface preparation, including preheating, removal of steel defects, method of pipe cleaning, dust removal, abrasive blast cleaning and surface profile, methods of measurements and consumables.

c. Complete details of chemical pre-treatment viz phosphoric acid wash, deionised water wash, and chromate wash including product data sheets, health and safety sheets and manufacturer's recommended application procedure.

d. Pipe heating, temperatures and control prior to epoxy application.

e. Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendation from manufacturer(s).

f. Application of FBE powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time, etc.

g. Quenching and cooling, including time and temperature.

h. Quality assurance system, Inspection and testing methods and reporting formats, including instrument and equipment types, makes and uses etc.

i. Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repairs thereof including coating stripping technique.

j. Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates.

k. Complete details and inventory of laboratory and equipment for procedure qualification and regular production.

l. Pipe handling and stock piling procedures.

m. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per clause 6.0 of this specification.

n. Complete details of test certificates for raw materials including test methods standards used.

o. Test certificates from PE compound manufacturer for tests for thermal aging coating resistivity and aging under exposure to light. These test certificates shall not be older than three years.

p. Health, safety and environment plans.

q. Storage details of coating materials and chemicals.

r. Continuous temperature monitoring at various stages of coating.

Procedure Qualification Tests (PQT) shall be carried out only after obtaining written approval of the above procedure from the Company. No change in the procedure shall be made after approval has been given by the Company.

However, unavoidable changes shall be executed only after obtaining written approval from the Company.

7.3 Prior to start of production, the Contractor shall carry out a coating procedure qualification trial for each pipe diameter, and for each plant, to prove that his plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in clause 5.3, relevant standards, specifications and material manufacturer's recommendations. The Contractor shall give seven(7) working days notice to witness procedures and tests.

A batch representing a normal production run, typically 15 pipes, shall be coated in accordance with the approval coating procedure and the coating operations witnessed by the Company Representative. Out of these pipes, at least one pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers. At east 5 (five) test pipes shall be selected by Company Representative for coating procedure approval tests and shall be subjected to procedure qualification testing as described hereinafter. All tests shall be witnessed by the Company's representative. Out of 5(five) test pipes 1(one) pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers. Remaining 4(four) test pipes shall be coated with all three layers.

During PQT, the Contractor shall qualify various procedures forming a part of coating operations as detailed subsequently.

7.4 **Qualification of Procedures**

7.4.1 Epoxy Powder Application & Recycling

During pre-qualification, air pressure in the epoxy spray guns, satisfactory functioning of monitoring system, line speed vs coating thickness, etc. shall be established. Dew point of air used to supply the fluidised bed, epoxy spray system and epoxy recycling system shall be recorded during the PQT. Also, the Contractor shall remove samples of reclaimed powder from the reclamation system. These of reclaimed powder shall be subject to a detailed visual examination, thermal analysis and moisture content tests. The properties of the reclaimed powder shall be within the range specified by the Manufacturer of epoxy powder. In case the properties of the reclaimed powder are out of the range specified by the Manufacturer, the Contractor shall not the use the reclaimed powder during the regular production.

7.4.2 Pipe Pre-Heating

The Contractor shall establish the temperature variation due to in-coming pipe temperature, line speed variation, wall thickness variation, emissivity, interruptions, etc. and document the same during the PQT stage. During PQT, proper functioning of pipe temperature monitoring and recording system including alarm/ hooter shall be demonstrated to the Company.

7.4.3 Surface Preparation

The procedure to clean and prepare the pipe surface shall be in accordance with the requirements of this specification. The ratio to shots to grits shall be established during procedure qualification testing, such that the resultant surface profile is not dished and rounded. The qualification shall be performed through a visual inspection, measurement of roughness and check of the presence of dust in the abrasive blast cleaned pipe surface.

7.4.4 Chemical Pre-Treatment

7.4.4.1 Phosphoric Acid Wash followed by De-ionised Water Wash

The procedure to apply the chemical pre-treatment viz. phosphoric acid wash followed by de-ionised water wash shall be in accordance with the recommendation of the manufacturer and shall result in intended cleaning requirements of this specification. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the cleanliness/ temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs line speed vs dwell time, rinsing procedure, testing & control, rectificatory measures, drying procedure etc. shall be clearly established during PQT. Also the quality of the de-ionised water shall be established during PQT.

7.4.4.2 Chromate Treatment

The procedure to apply the chromate treatment shall be in accordance with the recommendation of the manufacturer. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe preheat temperature vs line speed, pipe heating after chromating and time limit within which the pipe to be heated, testing & control, rectificatory measures, shall be clearly established during PQT.

7.4.5 Coating Application

The Company will check the correctness of each coating application operation, values of the main parameters of each operation, preheating pipe surface temperature prior to epoxy powder application temperature, line speed, fusion bonded epoxy curing time, temperature and flow rate of copolymer adhesive and polyethylene etc. and the same shall be recorded. These values shall be complied with during regular production.

