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دستورالعمل

سیستم پوشش قیر پایه نفتی پلیمری اصلاح شده کارخانه ای برای سطح خارجی
لوله های مدفون و غوطه ور در آب

polymer modified bitumen enamel factory coating system for
external surface of buried and submerged linepipes



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باسلام،

به استحضار می‌رساند در جلسه ۲۰۲۰ مورخ ۱۴۰۲/۰۵/۱۵ هیأت مدیره، نامه شماره گ/۹/۰۰۰/۶۶۳۵۶ مورخ ۱۴۰۲/۰۴/۲۰ آن مدیریت در مورد تصویب نهایی مقررات فنی شرکت ملی گاز ایران به شرح زیر مطرح و مورد تصویب قرار گرفت.

۱- سیستم پوشش قیرپایه نفتی پلیمری اصلاح شده کارخانه ای برای سطح خارجی لوله های مدفون و غوطه ور در آب

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Foreword

This standard specification is intended to be mainly used by N.I.G.C. and contractors, and has been prepared base on interpretation of recognized standards and technical documents, as well as knowledge, backgrounds and experiences in gas industries at national and international levels.

Iranian Gas Specification (IGS) are prepared, reviewed and amended by technical standard committees within NIGC standardization division of research and technology management and submitted to "the standards council of NIGC" for approval.

IGSs are subjected to revision, amendment or withdrawal, if required, and thus the latest edition of IGS shall be checked / inquired by NIGC'S users.

This standard must not be modified or altered by NIGC employees or its contractors. Any deviation or conflicts between this specification and other applicable standards, codes, procedure or well-known manufacturer's specifications must be resolved in writing by the user or its representative through Manager, Engineering Department or standardization division of NIGC.

The technical standard committee welcomes comments and feedbacks from concerned or interested corporate and individuals about this standard, and may revise this document accordingly based on the received feedbacks.

General Definitions

Throughout this standard the following definitions, where applicable, should be followed:

- 1- "STANDARDIZATION DIV." is organized to deal with all aspects of industry standards in NIGC. Therefore, all enquiries for clarification or amendments are requested to be directed to mentioned division.
- 2- "COMPANY": refers to National Iranian Gas Company (NIGC).
- 3- "SUPPLIER": refers to a firm who will supply the service, equipment or material to IGS specification whether as the prime producer or manufacturer or a trading firm.
- 4- "SHALL ": is used where a provision is mandatory.
- 5- "SHOULD": is used where a provision is advised only.
- 6- "MAY": is used where a provision is completely discretionary.

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1. SCOPE

This standard specification covers the minimum requirements for the materials, performance properties, application, inspection and testing, repair, handling and storage of polymer modified bitumen enamel factory applied coating system for corrosion protection of external surface of buried or submerged service linepipes.

This standard specification covers the use of modified polymer bitumen enamel when the design temperature of pipeline is within -20°C to $+60^{\circ}\text{C}$.

Note1: In the following conditions polymer modified bitumen enamel coating system shall not be used:

- Line pipes with O.D greater than 30 inches;
- In ambient temperature more than 40°C before installation;
- In continues operation temperatures more than 45°C .

Note2: Effective long terms performance of polymer modified bitumen coating system shall be attained when appropriate types of polymers have been used in sufficient amounts. Also, the desired resistance of polymer modified bitumen coating to microorganisms attack and root penetration shall be obtained if specific additives are added.

Therefore, the coating applicator shall provide related certificates from a reliable and independent testing laboratory to confirm the above mentioned characteristics of polymer modified bitumen coating system.

Note3: This standard withdraws and replaces IGS-M-TP-016 (2).

2. REFERENCES

Throughout this technical specification the following standards and codes are referred to. The applicability of changes in codes and standards that occur after the date of this standard specification shall be mutually agreed upon by the purchaser and manufacturer and/or applicator.

