



شرکت ملی گاز ایران

مدیریت پژوهش و فناوری

امور تدوین استانداردها

IGS

Iranian Gas Standards

دستورالعمل

پوشش 3 لایه پلی اتیلن خطوط لوله قسمت (2)

3 LAYER POLYETHYLENE & ASSOCIATED COATING SYSTEM
Part (2)

FOREWORD

THIS STANDARD IS PART 2 OF A THREE-PART SPECIFICATION AND DEALS WITH THE FACTORY APPLICATION AND REPAIR OF EXTERNAL COATINGS APPLIED AS PROTECTION TO LINE PIPE.

THE OTHER PARTS IN THE SERIES ARE:

PART 1- REQUIREMENTS FOR COATING MATERIALS AND METHODS OF TEST.

PART 3- FIELD APPLIED COATINGS.

SPECIFICATION FOR THE EXTERNAL PROTECTION OF STEEL LINE PIPE AND FITTINGS FOR SERVICE TEMPERATURE -30°C TO +80°C , USING 3 LAYER POLYETHYLENE AND ASSOCIATED COATING SYSTEMS.

PART 2- FACTORY APPLIED COATINGS

SECTION ONE – GENERAL REQUIREMENTS

INTRODUCTION

SECTION ONE IS APPLICABLE, TO SECTION TWO INCLUDED IN THIS ENGINEERING CONSTRUCTION STANDARD.

SECTION TWO DEALS WITH THE APPLICATION OF EPOXY RESIN POWDER, ADHESIVE AND POLYETHYLENE AS AN ANTI – CORROSION 3 LAYER POLYETHYLENE COATING ON STEEL PIPE AND SHALL BE READ IN CONJUNCTION WITH SECTION ONE.

1. SCOPE

THIS PART 2 OF NIGC ENGINEERING STANDARD IGS-ES-TP-010 SPECIFIES THE OPERATIONS AND REQUIREMENTS FOR THE FACTORY APPLICATION OF MATERIALS IDENTIFIED IN NIGC ENGINEERING CONSTRUCTION STANDARD IGS-ES-TP-010 PART1 , TO BURIED STEEL PIPES PROVIDING A FINISHED PRODUCT CAPABLE OF PIPE LAYING AND OPERATING AT UP TO 80°C .

2. REFERENCES

THE CODES AND STANDARDS REFERRED TO IN THIS ENGINEERING CONSTRUCTION STANDARD ARE LISTED BELOW.

UNLESS OTHERWISE SPECIFIED, THE LATEST EDITIONS OF THESE CODES AND STANDARDS INCLUDING ALL ADDENDA AND REVISIONS SHALL APPLY.

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D 1693

ASTM G 8

BRITISH STANDARDS INSTITUTION

B.S.5750

DEUSCHE INSTITUT FUR NORMUNG

DIN 30670

DIN 50049

SWEDISH STANDARD

SIS 055900

AMERICAN PETROLIUM INSTITUTE

API RP 515

IRANIAN PETROLIUM STD. FOR SURFACE PREPARATION

IPS-C-TP-101

3. DEFINITIONS

FOR THE PURPOSES OF THIS SPECIFICATION FOLLOWING DEFINITION APPLY:

N.I.G.C : NATIONAL IRANIAN GAS COMPANY .

CONTRACTOR: THE COMPANY WITH WHOM N.I.G.C ENTERS IN TO A CONTRACT TO WHICH THIS N.I.G.C STANDARD APPLIES , INCLUDING THE CONTRACTOR'S PERSONAL REPRESENTATIVES.

INSPECTOR: THE PERSON APPOINTED FROM TIME TO TIME BY N.I.G.C AND NOTIFIED IN WRITING TO THE CONTRACTOR TO ACT AS ENGINEER FOR THE PURPOSES OF THE CONTRACT.

MANUFACTURER: THE PRODUCER OF THE COATING MATERIAL BEING OFFERED FOR TEST.

4. MATERIAL - GENERAL

4.1 ACCEPTABLE MATERIALS

4.1.1 ONLY POLYMER SYSTEMS CONFORMING TO THIS STANDARD SHALL BE CONSIDERED FOR USE AS COATINGS APPLIED IN ACCORDANCE WITH PART 2 OR PART 3 OF THIS STANDARD.

4.1.2 THE CONTRACTOR SHALL BE RESPONSIBLE FOR WITH THE REQUIREMENTS OF NIGC ENGINEERING CONSTRUCTION STANDARD IGS-ES-TP-010 PART 1. THE CONTRACTOR SHALL OBTAIN AND RETAIN ALL CERTIFICATES (SEE 4.2.)AND MANUFACTURER'S DATA SHEETS. CERTIFICATES SHALL BE MADE AVAILABLE ON REQUEST TO NIGC.

4.2 IDENTIFICATION OF COATING MATERIALS

THE CONTRACTOR SHALL ENSURE THAT ALL MATERIALS SUPPLIED FOR COATING OPERATIONS ARE CLEARLY MARKED WITH THE FOLLOWING INFORMATION:

- A) MANUFACTURER'S NAME , TRADE MARK AND ADDRESS**
- B) NAME OF MATERIAL , ORDER NUMBER AND L/E NUMBER**
- C) BATCH NUMBER**
- D) DATE OF MANUFACTURER, AND EXPIRY DATE FOR USE**
- E) SAFETY DATA SHEET**

4.3 STORAGE OF COATING MATERIALS

TO ENSURE THAT THE PROPERTIES OF ALL COATING MATERIALS ARE MAINTAINED IN COMPLIANCE WITH THE RELEVANT SECTION OF NIGC ENGINEERING CONSTRUCTION STANDARD IGS-ES-TP-010 PART 1 ALL COATING MATERIALS CONSIGNED TO THE COATING PLANT SHALL BE PROPERLY STORED IN ACCORDANCE WITH THE MANUFACTURER'S

RECOMMENDATIONS AT ALL TIMES TO PREVENT DAMAGE AND DETERIORATION PRIOR TO USE. MATERIALS SHALL BE USED IN THE ORDER IN WHICH THEY ARE DELIVERED.

5. PIPES IDENTIFICATION

5.1 ALL IDENTIFICATION MARKINGS, WHETHER INTERNAL OR EXTERNAL TO THE PIPES SHALL BE CAREFULLY RECORDED BEFORE SURFACE PREPARATIONS BEGIN.

5.2 THE DATE OF COATING FINISH AND THE COATING FACTORY MARKINGS INCLUDING PIPE IDENTIFICATION SHALL BE LEGIBLY MARKED ON COATING SURFACE OF EACH PIPE.

6. PROTECTION OF WELD PREPARATIONS

6.1 WELD END PREPARATIONS SHALL BE PROTECTED FROM MECHANICAL DAMAGE DURING HANDLING, STORAGE, SURFACE PREPARATION AND THE COATING PROCESSES .

THE METHODS USED SHALL ALSO ENSURE THAT NO DAMAGE OCCURS TO THE INTERNAL SURFACE OF THE PIPE.