7.5 Qualification of Applied Coating

7.5.1 Tests on pipe coated partly with epoxy and partly with epoxy & adhesive Layers

a. **Degree of Cure**

Epoxy film samples (min 4 Nos.) shall be scrapped from the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using Differential Scanning Calorimatry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (.Tg) and % cure (.H) shall comply the specified requirements.

b. **Epoxy Layer Thickness**

Epoxy layer thickness shall be checked at every one meter spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply the specified thickness requirements.

c. **Adhesive Layer Thickness**

Adhesive layer thickness shall be checked at every one meter spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply the specified thickness requirements.

d. **Holiday Inspection**

Entire pipe shall be subject to holiday inspection and the test voltage shall be set to exceed 5 v/micron of epoxy thickness specified for the portion coated only with epoxy layer.

e. **Adhesion Test**

i) Adhesion Test (24 hrs or 48 hrs) shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table 4.

ii) Adhesion of FBE shall also be separately determined at ambient temperature at two locations by the "St Andrews Cross" method and the test shall comply with the specified requirements.

f. **2.5° Flexibility Test**

2.5° Flexibility test shall be carried out on the epoxy coated pipe at test temperature of 0°C. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98.

g. **Cross-section & Interface Porosity Test**

Cross section porosity and interface porosity tests shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table-4.

7.5.2 **Tests on pipes coated only with all three layers**

a. **Bond Strength**

Three test pipes shall be selected for bond strength tests. On each of the selected pipes, three bond strength test shall be performed for each specified temperature i.e. one at each end and one in the middle of the pipe and specified requirements shall be complied with, i.e. bond strength as well as mode of separation. Length of peel shall be minimum 65mm. None of these samples shall fail.

b. **Impact Strength**

Three test pipes shall be selected for impact strength test and the test shall meet the requirement.

c. **Indentation Hardness**

Two samples for both the temperatures from all pipes shall be taken. If any one of these samples fail to satisfy the requirements, then the test shall be repeated on four more samples. In this case, none of the samples must fail.

d. **Elongation at Failure**

Six samples each from two coated pipes i.e. 18 samples in all shall be tested and the test shall comply the specified requirement. Only one sample per pipe may fail.

e **Cathodic Disbondment Test**

Two CD test shall be carried out for the total lot of test pipes having all three layers. One test shall be carried out for 30 days duration and another test for 45 hours duration The tests shall comply the specified requirement. Whenever Procedure Qualification is necessitated for different pipe size with same coating material combination, 48 hours test only be conducted. 30 days CD test is not mandatory in this case.

f **Holiday Inspection**

All the pipes shall be subject to holiday inspection. The test voltage shall be as specified in para 10.4(b)

g **Coating Thickness Measurement**

All pipes shall be subject to coating thickness measurement. Acceptance criteria shall be as per para 10.3

h **Air Entrapment**

One sample each from pipe body and on weld (if applicable) shall be taken from all four coated pipes and the specified requirements shall be complied with.

i. **Degree of Cure**

Epoxy film samples (minimum 4 no., equally spaced) shall be scrapped from one coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (.Tg) and % cure (.H) shall comply with the specified requirements.

7.5.3 **Inspection of all test pipes**

All pipes shall be subject to the following inspections:

a. Surface cleanliness, surface roughness measurements and dust control immediately after second abrasive blast cleaning and salt test immediately after De-ionised water wash.
b. PH of pipe surface before and after phosphoric acid wash.
c. Visual inspection of chromate coating.
d. Visual inspection of finished coating, cut back dimension, internal/ external cleanliness, end sealing and bevel inspection.

Acceptance criteria for all inspection and testing shall be as specified in this specification.

7.6 After completion of the qualification tests and inspection as per para 7.4 and 7.5 above, the Contractor shall prepare and issue to the Company for approval a detailed report of the above tests and inspection including test reports / certificates of all materials and coatings tested. Only upon written approval from the Company, the Contractor shall commence production coating.

7.7 On successful completion of PQT, coating of all five(5) test pipes shall be removed and completely recycled as per the approval coating procedure specification. Remaining pipes will be accepted by the Company provided they meet the requirements of this specification and need not be stripped and re-cycled.

7.8 The Contractor shall re-establish the requirements of qualification and in a manner as stated before or to the extent considered necessary by the Company, in the event of, but not limited to, the following :

- Every time there is a change in the previously qualified procedure.
- Every time there is a change in the manufacturer and change in formulation of any of the raw materials and change in location of raw material manufacture.
- Every time the coating yard is shifted from one location to the other or every time the critical coating equipments (induction heater, epoxy spray system, extruder, etc) are shifted.
- Any change in line speed during coating application.
- Any time when in the Company's opinion the properties are deemed to be suspect during regular production tests.

7.9 The Company reserves the right to conduct any or all the test required for qualification through an independent laboratory or agency at the cost of the Contractor when in the Company's opinion, the results are deemed suspect. the Company's decision shall be final.

