



شرکت ملی گاز ایران

امورتدوین استانداردها

IGS

پوشش FBE دولایه برای سطوح خارجی خطوط لوله گاز طبیعی

External Dual Layer Fusion Bonded Epoxy Coating for Line Pipe



شرکت ملی گاز ایران

دفتر مدیر عامل

تاریخ: ۱۳۹۱/۷/۱۸

شماره: گ/دب/۰-۳۰۶/۱۶۳۴۱

ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری و رئیس شورای استاندارد

باسلام،

به استحضار می‌رساند در جلسه ۱۵۱۳ مورخ ۱۳۹۱/۶/۱۲ هیأت مدیره، نامه شماره گ/۰۰۰/۷۶۴۶۹ مورخ ۱۳۹۱/۶/۴ آن مدیریت در مورد تصویب نهایی استاندارد تحت عنوان "مشخصات استاندارد پوشش FBE دو لایه برای سطوح خارجی خطوط لوله گاز طبیعی به شماره تقاضای (0) IGS-M-TP-026" مطرح و مورد تصویب قرار گرفت.

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

ناصر آنگون
دبیر هیأت مدیره

رونوشت: مدیرعامل محترم شرکت ملی گاز ایران و قائم مقام رئیس هیأت مدیره

: اعضای محترم هیأت مدیره

: مدیر محترم توسعه منابع انسانی

: مدیر محترم هماهنگی و نظارت بر تولید

: مدیرعامل محترم شرکت انتقال گاز ایران

: رئیس محترم امور حسابرسی داخلی

: رئیس محترم امور سازمان و بهبود روشها

: رئیس محترم امور حقوقی

: رئیس محترم امور مجامع



Documents

Document Sharing Hub

FOREWORD

This standard is intended to be mainly used by NIGC and Applicator s 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 Applicators. 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 DIV." 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 div.
- 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 .

Website : <http://igs.nigc.ir>

E-mail : igs@nigc.ir

CONTENT	PAGE
1. SCOPE	1
2. REFERENCES	1
3. DEFINITIONS	3
4. GENERAL REQUIREMENTS	5
5. MATERIAL REQUIREMENTS	7
6. COATING SYSTEM QUALIFICATION	10
7. PRODUCTION APPLICATION PRACTICES AND EQUIPMENT	14
8. COATING APPLICATION	17
9. INSPECTION AND TESTING	20
10. COATING REPAIRS	24
11. DOCUMENTATION	25
12. MARKING	25
13. HANDLING AND STORAGE	26
14. SAFETY	26
TABLES:	
TABLE 1 - Epoxy Powders Requirements	8
TABLE 2 - Qualification Test Requirements	9
TABLE 3 - Laboratory Coating Test Requirements by the Applicator	12
TABLE 4 - PQT and Production Coating Testing Requirements	13
TABLE 5 - Requirements for Inspection of Surface Preparation	19
FIGURES:	
FIGURE 1 - Maximum allowable cross – section porosity	27
FIGURE 2 - Maximum allowable interface porosity	28
APPENDICES:	
APPENDIX A - Receipt, Unloading, Handling and Storage of Materials	29
APPENDIX B - Applicator's Coating Plant Qualification	33
APPENDIX C - Coating of Pipe Fittings and Bends	35
APPENDIX D –Dry Adhesion Test	38
APPENDIX E –Gouge Resistance of Coating	39

1. SCOPE

This standard specification specifies the NIGC minimum requirements for materials, qualification, application, testing, inspection, repair and handling of plant-applied dual layer fusion bonded epoxy (FBE) coating to the external surface of high pressure gas transmission pipeline systems, pipe joints, bends and fittings, for buried or submerged service with cathodic protection. The dual layer FBE coating system will provide improved resistance to both elevated temperature and abrasion.

Notes:

A) An anti-slip coating is not considered a dual layer system for the purposes of this standard specification. Dual layer FBE consist a corrosion coating layer and a gouge resistance overcoat.