ASTM D 146(2020) " Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and waterproofing "

ASTM E 337 (2015) "Measuring Humidity with a Psychrometer (the Measurement of Wet and Dry-Bulb Temperatures)"

ASTM G 42 (2019) "Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures"

ASTM G 8 (2019) "Cathodic Disbonding of Pipeline Coatings"

DIN 30670 (2012) "Polyethelene Coatings for Steel Pipes and Fittings"

EN 10300 (2005) "Steel Tubes and Fittings for Onshore and Offshore Pipelines – Bituminous Hot Applied Materials for External Coating"

EN 12311-1 (2000) "Flexible Sheets for Waterproofing. Determination of Tensile Properties. Bitumen sheets for roof waterproofing"

EN 1426 (2015) "Bitumen and Bituminous Binder – Determination of Needle Penetration"

EN 1427 (2015) "Bitumen and Bituminous Binder – Determination of Softening Point (Ring and Ball Method)"

EN 1849-1 (2000) "Flexible Sheets for Waterproofing. Determination of Thickness and Mass per Unit Area. Bitumen Sheets for Roof Waterproofing"

IGS-M-PL-001-2(1) (2016) SMLS/HFW/SAWH Carbon Steel Pipes, Part 2- Grades B to X80, Sizes 6 to 56 inches

IGS-M-PL-001-2(1) (2017) SMLS/HFW Carbon Steel Pipes, Part 1- Grades B, 0.5 to 4 inches

ISO 11124 (2018) "Preparation of Steel Substrates before Application of Paints and Related Products – Specifications for Metallic Blast-Cleaning Abrasives – Part 1, 2, 3, & 4"

ISO 11126 (2018) "Preparation of Steel Substrates before Application of Paints and Related Products – Specifications for Non-Metallic Blast-Cleaning Abrasives – All Parts"

ISO 13736 (2021) "Petroleum Products and Other Liquids. Determination of Flash Point. Abel Closed Cup Method"

ISO 2431 (2019) "Paints and Varnishes – Determination of Flow Time by Use of Flow Cups"

ISO 2592 (2017) "Determination of Flash and Fire Points-Cleveland Open Cup Method"

ISO 5256 (2013) "Steel Pipes and Fittings for Buried or Submerged Pipe lines – External and Internal Coating by Bitumen or Coal Tar Derived Materials"

ISO 8501-1 (2007) "Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness – Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after Overall Removal Previous Coatings"

ISO 8502-3 (2017) "Preparation of Steel Substrates before Application of Paints and Related Products – Tests for Assessment of Surface Cleanliness – Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)"

ISO 8503-2 (2012) "Preparation of Steel Substrates before Application of Paints and Related Products – Surface Roughness Characteristics of Blast-Cleaned Steel Substrates – Part 2: Method for The Grading of Surface Profile of Abrasive Blast-Cleaned Steel – Comparator Procedure"

SHELL 31.40.30.33 (2013) "Bituminous Enamel Coating of Steel Linepipe"

AWWA C203 (2020) "Coal-Tar Protective Coatings and Linings for Steel Water Pipelines Enamel and Tape –Hot applied"

3. DEFINITIONS

Application Procedure Specification (APS)

Document describing procedures, methods, equipment and tools used for coating application

Batch

Quantity of coating material produced in a single production run.

Coating Applicator

The party, which is ultimately responsible for the coating operation which include supply coating materials, application of the coating materials, etc. as specified in the relevant contract.

Composite Polyester/Glass Fabric

A woven polyester/glass mesh with a layer of glass fibre tissue held together by a binder.

Cutback

The length of pipe left uncoated at each end for joining purposes (e.g. welding, push-on, etc.).

Inert Filler

Does not react with other ingredients of the coating material or with the environment in finely divided mineral powder, which is not hygroscopic, not electrically conductive and which it will be used.

Inspection and testing plan (ITP)

Document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures.

Latex Paint

A paint containing a stable aqueous dispersion of synthetic resin , produced by emulsion polymerization , as the principal constituent of the binder . Modifying resins may also be present.

Modified Bitumen Enamel

Bitumen enamel, which has been rheologically changed by the addition of a polymer or polymers.