8.0 PIPE SURFACE PREPARATION

8.1 Unless specified otherwise, the pipes shall be supplied free from mill applied oils but may be subject to contamination occurring during transit.

8.2 Prior to cleaning operation, the Contractor shall visually examine the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The Contractor shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers of ensure traceability of pipe after coating.

8.3 Any oil, grease, salt or other contaminants detrimental to the formation of a good coating bond or coating quality shall be removed prior to coating application. Contaminants may be removed by the use of non-oily solvents. Gasoline or kerosene shall not be used for this purpose. Visible oil and grease spots shall be removed by solvent wiping. Solvents cleaning shall be in accordance with SSPC-SP1. Steel surface shall be allowed to dry before abrasive cleaning.

8.4 All pipes shall be preheated to a temperature 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blasting cleaning units to achieve the specified surface cleanliness and profile. After first abrasive blast cleaning, chemical pre-treatment with phosphoric acid solution as per para 8.6 shall be carried out prior to second abrasive blast cleaning. However at the option of the Contractor, chemical pretreatment with phosphoric acid solution as per para 8.6 may be carried out after the second abrasive blaster.

The abrasive blast cleaning units shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from the pipe surface. The equipment used for abrasive blast cleaning shall meet the specified requirements and shall be free from oil, water soluble salts and other forms of contamination to ensure that the cleaning process is not impaired. Traps, separators and filters shall be checked for condensed water and oil at the start of each shift and emptied and cleaned regularly. During abrasive blast cleaning the metallic abrasive shall be continuously sieved to remove "fines" and "contaminates" and the quality checked at every four hours. Abrasive used for blast cleaning shall comply ISO- 11124.

8.5 Suitable plugs shall be provided at both pipe ends to prevent entry of any shot/grit into pipe during blast cleaning operations. These plugs shall be removed after blast cleaning. Alternatively the Contractor may link pipes suitably together to prevent the entry of any short/grit into the pipe.

8.6 Chemical Pre-treatment with Phosphoric Acid Solution

8.6.1 All pipes shall provided chemical pre-treatment with phosphoric acid solution. 10% solution of phosphoric acid, Oakite 31 / 33 or equivalent, shall be used to remove all soluble salts and other soluble contaminations.

The Contractor shall provide data sheets and supporting documentation for the phosphoric acid to be used. The documentation shall verify that the phosphoric acid is suitable for the treatment of line prior to the application of the specific fusion bonded epoxy powder being applied.

8.6.2 The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 45 to 75 °C. Phosphoric acid treatment shall be followed immediately by washing with de-ionised water. Deionised water used shall conform to the following requirements :

Sl	Properties	Unit	Requirement
a	Turbidity	NTU	1 max.
b	Conductivity	µmho/cm	5 max.
c	Hardness	-	Nil
d	Total Alkalinity as CaCO3	mg/l	2 to 3
e	Chloride as Cl	mg/l	1 max.
f	Sulphate as SO4	mg/l	1 max.
g	PH	-	6.5 to 7.5

Tests to determine the above properties shall be carried out in accordance with "Standard Methods for the Examination of Water and Wastewater" published jointly by American Public Health Association, American Water Works Association and Water Pollution Control Federation.
Quality of the deionised water shall be monitored at the start of each shift and at every four hours interval. Non-compliance of deionised water wrt the above requirements shall cause for stoppage of the operations.

8.6.3 The pH of the pipe surface shall be determined both before and after the deionised water rinse initially on each pipe and in case of consistent results, the frequency may be relaxed to once per hour at the discretion of the Company. The measured pH shall be as follows :
Before de-ionised water wash : 1 to 2
After de-ionised water wash : 6 to 7

8.6.4 After the de-ionised water wash, the pipe shall be dried with dry air and preheated to a temperature of 65°C to 85°C.

8.6.5 The salt tests shall be carried out after de-ionised water rinse. The testing of frequency shall be two pipes per shift, but not less than 4 pipes per every 100 pipes. The acceptance criteria shall be 2µg/cm2. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendation.

8.7 Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to Sa 2½ of Swedish Standard SIS 055900 latest edition. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 70 microns(Rz). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness (Sa 2½), degree of dust and shape of profile. Degree of dust shall comply the requirements of ISO:8502 – 3. Acceptance limit shall be either quality rating 2 or Class 2.

8.8 All pipes shall be visually examined for presence of any shot/ grit/ loose material left inside the pipe during blast cleaning. Suitable mechanical means (stiff brush) shall be employed to remove the same before the pipes are processed further. In addition, inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focused at the middle of the pipe at one end while inspection is carried out visually from other end. Any foreign material or shots/ grit present in the pipe shall be completely removed by mechanical/ brush, high pressure air jets, by tilting of pipe etc.

8.9 At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The Contractor shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.