6.2 WELD END PREPARATIONS SHALL BE PROTECTED FROM COATING DURING THE PROCESS BY A SUITABLE METHOD.

6.3 FOR TECHNICAL WELDING REASONS THE ENDS OF THE PIPES SHALL BE FREE OF ANY COATING LAYER (CUT BACK) OVER A LENGTH OF 100MM UP TO SIZE DN 500 (20 IN.) INCLUSIVE AND OVER A LENGTH OF 150MM FOR SIZES OVER DN500 , UNLESS OTHERWISE SPECIFIED BY NIGC.

6.4 THE UNCOATED ENDS OF PIPES SHALL NOT EXCEED 150MM UNLESS OTHERWISE SPECIFIED BY NIGC.

- 6.5 THE UNCOATED ENDS OF PIPES SHALL BE TEMPORARILY PROTECTED AGAINST ATMOSPHERIC CORROSION BY A TEMPORARY PAINT EASILY REMOVABLE BY BRUSHING.**

7. SURFACE PREPARATION

THE METHOD OF SURFACE CLEANING AND SURFACE PREPARATION SHALL BE SPECIFIED BY THE CONTRACTOR AS PART OF THE COATING PROCEDURE QUALIFICATION AND SHALL TAKE INTO ACCOUNT THE REQUIREMENTS SPECIFIED IN 7.1 TO 7.4 INCLUSIVE , IN ACCORDANCE WITH IRANIAN PETROLIUM STD. FOR SURFACE PREPARATION (IPS-C-TP-101) IN PREPARATION FOR THE APPLICATION OF THE COATING , THE SURFACE PREPARATION SHALL BE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS OF 7.1 TO 7.4 INCLUSIVE.

- 7.1 WHERE OIL , GREASE OR OTHER CONTAMINANTS ARE PRESENT THEY SHALL BE REMOVED , WITHOUT SPREADING THEM OVER THE SURFACE , WITH A SUITABLE SOLVENT. FOR PIPES WHICH HAVE BEEN SUBJECTED TO CONTAMINATION , THE CONTAMINANT SHALL BE REMOVED BY WASHING EITHER WITH POTABLE WATER OR AN APPROVED CHEMICAL CLEANER. IF A CHEMICAL CLEANER IS USED , SUBSEQUENT WASHING WITH POTABLE WATER WILL BE NECESSARY . THE PIPE SHALL BE DRIED BEFORE BLAST CLEANING. ALL PROCESSES SHALL BE AGREED WITH NIGC.**
- 7.2 PIPES SHALL BE BLAST CLEANED TO A MINIMU STANDARD OF SIS 055900-SA2½ FINISH . THE BLAST PROFILE SHALL BE BETWEEN 40um AND 100um HEIGHT, MEASURED BY AN AGREED METHOD. THE BLAST CLEANING MEDIUM USED SHALL BE AGREED WITH NIGC.**
- 7.3 THE METAL SURFACE SHALL BE INSPECTED IMMEDIATELY AFTER BALST CLEANING AND ALL SLIVERS , SCABS, ETC . , MADE VISIBLE BY BLAST CLEANING AND DETRIMENTAL TO THE COATING PROCESS SHALL BE REMOVED .**

USING A METHOD APPROVED BY NIGC . AFTER THE REMOVAL OF DEFECTS , THE REMAINING WALL THICKNESS SHALL COMPLY WITH THE RELEVANT PIPE SPECIFICATION . ANY RECTIFIED AREAS SHALL BE BLAST CLEANED TO MEET THE REQUIREMENTS OF 7.2 .

7.4 ANY PIPE FOUND TO HAVE DEFECTS WHICH EXCEED THE LEVELS PERMITTED IN THE RELEVANT PIPE SPECIFICATION SHALL BE SET ASIDE FOR EXAMINATION BY AN AUTHORISED NIGC REPRESENTATIVE AND NO SUBSEQUENT ACTION TAKEN WITHOUT THE AGREEMENT OF NIGC.

7.5 DIRECTLY BEFORE COATING, ANY DUST , GRIT OR OTHER CONTAMINANTS SHALL BE REMOVED FROM THE PIPE SURFACE BY A METHOD ESTABLISHED AS ACCEPTABLE BY THE RELEVANT COATING PROCEDURE TEST AND RECORDED IN THE RELEVANT COATING PROCEDURE.

7.6 WHERE RUST BLOOMING OR FURTHER SURFACE CONTAMINATION (SEE 7.1) HAS OCCURRED , THE PIPE SHALL BE CLEANED AGAIN IN ACCORDANCE WITH 7.1 AND AGAIN BLAST CLEANED IN ACCORDANCE WITH 7.2 COATING SHALL TAKE PLACE BEFORE ANY FURTHER CONTAMINATION OR RUST BLOOMING APPEARS.

8. COATING PROCEDURE TESTS

THE COATING PROCESS SHALL COMPLY WITH THE PROCEDURE ESTABLISHED IN THE RELEVANT COATING PROCEDURE QUALIFICATION . ANY CHANGES IN COATING MATERIALS , PIPE DIMENSIONS , PIPE MANUFACTURING PROCESS OR THE COATING PROCESS MAY , AT THE DISCRETION OF NIGC , NECESSITATE A NEW COATING PROCEDURE APPROVAL TESTS.

ADDITIONALLY , APPROVED PROCEDURE TESTS SHALL BE CONFIRMED AS PROVING TESTS , AT INTERVALS OF NOT MORE THAN 1 YEAR FOR EACH TYPE OF POWDER , ADHESIVE AND POLYETHYLENE USED BY THE CONTRACTOR AND FOR EACH SIZE OF PIPE AND PIPE MANUFACTURING PROCESS AS REQUESTED BY NIGC.

9. INSPECTION AND TESTING (QUALITY CONTROL)

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- 9.1 THE QUALITY CONTROL SYSTEM SHALL INCLUDE AS A MINIMUM THE REQUIREMENTS LISTED IN TABLE 1.**
- 9.2 ALL INSPECTIONS AND TESTINGS LISTED IN TABLE 3 SHALL BE MADE BY THE CONTRACTOR AND WITNESSED AND CERTIFIED BY THE INSPECTOR.**
- 9.3 AFTER EXAMINATION OR TEST , SHOULD THE INSPECTOR FIND OUT THAT ANY PIPE HAS NOT BEEN CLEANED OR COATED IN ACCORDANCE WITH THIS ENGINEERING STANDARD , THE CONTRACTOR SHALL BE REQUIRED TO REMOVE THE COATING WHICH IS CONSIDERED DEFECTIVE OR INADEQUATE , AND TO RECLEAN AND RECOAT THE PIPE TO THE REQUIREMENTS FOR APPROVAL OF THE INSPECTOR.**
- 9.4 THE INSPECTOR SHALL HAVE ACCESS AT ANY TIME TO THE CONSTRUCTION SITE AND TO THOSE PARTS OF ALL PLANTS THAT ARE CONCERNED WITH THE PERFORMANCE OF WORK UNDER THIS STANDARD.**
- 9.5 THE CONTRACTOR SHALL PROVIDE THE NECESSARY INSPECTION TOOLS AND INSTRUMENTS FOR THE INSPECTOR AS WELL AS AN OFFICE CONSISTING OF NORMAL FURNITURES , TEL , REFRIGERATOR , ETC.**

