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شرکت ملی گازایران

مدیریت پژوهش وفناوری

امورتدوین استانداردها

IGS

Iranian Gas Standards

مشخصات فنی برای خرید

موادپوششی قیراصلاح شده

Polymer Modified Bitumen Enamel Coating System for Line Pipe

.

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شرکت ملی گاز ایران

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ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری و رئیس شورای استاندارد

باسلام،

به استحضار می رساند در جلسه ۱۵۰۱ مورخ ۱۳۹۱/۳/۲۱ هیأت مدیره، نامه شماره گ۹/۰۰۰/۳۱۸۷۹ مورخ ۱۳۹۱/۳/۸ آن مدیریت در مورد تصویب نهایی استاندارد تحت عنوان «مواد پوششی قیر اصلاح شده » به شماره تقاضای IGS-M-TP-016(2) مطرح و مورد تصویب قرار گرفت.

این مصوبه در حکم مصوبه مجمع عمومی شرکتهای تابعه محسوب و برای کلیه شرکتهای تابعه لازم الاجراء می باشد.

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FOREWORD

This standard is intended to be mainly used by NIGC and contractors and has been prepared on interpretation recognized standards, technical documents, knowledge, backgrounds and experiences in gas industries at national and international levels.
Iranian gas standards (IGS) are prepared, reviewed and amended by technical standard committees within NIGC Standardization division and submitted to the NIGC's "STANDARDS COUNCIL" for approval.
IGS Standards are subject to revision, amendment or withdrawal, if required, thus the latest edition of IGS shall be checked/inquired by NIGC users.
This standard must not be modified or altered by the end users within NIGC and her contractors. Any deviation from normative references and/or well known manufacturers specifications must be reported to Standardization division.
Any comments from concerned parties on NIGC distributed IGS are welcome to technical standards committees and will receive serious attention and consideration should a revision to standards is recommended.

GENERAL DEFINITIONS

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

1- "STANDARDIZATION DIVISION": has been organized to deal with all aspects of industrial standards in NIGC. Therefore, all queries for clarification or amendments are requested to be directed to mentioned division.
2- "COMPANY": refers to national Iranian gas company.
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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CONTENT

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 coating system for corrosion protection of external surface of buried or subsea linepipes.
This standard specification covers the use of modified polymer bitumen enamel when the design temperature is within -20 ^{0}C to +60 ^{0}C.

Note 1: 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 35 ^{0}C;
- In continues operation temperatures more than 45 ^{0}C.

Note 2: In the following conditions polymer modified bitumen enamel coating system with PP (polypropylene) overcoated shall not be used:

- Line pipes with O.D greater than 30 inches;
- In ambient temperature more than 40 ^{0}C;
- In continues operation temperatures more than 45 ^{0}C.

Note 3: In rocky terrains polymer modified bitumen enamel coating system shall be overcoated with PP extruded sheet by considering limitation in note 2.

Note 4: Extruded polypropylene (PP) overcoating mentioned in this standard specification has a minimum of 1 mm thickness.
The physical properties of PP shall comply with the requirements given in Table 1. It is clear the anti UV coating shall not be applied when the PP layer is used.

Note 5: Effective long terms performance of polymer modified bitumen coating system would 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 would 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.

2. NORMATIVE 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.

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

DIN EN 1426 (1999) "Bitumen and Bituminous Binder – Determination of Needle Penetration**"**

DIN EN 1427 (1999) "Bitumen and Bituminous Binder – Determination of Softening Point (Ring and Ball Method)**"**

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

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**"**

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

ASTM G 8 (2003) "Cathodic Disbonding of Pipeline Coatings**"**

ASTM G 21 (2002) "Determining Resistance of Synthetic Polymeric Materials to Fungi**"**

ASTM G 22 (1996) "Determining Resistance of Plastics to Bacteria (withdrown 2002)**"**

ASTM G 42 (2003) "Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures**"**

ASTM E 337B (2002) "Measuring Humidity with a Psychrometer (the Measurement of Wet and Dry-Bulb Temperatures)**"**