8.10 The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall be surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating. After blast cleaning, all surfaces shall be thoroughly inspected under adequate lighting to determine anchor pattern, quality of blasting and identify any surface defects prior to coating application. All surface defects such as slivers, scab, burns, laminations, welds spatters, gouges, scores, indentations, slugs or any other defects considered injurious to the coating integrity made visible during blast cleaning shall be reported to the Company and on permission from the Company, such defects shall be removed by filing or grinding. After any grinding or mechanical repairs, the remaining wall thickness shall be checked and compared with specified thickness. Ay pipes having thickness less than 95% of specified thickness shall be kept aside and disposed off as per the instructions of the Company. The method employed to remove surface defects shall not burnish or destroy then anchor pattern or contaminate the surface. Pneumatic tools shall not be used unless they are fitted with effective air/ oil and water traps. Where burnishing results in destruction of anchor pattern, the anchor patter shall be restored by suitable means. Pipes which have damages repaired by grinding and have ground areas more than 50 mm in diameter shall be recycling-blasted.

Any dust or loose residues that have been accumulated during blasting and/ or during filing/ grinding operations shall be removed by vacuum cleaning.

If contamination of surface occurs, the quality of blast cleaning method and process shall be examined. If the surface roughness is outside the specified limit, the blast cleaning material shall be checked and replaced.

8.11 Upon Completion of the blasting operations, the quality control supervisor shall accept the pipe for further processing or return for re-blasting after removal of defects/ imperfections. In case imperfections are considered detrimental to the coating quality, the same shall be reported to the Company for final decision on rejection or re-blasting/ removal of defects. Re-blasting/ removal of defects or returning pipe to the yard shall be the Contractor's responsibility.

The Company, in additions, reserves the right to initiate any of the above actions during periodic inspections for oil, dust, salt, imperfections, surface defects, lack of white metal finish etc.

8.12 In order to ensure that pipe with defects are not processed further, provisions shall be available to lift the pipes from inspection stand.

8.13 Chemical Pre-treatment with Chromate Solution

8.13.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically Pre-treated with a 10% strength chromate solution.

8.13.2 The Contractor shall provide data sheets and supporting documentation for the chemical to be used. The documentation shall verify that the chemical is suitable for the treatment of line pipe prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.

8.13.3 The chemical pre-treatment shall be applied fully in accordance with the chemical suppliers' instructions and in a manner that ensures 100% uniform coverage of the pipe surface without introducing surface contamination.

8.13.4 The Contractor shall check that the concentration for the chemical pretreatment solution remains within the range recommended by the chemical manufacturer for the pipe coating process. The concentration shall be checked at the make up of each fresh solution and once per hour, using a method approved by the chemical manufacturer. The Contractor shall also ensure that the chemical pre-treatment solution remains free from contamination at all times. Recycling of chemical pre-treatment solution is not permitted.

8.13.5 The Contractor shall ensure that the temperature of the substrate is maintained between 40°C and 80°C and the chromate solution temperature does not exceed 60° or as recommended by the manufacturer.

8.13.6 The chromate coating shall be smooth, even, free from runs, drips or excessive application and lightly adherent with no flaking of the coating. The chromate coated steel must be thoroughly dried immediately after application and shall be achieved by boiling off any residual solution on the surface.

8.14 The total allowable elapsed time between completion of the blasting operations and commencement of the pre-coating and heating operations shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every half on hour during the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below :

Relative Humidity%	Maximum elapsed time
> 80	2 hours
70 to 80	3 hours
< 70	4 hours

Any pipe not processed within the above time-humidity requirement shall be completely re-blasted. Any pipe showing flash rusting shall be re-blasted even if the above conditions have not been exceeded.

8.15 Pipe handling between abrasive blasting and pipe coating shall not damage the surface profile achieved during blasting. Any pipe affected by the damage to the surface exceeding 200mm2 in area/ or having contamination of steel surface shall be rejected and sent for re-blasting.

9.0 COATING APPLICATION

The external surface of the cleaned pipe conforming to clause 8.0 of this specification shall be immediately coated with 3-layer extruded polyethylene coating in accordance with the procedures approved by the Company, relevant standards and this specification. In general, the procedure shall be as follows:

9.1 Pipe Heating

9.1.1 Immediately prior to heating of pipe, all dust and grit shall be removed from both inside and outside of the pipe by a combination of air blast, brushing and vacuum cleaning. Suitable arrangement shall be made to protect the bevel ends from getting damaged during the coating operation.

9.1.2 Induction heater or gas furnace shall be used for heating the pipe. The method shall be capable of maintaining uniform temperature along the total length of the pipe, and shall be such that it shall not contaminate the surface to be coated. In case of induction heating, appropriate frequency shall be used to ensure 'deep heating' and intense skin heating is avoided. Gas fired heating system shall be well adjusted so that no combustion products are deposited on the steel surface. This shall be demonstrated on bare pipes prior to start of PQT. Oxidation of the cleaned pipe surfaces prior to coating (in the form of bluing or other apparent oxide formation) is not acceptable.