TABLE 1-MINIMUM QUALITY CONTROL REQUIREMENTS

REQUIREMENTS	CLAUSE REFERENCE
	SECTION TWO
1. CHECK CLEANLINESS OF PIPES IMMEDIATELY PRIOR TO BLAST CLEANING.	7.1
2. MONITOR SIZE, SHAPE AND CLEANLINESS OF THE BLAST CLEANING MATERIAL AND PROCESS.	7.2
3. CHECK VISUALLY IN GOOD LIGHT, THE SURFACE OF THE PIPES FOR METAL DEFECTS , DUST AND ENTRAPPED GRIT.	7.3
4. CHECK PIPE SURFACE BLAST PROFILE.	7.2
5. CHECK FOR RESIDUAL CONTAMINATION OF PIPE SURFACE.	7.3
6. PIPE TEMPERATURE CONTROL OF THE PIPE SURFACE	--
7. CHECK RECYCLED COATING MATERIAL FOR CONTAMINATION AND MOISTURE.	--
8. CHECK THE COATING THICKNESS (FIRST, SECOND LAYERS AND TOTAL)	14.1
9. CHECK THE TEMPERATURE CONTROL OF QUENCHING SYSTEM .	--
10. CHECK THE COATING ADHESION.	14.3
11. HOLIDAY DETECTION OF 100% OF THE SURFACE AREA OF ALL COATED PIPES.	14.2
12. SUPERVISION TO ENSURE THE ADEQUATE AND PROPER REPAIR OF ALL DEFECTS.	7
13. CHECK ON COATING COLOUR AND APPEARANCE , E.G. UNIFORMITY AND FLOW.	13.2
14. CHECK FOR DAMAGE TO WELD END PREPARATIONS.	6

10. QUALITY SYSTEMS

10.1 THE CONTRACTOR SHALL SET UP AND MAINTAIN SUCH QUALITY AND INSPECTION SYSTEMS AS ARE NECESSARY TO ENSURE THAT THE GOODS

OR SERVICES SUPPLIED COMPLY IN ALL RESPECTS WITH THE REQUIREMENTS OF THIS ENGINEERING STANDARD.

10.2 NIGC SHALL ASSESS SUCH SYSTEMS AGAINST THE RECOMMENDATIONS OF THE APPLICABLE PARTS OF BS 5750-PART 4 AND SHALL HAVE THE RIGHT TO UNDERTAKE SUCH SURVEYS AS ARE NECESSARY TO ENSURE THAT THE QUALITY ASSURANCE AND INSPECTION SYSTEMS ARE SATISFACTORY.

10.3 NIGC SHALL HAVE THE RIGHT TO UNDERTAKE INSPECTION OR TESTING OF THE GOODS OR SERVICES DURING ANY STAGE OF MANUFACTURING AT WHICH THE QUALITY OF THE FINISHED GOODS MAY BE AFFECTED AND TO UNDERTAKE INSPECTION OR TESTING OF RAW MATERIALS OR PURCHASED PIPES.

10.4 COMPLIANCE CERTIFICATES.

FOR EACH CONTRACT , THE CONTRACTOR SHALL ISSUE THE REQUIRED CERTIFICATES IN ACCORDANCE WITH DIN 50049 (PARA: 2.1 – 1986) AND PRESENTED TO NIGC .

10.5 TEST CERTIFICATES

10.5.1 THE CONTRACTOR SHALL ISSUE THE REQUIRED CERTIFICATES IN ACCORDANCE WITH DIN 50049 (PARA: 2.3 – 1986) FOR ALL COATING PRODUCTION TESTS IDENTIFIED IN 14.1 TO 14.3 INCLUSIVE AND PRESENTED TO NIGC.

10.5.2 FOR ALL TESTS WITNESSED BY THE INSPECTOR A CERTIFICATE SHALL BE PREPARED AND ISSUED BY THE CONTRACTOR AND CERTIFIED BY THE INSPECTOR IN ACCORDANCE WITH DIN 50049 (PARA :3.1.A – 1986)

SECTION TWO- 3 LAYER POLYETHYLENE COATING APPLICATION

11. PROCEDURE QUALIFICATION

11.1 GENERAL

BEFORE BULK COATING OF PIPE COMMENCES THE REQUIREMENTS OF 11.2 AND 11.3 SHALL BE MET AND A DETAILED SEQUENCE OF OPERATIONS TO BE FOLLOWED ON THE COATING OF PIPE SHALL BE PRESENTED TO NIGC FOR FORMAL APPROVAL.

11.2 COATING PROCEDURE SPECIFICATION

THE COATING PROCEDURE SPECIFICATION SHALL INCORPORATE FULL DETAILS OF THE FOLLOWINGS:

- A) THE 3 LAYER COATING SYSTEM TO BE USED TO GETHER WITH APPROPRIATE DATA SHEETS AS DEFINED IN CLAUSE 4.**
- B) PIPE CLEANING.**
- C) BLAST CLEANING MEDIUM AND TECHNIQUE .**
- D) BLAST CLEANING FINISH , SURFACE PROFILE AND SURFACE CLEANING.**
- E) DUST REMOVAL .**
- F) PREHEAT TIME AND TEMPERATURE.**
- G) POWDER EPOXY , ADHESIVE AND POLYETHYLENE INCLUDING USE OF RECYCLED MATERIAL.**
- H) CURING AND QUENCHING TIME AND TEMPERATURE.**

- I) REPAIR TECHNIQUE.**
- J) COATING STRIPPING TECHNIQUE.**

11.3 COATING PROCEDURE APPROVAL TESTS.

11.3.1 GENERAL

- 11.3.1.1 A BATCH OF 10 TO 20 PIPES OF ANY SPECIFIC PIPE MILL SHALL BE SELECTED BY THE INSPECTOR AND COATED BY THE CONTRACTOR IN ACCORDANCE WITH THE APPROVED**

COATING PROCEDURE SPECIFICATION (SEE 11.2) , THE COATING OPERATIONS BEING WITNESSED BY THE INSPECTOR. THREE PIPES FROM THE COATED PIPES SHALL BE SELECTED BY THE INSPECTOR AND SUBJECTED TO THE COMPLETE SET OF TESTS SPECIFIED IN 11.3.2 AND 11.3.3 TESTING SHALL BE WITNESSED BY THE INSPECTOR AND A FULL SET OF RECORDS SHALL BE PRESENTED TO NIGC FOR CONSIDERATION.

TABLE 2 MINIMUM COATING THICKNESS IN mm.

PIPE DIAMETER mm(in)	POWDER EPOXY RESIN (1 ST LAYER)	ADHESIVE (2 ND LAYER)	POLYETHYLENE (3 ND LAYER)
UP TO DN250(10")	0.060	0.30	2.5
DN250 (10")UP TO DN 500(20")	0.060	0.30	3.0
> DN 500 (20")	0.080	0.35	3.5

11.3.1.2 BULK COATING OF PIPES SHALL NOT COMMENCE UNTIL ALL SHORT AND LONG TERM TESTS RESULTS HAVE BEEN APPROVED OFFICIALLY BY NIGC , UNLESS THE CONTRACTOR TAKES RESPONSIBILITY OF FAILURE FOR ANY LONG TERM TEST.