DIN 30670 (1991) "Polyethelene Coatings for Steel Pipes and Fittings"

BS EN ISO 178 (2003) "Plastics – Determination of Flexural Properties**"**

BS EN ISO 179 -1 (2005) "Plastics – Determination of Charpy Impact Properties – Part 1: Non-Instrumented Impact Test/Amd**"**

DIN EN ISO 306 (2004) "Plastics – Thermoplastic materials – Determination of Vicat Softening Temperature (VST)**"**

BS EN ISO 527-2 (1996) "Plastics – Determination of Tensile Properties – Part 2 : Test Conditions for Moulding and Extrusion Plastics**"**

BS EN ISO 868 (2003) "Plastics and Ebonite – Determination of Indentation Hardness by Means of Durometer (Shore Hardness)**"**

BS EN ISO 1133 (2005) "Plastics – Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics**"**

BS EN ISO 1183 (2004) "Plastics – Method for Determining the Desity of Non-Cellular Plastics, Parts 1, 2 & 3**"**

BS EN ISO 2431 (1996) "Paints and Varnishes – Determination of Flow Time by Use of Flow Cups**"**

BS EN ISO 2591-1 (2000) "Test sieving – Part 1: Methods Using Test Sieves of Woven Wire Cloth and Perforated Metal Plate**"**

ISO 5256 (1985) "Steel Pipes and Fittings for Buried or Submerged Pipe lines – External and Internal Coating by Bitumen or Coal Tar Derived Materials**"**

BS EN ISO 8502-3 (2000) "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)**"**

BS EN ISO 8503-2 (1995) "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**"**

BS EN ISO 11124 (1997) "Preparation of Steel Substrates before Application of Paints and Related Products – Specifications for Metalic Blast-Cleaning Abrasives – Part 1, 2, 3, & 4**"**

BS EN ISO 11126 (1997) "Preparation of Steel Substrates before Application of Paints and Related Products – Specifications for Non-Metallic Blast-Cleaning Abrasives – All Parts**"**

DIN EN ISO 13736 (2000) "Petroleum Products and Other Liquids. Determination of Flash Point. Abel Closed Cup Method**"**

3. DEFINITIONS

Batch
Quantity of coating material produced in a single production run.

Bituminous Based Enamel
A coating material, which comprises oxidized or modified bitumen and filler.

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.

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.

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.

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

Shelf Life
The maximum allowed storage time for a coating material prior to its use .

4. REQUIREMENTS

4.1 Coating System Description
The modified bitumen enamel coating system shall consist of:

- Primer
- Modified bitumen enamel
- Outerwrap
- Anti UV coating

Note : 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.

4.2 Materials

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.

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

4.2.2 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.

Inert Filler

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

The 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 weigh

Note : The modified bitumen enamel shall be supplied hot in bulk. The hot bulk shall accompanied by a delivery note clearly marked with the manufacturer's name, material designation, date of manufacture and batch number.

4.2.3 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.

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-emolsion 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-emolsion 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 4 ^{0}C).

Additional physical properties:

Volume solids, min:	30 %	
Flash point:	Non-flammable	
Dry to touch:	1 hour at 20 ^{0}C (approximately)	
Application method:	Airless spray	Brush , Roller
Thinner (maximum volume):	Fresh water (up to 100%)	Fresh water (25%)
Dry film thickness (DFT), min:	25 microns	

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

4.4 Cutback
Each linepipe end shall be left uncoated over a length of (150 ± 10 mm) unless otherwise specified.

5. MANUFACTURING PROCEDURE SPECIFICATION (M.P.S)

The coating applicator shall submit his manufacturing procedure specification to company for review and approval.

6. QUALITY CONTROL PLAN (Q.C.P)

6.1 The coating applicator shall submit his quality control plan to company for review and approval.
Quality control plan shall include and meet the requirements given in Tables 7 and 8 as the minimum.

6.2 The coating applicator shall obtain the following documments from coating materials manufacturer and submit them to company:

- The guarantee that the delivered primer, modified bitumen enamel and outerwrap meets the required characteristics as set forth in this standard specification according to the specified methods.

