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شرکت ملی گاز ایران

مدیریت پژوهش و فنآوری

امورتدوین استانداردها

IGS

دستورالعمل اجرایی

پلی اورتان مایع برای تعویض و تعمیر پوشش خارجی خطوط لوله فولادی مدفون، سرجوش ها ، لوله کشی های مدفون ، شیرآلات نو ، اتصالات و سایر اجزاء لوله کشی

Liquid Polyurethane for Rehabilitation and Repair of External coating of Buried Steel Pipelines , Field joints , Buried Steel pipings new valves , Fittings and other piping components

دفترمدیرعامل

شرکت ملی گازایران

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ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری

باسلام،

به استحضار می‌رساند در جلسه ۱۹۷۱ مورخ ۱۴۰۱/۰۳/۲۹ هیات مدیره، نامه شماره گ۹/۰۰۰/۳۹۹۵۳ مورخ ۱۴۰۱/۰۳/۲۳ آن مدیریت درمورد تصویب نهایی مقررات فنی شرکت ملی گاز ایران به شرح زیر مطرح و مورد تصویب قرار گرفت.

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۲- دستورالعمل پلی اورتان مایع برای تعویض و تعمیر پوشش خارجی خطوط لوله مدفون، سرجوش ها، لوله کشی های مدفون ، شیرآلات نو، اتصالات و سایر اجزاء لوله کشی

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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 material, surface preparation, application, quality assurance and inspection of liquid polyurethane to be used for preventing external corrosion of underground steel pipeline systems. The coating system shall be used at maximum design temperature of the pipeline limited to 80 °C (T_{max}) for applications as follow:

- Rehabilitation of buried pipelines and piping's coatings.
- Field joints and repair of buried pipelines and piping, valves, fittings and other pipeline and piping components coated with FBE or liquid epoxy or liquid polyurethane coating systems.
- New coating of buried piping, valves, fittings and other piping components.

The liquid polyurethane shall be a two-component, 100% solid and solvent free coating. The polyurethane shall be of the type that can be applied by using either plural component spray equipment or brushes and rollers for brush grades.

Note 1: This standard specification does not cover factory coating of line pipes.

Note 2: If the design temperature is more than 40 °C or for field joints and pipe sizes with O.D. 30" and larger, the minimum thickness of coating shall be 1500 µm. For smaller sizes and lower temperatures, the minimum thickness of coating shall be 1000 µm.

Note 3: Manual / hand application is acceptable only for repair.

Note4: This standard withdraws and replaces IGS-M-TP-020 (2).

2. REFERENCES

Throughout this standard specification, the following standards and codes are referred to, the edition of them, that are in effect at the time of issue of this standard specification shall, to the extent specified herein, form part of this standard specification. The applicability of changes in standards and codes that occur after the date of standards that referred shall be mutually agreed upon by the purchaser and manufacturer or supplier**.**

2.1 Normative references

ASTM D 543 (2020) "Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents**"**

ASTM D 1640 (2018) "Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature**"**

ASTM D 4285-83 (2018) "Standard Test Method for Indicating Oil or Water in Compressed Air**"**
ASTM D 4940 (2020) "Standard Test Method for Conducti Metric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives**"**

EN 10290 (2002) "Steel Tubes and Fittings for Onshore and Offshore Pipelines – External Liquid Applied Polyurethane and Polyurethane-Modified Coatings**"**

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

ISO 4624 (2016) "Paints and Varnishes – Pull-Off Test for Adhesion**"**

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

ISO 8502-6 (2020) "Preparation of Steel Substrates before Application of Paints and Related Products – Test for Assessment of Surface Cleanliness – Part 6: Extraction of Soluble Contaminants for Analysis – The Bresle Method**"**

ISO 8502-9 (2020) "Preparation of Steel Substrates before Application of Paints and Related Products – Test for the Assessment of Surface Cleanliness – Part 9: Field Method for the Conduct Metric Determination of Water-Soluble Salts**"**

ISO 8503-2 (2012) "Preparation of Steel Substrates before Application of Paints and Related Products –Surface Roughness Characteristics of Blast-Cleaned Steel Substrates – Part2: Method for the Grading of Surface Profile of Abrasive Blast-Cleaned Steel – Comparator Procedure**"**

