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KUWAIT OIL COMPANY (K.S.C.)



**KOC STANDARD
FOR**

**EXTERNAL COATING OF PIPELINES
DOC NO: KOC-P-004
PART 2:
FIELD APPLIED POLYOLEPHINIC TAPE
(FORMERLY 015-IH-1012)**

ISSUING AUTHORITY:

STANDARDS DIVISION

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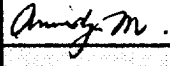
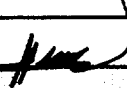
1	29/5/1996	Issued as Standard	Dr. M.A. Ajjawi		
Rev.	Date	Description	Prepared by: Tel. 61508	Senior Engineer Tel. 61408	Supdt. Stds. Div. Tel. 61541

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1.0 SCOPE

1.1 This Standard provides the minimum requirements for surface preparation, materials, application method and inspection and testing for field applied external polyolefinic tape coating used for corrosion protection of buried pipelines, buried branches/attachments and field joints for operating temperatures upto 85°C (185°F).

1.2 This standard covers both newly constructed and reconditioning/rehabilitation of buried pipelines.

2.0 GENERAL

2.1 All buried steel pipelines and field joints shall be coated/wrapped, inspected and tested to the satisfaction of KOC before backfilling takes place.

2.2 The materials and equipment used for surface preparation, coating/wrapping application, inspection & testing, shall conform to the requirements of this Standard and the reference standards and codes, except as modified or supplemented by project specification or data sheet.

3.0 TERMINOLOGY

3.1 Definitions

Cathodic Disbondment

The loss of adhesion between a coating and the pipe surface caused by products of a cathodic reaction or when coating is subjected to excessive current densities.

Discontinuity (Holiday)

Small faults (e.g., cracks, voids, etc.) or pinholes that permit current drainage through protective coatings on steel pipe.

Weld Zone

As used in this Standard, weld zone is the un-coated area, on the pipeline, that results when two joints with coating cutback are assembled in the field.

3.2 Abbreviations

KOC	Kuwait Oil Company (K.S.C)
CP	Cathodic Protection
HSE	Health, Safety and Environment
UV	Ultra Violet
RH	Relative Humidity
WVTR	Water Vapour Transmission Rate

4.0 REFERENCE CODES AND STANDARDS

4.1 In the event of conflict between this Standard and the standards/codes referenced herein, the most stringent requirement shall apply, unless otherwise specified.

4.2 Any exception or deviations from this Standard, along with their merits & justification, shall be brought to the attention of KOC's Controlling Department, for their review, consideration and amendment by Standards Div. (if required).

4.3 List of Standards and Codes :

The latest edition of the following standards, codes and specifications, including all amendments addenda and supplements, shall apply:

International Standards

BS 7079-A1} ISO 8501-1}	Specification for rust grades and preparation grades of uncoated steel substrate and of steel substrate after overall removal of previous coatings - Visual assessment of surface cleanliness.
NACE TM-0170	Visual standard for surfaces of new Steel air blast cleaned with sand abrasive
NACE TM-0175	Visual standard for surfaces of new steel centrifugally blast cleaned with steel grit and shot.
SSPC SP	Steel Structure Painting Council Surface Preparation Specifications (as referred in the text).
SIS 05 59 00	Pictorial surface preparation standards for painting steel surfaces.
ASTM	Testing & Material specifications (as referred in the text).
ASTM G 12	None destructive measurement of film thickness of pipe-line coatings on steel.
NACE RP-0287	Field measurement of surface profile of abrasive blast cleaned steel surfaces using a replica tape.
NACE RP-0274	High-Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.

KOC Standards/Codes

KOC-G-007	KOC Standard for basic design data.
KOC-P-001	Painting and coating of metal surfaces - New Construction.

5.0 ENVIRONMENTAL CONDITION

- 5.1** The environment of Kuwait, is severe on all equipment and must be considered carefully before selection of coating and wrapping materials. It must be assumed that, unless otherwise specified, coating/wrapping system may be subjected to sand and fine particle dust storms, salt laden winds and in some areas to airborne corrosive chemical contaminants (e.g., H₂S, SO₂ etc.).
- 5.2** KOC Standard for basic design data, KOC-G-007, provides the detailed design information regarding the environmental, site, and utility supply conditions prevailing throughout the KOC facilities.