- The batch test certificates for primer, modified bitumen enamel and outerwrap.

7. INSPECTION AND TESTING

7.1 Coating inspection shall be carried out by coating applicator in the presence of inspector(s).

7.2 The inspector shall have free access to the workshops, storage yards and laboratory of the coating applicator who shall provide him with all the facilities necessary for the proper execution of his mission.

7.3 Upon attendence in the coating plants, the coating applicator shall submit the documents supplied by coating manufacturer as specified in this standard specification.
Inspector may check the conformity of coating material with this standard specification.

7.4 Inspection certificate shall co-sign of with inspector(s), the coated linepipe inspection certificates including the results of all tests and inspection as set forth in this standard specification.

8. 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 acceptable.

9. 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.

10. DOCUMENTATION

The coating applicator shall keep accurate records of all relevant data of the coating process, materials and coating performance.
This documentation shall include:

- Copies of the coating materials'data including manufacturer's name, material designation, date of manufacture and batch number.

- Modified bitumen enamel samples retained.

- Serial numbers of rejected linepipes and the reason for rejection.

-The results of all quality control testing.

- Repair records.

- Test result of materials (Tables 1, 2, 3, 4 and 5) by independent labtoratories.

This documentation shall be submitted to the company after completion of the each individual order together with the calibration certificates of the testing and inspection instruments.

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

11.1 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.

11.2 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.

11.3 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.

11.4 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.

12. TABLES

Table 1 – Physical Propertie of Polypropylen (PP) Topcoat Layer

Item	Property	Unit	Requirement	Test Method
1	Density (base resin), min	kg/m^3	900	ISO 1183
2	Melt flow rate ($230^{\cdot 0}C$, 2.16 kg), min	g/10 min	0.8	ISO 1133
3	Tensile strain at break (50 mm/min), min	%	100	ISO 527-2
4	Tensile strees at yield (50 mm/min), min	MPa	20	ISO 527-2
5	Vicat softening temperature (10 N), min	^0C	140	ISO 306
6	Hardness,min	shore D	60	ISO 868

TABLE 2 – Characteristics of Primer

Item	Characteristic	Unit	Requirement	Test Method
1	Flow time (Flow cup n^o 4 at 23 ^0C)	seconds	35 to 60	EN ISO 2431
2	Flash point (Abel closed cup), min	^0C	23	EN ISO 13736
3	Volatile matter, max	% loss by mass	75	EN 10300 Annex H

TABLE 3 – Characteristics of Modified Bitumen Enamel

Item	Characteristic	Unit	Requirement	Test Method
1	Filler content by ignition	% by mass	25 to 35	EN 10300 Annex K
2	Density at 25 ^0C	g/cm^3	1.2 to 1.4	EN 10300 Annex L
3	Softening point (ring & ball)	^0C	130 to 160	EN 1427
4	Penetration - at 25 ^0C (100g/5 sec) - at 45 ^0C (50g/5 sec)	 0.1 mm 0.1 mm	 5 to 15 10 to 20	EN 1426
5	Flash point (Cleveland open cup), min	^0C	260	EN ISO 2592
6	Water absorption, max	g/m^2	1	ISO 5256

TABLE 4 – Characteristics of Modified Bitumen Enamel on Primed Metal

Item	Characteristic		Unit	Requirement	Test Method
1	Sag at 90 ^{0}C, 24h, max		mm	1.5	EN 10300 Annex D
2	Impact disbonded area at 0 ^{0}C, max		mm^2	6500	EN 10300 Annex E
3	Peel initial and delayed, min	30^{0}C 40^{0}C 50^{0}C 60^{0}C	N/cm	40 30 25 20	EN 10300 Annex F, F.4.2
4	Bend at -10 ^{0}C, min		mm	15	EN 10300 Annex G
5	Cathodic disbondment, 28 d, max** - at 23 ± 2 ^{0}C - at 65 ± 3 ^{0}C		mm	 5 * 12 *	 ASTM G 8 ASTM G 42

1 - Application temperature and primer thickness shall be as per manufacturer's recommendation.
2 - The test shall be performed on modified bitumen enamel applied on primed steel.
***** The average distance in millimetres from the edges of the pre-damaged areas.
****** The hole diameter shall be 3 times of the coating thickness.