9.1.3 External surface of the pipe shall be heated to about 190°C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.

9.1.4 Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. The recording method shall allow to correlate each line pipe. The monitoring instrument shall be able to raise an alarm/ activate audio system (hooter) in the event of tripping of induction heater/ gas fired heater or in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected. Such rejected pipes shall be stripped and recoated.

9.1.5 Temperature measuring & monitoring equipment shall be calibrated twice every shift and/ or as per the Company 's instruction.

9.1.6 The Contractor shall ensure that pipe surface emissivity variations are minimized during pipe heating. To avoid significant variance, more than once blasted joints should be coated at the same time and not mixed with joints blasted only once.

9.2 Pipe Coating

9.2 .1 Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe.

i. Electrostatic application of epoxy powder of minimum dry film thickness 0.150 mm, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.

ii. Grafted co-polymer adhesive applied by extrusion, minimum thickness 0.200 mm.

iii. Polyethylene coating by extrusion.

The coated pipe shall be subsequently quenched and cooled in water for a period which shall sufficiently lower the temperature of pipe coating to permit handling and inspection.

9.2.2 Minimum total thickness of finished coating shall be as under :

Pipe Size Specified outside diameter (mm)	Min. Coating Thickness (mm)(*) Normal Type (n)
Up to 10¾" (273.1)	1.8
Over 10¾" (273.1) to below 20" (508.0)	2.0
From 20" (508.0) to below 32" (813.0)	2.25

(*) HDPE material is to be used as top coat.

Required coating thickness shall be normal type (n), unless otherwise specified.

9.2.3 Coating materials shall be inspected in accordance with the manufacturer's recommendation prior to coating application and it shall be ensured that the materials are moisture free. In case the relative humidity exceeds 80%, the adhesive and polyethylene material shall be dried using hot air as per the directions of the Company.

9.2.4 Prior to starting the application of fusion bonded epoxy powder, the recovery system shall be thoroughly cleaned to remove any unused powder remaining from a previous line pipe coating application. The use of recycled powder shall be permitted subjected to:

a) Satisfactory qualification of the reclaimed system during PQT stage
b) The proportion of the reclaimed powder in the working mix does not exceed 20% at any one time.
c) The quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated at para 5.3.1.

9.2.5 Dry air, free of oil and moisture shall be used in the coating chamber and spraying system and for this purpose filters, dehumidifier/ heater as required along with control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (-) 40°C and this shall be shall monitored during the regular production.

9.2.6 Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be able capable of raising an alarm/ activate audio system (hooter) in the event of change in air pressure beyond the set limits. Any deviation from the pre-set limits shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of air pressure deviation shall be identified by suitable marking and rejected. Such rejected pipes shall be stripped and recoated.

9.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed. The application of the adhesive layer shall not be permitted after epoxy is fully cured. The Contractor shall establish, to the satisfaction of the Company, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The Contractor shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.

9.2.8 Extruded polyethylene layer shall be applied over the adhesive layer within the time limit established during PQT stage and within the time/ temperature range recommended by the manufacturer. The extrusion temperatures of the adhesive and polyethylene shall be continuously recorded. The monitoring instruments shall be independent of the temperature control equipment. The instruments shall be calibrated prior to start of each shift.

9.2.9 The Contractor shall ensure that there is no entrapment of air or void formation along the seam weld (where applicable) during application of coating. Air entrapment below the coating and also along the coating overlap shall be prevented by forcing the coating on to the pipe using high pressure roller of suitable design during coating application. In case it is not adequately achieved, the Contractor shall supplement by other method to avoid air entrapment. The methods used shall be witnessed and approved by the Company.

9.2.10 Resultant coating shall have a uniform gloss and appearance and shall be free from air bubbles, wrinkles, holidays, irregularities, discontinuities, separation between layers of polyethylene & adhesive, etc.

9.2.11 Coating and/ or adhesive shall terminate 120mm (+)20/(-)0 mm from pipe ends. The adhesive shall seal the end of applied coating. The Contractor shall adopt mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angle of 30° to 45°.

9.2.12 Failure to comply with any of the above applicable requirement and of the approved procedure shall be cause for the rejection of the coating and such coating shall be removed in a manner approved by the Company.

10.0 INSPECTION AND TESTING

10.1 General

The Contractor shall establish and maintain such quality assurance system as are necessary to ensure that goods or services supplied comply in all respects with the requirements of this specification. The minimum inspection and testing to be performed shall be as indicated subsequently herein.

10.2 Visual Inspection

Immediately following the coated, each coated pipe shall be visually checked for imperfections and irregularities of the coating. The coating shall be of natural colour and gloss, smooth and uniform and shall be blemish free with no dust or other particulate inclusion. The coating shall not slow and defects such as blisters, pinholes, scratches, wrinkles, engravings, cuts swelling, disbanded zones, air inclusions, tears, voids or any other irregularities. Special attentions shall be paid to the areas adjacent to he longitudinal weld (if applicable), adjacent to the cut back at each of pipe and within the body of the pipe.

