



شرکت ملی گاز ایران

مدیریت پژوهش و فناوری

امورتدوین استانداردها

IGS

Iranian Gas Standards

## دستورالعمل اجرایی

پوشش اپوکسی درون لوله های خطوط انتقال گاز طبیعی

Internal Epoxy Coating of Line Pipe for Sweet Gas  
Transmission Services



دفتر مدیر عامل



شرکت ملی گاز ایران



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## ابلاغ مصوبه هیأت مدیره

مدیر محترم پژوهش و فناوری و رئیس شورای استاندارد

باسلام،

به استحضار می‌رساند در جلسه ۱۴۲۳ مورخ ۱۳۸۹/۷/۲۵ هیأت مدیره، نامه شماره ک/۹۴۵۳۶/۰۰۰/۹۵ مورخ ۸۹/۷/۱۷ آن مدیریت در مورد استانداردها با مشخصات ذیل که توسط کمیته های تخصصی تدوین و بازرنگری استاندارد تهیه و در شورای استاندارد به تصویب رسیده است، مطرح و تأیید گردید.

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IGS-C-TP-23(0)	۵ پوشش اپوکسی درون لوله های خطوط انتقال گاز طبیعی

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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 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 .

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## 1.SCOPE

This standard specification specifies the NIGC's requirements and recommendations for the factory application of liquid epoxy as internal coating (flow coat) to bare or externally coated line pipes for use in single phase gas transmission pipelines with the objective of reducing surface roughness and pressure losses . The internal coating shall be applied by airless spray or other suitable spraying techniques . Brush application shall only be used for small repair jobs .

## 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 (2010) 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

**ISO 2409 (1995) "Paints and Varnishes – Cross-Cut Test"**

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

**ISO 2808 (2007) " Paints and Varnishes – Determination of Film Thickness "**

**ISO 2811 (2001) "Paints and Varnishes – Determination of Density"**

**ISO 2812-1 (2007) "Paints and Varnishes – Determination of Resistance to Liquids – Part 1 : Immersion in Liquids other than Water"**

**ISO 2812-2 (2007) "Paints and Varnishes – Determination of Resistance to Liquids Part 2 : Water Immersion Method"**

**ISO 2815 (1998) "Paints and Varnishes – Buchholz Indentation Test"**

**ISO 3233 (1999) "Paints and Varnishes – Determination of Percentage Volume of Non - Volatile Matter by Measuring the Density of a Dried Coating"**

**ISO 3251 (2003) "Paints , Varnishes and Plastics – Determination of Non-Volatile-Matter Content"**

**ISO 6860 (2007) "Paints and Varnishes – Bend Test (Conical Mandrel)"**

**ISO 7253 (2001) "Paints and Varnishes – Determination of Resistance to Neutral Salt Spray (Fog)"**

**ISO 8501-1 (2001) "Preparation of Steel Substrates before Application of Paints and Related Products – Group A. Visual Assessment of Surface Cleanliness – Part a1. Specification for Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after Overall Removal of Previous Coatings"**

**ISO 8503-1 (1995)** "Preparation of Steel Substrates before Application of Paints and Related Products – Surface Roughness Characteristics of Blast-Cleaned Steel Substrate – Part 1 : Specifications and Definitions for ISO Surface Profile Comparators for the Assessment of Abrasive Blast-Cleaned Surface"

**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"

**ISO 15741 (2001)** "Paints and Varnishes – Friction-Reduction Coatings for the Interior of on- and Offshore Steel Pipelines for Non-Corrosive Gases"

## **2.2 Informative References**

**API 5L2 (2002)** "Recommended Practice for Internal Coating of Line Pipe for Non - Corrosive Gas Transmission Service"

**SHELL DEP 31.40.30.35 (1998)** "Technical Specification for Internal Coating of Line Pipe for Non - Corrosive Gas Transmission Service"

## **3. DEFINITIONS**

### **Batch**

The quantity of coating material manufactured at one time in a single vessel and identified by a unique batch number .