6.0 HEALTH, SAFETY AND ENVIRONMENT

- 6.1** The contractor shall employ all necessary health and safety procedures to protect personnel and surrounding environment during surface preparation, application of coating/wrapping materials and other field work procedures.
- 6.2** All relevant safety requirements of KOC Fire & Safety Regulations and KOC's HSE requirements shall be conformed for all works performed within KOC operation areas.
- 6.3** Manufacturer's health & safety procedures for handling, storage and application of all coating shall be strictly adhered. Health & safety precautions shall be clearly described on primer and tape coating material container/package.

7.0 COATING\WRAPPING MATERIALS

7.1 General

All coating and wrapping materials shall be chemically pure, and free from inclusions and foreign contaminants. The age of the material components shall not exceed the recommended storage life as limited by the manufacturers.

7.2 Packaging, Handling and Storage

- 7.2.1** Coating and wrapping materials shall be packaged and delivered to the site/field in original, tightly sealed, manufacturer's containers with batch/code numbers, storage conditions, date of manufacture and date of expiry clearly marked thereon.
- 7.2.2** Coating and wrapping materials shall be stored in covered dry locations and shall be kept clean, dry and free from any contaminants or damage prior to and during field application.
- 7.2.3** All coating materials shall be stored at temperatures within manufacturer's recommended range, and exposure to extreme temperatures should be avoided.
- 7.2.4** Tapes and wrappers should not be handled with hooks or be thrown from trucks. Materials showing evidence of damage or deterioration shall not be used.

7.3 Approvals

- 7.3.1** All coating and wrapping (tapes and wrappers) materials in any one system shall originate from one manufacturer.
- 7.3.2** The contractor's submittal for coating and wrapping materials shall include details of manufacturer, generalized composition, technical specifications and physical properties laboratory testing certificates for all products to be used for KOC review and approval.
- 7.3.3** The composition, description and physical properties of primer and coating materials to be used shall comply with the following clauses. Any deviation from these clauses shall be referred to KOC for approval.

7.4 Linepipe Wrap Tape Coating System

- 7.4.1** The coating system shall consist of three layers: primer layer, corrosion protection inner layer and mechanical protection outer layer. The minimum thickness for the total coating system shall be 1125 micron (45 mils).
- 7.4.2** The inner and outer wrap tapes shall be in the form of prefabricated tapes supplied in rolls. To assure a proper smooth coating the inner layer tape should be furnished in standard width consistent with the pipe diameter.
- 7.4.3** The primer, innerwrap tape and outerwrap tape specifications shall meet the following requirements.
- 7.4.4 Primer**
- (a) The primer shall consist of a suitable rubber based solid compounds dissolved in an organic solvent with stress corrosion cracking inhibitors.
 - (b) It shall be highly compatible with the inner wrap tape and shall be made to apply smoothly and evenly to the abrasive blasted pipe surface and form an insulating bond between the steel pipe and the inner tape.
 - (c) The primer shall be suitable for brush and machine application to abrasive cleaned pipe surfaces.
 - (D) The primer shall be capable of withstanding application temperature of up to 71°C and service temperature of up-to 85°C. The minimum shelf life shall be 3 years.

7.4.5 Innerwrap Tape

- (a) The innerwrap tape system shall consist of polyethylene backing and butyl rubber based adhesive, uniquely bonded into a single layer, to insure immediate high bond to primed steel. It shall provide life time corrosion protection for buried pipelines.
- (b) The material shall provide excellent conformability when applied over seamed, spiral welded or extruded pipe.