11.3.1.3 ALL TEST METHODS SHALL BE IN ACCORDANCE WITH TABLE 3.

11.3.2 SHORT TERM APPROVAL TESTS

11.3.2.1 THICKNESS

FOR THIS PURPOSE , AT LEAST TO MEASUREMENTS SHALL BE MADE IN ACCORDANCE WITH TABLE 3 AT LOCATIONS UNIFORMLY DISIRIBUTED OVER THE LENGTH AND PERIPHERY

OF EACH PIPE SELECTED FOR THE TEST AND CHECKED FOR COMPLIANCE WITH TABLE 2.

50% OF THESE MEASUREMENTS SHALL BE MADE ALONG AND OVER THE LONGITUDINAL WELD SEAM, IF ANY.

11.3.2.2 POROSITY

EACH PIPE SELECTED FOR THE TEST SHALL BE HOLIDAY DETECTED OVER 100% OF ITS COATED SURFACE AND CHECKED FOR COMPLIANCE WITH TABLE 3.

11.3.2.3 ADHESION

THIS TEST SHALL BE CARRIED OUT ON EACH PIPE AT 5 LOCATIONS UNIFORMLY DISTRIBUTED OVER THE LENGTH AND PERIPHERY OF THE PIPE, IN THIS RESPECT THE MEAN FORCE NECESSARY TO PULL OF THE COATING SHALL COMPLY WITH TABLE 3.

NONE OF THESE TESTS MUST FAIL.

11.3.3 LONG TERM APPROVAL TESTS

THE TESTS IDENTIFIED IN 11.3.3.1 TO 11.3.3 INCLUSIVE SHALL BE PERFORMED ON TEST SECTIONS TAKEN FROM ALL THREE COATED PIPES SELECTED FOR THE COATING PROCEDURE APPROVAL TESTS.

11.3.3.1 ADHESION

THIS TEST SHALL BE CARRIED OUT AT 5 DIFFERENT LOCATIONS ON 5 TEST SECTIONS IN ACCORDANCE WITH 11.3.2.3 BUT AFTER 30 DAYS KEEPING IN THE HOT AIR OF 80°C.

NO CHANGE IN THE MEAN FORCE NECESSARY TO PULL OF THE COATING MUST OCCUR.

11.3.3.2 CATHODIC DISBONDING

THE TEST SECTIONS SHALL BE TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.

- 11.3.3.3 ENVIRONMENTAL STRESS CRACKING RESISTANCE. THE TEST SECTIONS SHALL BE TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.**
- 11.3.3.4 THERMAL CYCLE RESISTANCE THE TEST SECTIONS SHALL BE NOTCHED WITH A LENGTH OF 30mm AND A DEPTH OF 0.3mm AND THEN TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.**
- 11.3.3.5 IMPACT RESISTANCE:
THE TEST SECTIONS SHALL BE TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.**
- 11.3.3.6 THERMAL AGING:
THE TEST SECTIONS SHALL BE TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.**
- 11.3.3.7 ELONGATION:
THE SAMPLES TAKEN FROM THE THREE PIPES SHALL BE TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.**
- 11.3.3.8 SPECIFIC ELECTRICAL RESISTANCE:
THE SAMPLES TAKEN FROM THE THREE PIPES SHALL BE TESTED AND CHECKED FOR COMPLIANCE WITH TABLE 3.**
- 11.3.3.9 INDENTATION RESISTANCE:
THE SAMPLES TAKEN FROM THE THREE PIPES SHALL BE TESTED AND CKECKED FOR COMPLIANCE WITH TABLE 3.**

TABLE 3 COATING REQUIREMENTS AND TEST METHODS FOR COATING
PROCEDURE APPROVAL TESTS

TESTS/INSPECTION	TEST METHODS AND REQUIREMENTS
1. SURFACE PREPARATION	1- VIAUAL INSPECTION 2- ACCEPTABLE LIMIT:AS SPECIFIED IN 4.5.2
2. COATING THICKNESS	- ELECTRO-MAGNETIC THICKNESS GAUGE IS USE. - THE GUAGE SHALL BE CALIBRATED DAILY WITH THE STANDARD CALIBRATED PLATES. - MIN REQUIREMENTS: AS SPECIFIED IN TABLE 2.
3. POROSITY	DIN 30670 NO DEFECT AT 25 KV
4. ADHESION	DIN 30670 , METHOD I ACCEPTABLE LIMIT; 8 KGF/CM (MEAN FORCE) AT ROOM TEMP 23°C
5. IMPACT RESISTANCE	DIN 30670 ACCEPTABLE LIMIT: ZONE A
6. ELONGATION	DIN 30670 ACCEPTABLE LIMIT: MIN. 200% FOR EXTRUDED COATING AND MIN. 100% FOR MELTED ON COATING.

TESTS/INSPECTION	TEST METHODS AND REQUIREMENTS
7. INDENTATION(HARDNESS)	DIN 30670 ACCEPTABLE LIMIT: 0.3mm
8. THERMAL CYCLE RESTISTANCE	1- CYCLE:- 30°C 1HR +60°C 1HR - NUMBER OF CYCLES :100 ACCEPTABLE LIMIT : NO CRACK.
9. ENVIRONMENTAL STRESS CRACKING RESISTANCE	ASTM D 1693 ACCEPTABLE LIMIT:NO CRACK AFTER 300 HR.
10. TERMAL AGING	DIN 30670 ACCEPTABLE LIMIT: ±35% CHANGE IN MELTING INDEX VALUE.
11. SPECIFIC ELECTRICAL	DIN 30670 ACCEPTABLE LIMIT: 10 ⁸ Ω M ² MIN.
12. CATHODIC DISBONDING	ASTM G8 ACCEPTABLE LIMIT: 5mm

12. PRODUCTION COATING REQUIREMENTS

12.1 SURFACE PREPARATION

THE SURFACE OF THE PIPE TO BE COATED SHALL BE PREPARED IN ACCORDANCE WITH CLAUSE 7.

12.2 COATING PROCESS

12.2.1 THE PRODUCTION COATING PROCESS SHALL BE CARRIED OUT USING A PROCEDURE APPROVED IN ACCORDANCE WITH CLAUSES:4, 8 AND 11.

12.2.2 THE THICKNESS OF EACH LAYER AND THE TOTAL THICKNESS SHALL COMPLY WITH THE VALUES IN THE TABLE 2 WHEN TESTED IN ACCORDANCE WITH DIN 30670.

12.2.3 WHERE PIPE IS TO BE CONCRETE COATED REFERENCE SHALL BE MADE TO NIGC WHO WILL ADVISE THE CORRECT THICKNESS OF ANTI-CORROSION COATING TO BE APPLIED.

12.3 PROTECTION OF WELD END PREPARATIONS

PROTECTION OF WELD END PREPARATIONS SHALL BE IN ACCORDANCE WITH CLAUSE 6.

13. INSPECTION OF FINISHED COATING**13.1 GENERAL**

THE INSPECTION OF FINISHED COATING SHALL BE IN ACCORDANCE WITH CLAUSE 14. THE QUALITY AND VALUES TO BE ACHIEVED SHALL BE THE SAME AS THOSE IDENTIFIED IN 13.2 AND CLAUSE 14.