### **Coater**

The company which is responsible to the purchaser for application of the coating in accordance with the provisions of this standard specification .

### **Coating material manufacturer**

The supplier of the coating material .

### **Dry Film Thickness (DFT)**

The thickness of a coating remaining on the surface when the coating has hardened .

### **Pinhole**

Film defect characterized by small pore-like flaws in a coating which extend entirely through the applied film and have the general appearance of pinpricks when viewed by reflected light .

### **Pot life**

The maximum time during which a coating material supplied as separate components should be used after they have been mixed together .

### **Purchaser**

The organization or individual that buys the coated pipes and fittings .

### **Tack – free**

The state of a coating when a finger touching the surface no longer leaves a pronounced mark .

## 4. COATING MATERIAL

### 4.1 General

- The coating material shall be a two – pack epoxy and contain no substances , which could be released , after it has cured .
- The coating material shall be qualified in accordance with clauses 4.2 and 4.3 .
- The manufacturer of the coating material shall provide a product data sheet (see Table 3 ) , MSDS (Material Safety Data Sheets) , batch test certificates (see Table 4) and a certificate stating the test results obtained in accordance with Table 5 respectively .
- The applied coating shall provide corrosion protection of the internal surfaces of the line pipes during storage and transport for a minimum period of one year without significant breakdown of the coating .
- The coating material shall neither degrade nor produce hazardous vapors when later subjected to external coating thermal cycles up to 300 °C .

Any material which has exceeded its pot life shall be rejected .

### 4.2 Particular Requirements for Qualification of the Coating Material

The specified tests in Table 1 shall be carried out for qualification of the coating material .

**TABLE 1. Coating Material Properties**

ITEM	TEST	RESULT	TEST METHOD
1	Non – volatile matter* (by mass)	within the manufacturer's specification	ISO 3251
2	Non–volatile matter* (by volume)	within the manufacturer's specification	ISO 3233
3	Viscosity (the ready – mixed)	within the manufacturer's specification	ISO 2431
4	Density	within the manufacturer's specification	ISO 2811
5	Ash**	within the manufacturer's specification	ISO 15741 Annex A
6	Pot life	within the manufacturer's specification	---
7	Infrared spectrograms	shall be submitted on request for the base component and the curing agent component	---
8	Appearance continuity	good	Visually

\*Separately for base component , curing agent component and mixed coating material .

\*\* Separately for base component and curing agent component (if pigmented) .

### 4.3 Particular Requirements for Qualification of the Cured Coating Film

#### 4.3.1 Preparation and conditioning of test panels

The tests specified in Table 2 shall be performed for qualification of the coating material on coatings applied to the required dry film thickness by spraying to steel test panels . Steel test panels shall be prepared as specified in clauses 5.2 , 5.3 and 5.4 .

The coating shall be applied in accordance with the instructions of the coating material manufacturer . Each test shall be performed at least in duplicate . The coated test panels shall be conditioned as follow :

- At 18 °C to 25 °C and ≤ 80% relative humidity until the coating is at least tack – free .
- Dry for 30 minutes in a circulating – air oven at 75 ± 2 °C .
- For a minimum of 30 minutes at 18 °C to 25 °C and ≤ 80% relative humidity before testing.
- The dry film thickness (DFT) for the coating , applied on a steel panel shall be between 60 µm and 100 µm except for the test of item No. 3 (resistance to neutral salt spray) . The DFT shall be measured in accordance with ISO 2808 No. 10 and Annex B ISO 15741 .

#### 4.3.2 Tests on test panel

The specified tests in Table 2 shall be carried out for qualification of the cured coating film .