Outer-wrap

Continuous sheet of reinforced glass fiber fabric or glass fiber/polyester composite fabric impregnated by a suitable bitumen based material which is compatible with the bitumen based and fused into the outer surface to improved its mechanical performance.

Plasticizer

A substance incorporated in a material to increase its workability, flexibility, or distensibility.

Primer

A material applied as a thin film to metal in order to ensure adhesion of the subsequent protective coating.

Principal

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

Procedure qualification trial (PQT)

Application of a coating and subsequent inspection/testing of its properties, to confirm that the APS is adequate to produce a coating with the specified properties, carried out prior to the start of production.

Resin

A material, natural or synthetic, contained in varnishes, laquers, and paints, the film former.

4. REQUIREMENTS

4.1 Coating System Description

The modified bitumen enamel coating system shall consist of:

- Primer
- Polymer modified bitumen enamel
- Outerwrap
- Anti UV coating

Note4 : In special cases (for example, for onshore use, due to the nature of backfill material, or for offshore use) additional mechanical protection or a concrete weight coating may be applied.

4.1.1 Primer

The primer shall consist of hydrocarbon resins and plasticizer and, when required, coloring matter, together with solvents needed to give a consistency suitable for application by spray, brush or other approved method. It shall be fast drying and compatible with the modified bitumen enamel and shall be supplied by the same manufacturer of the modified bitumen enamel. The primer shall comply with the requirements given in Table 1 when tested by the methods specified and, when dry, shall provide a suitable bond between the metal and subsequent coating.

Note5 : The primer shall be supplied in bulk or in sealed new steel containers.

Table 1-Primer Characteristics

Item	Characteristic	Unit	Requirement	Test Method
1	Flow time (Flow cup No. 4 at 23 °C)	seconds	35 to 60	ISO 2431
2	Flash point (Abel closed cup), min	°C	23	ISO 13736
3	Volatile matter, max	% loss by mass	75	EN 10300 Annex H

4.1.2 Modified bitumen enamel

The modified bitumen enamel shall consist of modified bitumen with inert filler. The modified bitumen enamel shall comply with the requirements given in Table 2 when tested by the methods specified.

The modified bitumen enamel in conjunction with an appropriate primer shall comply with the requirements given in Table 3 when tested by the methods specified.

The inert filler shall be physically and chemically stable at the maximum application temperature of the coating material. Powdered slate and talc are typical examples of suitable filler types. Bituminous enamel may be supplied either cold in drums or kegs.

The fillers graded in accordance with ISO 2591-1, subclause 7.3, shall meet the following requirements:

- Passing 90 μm : more than 93% by weight
- Passing 250 μm : more than 99% by weight

Table 2-Modified Bitumen Enamel Characteristics

Item	Characteristic	Unit	Requirement	Test Method
1	Filler content by ignition	% by mass	25 to 35	EN 10300 Annex K
2	Density at 25 °C	g/cm^3	1.2 to 1.4	EN 10300 Annex L
3	Softening point (ring & ball)	°C	130 to 160	EN 1427
4	Penetration at 25 °C	0.1mm	5 to 15	EN 1426
5	Flash point (Cleveland open cup), min	°C	260	ISO 2592
6	Water absorption, max	g/m^2	0.7	ISO 5256

Table 3-Characteristics of Modified Enamel on Primed Metal

Item	Characteristic	Unit	Requirement	Test Method	
1	Sag at 90 °C, 24h, max	mm	1.5	EN 10300 Annex D	
2	Impact disbonded area at 0 °C, max	mm ²	6500	EN 10300 Annex E	
3	Peel initial and delayed, min	30°C 40°C 50°C 60°C	N/cm	40 30 25 20	EN 10300 Annex F, F.4.2
4	Bend at -10 °C, min	mm	15	EN 10300 Annex G	
5	Cathodic disbondment,max** at 23 ± 2 °C	mm	5 *	EN 10300 Annex I	

1 - Application temperature and primer thickness shall be as per recommendation of manufacturer.