13.2 CHECK ON COATING COLOUR AND APPEARANCE

COATING COLOUR AND APPEARANCE SHALL BE UNIFORM AND FREE FROM RUNS, SAGS , BLISTERING , ROUGHNESS, FOAMING AND GENERAL FILM DEFECTS

14. COATING REQUIREMENTS AND TEST METHODS**14.1 GENERAL**

14.1.1 AFTER FORMAL APPROVAL OF ALL SHORT AND LONG TERM TESTS BY NIGC , THE CONTRACTOR WILL BE AUTHORISED TO COMMENCE THE BULK PRODUCTION.

14.1.2 THE CONTRACTOR SHALL PERFORM THE ROUTINE INSPECTION AND TESTS IN ACCORDANCE WITH 14.2 TO 14.4 INCLUSIVE DURING COATING PRODUCTION.

14.1.3 ALL THE INSPECTION AND TESTS WITNESSED BY THE INSPECTOR SHALL BE CERTIFIED.

14.1.4 THE PIPE COATING SHALL COMPLY WITH ALL REQUIREMENTS IDENTIFIED IN 14.2 TO 14.4 INCLUSIVE.

14.2 THICKNESS

THIS TEST SHALL BE CARRIED OUT 3 TIMES DURING EACH 8 HOUR PRODUCTION SHIFT AND EACH TIME ON 4 CONSECUTIVE PIPE LENGTHS IN ACCORDANCE WITH DIN 30670 (SECTIONS 5.2.1 AND 6.3) EVERY PIPE WHICH DOES NOT COMPLY WITH THE MINIMUM REQUIREMENTS OF TABLE 3 SHALL BE REJECTED FOR SUBSEQUENT STRIPPING AND RECOATING. SHOULD TWO CONSECUTIVE PIPES FAIL TO SATISFY THE REQUIREMENT , THE CAUSE SHALL IMMEDIATELY BE INVESTIGATED. IF THE CAUSE IS NOT RESOLVED AFTER FOUR CONSECUTIVE PIPES THE COATING PROCESS SHALL BE STOPPED FOR FULL INVESTIGATION : THIS SHALL INVOLVE CHECKING ALL PIPES BACK TO THE PRECEDING ACCEPTABLE PIPE.

14.3 POROSITY

EACH INDIVIDUAL LINE PIPE SHALL BE HOLIDAY DETECTED OVER 100% OF ITS COATED SURFACE IN ACCORDANCE WITH DIN 30670. UP TO 2 HOLIDAYS PER PIPE LENGTH WILL BE ALLOWED ON A MAX. OF 5% OF COATED PIPE LENGTHS DURING EACH 8 HOUR PRODUCTION SHIFT.

ANY INDIVIDUAL PIPE WITH MORE THAN 2 HOLIDAYS SHALL BE REJECTED FOR SUBSEQUENT STRIPPING AND RECOATING. IF MORE THAN 2 HOLIDAYS PER PIPE LENGTH ARE DETECTED ON TWO CONSECUTIVE PIPES, THE CAUSE OF THE HIGH HOLIDAY RATE SHALL IMMEDIATELY BE INVESTIGATED. IF THE CAUSE IS NOT RESOLVED AFTER FOUR CONSECUTIVE PIPES, THE COATING PROCESS SHALL BE STOPPED FOR FULL INVESTIGATION. ALL HOLIDAYS DETECTED ON NON-REJECTED PIPES SHALL BE REPAIRED IN ACCORDANCE WITH CLAUSE 17 AND SATISFACTORILY RETESTED.

14.4 ADHESION

THIS TEST SHALL BE CARRIED OUT 3 TIMES DURING EACH 8 HOUR PRODUCTION SHIFT, EACH TIME ON ONE INDIVIDUAL LINE PIPE. THE TEST SHALL BE CARRIED OUT AT ROOM TEMPERATURE AND AT 2 ENDS OF THE PIPE COATING SURFACE AND CHECKED FOR COMPLIANCE WITH TABLE 3 . IF THE COATING ADHESION AT ANY LOCATION IS BELOW THE REQUIREMENT OF TABLE 3 THE PIPE SHALL BE REJECTED FOR SUBSEQUENT STRIPPING AND RECOATING; IN THIS CASE THE SECOND

CONSECUTIVE PIPE SHALL BE CHECKED. SHOULD TWO CONSECUTIVE PIPES FAIL TO SATISFY THE REQUIREMENT, THE CAUSE SHALL IMMEDIATELY BE INVESTAGATED; IF THE CAUSE IS NOT RESOLVED AFTER FOUR CONSECUTIVE PIPES , THE COATING PROCESS SHALL BE STOPPED FOR FULL INVESTIGATION , THIS SHALL INVOLVE CHECKING ALL PIPES BACK TO THE PRECEDING ACCEPTABLE PIPE.

15. DEFECT RATE

SHOULD TESTS SPECIFIED IN 14.2 TO 14.4 INCLUSIVE IN ANY PRODUCTION SHIFT SHOW A REJECTION RATE OF MORE THAN 10% FOR 2" –18" AND 5% FOR 20-56 OF COATED PIPES FOR ANY ONE TEST , THEN EVERY PIPE IN THAT SHIFT SHALL BE INDIVIDUALLY SUBJECTED THAT TEST. IN SUCH CASES THE CONTRACTOR SHALL SIMULTANEOUSLY CONDUCT AN INVESTIGATION TO ESTABLISH THE CAUSE OF THE DEFECT. THE COST OF RETRIEVAL AND /OR ANY ADDITIONAL EXPENSES INCURRED AS A RESULT OF ADDITIONAL EXAMINATION SHALL BE BORNE BY THE CONTRACTOR.

16. HANDLING AND STORAGE REQUIREMENTS

- 16.1 ALL COATED PIPES SHALL BE HANDLED AND STORED IN SUCH A MANNER AS TO PREVENT DAMAGE TO THE PIPE WALLS, THE WELD END PREPARATIONS AND THE COATING.
- 16.2 NYLON SLINGS OR PROTECTED HOOKS WHICH DO NOT DAMAGE PIPE ENDS SHOULD BE USED FOR LOADING , UNLOADING AND STACKING.
- 16.3 THE COATED PIPES SHALL BE STORED AT ALL TIMES FREE FROM THE GROUND. STORAGE MAY BE EFFECTED BY THE USE OF BATTENS SUITABLY COVERED WITH SOFT MATERIAL SUCH AS RUBBER SHEET.

- 16.4 THE COATED PIPES MAY ONLY BE STACKED TO A HEIGHT SUCH THAT NO FLATTENING OF THE COATING OCCURS, IN THIS RESPECT THE FORMULA GIVEN IN API RP 515 SHALL BE USED FOR THE CALCULATION OF STATIC LOAD STRESS. (SEE THE ATTACHED NOMOGRAPH).
- 16.5 THE PIPES SHALL BE SEPARATED FROM EACH OTHER WITH SUFFICIENT AND PROPER DUNNAGE.
- 16.6 DURING LONG STORAGE THE POLYETHYLENE COATING SHALL BE PROTECTED FROM CONTACT WITH PETROL , OIL OR GREASE , AS SOME OF THESE SUBSTANCES CAN CAUSE SWELLING IN THE POLYETHYLENE LAYER.