**TABLE 2. Laboratory Tests for Qualification of the Cured Coating**

ITEM	TEST	RESULT	TEST METHOD
1	Adhesion , max	classification rating 1	ISO 2409
2	Buchholz hardness , min	94	ISO 2815
3	Resistance to neutral salt spray (DFT 60 µm to 75 µm) (480h)	free from any signs of deterioration , cracking and staining	ISO 7253
4	Bend test after resistance to artificial ageing	≤13mm* and no loss of adhesion	ISO 15741 and ISO 6860
5	Bend test	≤13mm* and no loss of adhesion	ISO 6860
6	Adhesion test after resistance to gas pressure variations , max	classification rating 1	ISO 15741 Annex C
7	Resistance to water immersion (480 h)	No blistering and softening	ISO 2812-2
8	Adhesion test after resistance to chemicals , max	classification rating 1 and no blistering	ISO 2812-1 (method No.1) and ISO 15741 (clause 4.3.11)
9	Adhesion test after hydraulic blistering , max	classification rating 1 and no blistering	ISO 15741 Annex D

\*The maximum extent of cracking along the panel from the small end of the mandrel .



#### 4.4 Product Data Sheet

The coating material manufacturer's product data sheet shall give information regarding the items listed in Table 3 .

**TABLE 3. Information to be Supplied by the Coater**

Date of issue
Name and designation of coating material
Name of coating material manufacturer
Colour of coating material
Type of curing agent
Mixing ratio of base and curing agent
Shelf life
Total non – volatile matter (by weight and volume) <sup>1)</sup>
test method used (see Table 1)
Density <sup>2)</sup>
test method used (see Table 1)
Viscosity
Pot life <sup>1)</sup>
(see Table 1)
Stability
Pigment dispersion
Flash point <sup>3)</sup>
Time to complete curing
Recommended thinner
Maximum allowed quantity of thinner
Recommended surface preparation grade
Recommended method of application
Recommended maximum / minimum dry film thickness of the applied coating
Recommended cleaning solvent (for the application equipment)
Recommended application conditions (air and steel temperature and relative humidity)
Recommended minimum curing conditions
Recommended maximum / minimum service temperature
Recommended storage conditions
Reference to instructions and warning regarding health , safety and environmental protection
Theoretical spreading rate ( l/m <sup>2</sup> or kg /m <sup>2</sup> ) for a given dry film thickness
Wet film thickness to give dry film thickness of 50 µm , in one coat
<sup>1)</sup> Only for the mixed coating material .
<sup>2)</sup> Give separately for base component and curing agent component (if pigmented) .
<sup>3)</sup> Give separately for base component , curing agent component and mixed coating material .

#### 4.5 Batch Test Certificate

Coating material manufacturer shall provide batch test certificate including the tests and test results listed in Table 4 .

**TABLE 4. Batch Test Certificate**

Item	Test method	Information from the coating material manufacturer	Test result
Date of issue			
Batch number			
Name and type of coating material			
Name of coating material manufacturer			
Production date			
Expiry date for use			
Non – volatile matter by mass – base component	ISO 3251		
Non – volatile matter by mass – curing agent component <sup>1)</sup>	ISO 3251		
Viscosity – base component	2)		
Viscosity – curing agent component	2)		
Density – base component	ISO 2811		
Density – curing agent component	ISO 2811		
Ash – base component <sup>3)</sup>	ISO 15741 Annex A		
Ash – curing agent component <sup>3), 4)</sup>	ISO 15741 Annex A		
Infrared spectrogram <sup>4), 5)</sup>			
<sup>1)</sup> The non – volatile matter by mass of the curing agent component shall not be used for any purposes other than batch consistency checks . <sup>2)</sup> As specified by the coating material manufacturer . <sup>3)</sup> If required . <sup>4)</sup> If pigmented . <sup>5)</sup> Separately for the base component and the curing agent component .			

#### 4.6 Qualification Certificate

The coating material manufacturer shall provide qualification certificate including the values of the properties listed in Table 5 .