2 - The test shall be performed on modified bitumen enamel applied on primed metal.

* The average distance in millimetres from the edges of the pre-damaged areas.

** The hole diameter shall be 3 times of the coating thickness.

4.1.3 Outerwrap (sheet)

The outerwrap shall consist of a continuous sheet of glass fibre / polyester composite fabric impregnated by a suitable bituminous material.

The outerwrap shall have a uniform porosity to allow air and fumes to escape.

The outerwrap shall have a uniform appearance, free from holes, slits and other visible faults. The outerwrap shall comply with the requirements given in Table 4.

Table 4-Outer Wrap Characteristics

Item	Characteristic	Unit	Requirement	Test Method
1	Mass per area of base glass before impregnation, min	g/m ²	110	EN 10300 Annex M
2	Mass per area, min	g/m ²	450	EN 10300 Annex M
3	Thickness, min	mm	0.6	EN 1849-1*
4	Tensile strength, min - longitudinally - transverse	N/cm	160 160	EN 12311 -1 Modified as in Annex N
5	Pliability at 23 ± 2 °C	---	No cracking	AWWA C203

*Modified to give a cross-sectional area of 645 mm² and a pressure of 13.8 kPa.

4.1.4 Solar Protection

The anti UV coating should be applied to the coated linepipe prior to stockpiling. It should be light in color, water resistant and should cover the coating sufficiently to form an effective barrier to solar radiation.

The anti UV coating shall be water emulsion latex paint as described as follows:

All water-emulsion latex paints to be used should be stabilized, pigmented dispersions of water-insoluble, film-forming, high-molecular-weight (100,000 and higher) synthetic polymeric materials in water. After application and drying, the paint should be able to produce a film that adheres to the modified bitumen enamel, is white in color, water-resistant, and able to withstand exterior exposure for a minimum of 90 days without degradation.

The water-emulsion latex paint shall not be applied to wet surfaces or to surfaces that may be exposed to rain before the paint is dry. Neither shall it be applied when the relative humidity is above 80%, nor when either the ambient air temperature or the substrate temperature is below 5 °C).

4.2 Coating Thickness

The minimum thickness of the coating system over the weld and linepipe body shall be 4mm.

Note6: It is recommended that a strip of bitumen based enamel is applied over the seam weld (approximately 50mm wide by 2mm thick) after priming and before coating to ensure adequate coating thickness.

5. INFORMATION TO BE SUPPLIED IN THE PURCHASE ORDER

The purchase order shall include the following information:

- Number of this standard and year of publication;
- Pipe quantity, outside diameter, minimum wall thickness, minimum, maximum and nominal length, grade of steel;
- Bare pipe standard (IGS-M-PL-001-1&2) otherwise to be approved by the purchaser;
- Design temperature range;
- Coating thickness;
- Type of certificate of compliance;

6. DOCUMENTS TO BE SUPPLIED BY THE APPLICATOR

Before the start of coating production, the following documents shall be submitted to the purchaser for approval:

- Checking bare pipe traceability based on pipe number;
- Incoming bare pipes inspection;
- Surface preparation procedures;
- Marking detail of coated pipes;
- Storage and handling procedures;
- Certificates and inspection documents of incoming coating materials;
- Checking incoming coating materials traceability based on the batch number;
- Incoming coating materials inspection;
- Application procedure specifications (APS);
- Inspection and testing plan and/or daily log;

- Quality Control Plan (QCP) consisting of Manufacturing Plan (MP) and Inspection and Test Plan (ITP);
- Coating system qualification information;
- Applicator's qualification information;
- Coating application procedures;
- Procedure qualification trial (PQT);
- Handling and storage procedures for coated pipes;
- Protection against adverse ambient conditions during storage;
- Marking pattern details for coated pipes;
- Documentation;
- Pipe end protection.
- expected ambient temperatures during installation;

The applicator shall confirm that the coating system is suitable for use under the requirements of this standard specification.