17. TRANSPORTATION LOADING

- 17.1 THE LOADING OPERATIONS SHALL BE WITNESSED AND CERTIFIED BY THE INSPECTOR.
- 17.2 THE COATED PIPES SHALL BE LOADED ON TRUCKS WITH PROVISIONS OF 16.2 .
- 17.3 THE COATING MANUFACTURER SHALL PROVIDE ALL NECESSARY MEANS, SUCH AS SADDLES , BATTENS , ETE , FOR SAFE TRANSPORTING OF THE COATED PIPES.

18. REPAIRS

REPAIRS OF HOLIDAYS AND DAMAGED AREAS DUE TO DESTRUCTIVE TESTS SHALL BE MADE USING A MATERIAL IN ACCORDANCE WITH SECTION 3 OF PART 1 OF THIS STANDARD AND A METHOD AGREED BY NIGCC.

ALL REPAIRS SHALL BE RETESTED FOR HOLIDAYS IN ACCORDANCE WITH DIN 30670.

19. STRIPPING OF COATING

REJECTED COATING SHALL BE REMOVED ONLY BY A PROCEDURE AGREED WITH NIGC. THE PROCESS SHALL CAUSE NO MECHANICAL DAMAGE TO THE PIPE AND THE STEEL TEMPERATURE SHALL NOT EXCEED 250°C.



شرکت ملی گاز ایران - مدیریت پژوهش و فناوری

امور تدوین استانداردها

IGS

Iranian Gas Standards

مشخصات فنی مواد و دستورالعمل

اصلاحیه شماره 2 مربوط به پوشش 3 لایه پلی اتیلن خطوط لوله

Amendment No. 2 to Three Layer Polyethylene Coating System

Foreword

This amendment cancels and replaces amendment No. 1 related to IGS-ES-TP-010:1372 .
Amendment No. 1 has been revised and updated on the basis of ISO 21809-1 , CSA Z245.20 ,
CSA Z245.21 .

This amendment is summarized as follows :

IGS-TP-010(0) : Part 1

KEY CHANGES

Amendment No. 2 Section	IGS-ES-TP-010	Previous Amendment	IGS-ES-TP-010 Page	Previous Amendment Page	New Page
TABLE 1 – Liquid Epoxy Properties	Added	---	---	1	1
TABLE 2 – Raw Epoxy Powder Properties	Substituted	Modified	8	2	2
TABLE 3 – Adhesive Properties	Substituted	Modified	11	3	3
TABLE 4 – Black Polyethylene Properties	Substituted	Modified	13	4	4

IGS-TP-010(0) : Part 2

KEY CHANGES

Amendment No. 2 Section	IGS-ES-TP-010	Previous Amendment	IGS-ES-TP-010 Page	Previous Amendment Page	New Page
TABLE 2 Minimum Coating Thickness	Modified	---	15	5	5
TABLE 2 Liquid Epoxy Thickness	Added	---	---	5	5
Clause 7.2 – Blast Profile and Methods	Modified	Modified	6	5	5
Clause 7.7 – Chemical Treatment requirements	Added	Modified	---	5	5
TABLE 3 – Coating Requirements and Test Methods for Coating Procedure Approval Tests	Modified	Modified	18	6	6
TABLE 4 – Requirements for Inspection of Surface Preparation	Added	Modified	---	8	8
TABLE 5 – Requirements for Inspection and Testing of Applied Coating	Added	Modified	---	9	9
ANNEX A – 3LPE Coating Repair Procedure for the Coating Plant	Added	Added	---	---	11

TABLE 1 – Liquid Epoxy Properties

Item	Property	Unit	Requirement	Test Method
1	Density	g/cm ³	as per manufacturer's specification ± 0.05	ISO 2811
2	Solid content of base and hardener	% mass	≥95	ISO 3251
3	Minimum glass transition temperature (DSC analysis)*	°C	≥95 manufacturer's specification	ISO 11357
4	Gel time(s) at 205 °C	---	within the manufacturer's specification	manufacturer's specification

* Curing condition (procedure as manufacturer's specification)

TABLE 2 – Raw Epoxy Powder Properties

Item	Property	Unit	Requirement	Test Method
1	Density	g/cm ³	as per manufacturer's specification ± 0.05	ISO 8130-2
2	Gel time	sec	within 20% of manufacturer's specification	ISO 8130-6
3	Particle size : Maximum powder retained on 150 μ m mesh Maximum powder retained on 250 μ m mesh	%	3.0 0.2	CSA Z245.20-06
4	Specific coating resistance after 100 days of exposure in 3% NaCl solution at 23 °C	ohm.m ²	> 10 ⁸	NFA 46-710
5	3.0° flexibility test at 23 °C , 0 °C and -20 °C	---	no cracking	CSA Z245.20.06
6	Cathodic disbandment after 28 days at 65 °C in 3% NaCl solution at -1.5 volts (calomel electrode) potential , initial defect diameter Do = 6 mm , max	mm	7	CSA Z245.20
7	Moisture content , max	% by mass	0.5	ISO 21809-1
8	Degree of cure (differential thermal analysis)	°C	-2 °C $\leq \Delta T_g \leq$ +3 °C	ISO 21809-1
9	Glass transition temperature (Tg ₂) (DSC analysis)	°C	≥ 95	ISO 21809-1
10	Water resistance , 1000 hrs at 80 °C	---	no blistering , swelling < 5% , loss of hardness < 10%	ASTM D 870
11	Adhesion to pipe surface , max	---	rating 2	CSA Z245.20-06

TABLE 3 – Adhesive Properties

Item	Property	Unit	Requirement	Test Method
1	Density at 23 ± 2 °C	gr/cm ³	0.900-0.950	ISO 1183
2	Melt flow rate (2.16 kg /190 °C)	gr/10minutes	0.5-2	ISO 1133
3	Elongation at break at 23 ± 2 °C , min	%	600	ISO 527
4	Melting point (DSC) , min	°C	105	ISO 3146
5	Vicat softening temperature A /50 (9.8 N) , min	°C	95	ISO 306
6	Tensile strength , at 23 ± 2 °C , min	MPa	8	ISO 527
7	Water content , max	Weight %	0.1	ISO 15512

TABLE 4 –Black Polyethylene Properties

Item	Property	Unit	Requirement	Test Method
1	*Density at 23 ± 2 °C (base resin) , min	gr/cm ³	0.940	ISO 1183
2	Melt flow rate (2.16 kg /190 °C)	gr/10minute	0.3 – 0.8	ISO 1133
3	Elongation at break at 23 ± 2 °C , min	%	600	ISO 527
4	Yield strength at 23 ± 2 °C , min	MPa	15	ISO 527
5	Hardness Shore D , min	---	55	ISO 868
6	Vicat softening temperature A /50 (9.8 N) , min	°C	115	ISO 306
7	Melting point , min	°C	125	ISO 3146
8	Low temperature brittleness (-70 °C or lower)	---	no fracture	ASTM D 746
9	Stress cracking resistance (methyl-ethyl-ketone) , min	hour	1000	ASTM D 1693
10	Carbon black content	% by mass	2–2.5	ASTM D 1603
11	Water content , max	weight %	0.05	ISO 15512
12	Oxidation – Induction time , at 210 °C , min	minute	30	ISO 11357
13	**UV resistance and thermal ageing	%	△MFR ≤35	Annex G ISO 21809-1

* Preparation of the test specimen compression moulded sheet annealed for 30 minutes at 100 °C .