ISO 11124 (all parts) (2018) "Preparation of Steel Substrates before Application of Paints and Related Products –Specifications for Metallic Blast-Cleaning Abrasives**"**

ISO 11126 (all parts) (2018) "Preparation of Steel Substrates before Application of Paints and Related Products –Specifications for Non-metallic Blast-Cleaning Abrasives**"**

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

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 of Previous Coatings**"**

ISO 8503-5 (2017) "Preparation of Steel Substrates before Application of Paints and Related Products –Surface Roughness Characteristics of Blast-Cleaned Steel Substrates – Part 5: Replica Tape Method for the Determination of the Surface Profile**"**

ISO 21809-3+A1 (2020) "Petroleum and Natural Gas Industries – External Coatings for Buried or Submerged Pipelines Used in Pipeline Transportation Systems – Part 3: Field Joint Coating**"**

2.2 Informative references

SHELL 31403037 (2008) "External Field Joint and Rehabilitation Coating Systems for Line Pipe**"**

SHELL 31403038 (2005) "Liquid Rehabilitation Coating of Onshore Pipelines**"**

3. DEFINITIONS

Applicator
The company that applies the liquid polyurethane coating system.

Backfill
Material placed in a hole to fill the space around the buried pipes.

Backfill-ready
The stage or degree of cure, which may not be full chemical cure, that the coating has attained that provides resistance to moisture absorption and toughness to handle mechanical stresses including abrasion and backfill.

Backfill Time
Time required for the coating to dry hard enough to resist mechanical damage by the backfill soil.

Batch
Amount of materials produced within one uninterrupted production run of maximum 8 hours under constant production conditions.

Dry-to-Touch Time
Time taken by the coating to dry until it becomes tack-free.

Field Joint Area (weld zone)
Uncoated area that results when two pipe sections or a pipe section and a fitting with coating cutbacks are assembled, by welding, in the field.

Holiday
Discontinuity in a protective coating that exposes the unprotected surface to the environment, or a thin coating spot that cannot provide good barrier to the environment, normally detected by a low or high voltage holiday detector.

Liquid Polyurethane
Liquid polyurethane coatings are two-pack coating systems composed of polyol and isocyanate. This type of coating has a fast cross linking reaction between the isocyanate and polyol monomer, and limited pot-life after the two components are mixed.

Manufacturer/Supplier
The company that manufactures or supplies coating material.

Maximum design temperature (T_{max})
temperature which is specified by the Principal as the maximum design temperature of the pipeline.

Overlap
Length of the field joint coating over the plant-applied coating including the coating bevel ends.

Plural Component Spray
Application method that automatically proportions and mixes two or more components of a coating material in the process of delivering them to the spray gun. Plural component spray equipment is used to apply coatings with a pot life that is too short to permit mixing and application by conventional air and airless spray equipment.

Pot Life
Time within which a coating can be effectively applied after all components of the coating have been thoroughly mixed.

Purchaser
The owner company that has the authority for the pipeline or piping systems to which the coating is to be applied.

Room Temperature (RT)
Indoor temperature generally between 20 ºC and 25 ºC.

Shelf Life
Amount of time a coating or other material remains in useable condition.

Third Party Inspection (TPI)
Third party inspection authorities approved by purchaser (NIGC).

4. COATING MATERIAL

4.1 General

– The two-component liquid coating is generally composed of a polyol and an isocyanate. The polyol and isocyanate should have different colors allowing the verification of the correct mixing and checking the uniformity of the color of the mixed product. The mixed coating shall not be black.

– Normally, the liquid pipeline coatings shall be high-solid coatings to form a thick film of smooth appearance without drips, running, sags, pinholes or fisheyes.
– No primer shall be required for the polyurethane coating to achieve proper performance.
– The polyurethane material shall have sufficient pot life to ensure convenient application in site condition.
– Only qualified brands supported by manufacturer test certificates in accordance with the specified standard test methods in Table 2 of this specification shall be selected by the applicator and approved by the purchaser.

4.2 The dry-to-touch time shall be no longer than 2 hours at room temperature when tested in accordance with ASTM D 1640.

Note: For rehabilitation purposes, due to unforeseen conditions in site such as climate change etc. the dry-to-touch time may be reduced down to 15 minutes.

4.3 The backfill time shall be no longer than 6 hours at room temperature. The backfill time is that taken for the film to attain the hardness of 70 Shore "D" as per ISO 868 standard.