7. COATING SYSTEM AND APPLICATOR QUALIFICATION

7.1 Coating system qualification

7.1.1 General

The tests of raw coating materials shall be carried out in accordance with Tables 1 to 4 before starting of the coating system qualification.

The coating system shall be qualified as follows:

3 of the 10 coated pipes shall be selected by the inspector and the tests specified in Table 6 shall be performed on each pipe. The test specimens needed as per table 5 shall be marked at one end and just before the cut back area of each pipe. The specimens shall then be cut and sent to an independent test laboratory or if approved by the purchaser to the applicator's test laboratory.

Coating system shall be considered qualified if the results of all test specimens comply with the requirements of Table 6.

Qualification shall be carried out separately for each coating line. The applicator shall carry out and report the coating qualification in accordance with the requirements of this standard specification. The test report shall contain the results of the qualification tests and data as required in Table 6. The applicator shall exclusively use the coating materials qualified in accordance with the requirements of this standard specification.

Qualification shall be repeated in case of modifications to the coating line, coating materials or application procedures.

7.1.2 Application procedure specifications (APS)

The APS shall cover all items associated with quality control as defined in this standard specification. Prior to the start of coating production and any specified PQT, the applicator shall prepare an APS, including:

- Incoming inspection of bare pipes and coating material;
- Data sheets for coating materials, including any materials used for coating repairs;
- Data sheets for abrasive blast cleaning materials;
- Certification, receipt, handling and storage of materials for coating and abrasive blast cleaning;

- Cleaning procedure for all application equipment;
- Preparation of the steel surface including monitoring of environmental parameters, methods and tools for inspection, grinding of pipe surface defects and testing of surface preparation;
- Coating application, including tools/equipment for control of process parameters essential for the quality of the coating;
- Lay-out sketch or flow diagram for the coating plant;
- Methods and tools/equipment for inspection and testing of the applied coating;
- Repair of pipes with defective coating and any associated inspection and testing;
- Stripping of defective coating;
- Preparation of coating cutback areas;
- Marking and traceability;
- Handling and storage of pipes;
- Any special conditions for dispatch of coated pipes, including protection of pipe ends;
- Documentation.

7.1.3 Procedure qualification trial (PQT)

Procedure qualification trial, PQT, shall be carried out to verify the capability of the coating application procedure, coating materials, tools/equipment and personnel to produce pipeline coating with the required properties.

The application procedure specifications (APS) shall be qualified by PQT.

The APS shall be available to the purchaser on request at any time during production.

For new applicators, the APS shall be qualified prior to the start of production.

PQT shall be repeated in case of modifications to the coating line, coating materials or application procedures.

7.1.4 Quality Control Plan (QCP)

The applicator shall prepare a Quality Control Plan (QCP) including application procedure specifications (APS), consisting of Manufacturing Plan (MP) and Inspection and Test Plan (ITP) and a daily log to record quality control data.

7.2 Applicator qualification

7.2.1 General

For new applicators, before coating production commences, the applicator shall be qualified for the application of the coating system. The qualification shall be carried out according to the following procedures:

7.2.2 Coating plant

To demonstrate that the available equipment is capable of applying the specified coating according to this standard, the applicator shall submit full details of the coating plant, including:

- Layout diagram of the coating plant and plant flow scheme;
- General description of the equipment available to carry out the coating process;
- Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, laboratory equipment, etc.;
- Details on the line pipe marking, handling, storage and transport equipment and procedures;
- Applicator's QCP including application procedure specifications(APS).

7.2.3 Qualification

After approval of the coating plant (7.2.2) and before the coating production starts, the applicator shall be qualified with the requirements of this standard specification. The experienced applicators shall demonstrate by means of submitting documents to the purchaser of prior projects that he has successfully applied the similar coating systems on pipes of the similar material, and that the coating system qualification was approved and the quality control test results have complied with the requirements of Tables 5 and 6.