(c) Material properties shall be as follows:

Property	Minimum Requirement	Test Method
Thickness Backing thickness Adhesive thickness Total thickness	325 micron (13 mils) 300 micron (12 mils) 625 micron (25 mils)	ASTM D1000
Width and Length	Shall be a function of pipe diameter	
Mechanical Tensile Strength Elongation Adhesion to Primed Steel	6 Kgf/cm (33lbf/inch) width 400% 2.7 Kgf/cm (15lbf/inch) Width	ASTM D1000 ASTM D1000 ASTM D1000
Electrical Dielectric Strength Insulation Resistance Cathodic Disbondment	47 kV/mm 1,000,000 megohms 12.5 mm (0.5 inch)	ASTM D149 ASTM D257 ASTM G8
Water Resistance Water Vapour Transmission Rate (WVTR) (24 hours) Water Absorption Water Penetration	< 0.03 g/100 cm ² /24 hrs. (< 0.2 g/100 inch ² /24 hrs.) 0.1% (max.) Nil	ASTM E96 ASTM D570 ASTM G9
Temperature Range Normal Application (ambient) Normal Service (operating service)	-34°C to 71°C (-30° to 160°F) -34°C to 85°C (-30° to 185°F)	-
Storage Temperature	Up to 65°C (150°F)	-
Shelf Life	Minimum 3 years	-

7.4.6 Outerwrap Tape

- (a) The outer layer wrap tape shall consist of a polyethylene backing laminated with butyl rubber base adhesive. It shall be designed to withstand at the environmental conditions described in clause 5 and resist UV degradation for 12-18 months.
- (b) The outer layer wrap shall provide mechanical protection to the innerwrap tape from potential hazards due to back-fill operations and soil stresses; as well as from chemical and biological attack.
- (c) The outer layer shall be highly compatible with the innerlayer wrap tape.
- (d) Material properties shall be follows:

Property	Minimum Requirement	Test Method
Thickness Backing thickness Adhesive thickness Total thickness	375 micron (15 mils). 125 micron (5 mils). 500 micron (20 mils).	ASTM D1000

Property	Minimum Requirement	Test Method
Mechanical		
Tensile Strength	5.4 Kg/cm (30 lbf/inch) width	ASTM D1000
Elongation	300%	ASTM D1000
Adhesion to Innerwrap	0.72 Kg/cm (4.0 lbf/inch) width	ASTM D1000
Puncture Resistance	1.76 Kg/cm ² (25 psi)	ASTM D1000
Tear Resistance	71.6 Kg/cm (400 lbf/inch)	ASTM D624
Abrasion Resistance	Excellent	ASTM D1000
Electrical		
Dielectric Strength	42 kV/mm (1.2 kV/mil)	ASTM D149
Insulation Resistance	1,000,000 megohms	ASTM D257
Average Current Density	<10 ⁻⁶ A/m ² (<10 ⁻⁷ A/ft ²)	ASTM G8
Weather/Environmental		
UV Resistance at 60°C	Excellent	ASTM G53
Environmental Stress Cracking Resistance	No Cracking	ASTM D1693
Water Resistance		
WVTR (24 hours)	< 0.03 g/100 cm ² /24 hrs. (< 0.2 g/100 inch ² /24 hrs.)	ASTM E398
Temperature Range		
Normal Application (ambient)	-34°C to 71°C (-30° to 160°F)	
Normal Service (operating service)	-34°C to 85°C (-30° to 185°F)	
Storage Temperature	Up to 65°C (150°F)	-
Shelf Life	Minimum 3 years	-

7.5 Field Joints/Attachments Coating Materials

7.5.1 Primer

The primer shall be quick-drying, brush/spray applied, compatible with the tape coating system to be employed and as per the manufacturer's recommendations.

7.5.2 Heat-Shrinkable Wraparound Sleeve for Grith Weld Surfaces

The sleeves shall have a thick radiation cross-linked polyolefin backing coated with a high shear-strength thermoplastic hot melt adhesive. The material properties shall be as per the following:

Property	Minimum Requirement	Test Method
Thickness (Total)	1.5 mm (60 mils)	ASTM D1000
Width	Shall be a function of pipe diameter	
Mechanical		
Tensile Strength	176 Kg/cm ² (2500 lbf/inch ²)	ASTM D 638
Elongation	580%	ASTM D1000
Adhesion to Steel	5.2 Kg/cm (560 oz/inch) width	ASTM D1000
Penetration Resistance at 80°	No holiday with 10 Kv detector	ASTM G17
Impact Resistance	1.15 Kg/m (100 inch-lb)	ASTM G 14
lap Shear Strength at 80°	3.9 Kg/cm ² (55 lbf/inch ²)	ASTM D1002