4.4 Documents to be submitted by the manufacturer

The following documents shall be provided to the purchaser by the applicator from the coating material manufacturer/supplier:

a. Technical specification and material data sheets as detailed in Table 1;
b. Test reports as detailed in Table 2 (The test methods shall be specified for any tests);
c. Batch certificates;
d. Application procedure of the coating material;
e. Dry-to-touch time curve;
f. Directions for handling and storage;
g. Material safety data sheets (MSDS).

4.5 Documents to be submitted by the applicator

The following documents shall be prepared by the applicator and submitted to the purchaser for review and approval:

a. Quality control plan (QCP) for application of the coating;
b. Repair procedure.

4.6 Packaging

Each part of polyurethane coating material shall be packed in hermetically sealed metallic containers and suitably marked giving as a minimum, the following details:

- Product manufacturer's name;
- Name of material;
- Application method;
- Batch number;
- Date of manufacture and expiry date (shelf life);
- Recommended storage conditions;
- Color of the materials;
- Health and safety warnings.

Table 1 – Contents of Data Sheets and Certificates

Elements	Technical data	Test certificate
Date of issue	×	×
Name of manufacturer	×	×
Name, use and type of product	×	×
Type of polyol and isocyanate	×	×
Factory of origin		×
Batch or production lot number [a]		×
Date of manufacture and use by date [a]		×
Color [b]	×	
Physical state of the delivered product [a]	×	
Methods of application	×	
Solids by volume	×	
Solids by weight	×	
Theoretical coverage per m^2 for nominal thickness	×	
Size of container [a]	×	
Shelf life [a]	×	
Storage conditions	×	
Pot-life	×	×
Surface preparation	×	
Recommended instructions for application	×	
Recommended repair material(s)	×	
Mixing instructions	×	
Recommended dry film thickness	×	
Typical thickness applicable in one layer	×	
Minimum and maximum over coating time	×	
Range of pipe service temperature	×	
Range of application temperature (ambient, pipe and product) and humidity	×	
Specific curing – Requirements	×	
Shore "D" hardness at 23 ± 2 ºC	×	
Time at 23 ± 2 ºC to achieve Shore "D" hardness at curing	×	
Time at 23 ± 2 ºC at Shore "D" hardness before handling	×	
Viscosity [a]	×	×
Fineness of grind	×	×
Density	×[b]	×[a]
Gel time	×	×
Sag resistance	×	×
Adhesion test, resistance to removal at 23 ± 2 ºC	×	
Adhesion test, pull off method at 23 ± 2 ºC	×	
Cathodic disbondment at 23 ± 2 ºC	×	
Cathodic disbondment at Tmax ± 2 ºC	×	
Impact resistance	×	
Indentation resistance at 10 N/mm^2	×	
Specific electrical insulation resistance	×	
Flexibility	×	
Thermal ageing	×	
Hot water immersion test	×	
Water absorption	×	
Chemical resistance	×	
Abrasion resistance	×	
Cure time before handling for shop coatings	×	
backfill time	×	

Test methods described in the present standard shall be used. In any case test methods used shall be mentioned for any tests. The acceptable limits shall be mentioned in the test certificate.

[a] Required for the polyol and isocyanate.
[b] Required for the polyol, isocyanate and for the mixed product.