**TABLE 5. Qualification Certificate**

Date of issue	
Name of coating material	
Name of coating material manufacturer	
Authority for issue	
Property	Test Method
Non – volatile matter by mass <sup>1)</sup>	ISO 3251
Ash <sup>2)</sup>	ISO 15741 Annex A
Viscosity <sup>3)</sup>	
Adhesion	ISO 2409
Buchholz hardness	ISO 2815
Resistance to neutral salt spray	ISO 7253
Resistance to artificial ageing	
Bend test (conical mandrel)	ISO 6860
Resistance to gas pressure variations	ISO 15741 Annex C
Resistance to water immersion	ISO 2812-2
Resistance to chemicals  – resistance to cyclohexane – resistance to 95% by volume diethylene glycol solution in water – resistance to hexane – resistance to methanol – resistance to toluene – resistance to lubricating oil (e.g. compressor oil)	ISO 2812-1
Resistance to hydraulic blistering	ISO 15741 Annex D
<sup>1)</sup> Separately for base component , curing agent component and mixed coating material . <sup>2)</sup> Separately for base component and curing agent component (if pigmented) . <sup>3)</sup> Only for the mixed coating material .	

#### **4.7 Labeling and Instructions**

All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions . The following information shall be shown on the label:

- the name of the coating material ;
- the name of the manufacturer of the coating material ;
- the colour of the coating material ;
- the batch number ;
- instructions and warnings regarding the health , safety and environmental protection ;
- a reference of the relevant product data sheet .

#### **4.8 Quality Assurance**

The coater shall set up and maintain a quality assurance system for line pipes and services supplied . The purchaser shall have the right to undertake inspection and testing of the coating materials and coated line pipes during any stage of coating to ensure compliance with requirements of this standard specification .

### **5. APPLICATION OF THE COATING MATERIALS**

**5.1** During application of the coating material all steps including the parameters listed in Table 6 shall be assessed and recorded .

**5.2** The line pipes internal surfaces shall be blast – cleaned to surface preparation grade Sa 2½ in accordance with EN ISO 8501-1 . Before blast cleaning the surfaces shall be checked to ensure that are free from any foreign matter such as welding flux , welding spatter , salts , oil or grease . If necessary , the surfaces shall be washed with a high – pressure jet of fresh water . Organic contaminants may be removed with using detergents or suitable organic solvents .

**5.3** The surface profile shall be such that  $R_{y5}$  (see ISO 8503-1) is between 25 µm and 60 µm (BS EN ISO 4287-A1) .

**5.4** During and after blast – cleaning and prior to application of the coating material , the temperature of the steel surface shall be at least 3 °C above the dew point or the minimum curing temperature given by the coating material manufacturer , whichever is the higher , and the relative humidity shall be less than 85% .

**5.5** The coating material shall be homogeneous in its container . Stirring and agitating may be used for homogenizing without excessively entraining air into the material . The two components of epoxy , and diluent if necessary , shall be mixed thoroughly in accordance with the manufacturer's instruction . The mixed coating shall be free of any lumps and pieces of skin . The viscosity shall be kept constant during the application procedure and complied with the value specified by the manufacturer .

**5.6** The coating material shall be applied in a covered or enclosed space , shielded from wind , blowing dust and inclement weather , using the application parameters .

**TABLE 6. Minimum Items to be Checked and Recorded During the Coating Process**

Item	Parameter	Test Method	Minimum Production Control	Acceptance criteria
1	<b>Coating material</b> Name of product Name of manufacturer Batch number	Visual examination	At every change of shift At every change of shift At every change of shift	As specified As specified As specified
2	<b>Surface condition prior to surface preparation</b>	Visual examination	Every pipe	As specified
3	<b>Surface condition after surface preparation</b> Surface cleanliness Surface profile	ISO 8501-1 ISO 8503-2	Twice per shift Twice per shift	As specified As specified
4	<b>Surface imperfections</b> (i.e. dents , laps , ...)	Visual examination	Every pipe	Subject to agreement
5	<b>Wet coating materials (mixed )</b> Viscosity and temperature	As specified	Every time coating components are mixed and every time coating application is interrupted	As specified
6	<b>Environmental conditions in the coating area</b> Ambient temperature Steel temperature Relative humidity Dew point	Instrumental Instrumental Instrumental Instrumental	Continuously Continuously Continuously Continuously	As specified As specified As specified As specified
7	<b>Cured coating film on pipes</b> Appearance and continuity Dry film thickness  Porosity (pinholes )	Visual examination ISO 2808:1997, method 10  Wet – sponge test (Annex G ISO 15741)	Spot test Twice per shift  See Note 1*	No sagging As specified  As required
8	<b>Cured coating film on steel test panels</b> As described in Table 7	See Table 7	Twice per shift	As specified in Table 7
9	<b>Coating film on glass test panels</b> Porosity (pinholes )	ISO 15741 Annex E	At every change of shift and for every new batch	max. 5 pores**