B) The service temperature for dual layer FBE is -20 °C to +90 °C.

C) If a concrete weight coating is required, this will be applied on site by a method approved by the purchaser and in accordance with the relevant project specification that will apply in conjunction with this FBE coating specification. If slippage of the concrete during transportation and installation may be a problem, an outer rough coat of FBE, or spiral non-slip bands, shall be considered as part of the FBE coating system.

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 (2012) 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 applicator.

2.1 Normative References

API 5L9 (2001) "Recommended Practice for External Fusion Bonded Epoxy of Line Pipe"

ASTM D 4060 (2004) "Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser"

ASTM D 4940 (2004) "Standard Test Method for Conductmetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives"

BS EN 10204 (2004) "Standard for Metallic Products – Types of Inspection Documents"

IPS-M-PI-190(2) (2004) "Material and Equipment Standard for Line Pipe"

ISO 8501-1 (1994) "Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness – Part1: Rust Grades and Preparation Grades of Uncoated Steel Substrates after Overall Removal of Previous Coatings"

ISO 8502-3 (2000) "Preparation of Steel Substrates before Application of Paints and Related Products – Tests for Surface Cleanliness – Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)"

ISO 8502-6 (2000) "Preparation of Steel Substrates before Application of Paints and Related Products – Test for the Assessment of Surface Cleanliness – Part 6: Extraction of Soluble Contaminants for Analysis – The Bresle Method"

ISO 8502-9 (2001) "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 8503-4 (1995) "Preparation of Steel Substrates before Application of Paints and Related Products – Surface Roughness Characteristics of Blast-Cleaned Steel Substrate"

ISO 8503-5 (2003) "Replica Tape Method for the Determination of the Surface Profile"

ISO 9001 (2008) "Quality Systems – Model for Quality Assurance in Design, Development, Production, Installation and Servicing"

ISO 10474 (1991) "Steel and Steel Products – Inspection Documents"

ISO 11124 (all parts) (1997) "Preparation of Steel Substrates before Application of Paints and Related Products – Specification for Metallic Blast-Cleaning Abrasives"

ISO 11126 (1997) "Preparation of Steel Substrates before Application of Paints and Related Products – Specification for Non-Metallic Blast-Cleaning Abrasives"

ISO 21809-2 (2006) "Petroleum and Natural Gas Industries – External Coatings for Buried and Submerged Pipelines Used in Pipeline Transportation Systems – Part 2: Fusion-Bonded Epoxy Coatings"

ISO 21809-3 (2008) "Petroleum and Natural Gas Industries – External Coatings for Buried and Submerged Pipelines Used in Pipeline Transportation Systems – Part 3: Field Joint Coatings"

NACE RP0490 (2001) "Holiday Detection of FBE External Pipeline Coatings of 250 to 760 Micrometers"

2.2 Informative References

CSA Z245.20 (2006) "Standard for External Fusion Bond Epoxy Coating for Steel Pipe"

NACE RP0394 (2002) "Recommended Practice for Application, Performance, and Quality Control of Plant-Applied Fusion-Bonded Epoxy External Pipe Coating"

SHELL 31.40.30.32 (2011) "DEP Specification for Fusion-Bonded Epoxy Powder Coating for Line Pipe (Amendments/Supplements to ISO 21809-2)"

3. DEFINITIONS

Anti-Slip Coating

A fusion bond epoxy coating applied over on FBE coating system for the purpose of increasing the shear resistance between concrete coating and the coated steel pipe.

Applicator (Contractor)

The organization responsible to the purchaser for the application of the coating.

Batch

The quantity (not more than 20 tones) of epoxy powder of the same source produced during a continuous production run of not more than eight hours.

Bolster

Support for coated pipes during transport and storage.

Certificate of Compliance

Document issued according to ISO 10474 or EN 10204 stating compliance with the purchase order for coated pipes, but without mention of any test results, issued in accordance with the purchasing requirements.