** 2mm thick compression moulded sheet , specimen ISO 527-2 , strained at 50 mm/min.

TABLE 2 – Minimum Coating Thickness

Pipe Diameter , mm (in)	Liquid Epoxy (1 st layer) , mm (µm)	Powder Epoxy Resin (1 st layer) , mm (µm)	Adhesive (2 nd layer) , mm (µm)	Total Thickness , mm
Up to DN 250 (10)	0.025 (25)	0.150 (150)	0.150 (150)	2.0
DN 250 (10) up to DN 500 (20)	0.025 (25)	0.150 (150)	0.150 (150)	2.5
DN500(20) up to DN 900 (36)	0.025 (25)	0.150 (150)	0.150 (150)	3
>DN900 (36)	0.025 (25)	0.150 (150)	0.150 (150)	3.5

7.2 Pipes shall be blast cleaned to Sa 2½ as a minimum (SIS 055900) . The surface profile after blasting shall be between 60 µm and 100 µm (R_z) height , measured by a Talysurf instrument or Replica method. The blast cleaning medium used shall be agreed with NIGC . The surface shall be angular shape not rounded .

7.7 Chemical Treatment

After blast cleaning and before application of the epoxy primer , linepipes shall be subject to chemical pretreatment using an approved phosphoric acid solution .

The surface to be coated shall be heated to a temperature of 45 – 65 °C and treated with a low pressure (0.5 – 2.0 bar) spray application of a max. 10% v/v solution of an approved acid washing material and process . A uniform PH of 1 or less shall be maintained over the entire surface of treated area . The acid washed pipe surface shall remain wetted for 10 – 30 seconds and then rinsed with clean water before its starts to dry out .

High-pressure water rinses at 700 – 1000 psi (50 – 70 bar) shall be used to remove any treatment residue . The water used shall meet the following requirements :

Chlorides shall not exceed 10 ppm , sulfates shall not exceed 40 ppm , and nitrates shall not exceed 10 ppm . The total of these salts shall not exceed 60 ppm . The water shall not be reused . Soluble salts (Chloride contamination) on the steel surface shall be checked using an approved salt detector instrument measuring conductivity SCM400 or equivalent . Soluble salt content shall not exceed 2 micrograms / cm² .

After chemical pretreatment and before coating application , preheating shall be exclusively performed by induction coil (electrical) .

TABLE 3 – Coating Requirements and Test Methods for Coating Procedure Approval Tests

Item	Property	unit	Requirement	Test method
1	Surface preparation	---	As specified in 7.2	Visual inspection
2	Coating thickness	---	As specified in Table 2	Electro-magnetic thickness gauge . The gauge shall be calibrated daily with the standard calibrated plates . Annex A ISO 21809-1
3	Porosity (Holiday detection test) with maximum speed of 0.3 m/s and with 5 kV + 5 kV/mm , max	kV	25	DIN 30670
4	Peel strength (Adhesion) , min: - at 23 ± 2 °C - at 80 ± 3 °C	N/mm N/mm	15 3	Annex C ISO 21809-1
5	Impact resistance , min - at 23 ± 2 °C - at -30 ± 3 °C	J/mm	7 3	Annex E ISO 21809-1 CSA Z245.20-06
6	Elongation at break at 23 ± 2 °C , min	%	400	ISO 527
7	Indentation , max : - at 23 ± 2 °C - at 80 °C	mm mm	0.2 0.4	Annex F ISO 21809
8	Thermal cycle resistance	---	No crack	Cycle : -30°C 1hour +60 °C 1 hour No. of cycles:100

Continued

Item	Property	Unit	Requirement	Test Method
9	Product stability during extrusion of the PE top layer process	%	$\Delta MFR \leq 20$	ISO1133
10	Specific electrical resistance (Coating resistivity) , min	Ωm^2	10^8	DIN 30670
11	*Cathodic disbondment , max : - at 23 ± 2 °C /28 days , -1.5 V - at 80 °C / 28 days / -1.5V	mm mm	5 12	Annex H ISO 21809-1
12	Hot water soak test , at 80 °C / 28 days	---	No loss of adhesion (Rating 1)	Annex J NACE RP 0394 : 02
13	Degree of cure of the epoxy as first layer	°C	$\Delta Tg \leq +3$ for FBE Scratch test for liquid epoxy	Annex D ISO 21809-1
14	Flexibility at 0 °C \pm 3 °C	%	No cracking at 2.5 degree per pipe diameter length	Annex I ISO 21809-1

* The hole diameter shall be equal to $3 \times$ total coating thickness .

TABLE 4 –Requirements for inspection of surface preparation

Item	Property	Unit	Test Method	Requirement	Frequency Qualification	Frequency production
1	Bare pipe	---	Visual inspection	Free from dent , porosity , corroded debris	each pipe	each pipe
2	Surface condition before blasting	---	Visual inspection	Free of contaminations	each pipe	each pipe
3	salt content after blasting , max	mg/m ²	Conductive measurement , ISO 8502-9	20	3 pipes at start up and 1 pipe / shift*	3 pipes at start up and 1 pipe / 4h
4	Humidity	---	Calculation	as determined at time of measurement	1 / shift*	1 / 4h
5	Pipe temperature before blasting , min	°C	thermocouple	3above the dew point	1 pipe / shift*	1 pipe / 4h
6	Size , shape and properties of abrasive	---	Visual + certification ISO 11124 resp. ISO 11126	compliance to APS**	1 / day	1 / shift*
7	Water soluble contamination of abrasives , max	µS/cm	ASTM D 4940	Conductivity 60	1 / day	1 / shift*
8	Surface roughness of blasted surface (R _z) : - liquid - powder	---	ISO 8503-4	40 µm to 100 µm 60 µm to 100 µm	3 pipes / shift*	each pipe
9	Visual inspection of blasted surface	---	ISO 8501-1	grade Sa 2½	3 pipes / shift*	each pipe
10	Presence of dust after dust removal , max	---	ISO 8502-3	class 2	3 pipes / shift*	each pipe
11	Pipe condition prior to coating	°C	monitoring	no rust , pipe temperature at least 3 above the dew point	3 pipes / shift*	each pipe
12	Temperature of extruded adhesive and polyethylene	---	thermometer	compliance to APS**	3 / shift*	continuous
13	Preheating temperature before coating	---	thermometer	compliance to APS**	3 / shift*	continuous

* Shift : every 8 working hours .

** APS (Application Procedure Specification) :

Document describing procedures , methods , equipment and tools to be used for coating application according to clause 9.2 of ISO 21809-1 : 2007.