In addition inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focussed at the middle of the pipe at line end while inspection is carried out visually form other end.

10.3 Coating Thickness

a. The coating thickness shall be determined by taking at least 10 measurement at locations uniformly distributed over the length and periphery of each pipe. In case of weld pipes, five of the above readings shall be made at the apex of the weld seam, uniformly distributed over the length of the coated pipe. All the readings must meet the minimum requirements. However, localised coating thickness of less than the permissible minimum thickness can be tolerated on the condition that it does not attain a total extent of more than 5cm2 per meter length of coated pipe, and the actual coating thickness does not drop more than 10% below the permissible minimum coating thickness at these locations. The frequency of thickness measurement as stated above shall be initially on every pipe, which shall be further reduced depending upon consistency of results, at the sole discretion of the Company. Results of all measurement shall be recorded.

b. Thickness of epoxy and adhesive shall be measured at the beginning of each shift and whenever the plant re-starts after any stoppage for compliance. Coating of epoxy and adhesive on portion of pipe required for this purpose, stripping and recoating of such partly coated pipe shall be the Contractor's responsibility.

c. Coated pipes not meeting the above requirements shall be rejected. The Contractor shall remove the entire coating and the pipe shall be recycled to the cleaning and coating operations as per the approved procedure.

10.4 Holiday Detection

a. Each coated pipe length shall be checked over 100% of coated surface by means of a "holiday detector" of a type approved by the Company for detecting holidays in the finished coating.

b. The holiday detector shall be a low pulse DC full circle electronic detector with audible alarm and precise voltage control with DIN VDE 0433 Part 2. The set voltage for inspection shall be 25 kV. Travel speed shall not exceed 300 mm/s.

c. The Contractor shall calibrate the holiday detector at least once every 4 hours of production. The Contractor shall have necessary instruments or devices for calibrating the holiday detector.

d. Any pipe coating shall be rejected if more than 1(one) holiday & area more than 100 cm2 in size are detected in its length attributable to coating process.

e. Holidays which are lesser in number and size than those mentioned in (d) above, shall be repaired in accordance with a approved procedure.

10.5 Bond Strength Test

a. The Contractor shall conduct bond strength test for composite coating as per clause 5.3.3 (a) of this specification. A minimum of 65mm length shall be peeled. First 20mm and last 20mm shall not be counted for assessment of bond strength.

b. The frequency of test for cut back portions shall be one pipe in every fifteen (15) pipes coated and for middle of pipe shall be one pipe in every sixty(60) pipes coated or one pipe per shift whichever is higher. On each selected pipe, bond strength shall be performed for each specified temperature. Test shall be performed at each cut back portion and one in the middle of pipe. The system shall disbond/ separate cohesively either in adhesive layer or in polyethylene layer. Majority of the peeled off area on the pipe shall show presence of adhesive. Dis-bondment / separation at epoxy to steel interface or epoxy/ adhesive interface or adhesive/ polyethylene interface shall not be permitted. The failure mode shall be recorded for each test.

c. In case the above tests do not comply with the above requirement, the Contractor shall test all the preceding and succeeding coated pipes. If both pipes pass the test, then the remainder of the pipe joints in that shift shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated during the shift shall be tested until the coating is provided acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure.

d. The frequency of bond strength test as per para 10.5(b) for cut back portion may be reduced depending upon the consistently of result to one pipe in every twenty five(25) instead of every fifteen pipes, at the sole discretion of the COMPANY Representative.

10.6 Impact Strength

a. Impact resistance test shall be conducted as per clause 5.3.3 (b) of this specification. Initially the frequency of test shall be 2(two) coated pipes per shift, which may be further reduced and/ or waived depending upon consistently acceptable results at the sole discretion of the Company.

b. Minimum thirty(30) impacts located equidistant along the length of coated pipe shall be performed.

c. Immediately after testing, the test area shall be subjected to holiday detection at the same voltage as used prior to impact strength test. The pipe shall be rejected if any holiday is noted in the test area.

d. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.7 **Indentation Hardness**

a. Indentation hardness test shall be as per clause 5.3.3 (c) of this specification. The frequency of test shall be initially 2(two) coated pipes per shift which shall be further reduced to one test each on 2 coated pipes per week at random after 1 week of consistently acceptable results. Two samples for each temperature shall be taken from the cut back portion of coated pipe and one in middle of the pipe for this test.

b. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.8 **Air Entrapment Test**

a. Strips from bond strength tests or coated pipe may be used to help determine the porosity of the finished coating. Strip shall be also cut from longitudinal weld (if applicable) at cut back portion and examined for the presence of voids.

b. Bond strength strip shall be viewed from the side and at the failure interface. At the pipe bond strength test location, utility knife shall be used to cut the edge of the coating to a 45° angle and view with a microscope. Similar examination shall be done in the coating cut back area.