Corrosion Coating

A fusion bond epoxy coating applied directly on steel for the purpose of corrosion protection.

Cut-Back

Length of pipe left uncoated at each end for joining purposes, (e.g. welding).

Design Temperature Range

Temperature range including maximum and minimum temperature likely to be reached during transport, handling, installation and operation.

Drop

Non-homogenous or partially cured lump of powder deposited on the surface of the coating.

Glass Transition

The reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one.

Glass Transition Temperature

Approximate midpoint of the temperature range over which the glass transition takes place.

Note:

The assigned glass transition temperature, T_g , can vary, depending on the specific property and on the method and conditions selected to measure it.

Gouge Resistant Overcoat

A fusion bonded epoxy coating applied over a FBE corrosion coating for the purpose of gouge or other mechanical damage resistance.

Inspection Certificated 3.1.B**Inspection Certificate 3.1**

Document in accordance with ISO 10474 or EN 10204 giving the results of the testing of coated pipes, supplied and signed by a representative of the manufacturer or applicator, authorized to issue such documents.

Manufacturer

The company responsible for the manufacture of coating materials.

Manufacturer's Specification

Document which specifies the characteristics, test requirements and application recommendations for the coating materials.

Operating Temperature

Temperature experienced by the pipe or pipeline system during operation which should not exceed the design temperature.

Purchaser (Company)

The company responsible for providing the product order requirements.

Rust Bloom

Visual detectable color change on the surface of the pipe due to oxidation, other than as a result of pre-treatment.

Strain Ageing

A change in the properties of steel associated with ageing at elevated temperature subsequent to cold working.

Test Panel

Sample of steel plate coated with fusion bonded epoxy for laboratory tests.

4. GENERAL REQUIREMENTS

4.1 Purchasing Requirements

4.1.1 Information to be supplied by the purchaser

The following information shall be included in purchase order:

- a) IGS standard designation and year of publication (IGS-M-TP-026);
- b) Line pipe standard, quantity, outside diameter, wall thickness, nominal length and grade of steel;
- c) Minimum and maximum permissible thickness of the coating system and the minimum and maximum permissible thicknesses of individual layers;
- d) Maximum/minimum design and operating temperature ($^{\circ}\text{C}$) of pipeline;
- e) Other special requirements or additional tests (if any).

4.1.2 Information to be supplied by the coating applicator

The following information shall be supplied by the coating applicator:

- (a) A quality assurance manual in accordance with ISO 9001;
- (b) Name and location of the coating materials manufacturer;
- (c) Technical data sheets obtained from the coating material manufacturer, showing at least, the properties and test results for items specified in Tables 1 and 2;
- (d) Results of DSC and Infra-red scan tests on the fusion-bonded epoxy resin powders in the form of a graph and typical of the powders proposed;
- (e) Production rates of pipe coating;
- (f) Handling, transport and storage methods for powders, uncoated pipe and coated pipe in accordance with the powder manufacturer's recommendations;
- (g) Safety procedures;
- (h) Identification of powders, pipe coating;
- (i) Material manufacturer's recommended methods of application of powders;
- (j) Quality plan consisting of Manufacturing Plan (MP) and Inspection and Test Plan (ITP)
- (k) Other special requirements.

Note:

The same documents (b, c, d, h, i & k above) shall be submitted for repair material by the applicator.

4.2. Quality Control Plan (QCP)

Prior to the start of coating production, the applicator shall submit a detailed technical procedure, including description of the coating equipment, materials, surface preparation, coating application and repair, handling and stacking, testing and inspection and frequencies in the form of a Quality Control Plan (QCP) specific to the order for purchaser's review and approval.

The description shall be accompanied by full technical details and results of tests on similar coatings, using similar line pipe (diameters, lengths and wall thickness), or trials performed by applicator, which document the quality of the finished coating. Such test results and/or trials shall demonstrate, to the satisfaction of purchaser, that applicator equipment, procedures and materials can supply a finished coating meeting the requirements of this standard specification.