Table 2 – Qualification Requirements

Item	Property	Test temp.	Unit	Acceptance criteria	Test method
1	Minimum thickness	-	µm	- 1500 µm: If the operating temperature is more than 40 °C or for field joints and pipe sizes with O.D. 30" and larger - 1000 µm: For smaller sizes and lower temperatures	ISO 21809-3/Annex B
2	Visual inspection	-	-	Continuous and uniform film free of sags runs and color striations (when applicable)	-
3	Holiday detection at 5 kV/mm at a maximum of 25 kV	-	-	no holiday	ISO 21809-3 Annex C
4	Impact resistance (holiday detection at 5 kV/mm)	23 °C −5 °C	J/mm	≥5 ≥2.0	ISO 21809-3 Annex D
5	Indentation resistance at 10 N/mm2	*T*max limited to 80 °C± 2 ºC	% DFT	≤30	ISO 21809-3 Annex E
6	Cathodic disbondment at 28 days	23 °C *T*max limited to 80 °C± 2 ºC	mm	≤8 ≤20	ISO 21809-3 Annex G
7	Cathodic disbondment at 48 h	65 °C	mm	≤8	ISO 21809-3 Annex G
8	Hardness (Shore D) Min.	23 °C	-	70	ISO 868
9	Adhesion to pipe surface Min.	23 °C	MPa	≥10,0[a]	ISO 4624
10	Adhesion to FBE, liquid applied epoxy or PU plant coatings Min.	23 °C	MPa	≥10,0[a]	ISO 4624
11	Adhesion to pipe surface after 28-day hot-water immersion test at Tmax limited as per Annex I	23 °C	MPa	≥7,0	ISO21809-3Annex I Plus ISO 4624
12	Adhesion to FBE, liquid applied epoxy or PU plant coatings after 28-day hot-water immersion test at Tmax limited as per Annex I	23 °C	MPa	≥7,0	ISO 21809-3 Annex I plus ISO 4624
13	Specific electrical insulation resistance (*R*S100)	23 °C	Ω·m2	≥106	ISO 21809-3 Annex F

Table 2 – Qualification Requirements(cont.)

Item	Property	Test temp.	Unit	Acceptance criteria	Test method
11	Adhesion to pipe surface after 28-day hot-water immersion test at Tmax limited as per Annex I	23 °C	MPa	≥7,0	ISO21809-3Annex I Plus ISO 4624
12	Adhesion to FBE, liquid applied epoxy or PU plant coatings after 28-day hot-water immersion test at Tmax limited as per Annex I	23 °C	MPa	≥7,0	ISO 21809-3 Annex I plus ISO 4624
13	Specific electrical insulation resistance (R_{S100})	23 °C	Ω·m2	≥10^6	ISO 21809-3 Annex F
14	R_{S100}/R_{S70}	-	-	≥0,80[b]	-
15	Thermal ageing 100 days to pipe surface	T_{max} limited to 80+(20 ± 2 ºC)	MPa	[C] No defect, no holiday ≥7,0	Annex J EN10290
16	Chemical resistance, change in mass, length and width after 30 days immersion, max (10% H2SO4, 30% NaCl, 30% NaOH and #2 diesel fuel)	-	-	5%	ASTM D 543
17	Infra-red scan	-	-	[a]cceptable comparison with reference scan	

a Figures applicable for PQT and PPT. For production testing, results of 70 % of these figures may be accepted by agreement due to a possible lack of curing of the glue during the allowable duration of testing, provided that the failure occurs within the glue.
b It is necessary that this requirement (RS100/RS70 ≥ 0,8) be fulfilled only if the specific electrical insulation resistance after 70 days is less than 10 times the requirement of the specific electrical insulation resistance after 100 days.

c at the discretion of the purchaser, the qualification tests may be waived, provided that the certificates and the results of tests carried out at a reputable third-party test laboratory, not exceeding two years from the date of tests, submitted by the manufacturer/supplier and approved by the purchaser.
d an infera-red scan spectrogram performed on polyol, isocyanate and cured product with a KBr standard disk obtained from the original manufacturer shall be supplied by the applicator. This spectrogram should subsequently be used for comparison with reference scan.

5. QUALITY ASSURANCE

5.1 The product supplier shall guarantee the consistent quality of the products and maintain for the properties listed in Table 1. The purchaser or applicator may also perform any or all of the specified tests in Table 1 as part of a quality assurance program.

5.2 The applicator's operators shall be trained and certified by the coating material manufacturer/supplier. The applicator's equipment shall be approved by the coating manufacturer. The applicator shall submit to the purchaser, all documents that prove satisfactory training and certification from the manufacturer for review and approval.

5.3 The applicator shall be responsible for all HSE aspects, regulations and rules.

6. QUALIFICATION

6.1 Qualification of coating applicator

Coating applicator shall be qualified at the presence of the purchaser as follows:

– A piece of steel pipe shall be blast cleaned and coated to the specified coating thickness identical to production coating. It shall be inspected and tested for surface condition before and after cleaning. After the coating has hardened, it shall be inspected and tested for DFT, appearance and continuity, holiday detection, hardness Shore "D" and adhesion. The acceptance criteria and test methods are listed in Table 2.

6.2 Coating system qualification

The coating system shall be qualified by the applicator prior to coating application. The tests specified in Table 2 shall be conducted on one batch of material and meet the acceptance criteria. The batch of material to be tested shall be selected by the purchaser's representative.