Property	Minimum Requirement	Test Method
Water Resistance WVTR (24 Hrs.)	0.8 g/m ² /24 hrs. (0.05 g/100 inch ² /24 hrs.)	ASTM E 398
Electrical Volume Resistivity Dielectric Breakdown Cathodic Disbondment	5.0 x 10 ¹⁵ ohm/cm 45 Kv 26 mm (1 inch)	ASTM D257 ASTM D149 ASTM G42
Temperature Range Normal Application (ambient) Normal Service (operating service)	-34°C to 71°C (-30° to 160°F) -34°C to 80°C (-30° to 175°F)	-
Storage Temperature	Up to 65°C (150°F)	-
Shelf Life	Minimum 3 years	-

7.5.3 Joint Wrap Tape for Pipe Attachments/Fittings

- (a) Wrap tape shall be co-extruded cold-applied self-adhesive, stress-relieved, conformable, thick and durable polyolephinic tape consisting of a polyethylene backing and butyl rubber adhesive. The material properties shall be as per the following:

Property	Minimum Requirement	Test Method
Thickness Backing thickness Adhesive thickness Total thickness	0.15 mm (6 mils) 0.725 mm (29 mils) 0.875 mm (35 mils)	ASTM D1000
Width and Length	Shall be a function of pipe diameter	
Mechanical Tensile Strength Elongation Adhesion to primed steel Adhesion to backing	2.7 kgf/cm (15 lbf/inch) 250 % 3 Kg/cm (18 lbf/inch) 3 kgf/cm (18 lbf/inch)	ASTM D1000 ASTM D1000 ASTM D1000 ASTM D1000
Electrical Dielectric Strength Insulation Resistance Cathodic Disbondment	47 Kv/mm 1,000,000 megohms 12.5 mm (0.5 inch)	ASTM D149 ASTM D257 ASTM G 8
Water Resistance WVTR (24 Hrs.) Water Absorption	< 0.03 g/100 cm ² /24 hrs (0.2 g/100 inch ² /24 hrs) 0.1 %	ASTM E398 ASTM D570
Temperature Range Normal Application (ambient) Normal Service (operating service)	-34°C to 71°C (-30° to 160°F) -34°C to 85°C (-30° to 185°F)	-
Storage Temperature	Up to 65°C (150°F)	-
Shelf Life	Minimum 3 Years	-

- (b) A removable interleaf shall be incorporated against the adhesive compound which must extend a minimum of 12.5 mm (0.5 inch) wider, each side, than the width of the wrap, i.e., for 150 mm (6 inches) wide wrap, 175 mm (7 inches) wide interleaf shall be used. This is to prevent contamination to the edge of the wrap during storage and handling.

8.0 SURFACE PREPARATION

8.1 General requirement

The pipe external surface shall be prepared to the satisfaction of KOC and in accordance with the requirements of this standard and the recommendations of tape coating manufacturer. Any area not specifically covered shall be referred to clause 8.0 of KOC-P-001.

8.2 Contaminants removal

Prior to blast cleaning of pipe surfaces, foreign materials like deposits, oil, grease, mill, lacquer, wax, old coating, dirt, mud etc. shall be removed by using the applicable method(s) of the following:

- (a) Approved mechanical machinery equipped with suitable combination of cutters, scrapper and wire brushes may be used to remove all contaminants, deposits, old coatings, mud, etc. The tension of cutting/scraping mechanism or travelling type equipment should be such that it will not produce burrs or damage the pipe surface. For small diameter and short length pipes, hand wire brushing and wiping down with clean dry rags can be used for the same purpose.
- (b) Solvent cleaning in accordance with SSPC SP1. Only solvents (e.g., hexane, xylol, etc.) that do not leave any oily residue on the surface shall be used. Kerosene shall not be used for solvent cleaning.
- (c) An appropriate high-detergent cleaning (using emulsifying cleaners) followed by washing with water or steam rinsing. The high-detergent cleaned surface shall be allowed to dry and all before proceeding with further preparation or priming.
- (d) Preheating to remove oil, grease and mill scale may be used provided that all pipe is preheated in a uniform manner to avoid distortion.