The coating procedure and QCP shall include, but not necessarily be limited to the following:

- Safety aspects;
- Traceability;
- Incoming Inspection of line pipes and pipe tracking;
- Lay-out sketch or flow diagram for the coating plant;
- Data sheets for coating materials, repair material, abrasive blasting materials, chemical pretreatment material, etc;
- Pipe handling and storage (incoming and preparation for shipment);
- Pipe cleaning;
- Substrate preparation and blast cleaning media;
- Pipe pre-heating;
- Chemical treatment
- Application method;
- Testing and inspection;
- Quality control;
- Repair procedures, including stripping and re-coating;
- Preparation of coating cutback areas;
- Marking and traceability;
- Any special conditions for dispatch of coated pipes including protection of pipe end;
- Documentation.

The QCP shall cover all items associated with quality control as defined in this standard specification.

The QCP shall be approved by the purchaser prior to the start of production.

The QCP shall be available to the purchaser's inspector(s) on request at any time during production.

Coating work and associated inspection and testing shall be carried out in accordance with the approved QCP.

4.3 Compliance

The applicator shall be responsible for complying with all of the requirements of this standard specification. The purchaser may make any investigation necessary in order to be assured of compliance by the applicator and to reject any material that does not comply.

4.4 Raw Material Sampling

For each batch of FBE powders, the applicator shall, in the presence of the purchaser's representative, select three 100 gr. samples of powders for long-term quality assurance and guarantee purposes.

One sample shall be given to the purchaser's representative. The second sample shall be stored by the applicator at a temperature not to exceed 25 °C for a period of two years from the coating contract completion date. The third sample shall be used by the applicator to check the stability of the powders by measuring the properties of Table 1.

5. MATERIAL REQUIREMENTS

5.1 Fusion Bonded Epoxy Powders

5.1.1 The FBE powders (first and second layers of the coating system) shall be supplied by the same manufacturer and shall have a proven track record in pipeline coating applications.

5.1.2 The epoxy powders properties shall be in accordance with the requirements of Table 1. At least once per batch, the epoxy powders manufacturer shall conduct tests and provide the applicator with a test report for the epoxy powders properties specified in Table 1.

5.1.3 Each batch of epoxy powders shall be identified with the following:

- Powder manufacturer's name;
- Product description;
- Mass of material;
- Batch number;
- Location of manufacture;
- Manufacturing identification number;
- Temperature requirements for transportation and storage;
- Year, month and day of manufacture;
- Year, month and day of expiry date.

5.2 Abrasive Materials

Abrasive materials shall comply with the requirements of ISO 11124. They shall be free from contamination and contain less than 100 mg/kg chlorides and less than 0.3% copper.

Abrasives shall be shot or grit, or both, in accordance with ISO 11124. The particle size shall be such that the blasted steel pipe surface complies with Clause 7.3.

5.3 Repair Materials

The repair material shall be a two-component 100% solids liquid epoxy coating material that is compatible with the original coating. The liquid epoxy coating shall meet the requirements of Clause 13 of ISO 21809-3.

The liquid epoxy coating for dual layer system shall be of gouge resistant type.

Table 1. Epoxy Powders Requirements

Item	Test	Requirement	Test Method
1	Cure time	within the manufacturer's specification	ISO 21809-2 Annex A (A2)
2	Cure curve	within the manufacturer's specification	ISO 21809-2 Annex A (A2)
3	Gel time	within the manufacturer's specification	ISO 21809-2 Annex A (A3)
4	Particle size	within the manufacturer's specification	ISO 21809-2 Annex A (A6)
5	Thermal characteristics T_{g2}	within the manufacturer's specification $\geq 5^{\circ}\text{C}$ above the maximum pipeline design temperature	ISO 21809-2 Annex A (A8)
6	Density	within the manufacturer's specification $\pm 3.5\%$	ISO 21809-2 Annex A (A7)
7	Total Moisture content*	0.5% max	API 5L9 Appendix D
8	Total Volatile content*	0.6% max	API 5L9 Appendix E

* Either total volatile or moisture content may be determined at applicator's discretion.