TABLE 5 – Characteristics of outerwrap

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 ^{0}C	---	No cracking	AWWA C203

* Modified to give a cross-sectional area of 645 mm^2 and a pressure of 13.8 kPa.

TABLE 6 – Properties of Applied Coating

Item	Characteristic	Unit	Requirement	Test Method
1	Appearance and continuity	---	Uniform, free from any wrinkling, pinholes, voids, laminations, holidays, dry wrap, contamination, completely bonded to the linepipe surface.	Visually
2	Holiday detection (5 kV per mm of coating thickness), max	kV	20	EN 10300 Annex R
3	Adhesion - at 23 ± 2 ^{0}C - at 65 ± 3 ^{0}C *	N/cm	 70 20	EN 10300 Annex S
4	Thickness , min	mm	4	EN 10300 Annex T
5	Cathodic disbandment, 28 d, max - at 23 ± 2 ^{0}C - at 65 ± 3 ^{0}C	mm	 5 12	 ASTM G 8 ASTM G 42
6	Impact resistance test at 23 ± 2 ^{0}C, min	J/mm	5	DIN 30670
7	Coating electrical resistivity, min	Ω m^2	10 ^{8}	DIN 30670

***** Using water bath that set at 65 ± 3 ^{0}C and keeping sample in it for minimum 45 minutes or oven that set at 65 ± 3 ^{0}C and keeping sample in it for minimum 12 hours.

TABLE 7 – Requirements for Inspection of Materials

Item	Material	Requirement	Frequency
1	Primer	Table 1	each batch
2	Filler	Subclause 4.2.2	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 4.2.4	by agreement

TABLE 8 – Requirements 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	twice per shift	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	---	---	*	twice per shift	twice per shift
6	Pipe surface temperature before surface preparation, min	^{0}C	Surface contact or IR thermometer	3 above the dew point	once	once per 4 hour
7	Size, shape and properties of abrasive	---	Visual + certification ISO 11124 resp. ISO 11126	Conformity to certificate, compliance to manufacturing/ working procedures	once	once per shift
8	Surface profile	µm	ISO 8503-2	75 ± 25	10 pipes	once per hour
9	Presence of dust after dust removal, max	---	ISO 8502-3	Class 2	10 pipes	once per hour
10	Pipe surface temperature before priming	^{0}C	Surface contact or IR thermometer	Manufacturer's recommendations	each pipe	once per hour
11	Primer thickness and appearance	---	Manufacturer's recommendations	EN10300 Subclause 5.2	each pipe	5 pipes per shift
12	Coating system thickness, min	mm	EN 10300 Annex T	4	each pipe	every tenth pipes
13	Visual appearance of coating	---	Visual	EN 10300 Subclause 6.2.1	each pipe	every tenth pipes
14	Holiday detection (5 kV per mm of coating thickness), max	kV	EN 10300 Annex R	20	each pipe	each pipe
15	Adhesion - at 23 ± 2 ^{0}C - at 65 ± 3 ^{0}C	N/cm	EN 10300 Annex S	 70 20	 5 pipes 5 pipes	 3 pipes per shift once pipe per 200 pipes
16	Cathodic disbandment, max - at 23 ± 2 ^{0}C, 28 d - at 65 ± 3 ^{0}C, 28 d - at 65 ± 3 ^{0}C, 2 d	mm	 ASTM G 8 ASTM G 42 ASTM G 42	 5 12 7	 --- --- once	 3 per order once per order once per week
17	Cutback	mm	Measuring	150 ±10	each pipe	each pipe
18	Pipe ends	---	Visual	EN10300 Subclause 5.3.2	each pipe	by agreement
19	Coating electrical resistivity , min	Ω m^2	DIN 30670	10 ^{8}	---	once per order
20	Impact resistance test at 23 ± 2 ^{0}C, min	J/mm	DIN 30670	5	once	once per week

* 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.