8. COATING APPLICATION

8.1 General

Blast-cleaned pipes shall be coated before showing any visible rust stains, otherwise pipes shall be blast cleaned again. The application of the coating shall be in accordance with the Coating Manufacturer's application procedures.

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

Each pipe end shall be left uncoated over a length of 150 mm ± 10 mm unless otherwise specified. The beveled ends of uncoated pipe ends shall be protected by an end cap for transit.

8.2 Priming

The primer shall be applied to a dust-free, clean, dry, prepared surface and shall be applied in accordance with the primer Manufacturer's recommendations.

The primer, applied at the wet or dry film thickness specified by the Coating Manufacturer, shall be uniform and continuous. The wet or dry film thickness shall be measured according to Table 6. The primer shall be free from runs, drips, sags, holidays and bare areas. Bare areas may be primed by roller application of primer. Pipes not primed correctly shall be re-cleaned and re-primed in accordance with this standard. Pipes on which the primer has deteriorated, or become contaminated, shall be rejected and the rejected pipes shall be re-cleaned and re-primed in accordance with this standard.

8.3 Enamel preparation

The hot bituminous enamel shall be stored in approved containers and shall be maintained at a storage temperature recommended by the Coating Manufacturer, to avoid settlement and/or partial solidification.

All storage containers shall be fitted with mechanical agitators, which shall continuously agitate the bituminous enamel. At no time shall hot bituminous enamel be stored without agitation for a period of time in excess of 30 min.

Bituminous enamel that has been heated in excess of the Manufacturer's recommendations or has been held at application temperature for over 6 hours shall be rejected and replaced.

Bituminous enamel shall be used as supplied on a first-in, first-out basis. Delivery dates for each batch shall be recorded and shall be available for inspection.

The quantity of enamel remaining in the kettle, which may be reheated, shall never exceed 10% of the fresh loading.

All application kettles shall be equipped with screens to exclude foreign materials that may

cause coating flaws. Care shall be exercised to ensure there is no mixing of material from different sources or of different grades.

8.4 Modified bitumen enamel application

Modified bitumen enamel application shall commence within 4 hours of the start of primer application. The primed surface shall be dry and free from surface contamination prior to Modified bitumen enamel application.

The primed steel surface shall be at a temperature in accordance with the Coating Manufacturer's recommendations, but at least 3 °C above the dew point temperature.

A stripe of the line pipe bituminous enamel shall be applied to the line pipe weld seam(s) after priming, and before enamel coating, in order to ensure that the minimum coating thickness is achieved over the weld. The stripe is applied using an automatic weld seam applicator which extrudes hot enamel onto the weld in a stripe approximately 5 cm wide by 2 mm thick along the length of the weld.

The enamel shall be applied at a temperature in accordance with the coating Manufacturer's recommendations. The enamel shall flow evenly onto the pipe and be free from any solid particles that may cause irregularities in flow.

Due to their higher viscosities, modified bitumen enamels are not suitable for flood coating and are applied by an extrusion process. An even coating of enamel shall be applied by extrusion coating with equipment for spirally wrapping the outer wrap under controlled tension.

The extruded enamel shall be applied prior to the outer wrap. The outer wrap shall be pulled onto the enamel and be well bonded with bleed through of enamel occurring. The outer wrap shall be wrinkle-free with an overlap of at least 12 mm. The entire coating system shall have a thickness of at least 4 mm over the weld and pipe body.

8.5 Solar protection

A weather-resistant solar protection coating shall be applied to all the coated surfaces of pipes, after inspection and testing and prior to stockpiling. The solar protective coating shall not contain Portland cement or similar products or substances, which are considered detrimental to the outer wrap, bituminous enamel or to the concrete weight coating.

The solar protective coating is water emulsion latex as described in AWWA C203 sections 4.3.8 and applied in accordance with sections 4.4. Other protective coatings may also be used by agreement with the Principal.

9. INSPECTION AND TESTING

9.1 General

Inspection and testing of raw coating materials shall be carried out in accordance with the APS, and ITP and meet the requirements of Tables 1 to 4 according to frequencies of Table 6.