Table 2. Qualification Test Requirements

Item	Property	Acceptance criteria	Number of test specimens	Test method
1	Thermal characteristics T_{g2}	within the manufacturer's specification $\geq 5^{\circ}\text{C}$ above the maximum pipeline design temperature	2	ISO 21809-2 Annex A (A8)
2	Cathodic disbondment, 48 h, -3.5 V, at $80^{\circ}\text{C} \pm 3^{\circ}\text{C}$, max radius	5 mm	3	ISO 21809-2 Annex A (A9)
3	Cathodic disbondment 28 day, -1.5 V, at $80^{\circ}\text{C} \pm 3^{\circ}\text{C}$, max radius	10 mm	3	ISO 21809-2 Annex A (A9)
4	Cathodic disbondment 28 day, -1.5V, $20^{\circ}\text{C} \pm 3^{\circ}\text{C}$, max radius	5 mm	3	ISO 21809-2 Annex A (A9)
5	Hot water adhesion 48 h, at $80^{\circ}\text{C} \pm 3^{\circ}\text{C}$, max	< 5% of the test area blistering or disbonding no failure of adhesion	3	ISO 21809-2 Annex A (A15) and Appendix D
6	Hot water adhesion 28 days, at $80^{\circ}\text{C} \pm 3^{\circ}\text{C}$, max	< 10% of the test area blistering or disbonding no failure of adhesion pull off min 7 N/mm^2 (> 50% surface area cohesive)	3	ISO 21809-2 Annex A (A15) and Appendix D
7	Cross – section porosity	rating 2 (refer to figure 1)	2	ISO 21809-2 Annex A (A11)
8	Interface porosity	rating 2 (refer to figure 2)	2	ISO 21809-2 Annex A (A11)
9	Flexibility at 0°C and -20°C	no cracking at 2° ppd* length	3	ISO 21809-2 Annex A (A12)
10	Impact, min at 20°C at 30°C	3.6 J 1.5 J	3	ISO 21809-2 Annex A (A13)
11	Strained coating, cathodic disbondment 28 day, $20^{\circ}\text{C} \pm 3^{\circ}\text{C}$, -1.5 V	no cracking and no disbondment (1.5°)	3	ISO 21809-2 Annex A (A14)
12	Gouge resistance test, max	250 μm Gouge depth	2	APPENDIX E

*ppd : per pipe diameter

6. COATING SYSTEM QUALIFICATION

6.1 Qualification by Manufacturer

Each batch of epoxy powders shall be tested by the manufacturer for the properties specified in Table 2 except for the 28 day tests.

The tests to be conducted, the number of test specimens, the test methods to be used, and the acceptance criteria shall be as given in Table 2. These test results shall be made available to the applicator.

Note:

Alternatively, if purchaser approves the material manufacturer may provide a certificate of compliance, confirming that the powders supplied meets the requirements of Table 2, or a test certificate detailing the test methods used and results which demonstrate equivalent performance.

The manufacturer shall issue an "inspection certificate" for each batch of coating material in accordance with ISO 10474 (type 3.1.B) or EN 10204 (type 3.1) stating that the tests of Table 1 have been carried out on every batch and results are in accordance with the manufacturer's product specifications.

The same "inspection certificate" shall be furnished by repair material manufacturer.

Material which is not traceable to satisfactory test certificates shall not be used.

Note:

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

6.2 Qualification by Applicator

The production coating shall be qualified by the applicator for each coating system. Applicator shall use coating materials qualified in accordance with the requirements of clause 6.1.

Qualification shall be achieved by successful evaluation of laboratory coated specimens and pipe coated using the specified coating line. The requirements for testing of laboratory coated specimens are given in Table 3 and the requirements for testing pipe samples are given in Table 4.

The qualification shall be repeated in case of essential modifications of the coating line, coating materials and coating procedures.