TABLE 5 – Requirements for inspection and testing of applied coating

Item	Property	Unit	Test Method	Requirement	Frequency Qualification	Frequency production
1	Epoxy thickness , min	µm	ISO 2808	FBE : 150 Liquid epoxy : 25	1 pipe at start up and 1 pipe / shift*	1 pipe at start up and 1 pipe / shift*
2	Adhesive thickness , min	µm	ISO 2808	150 on pipe body	1 pipe at start up and 1 pipe / shift*	1 pipe at start up and 1 pipe / shift*
3	Degree of cure	°C	Annex D ISO 21809-1	$\Delta T_g \leq +3$ for FBE Scratch test for liquid epoxy	1 pipe / shift*	1 pipe / shift*
4	Appearance and continuity	---	Visual Annex B ISO 21809-1	Uniform colour , free of defects and discontinuities , delaminations , separations and holidays	continuous	continuous
5	Total thickness of coating**	mm	Annex A ISO 21809-1	See Table 2	3 pipes / shift*	each pipe
6	Impact resistance , min - at 23 ± 2 °C - at -30 ± 3 °C	J/mm	Annex E ISO 21809-1 CSA Z245.20-06	7 3	3 pipes at start up and 1 pipe / 50 km	3 pipes at start up and 1 pipe / 50 km
7	Peel strength (Adhesion) , min - at 23 ± 2 °C - at 80 ± 3 °C	N/mm N/mm	Annex C ISO 21809-1	15 3	3 pipes / shift* 3 pipes at start up and 1 pipe / 50 km	3 pipes / shift* 3 pipes at start up and 1 pipe / 50 km
8	Indentation , max : - at 23 ± 2 °C - at 80 °C	mm mm	Annex F ISO 21809-1	0.2 0.4	3 pipes at start up and 1 pipe / 50 km	3 pipes at start up and 1 pipe / 50 km
9	Elongation at break*** at 23 ± 2 °C , min	%	ISO 527	400	3 pipes at start up and 1 pipe / 50 km	3 pipes at start up and 1 pipe / 50 km
10	Cathodic disbondment , max : - at 23 ± 2 °C / 28 days , - 1.5 V - at 80 °C / 28 days / - 1.5V	mm mm	Annex H ISO 21809-1	5 12	3 pipes at start up and 1 pipe / 50 km	3 pipes at start up and 1 pipe / 50 km
11	Flexibility at 0 °C \pm 3 °C	%	Annex I ISO 21809-1	No cracking at 2.5 degree per pipe diameter length	1 pipe / order	1 pipe / order
12	In process degradation of polyethylene***	%	ISO 1133	Δ MFR \leq 20 for PE between raw and extruded material	3 pipes / order	3 pipes / order
13	Cutback	mm	Measuring	100 \pm 7 up to 20" 150 \pm 10 for \geq 20"	3 pipes / shift*	all pipes
14	Hot water soak test , at 80 °C / 28 days	---	Annex J NACE RP 0394 : 02	No loss of adhesion (Rating 1)	3 pipes at start up and 1 pipe / 50 km	3 pipes at start up and 1 pipe / 50 km
15	Glass transition temperature (DSC) , min	°C	Annex D ISO 21809-1	95	1 pipe / shift*	1 pipe / shift*

*Shift : every 8 working hours .

** The total thickness may be reduced by a maximum of 10 % on the weld seam for SAW welded pipes .

*** In case of change in batch of PE , retest shall be carried out .

Note 1 : Material Approval

1.1 For any order of three layer polyethylene coating of pipes , the coater shall submit manufacturer's raw material test certificate , test reports and technical data sheets showing , at least , the properties described in Tables 1 or 2 and 3 and 4 .

1.2 For any FBE raw material designation supplied from any manufacturer , a full set of tests as specified in Table 1 or 2 shall be performed by the coater in a reputable lab in IRAN or abroad .

The test certificates are considered to be valid for 5 years .

Test reports shall be submitted by the coater for each order .

1.3 For any adhesive or PE raw material designation supplied from any new manufacturer which supplied material for the first time for NIGC or NIGC subcontractor orders , a full set of tests as specified in Tables 3 and 4 shall be performed in a reputable lab in IRAN or abroad .

Test reports shall be submitted by the coater for each order .

1.4 A certificate of analysis (COA) should be issued by the manufacturer of each component . The manufacturer shall supply an inspection certificate for each batch .

1.5 Each batch of all coating materials shall be accompanied by a certificate of analysis (COA) according to EN 10204 , 3.1.B stating that all the tests have been carried out and results are in accordance with the manufacturer's product specifications and requirements of Table 1, Table 2 and Table 3 .

Note 2 : Retest

In case of failure in 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 any of the follow – up tests also fail to meet the requirements of this specification , all coated linepipes since the last acceptable test shall be rejected .

ANNEX A

"3LPE COATING REPAIR PROCEDURE FOR THE COATING PLANT"

1. SCOPE

In case of the 3LPE coating of pipe is damaged during production , handling , loading and unloading at the coating plant , the damage to the coating shall be repaired according to this Annex :

2. COATING REPAIR MATERIAL

Since the repair materials are required to be approved by NIGC , a copy of technical specification and data sheets of the repair materials including PE melt stick , filler mastic , repair patch and heat shrinkable sleeve shall be submitted to NIGC for review and approval .

3. QUALIFICATION OF REPAIR PROCEDURE

The repair procedure shall be qualified at the presence of NIGC inspector . In this case a line pipe with damaged coating shall be repaired in accordance with the instructions recommended by the repair material manufacturer . The repaired area shall then be inspected for minimum thickness , adhesion and holiday detection and if satisfactory results achieved , the repair procedure will be considered acceptable . The inspection findings shall then be recorded and signed by both parties and kept as a proof of repair procedure qualification .

4. ACCEPTABLE NUMBER OF REPAIRS IN A LINE PIPE

The maximum acceptable number of damage in any coated line pipe , may be up to three points , provided that the total damaged areas do not exceed 200 cm² , however the total number of pipes with coating repairs , shall not exceed 2% of total number of coated pipes in any individual order .

5. UNREPAIRABLE DAMAGE

The following damage are not allowed to be repaired :

5.1 If in every 200 pipes the damage to the coating , is reached to the FBE layer in only one pipe .

5.2 No repair will be allowed on coating edges at either sides of pipe coating .

5.3 The maximum surface of 3 repaired areas in any line pipe , shall not exceed 200 cm² . In such cases the pipe coating shall be fully stripped and the pipe recleaned and recoated.

6. REPAIRABLE DAMAGE

The damage which is allowed to be repaired is limited to the following :

6.1 Minor Damage

If the damaged depth is less than 1.5 mm and the related area is less than 5 cm² , the damage may be repaired by PE melt stick .

6.2 Intermediate Damage

If the damaged depth is less than the thickness of PE and adhesive layers (3 mm maximum) and the maximum area of the damages does not exceed 50 cm² , with the biggest dimension of 10 cm , the damage shall be repaired by filler mastic and repair patch .

6.3 Major Damage

If the damage depth is less than the thickness of PE and adhesive layers (3 mm maximum) and the maximum area of the damage does not exceed 100 cm² with the biggest dimension of 30 cm , the damage shall be repaired by filler mastic together with a wraparound heat shrinkable sleeve .

Note : Any repair activities shall be performed fully in accordance with the instructions recommended by the repair material manufacturer .

7. REPAIR QUALITY CONTROL

All repaired areas shall be subjected to visual inspection , thickness measurements , holiday inspection and adhesion when repair patch is used . In case of any failure , the repaired portion shall be removed , recleaned and repaired again .

Repair material shall be suitable for maximum operating pressure and also other physical properties to be matchable with 3 layer polyethylene coating .

The coater shall obtain the approval of NIGC for type and technical properties of repair material .