Inspection and testing of applied coating shall be carried out in accordance with the APS, and ITP and meet the requirements of Table 6.

Table 5-Material Inspection Requirements

Item	Material	Requirement	Frequency
1	Primer	Table 1	each batch
2	Filler	Subclause 4.1.2	each batch
3	Enamel	Table 2	each batch
4	Enamel	Table 3	by agreement
5	Outerwrap	Table 4	by agreement
6	Water emulsion latex paint	Subclause 4.1.4	by agreement

Table 6-Requirement for Inspection of Coating Operation and Coating System

Item	Propertie	Unit	Test Method	Requirement	*Frequency Qualification	Frequency production
1	Ambient conditions	---	ASTM E 337	EN 10300 Subclause 5.1.1	once at start up	twice per shift
2	Bare pipe	---	Visual inspection	Free from dent, porosity, corroded debris	each pipe	each pipe
3	Surface condition before blast cleaning	---	Visual	Free of contaminations	each pipe	each pipe
4	Cleanliness of blast-cleaned surface	---	EN ISO 8501-1	Grade Sa2½	each pipe	each pipe
5	Relative humidity check	---	---	****	once at start up	twice per shift
6	Pipe surface temperature before surface preparation, Min.	°C	Surface contact or IR thermometer	3 above the dew point	once at start up	once per 4 hour
7	Size, shapet, contaminations, and properties of abrasive	---	Visual + certification ISO 11124 resp. ISO 11126	Conformity to certificate, compliance to manufacturing/ working procedures	once at start up	once per shift
8	Surface profile	µm	ISO 8503-5 or ISO 8503-4	75 ± 25	each pipe	every tenth pipes
9	Presence of dust after dust removal, max	---	ISO 8502-3	Class 2	each pipe	every tenth pipes
10	Pipe surface temperature before priming	°C	Surface contact or IR thermometer	Manufacturer's recommendations	each pipe	every tenth pipes

Table 6-Requirement for Inspection of Coating Operation and Coating System(cont.)

Item	Propertie	Unit	Test Method	Requirement	*Frequency Qualification	Frequency production	
11	Soluble salt after blasting residual soluble salts (chloride contamination)	mg/m ²	ISO 8502-6 OR Elcometer 130 SCM 400	Less than 30 mg/m ²	each pipe	Every 4 h	
12	Primer thickness and appearance	---	Manufacturer,s recommendations	EN10300 Subclause 5.2	each pipe	every tenth pipes	
13	Coating system thickness, Min.	mm	EN 10300 Annex T	4	each pipe	every tenth pipes	
14	Visual appearance of coating	---	Visual	EN 10300 Subclause 6.2.1	each pipe	each pipe	
15	Holiday detection (5 kV per mm of coating thickness), max	kV	EN 10300 Annex R	25	each pipe	each pipe	
16	Adhesion	23 ± 2 °C	N/cm	***EN 10300 Annex S	80	3 pipes	3 pipes per shift
		**60 ± 3 °C			20	3 pipes	**once pipe per 400 pipes
17	Cathodic disbandment, max	23 ± 2 °C	mm	ASTM G 8	5	3pipes	--
		60 ± 3 °C		ASTM G 42	12	3pipes	--
18	Cutback	mm	Measuring	150 ±10	each pipe	each pipe	

* before start of bulk production of the coating.

** Using water bath that set at 60 ± 3 °C and keeping sample in it for minimum 45 minutes or oven that set at 60 ± 3 °C and keeping sample in it for minimum 12 hours.

***The bond shall be considered satisfactory if the peak force gauge reading for the 20mm wide strip is greater than 160N(i.e.160N/20mm).

**** The coating process shall commence after completion of blast cleaning of the steel surface. The total elapsed time between the start of blasting of any linepipe and the primer application shall not exceed the following time-humidity table:

Relative Humidity (R.H.)	Maximum Elapsed Time
R.H. > 80%	2 hours
70% < R.H. ≤ 80%	3 hours
R.H. ≤ 70%	4 hours

Any linepipe surface not processed within the above time-humidity table shall be completely re-blasted before coating.