Coating system qualification test results shall be approved by the purchaser. Coating system qualification shall be carried out at a third-party test laboratory approved by the purchaser. The tests shall be witnessed by TPI or the purchaser's representative. The applicator shall inform the purchaser well in advance prior to any qualification tests.

The coating manufacturers shall submit the certificates and test results of each batch of coating materials which complies with the requirements of Table 2.

Note 1: Coating application shall not be commenced before the results of coating system qualification tests are reviewed and approved by the purchaser.

Note 2: At the discretion of the purchaser, the qualification Type tests (items 13 and 15 of Table 2) may be waived, provided that the certificates and the results of tests carried out at a reputable third-party test laboratory, not exceeding two years from the date of tests, submitted by the manufacturer/supplier and approved by the purchaser.

Note 3: The coating system shall be requalified in case of any changes in the material formulation, manufacturer and changes in the production process which influence the material processing behavior and change in production facility.

6.3 Qualification testing steel panels

– Test panels shall be of carbon steel and shall be abrasive blast cleaned to SA 2½ degree and a surface profile of 60 µm to 100 µm.

– Coating application and curing procedure shall be in accordance with the manufacturer's recommendations and identical to the application procedure.
– The coating system shall be considered qualified when the results of test panels meet the acceptance criteria for all tests as specified in Table 2.

7. APPLICATION OF THE COATING

7.1 Surface preparation

– Prior to blast cleaning, the steel surface shall be dry and free from surface defects (such as slivers and laminations), contamination (such as oil, grease, hydrocarbons and temporary corrosion protection), previously applied coatings and deleterious materials. The pre blasting surface preparation processes may be used such as chemical treatment, solvent cleaning, water jetting and use of hand or power tools. These processes shall be approved by purchaser. After blast cleaning the degree of cleanliness shall be SA 2½ or better in accordance with ISO 8501-1 and the roughness R_Z shall be between 60 and 100 µm as measured in accordance with ISO 8503-5.
– Abrasive materials shall comply with the requirements of ISO 11124(all parts) or ISO 11126(all parts). They shall be free from contamination and contain less than 100 mg/kg chlorides and less than 0.3% copper. If the conductivity of the blasting material is greater than 50 µS/cm (in accordance with ASTM D 4940), the blasting material shall be replaced.
– Compressed air for surface preparation shall be free of oil and condensed water. These shall be determined daily with a blotter test in accordance with ASTM D4285. If necessary, after-coolers shall be provided to reduce the water content to an acceptable level. Traps, filters and separators shall be regularly emptied and cleaned.
– Nozzles for blast cleaning equipment shall be of venturi design and shall be discarded when wear reaches 30% of the original bore.
– The pipe surface shall be maintained at least 3 ºC above the dew point temperature and humidity shall not exceed 85% during cleaning and prior to coating.
– If pipe heating is used to meet required environmental conditions, the pipe must be heated with caution to prevent damage to parent coating or lining.
– Blast-cleaned pipe surfaces shall be protected from condensation, moisture, rainfall, frost and snow. Blast-cleaned surfaces shall also be protected from other contaminants including sand, grit and dirt. The blasted pipe surface shall not be allowed to flash rust or exhibit deterioration before coating.
– The maximum residual chloride level on the blast-cleaned surface shall be 20 mg/m^2 in accordance with ISO 8502-6 or ISO 8502-9 or using Elcometer 130/SCM400 or any other method approved by purchaser.
– Contaminants (e.g. residual abrasive dust and dirt) shall be removed from all blasted surfaces prior to coating application. Dust contamination shall be a maximum of class 2, in accordance with ISO 8502-3. A tape test shall be conducted to verify that the surface is free of contaminants.
– Prepared surface shall be visually inspected for surface defects and surface imperfections that may cause holidays in the coating.
– After blast cleaning, the surface of the pipe shall be inspected. All slivers, laminations, weld spatters and other surface imperfections made visible by the blast cleaning process shall be removed. After removal of these defects, the residual thickness of pipe shall satisfy the minimum requirements specified by IGS-M-PL-001-2(1). The treated areas greater than 10 cm^2 shall be ground flash to a smooth contour profile.