**\*Note 1** : The wet – sponge test shall be carried out only if the porosity test on glass panels constitutes a failure .

**\*\*Note 2** : The porosity of both the wet and the dry film shall be checked on glass panels by the method given in Annex E of ISO 15741 . Porosity is considered to be any coating defect (pinhole) through which light can pass directly . More than 5 pinholes shall constitute a failure .

If the porosity test on a glass panel is deemed a failure the wet – sponge test given in Annex G of ISO 15741 shall be carried out on the surface painted with the coating material which failed the glass – panel test , testing at least ten areas , excluding welds . The coating on these surface shall not have more than 1 pinhole per 100 cm<sup>2</sup> .

**5.7** If heating is employed for pipe drying , the maximum pipe temperature shall be 50 °C . The temperature shall be monitored using digital contact thermometers . Pipe surface shall be thoroughly dry before application of coating material .

**5.8** The temperature of the steel shall be at least 3 °C above the dew point . The temperature of pipe at time of application shall not exceed 65 °C or be less than 10 °C . In the case of accelerated curing, the temperature shall be as agreed between the coating material manufacturer and the coater .

**5.9** Air atomization application is not permitted under this standard specification . Spot repairs may be made with a manual atomizing spray gun or brush .

**5.10** The coating material shall be sprayed continuously and uniformly . The coating shall be uniform and particular attention shall be given to achieving the specified DFT . The cutback length shall be maintained  $20 \pm 5$  mm .

**5.11** The coater is responsible for the quality control production tests to ensure conformance with this standard specification . Coater shall be certified and qualified for application of raw materials by manufacturer .

**5.12** The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed , to all parts of the application site which concern surface preparation , coating of the pipe , and quality control tests .

## 6. PRODUCTION CONTROL

### 6.1 Assessment of the Coating on the Pipes

- **Appearance** : The coating shall be visually inspected for uniformity of colour , smoothness and freedom from runs , holidays and other defects .
- **DFT** : The minimum DFT of the coating shall be 60 µm above the peaks in the profile of the substrate and shall be determined in accordance with Annex B ISO 15741 .

### 6.2 Assessment of the Coating on Steel Panels

The required frequency of the tests on steel panels is shown in Table 7 .

**TABLE 7. Assessment of the Coating on Steel Panels**

Item	Test	Method	Frequency	Acceptance Criteria
1	Adhesion	ISO 2409	once per shift	classification $\leq 1$
2	Bend test	ISO 6860	once per shift	no loss of adhesion
3	Buchholz hardness	ISO 2815	once per shift	hardness $\geq 94$
4	Curing test	ISO 15741 Annex F	once per shift	no softening , wrinkling or blistering
5	Porosity test	ISO 15741 Annex E	twice per shift	$\leq 5$ pinholes*

\*See Note 2 of Table 6 .

## **7. REPAIRS**

- Defective coating , or areas with insufficient DFT shall be repaired in accordance with the coating material manufacturer's recommendation .
- Defective or damaged coating shall be repaired by the coater . If the total area of repair exceeds 1% of the total internal pipe surface , the entire pipe shall be recoated .

## **8. HANDLING**

- The coater shall take all relative precautions during handling , transportation , loading and storage to avoid damage to the coating .
- The coater is responsible for ensuring that all pipes delivered to the purchaser are correctly coated and the coating is properly cured .