9.2 RETEST

In case of failure of any required test, the coater shall test two additional linepipes, one linepipe before and one after the failed one. If the follow-up tests are successful, all coated linepipes since the last acceptable test shall be considered satisfactory, except for the failed linepipes that will be rejected. If the follow-up tests also fail to meet the requirements of this standard specification, all coated linepipes since the last test passed shall be rejected.

10. COATING REPAIR

The coating applicator shall submit detailed procedures for coating repairs to the company for review and approval.

These procedures shall contain:

- Repair of surface defects;
- Repair of holidays and small defects;
- Repair of damage due to quality control testing;
- Removal of rejected coating and cleaning the linepipe to the required standard for recoating;
- Testing to prove the effectiveness of the repairs.

11. MARKING

11.1 General

Coated pipes shall be marked in accordance with the requirements of 11.2 and with any additional markings specified in the purchase order. Additional markings, as desired by the applicator, shall be by agreement.

11.2 Required markings

Marking shall be carried out using a method such as stencil painting or printing to ensure legible and indelible identification.

The pattern of coated pipe marking shall be prepared by the applicator and approved by the purchaser.

The markings shall include as a minimum:

- Pipe number
- Applicator's name or code;
- IGS standard designation and year of publication;
- Date of coating production;
- Specified total coating thickness;

Note7: Marking shall be carried out at one end of pipe coating.

12. HANDLING, STORAGE AND TRANSPORTATION OF BARE AND COATED LINEPIPE

12.1 The coating applicator shall take receipt of the linepipes, and keep a record of the serial numbers of the delivered linepipes. Upon receipt, the linepipes shall be inspected for transport damage or other defects. Damaged linepipes shall be separately stored and reported to the company.

12.2 The coating applicator shall ensure that coated linepipes are handled without causing damage to the ends of the linepipes or to the coating. The use of steel ropes, steel slings or any lifting equipment, which could damage the coating and the linepipe ends, shall be prohibited.

Linepipes shall be handled by means of endhooks or by flat slings, which cradle the linepipe and other lifting equipment such as spreader bars, beams, hoists and cranes.

Lifting trucks or front-end loader shall have soft padded forks or grips to prevent damage to linepipes or linepipe coating.

Coated linepipes shall not be rolled or dragged over the ground.

12.3 During transportation to the storage area at the coating factory, the coating applicator shall take all relevant precautions to avoid damage to the linepipes and to the coating. During transportation, linepipes shall be stacked and secured such as to prevent movement, abrasion and/or peening.

12.4 Storage of the coated linepipes shall be such that the coating does not deteriorate. In particular, stacks of linepipes, which are intended to be stored for a long period, shall be protected from the action of ultraviolet light on the coating.

Linepipes shall not be stored with other consignments or linepipes for other contracts.

Linepipe supports shall be spaced such that no bending of linepipes occurs.

Linepipe supports shall be made of soft padded wooden bolsters or sand rows, free of stones, covered with plastic sheets. The linepipe surface shall be at least 150 mm clear from the soil.

Coated pipe shall be stacked using soft separators such as rubber pads, or tyre tread.

13. HEALTH, SAFETY AND ENVIRONMENT

The applicator shall comply with the requirements of the purchaser's HSE Management System, the product's MSDS and other requirements such as site regulations, safety rules, etc. The applicator shall ensure that updated MSDS are obtained from the manufacturer. The applicator shall provide all painters with approved protective clothing including safety glasses, safety shoes, hard hats, goggles, respirators, earplugs, fresh-air-fed hood and any other necessary safety equipment. All the safety equipment shall be maintained in a good working condition.

The applicator shall be required to test work areas for flammable vapors, with an appropriate vapor tester, prior to and throughout abrasive blasting and coating operations. The applicator shall post appropriate warning signs and erect appropriate barriers in the work area.