7.2 Application procedure

– The applicator shall follow the coating manufacturer's procedures and recommendations, which are subject to approval by the purchaser. The polyurethane shall be of the type that can be applied by using either plural component spray equipment or brushes and rollers for brush grades, with all necessary ancillary equipment in accordance with the coating manufacturer's recommendations.

–For twin feed airless application, appropriate monitoring equipment shall be used to ensure correct metering of the two pack materials specified by the manufacturer.

– Polyol and isocyanate shall be stirred or agitated and thoroughly mixed in separate containers in accordance with manufacturer's recommended practice.

– The coating shall be a single coat and may be applied in multiple passes to build the required film thickness in accordance with the manufacturer's recommended practice.

– No thinner shall be used to dilute or change the consistency of the coating material.

– Coating shall not be applied during rain, fog, mist or when there is free moisture on the prepared surface or rust flashed.

– The coating operation shall be suspended when the metal temperature falls to within 3 ºC of the dew point, or is less than 5 ºC and/or when the relative humidity is higher than 85%.

– If the surface to be coated is below 10 ºC, preheating of the substrate is recommended. Pipe temperature shall not exceed 70 ºC as a result of preheat.

– The maximum time between surface preparation and start of the coating application shall be no longer than 4 hours for relative humidity up to 70% and 2 hours for relative humidity between 70% and 85%.

– The curing temperature, the time interval between application and backfill and the methods used to determine whether the coating is backfill-ready such as hardness test shall be conducted to be within the limits recommended by the coating manufacturer.

– The coating is considered cured when it has attained the hardness recommended by the coating manufacturer.

– The finished coating shall be uniform and free of application defects such as pinholes, fish eyes, sags, drips, icicles, etc.

Note: It is recommended that the coated pipe be buried as soon as the full curing time of the coating is elapsed so that no color change occurs in the coating.

8. INSPECTION AND TESTING

8.1 INSPECTION FOR QUALIFICATION

– Inspection operations shall be carried out as per Table 2 by the applicator and according to item 6 (Qualification**)**. The results of inspection shall be recorded by the applicator and made available to the purchaser's inspector

– The purchaser's appointed inspector shall have free access to the workshops, storage yards and laboratory of the coating applicator. Inspector shall have the right and opportunity to witness any quality control tests and/or to perform such tests himself. The applicator shall furnish the purchaser's inspector with all tools and equipment necessary for inspection at the application site.

– Purchaser's inspector shall have free access at all times to all work related to the coating application process, with the right to inspect work and materials. All such work and materials shall be subject to approval by inspector. Failure of inspector to identify or reject defective work or materials shall not be construed as acceptance of such work or materials.

– The coating shall be of natural color, uniform sheen, smooth, blemish free and with no dust or other particulate inclusions. The coating shall not show any defects such as wrinkles, sags, fish eyes, pinholes, blisters, cuts, swellings, excess material thickness, dis bonded zones, air inclusions, tears, voids, etc.

8.2 INSPECTION FOR BATCH CERTIFICATE

To guarantee the quality of the products to be delivered, the inspection is carried out at the manufacturer's site prior to shipment.
Based on the results of material tests during the inspection and on the provided quality control data (process control, in-house and external tests) an inspection report shall be filled-out and signed by the inspector according to inspection type 3.1 of standard EN 10204.
This inspection and Testing Procedure regulates the steps that be performed during the inspection process.
The Inspector's works and duties consist of the following activities, but not limited to:

1. Checking of Documents

a. Checking the raw material quality control test results and Certificates for all items and verifying the results versus the manufacturer's data sheets.
b. Checking the manufacturer's daily production quality control test reports showing the amounts of produced material & results of the relevant tests and verify the results versus the manufacturer's data sheets.
c. Check the calibration certificates of the testing and inspection instruments.
d. Check the test report for all items (long terms and short terms) of qualification properties according to related standard IGS, not exceeding two years from issuance date.

2. Visual inspection of the produced goods:

a. Visual inspection of the marking and packaging (number and weight of container, batch number of components, etc.) according to this standard.
Requirement: purchase order
b. Crosscheck of purchase order quantities with stock

3. Selection of samples for material tests

a. Selection of one container per each batch of all material to prepare samples from coating system running for each item according to related test methods.

4. Batch certificate tests:

All short test which are done throughout 7 days shall be carried out according to table 2 of this standards.