c. One sample each either on the bond strength strip or coated pipe and strip cut from the longitudinal weld (if applicable) shall be examined for air entrapment per shift. Strips shall be viewed from the side.

d. All examination shall done using a 30X magnification hand-held microscope. The polyethylene and adhesive layers shall have no more than 10% of the observed area taken up with air entrapment (porosity or bubbles). Air entrapment shall not occupy more than 10% of the thickness in each case. Bubbles shall not link together to provide a moisture path to the epoxy layer.

e. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

10.9 **Degree of Cure**

a. Epoxy film samples shall be removed from cut back portion of the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using DSC procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (.Tg) and % cure (.H) shall comply the specified requirements.

b. Frequency of this test shall be once per shift. Pipe shall be selected randomly by the Company during the middle of a shift. Suitable provisions/ arrangements as per the instructions of the Company shall be made by the Contractor for this purpose.

c. In case of test failure, production carried out during the entire shift shall be rejected, unless the Contractor proposes a method to establish the compliance with the degree of cure requirements of all pipes coated during that shift.

10.10 **Epoxy Layer Adhesive Test**

a. Adhesion of epoxy layer shall be determined at ambient temperature by the "St Andrews Cross" method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of 30°/ 150°. The epoxy coating shall resist disbondment from the steel when attempts are made to flick/ lift the coating from the 30° angle with a sharp knife.

b. Frequency of this test shall be once per shift. The test shall be carried out at the cut back portion of the pipe from which the Degree of Cure test has been carried out as per para 10.9 above.

c. In case of test failure, retesting and disposal of coated pipe shall be as per 10.9(c) above.

10.11 **Cathodic Disbondment Test**

a. 48 hours CD test shall be conducted as per clause 5.3.3. (h) of this specification.

b. The frequency of this test shall be once in every two weeks or one test representing each batch of epoxy powder used, whichever is more frequent.

c. In case the test fails to conform to the specified requirement, at the option of the Contractor, all pipes coated after the previous acceptable test and prior to next acceptable test shall be rejected or the test shall be repeated or the shall be repeated using two additional samples taken from the same end of the affected pipe.

When both retests conform to the specified requirement, the lot of pipes shall be accepted. When one or both the retests fail to conform to the specified requirement, all coated pipes after previous acceptable test and prior to next acceptable shall be rejected. All rejected pipes shall be stripped, re-cleaned and re-coated. The Company may consider a further retest program to determine whether any of the affected pipe meet the criteria for acceptance upon written request by the Contractor.

10.12 Damages occurring to pipe coating during above tests shall be repaired in accordance with approved coating repair procedure.

10.13 Repairs occurring on account of the production test are however excluded from above mentioned limitations at para 10.4 (d) above.

10.14 The Company, reserves the right to perform inspection and witness tests on all activities concerning the pipe coating operations starting from bare pipe to finished coated pipe ready for dispatch and also testing of raw materials. CONTRACTOR shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection to the Company. Inspection and tests performed or witnessed by the Company shall in no way relieve the Contractors obligation to perform the required inspection and tests.

10.15 In case rate of defective or rejected pipes and/ or samples tests are 10% or more for a single shift (typically 8 hours), the Contractor shall be required to stop production and carry out a full and detailed investigation and shall submit findings to the Company for approval. The Contractor shall recommence the production only after getting the written permission from The Company. Under no circumstances any action or omission of the Company shall relieve the Contractor of his responsibility for material and quality of coating produced. No pipes shall be transported from the coating plants unless authorised by the Company in writing.

11.0 HANDLING, TRANSPORTATION AND STORAGE

11.1 The Contractor shall be fully responsible for the pipe identification marking in line with the requirement indicated at clause 6 above.

All pipes shall be checked for bevel damages, weld seam height, dents, gouges, corrosion and other damages. the Company shall decide whether pipe defects/ damages are suitable for repair.

11.2 The Contractor shall unload, load, stockpile and transport the bare pipes within the coating plant(s) using suitable means and in a manner to avoid damage to pipes.

The Contractor shall stockpile the bare pipes at the storage area of the coating plant. The Contractor shall prepare and furnish to the Company a procedure/ calculation generally in compliance with API RP-5L1 for pipe stacking, which shall be approved by the Company prior to commencement.

11.3 The Contractor shall load, unload, transport and stockpile the coated pipes within the coating plant using approved suitable means and in a manner to avoid damage to the pipe and coating. The procedure shall be approved by the Company prior to commencement of work.

11.4 Coated pipes may be handled by means of slings and belts of proper width (minimum 60mm) made of non-abrasive/ non-metallic materials. In this case, pipes to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of round sectional slings are prohibited. Fork lifts may be used provided that the arms of the fork lift are covered with suitable pads preferably rubber.

11.5 Bare/ coated pipes at all times shall be stacked completely clear from the ground so that the bottom row of pipes remain free from any surface water. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe.

Bare/ coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can, for example, consist of dry, germ free straw with a plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes.

Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. The Contractor shall submit calculations for the Company's approval in this regard. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes.

The ends of the pipes during handling and stacking shall always be protected with bevel protectors.

11.6 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there as pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 3 Nos. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes. All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitable padded at the contact points with the pipe.

11.7 Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity, exposure to high thermal excursions or other adverse weather conditions, shall be suitably stored and protected.

Deteriorated materials shall not be used. These materials, shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion.

When supplied in containers and envelopes, they shall bot be dropped or thrown, or removed by means of hooks, both during the handling operations till their complete use. During unloading transport and utilization, any contact with water earth, crushed stone and any other foreign material shall be carefully avoided. The Contractor shall strictly follow Manufacturer's instructions regarding storage temperature and methods for volatile materials which are susceptible to change in properties and characteristics due to unsuitable storage. If necessary the Contractor shall provide for a proper conditioning.

11.8 In case of any marine transportation of bare/ coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. The Contractor shall furnish all details pertaining to marine transportation including necessary drawings of cargo barges, storing/ stacking, sea fastening of pipes on the barges/ marine vessels to the Company for approval prior to undertaking such transportation works. In addition, the Contractor shall also carry out requisite analyses considering the proposed transportation scheme and establish the same is safe and stable. On-deck overseas shipment shall not be allowed.

12.0 REPAIR OF COATING

The Contractor shall submit to the Company, its methods and materials proposed to be used for executing a coating repair and shall receive approval from the Company prior to use. In open storage the repair coating materials must be able to withstand a temperature of at least +80°C, without impairing its serviceability and properties. The Contractor shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification.

All pipe leaving coating plant, shall have sound external coating with no holiday porosity on 100% of the surface. Defects, repairs and acceptability criteria shall be as follows :

- Fipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm2 or linear damage (cut) of less than 3 cm shall be repaired by stick welding using material of same quality.

- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2.0mm and an area not exceeding 20 cm2 shall be rebuild by heat shrink patch only and without exposing to bare metal.

- Defects or size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrinks repair patch by exposing the bare metal surface.

- Defects exceeding the above and in number not exceeding 2 per pipe and linear length not exceeding 500mm shall be repaired using heat shrinkable sleeves.

- Pipes with bigger damage shall be stripped and recoated.

- In case of coating defect close to coating cut back, the Contractor shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now if the coating cut back exceeds 140 mm of linear length of pipe then the coating shall be repaired by the use of heat shrinkable sleeves thereby making up the coating cut back length of 120 mm.

Not withstanding the above, under no circumstances, if the defects exceeds 70 mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

Defects to be repaired by heat shrink patch/ sleeve shall be maximum 2 (two) per pipe.

Cosmetic damages occurring only in the Polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the Company. In any case the Contractor shall establish his material, methods and procedure of repair that results in acceptable quality of product by testing and shall receive approval from the Company prior to use.

Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness. The Contractor shall test repairs to coating as and when required by the Company.

13.0 MARKING

The Contractor shall place marking on the outside surface of the coating at one end of the coated pipe, and marking shall indicate, but not limited to the following information:

a. Pipe number, Heat number
b. Diameter & Wall Thickness
c. Coated Pipe Number
d. Colour band
e. Any other information considered relevant by Company.
f. Pipe Manufacturer Name
g. Inspection Mark/ Punch

The Contractor shall obtain prior approval on making procedure to be adopted from the COMPANY.

14.0 QUALITY ASSURANCE

14.1 The Contractor shall have established within the organisation and, shall operate for the contract, a documented Quality System that ensures that the requirements of this specification are met in all aspects. The Quality System shall be based upon ISO 9001/2 or equivalent.

14.2 The Contractor shall have established a Quality Assurance Group within its organisation that shall be responsible for reviewing the Quality System and ensuring that it is implemented.

14.3 The Contractor shall submit the procedures that comprise the Quality System to the COMPANY for agreement.

14.4 The Contractor's Quality System shall pay particular attention to the control of Suppliers and sub-Contractors and shall ensure that the requirements of this specification are satisfied by the Suppliers and Sub-Contractors operating Quality system in their organisation.

14.5 The Contractor shall, prior to the commencement of work, prepare and issue a Quality plan for all of the activities required to satisfy the requirements of this specification. The plan shall include any sub-contracted work, for which the sub-contractor's Quality plans shall be submitted. The plan shall be sufficiently detailed to indicate sequentially for each discipline the requisite quality control, inspection , testing and certification activities with reference to the relevant procedures and the acceptance standards.

14.6 The Contractor's Quality system and associated procedures may, with due notice, be subject to formal audits. The application of quality control by the Contractor will be monitored by the Company who will witness and accept the inspection testing and associated work required by this specification.

15.0 WARRANTY

The Contractor/Vendor shall have final and total responsibility for the design and performance of all items supplied under this specification. The Contractor/Vendor shall warrant the items furnished by him and the performance of the said items in accordance with this specification and with warranty requirements as specified in the bid package.

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