5. Inspection report:

Inspection report shall be including of the following items, but not limited to:
-List of inspection materials, quantities and batch numbers
-Report of document check (according to section 1)
-Report of visual inspection (according to section 2), plus photos of activities
-Description of sample selection and preparation of specimens, plus photos of activities
-Report of calibration certificates of the testing and inspection instruments
-Date of presence in factory, preparation of specimens and start test
-Tests report include of tests result and graphs (if that to exist)
- Third party inspection agency approves

Notes: All in-house tests shall be performed in witness of inspector.

For external tests of one produced batch exemplary for the whole shipment, to be carried out by an internationally well-known independent laboratory and all of documents shall be accepted by inspector.
Details of all inspection and testing shall be fully documented by the manufacturer and certified by inspector.
The results of all mentioned tests shall be checked and complied by criteria which are remarked in related standard.
In the case of any failure to comply with any of the NIGC's requirements mentioned in related standard IGS, new samples according to above mentioned table shall be selected by inspector and all of required tests shall be carried out accordingly. If any failure occurred again, it shall be effect of rejection for each batch presented.
At least one photo of inspector next to the goods is required. The photos of the all parts (include of storage, batch number of drum, preparation of test specimens, test instruments and etc.), plus the image of the inspector's photo attached to the certificate on the inspection report (via CD/DVD) is required.
Third party inspector shall issue release note to supplier and purchaser (two copies) after enquiry items acceptance
Third party inspection agency shall issue inspection certificate after release note has been issued.

8.3 INSPECTION FOR FIELD

– The applicator shall prepare a daily production summary containing the following information for each pipe section coated:
Date and pipe section number;
Coating thickness readings;
Number of holidays;
Disposition (accepted, repair needed, rejected).
– Particular attention shall be given to the following external surface areas when carrying out visual inspection:
Adjacent to the longitudinal welds;
Adjacent to the cut-back at each end of pipe;
Within the body of the pipe.
- The nature and frequency of inspection operations shall be as per purchaser's ITP.

Table 3 – Field Tests and Control

Item	Property	Acceptance Criteria	Test Method
1	Surface condition before blast cleaning	dry, free from contamination, previously applied coating and deleterious materials	visual
2	Compressed air	no water, no oil contamination	ASTM D 4285
3	Blast abrasives	no oil contamination conductivity < 50 µS/cm	ASTM D 4940
4	Checking of the blast cleaning process	section 7.1	ISO 8503-5
5	Condition of prepared surface Anchor and surface profile Chloride Dust	section 7.1 60 µm to 100 µm < 20 mg/m^2 maximum of class 2	Visual ISO 8501-1 ISO 8503-2 ISO 8503-5 ISO 8502-6 ISO 8502-9 ISO 8502-3
6	Ambient conditions	humidity less than 85%, the surface temperature more than5 ºC and at least 3 ºC above the dew point	-----
7	Dry thickness of the coating system (minimum individual reading)	- 1500 µm: If the operating temperature is more than 40 °C or for field joints and pipe sizes with O.D. 30" and larger - 1000 µm: For smaller sizes and lower temperatures	ISO 21809-3 /Annex B
8	Hardness Shore "D" at 23 ± 2 ºC, min	70	ISO 868
9	Appearance and continuity	uniform color, free of holidays, blister and other defects	visual
10	Holiday detection test	no holidays (min 5 V/µm)	ISO 21809-3/ Annex C
11	Adhesion test, to pipe surface, at 23 ± 2 ºC Min.	10 MP	ISO 4624

9. REPAIR

– Any repair operation shall be carried out in accordance with the repair procedure approved by the purchaser. All coating defects and those resulting from destructive tests shall be repaired. This procedure shall contain:

- Repair of surface damages;
- Repair of holidays and small damages;
- Repair of damages due to site quality check;
- Testing to prove the efficiency of the repairs.

– The compatibility of repair material with the previously applied coating shall be approved by the manufacturer.
– The repair material and the application conditions shall be those defined in the manufacturer's technical specification and data sheets.
– The repair material and the application conditions shall be in accordance with IGS-O-TP-001
– The completed repair shall satisfy the values specified in the manufacturer's data sheets. After curing all repaired areas shall be holiday detected.
– The coating DFT after repair shall meet the minimum DFT requirements as the original pipe coating.

10. HEALTH, SAFETYAND 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.