8.3 Imperfection Removal

All surface imperfections such as slivers, scabs, slag, weld spatter sharp edges, burrs, etc. shall be removed or made smooth by wire brushing, grinding and/or filling. Similar imperfections revealed by blast cleaning shall be similarly treated and reblast cleaned after grinding.

8.4 Blast Cleaning

- 8.4.1** After the precleaning operations, the exterior steel pipe surface shall be cleaned

by dry abrasive blasting with grit or shot to a surface cleanliness as defined in SIS 055900 (ISO 8501-1/BS 7079-A1) Sa 2½ and NACE TM-0175 # 3.

- 8.4.2** Blast cleaning shall produce a surface profile of 38 - 72 micron (1½ - 2½ mils) as verified by NACE RP-0287 or as recommended by primer manufacturer. Sand or mineral slag blast cleaning, in accordance with NACE Standard TM-0170, may be used as abrasive blasting material subject to KOC's approval.
- 8.4.3** Blast cleaning shall not be carried out at ambient temperature below 5°C, or when RH is greater than 85%, or when the metal surface temperature is less than 3°C above the ambient dew point.
- 8.4.4** The prepared external pipe surface and pipe interior shall be cleaned from any dust and blast cleaning materials prior to coating application.
- 8.4.5** Blast cleaned pipe surfaces shall be protected from wet, humid, rainfall and surface moisture conditions. No pipe shall be allowed to flash rust prior to coating application. If flash rusting occurs, the surfaces must be recleaned by blasting as above.
- 8.4.6** If it is not feasible to prepare the pipe surface by abrasive blast cleaning, then mechanical (power tool) cleaning, in accordance with SSPC-SP11, may be used subject to KOC's approval and written permission from the tape manufacturer.

9.0 COATING / WRAPPING APPLICATION

9.1 General

The coating/wrapping application, on properly prepared pipe surface, shall be a continuous operation. Three steps following immediately one after the other shall consist of primer application on freshly prepared pipe surface, application of innerlayer tape directly on the primed pipe surface and application of the outer-layer tape on the top of the innerlayer tape.

9.2 Work/Weather conditions

Pipe coating & wrapping application shall not be carried out in the following conditions:

- (a) When the relative humidity (RH) is 85% or higher.
- (b) When air temperature is less than 7.2°C (45°F).
- (c) when pipe surface is wet from any form of precipitation.
- (d) Under adverse weather conditions, e.g, rainfall and sandstorm.
- (e) Where the specified surface finish is not existing at the time of primer application or when pipe surface is flash rusted.

9.3 Primer Application

- 9.3.1** The primer shall be applied immediately after cleaning pipe surface is completed. Before application the pipe shall be wiped free of sand particles/dust using dry clean rags. If line travelling equipment is used, a rotating wiping head shall be permitted.
- 9.3.2** The primer shall be thoroughly mixed and agitated as needed during application to prevent any settling.
- 9.3.3** Primer shall be spray applied in a uniform thin film to cover the required pipe surface. Other methods of application (e.g., roller, rug, brush) may be used subject to KOC's approval.
- 9.3.4** The primer coat on the pipe surface shall be uniform and free of floods, runs, sags, drips, bare spots and over spray.
- 9.3.5** Primer dry film thickness shall not be less than 25 micron (1 mil) and not greater than 50 micron (2 mils).
- 9.3.6** The primed pipe surface must be free of any foreign substances such as cleaning grit, sand, dirt grease, oil, rust particles and etc. Any contaminated pipe surface area, shall be solvent cleaned and reprimed.
- 9.3.7** Before applying the any tape coating, the primed pipe surface shall be allowed to dry in accordance with the manufacturer's recommendations.

9.4 Innerlayer & Outerlayer Wrap Coating Application

9.4.1 Application Temperature

- (a) The tape system components, elastomer inner layer and outer layer wrap, shall be applied and maintained at a minimum roll body temperature as recommended by tape manufacturer.
- (b) The tape system rolls shall be stored in a temperature controlled environment for a minimum of 24 hours prior to application. The ambient storage temperature shall not exceed the recommended storage temperature by tape manufacturer.

9.4.2 Application Equipment

- (a) The applicator shall use mechanical tape dispensing machine equipped with constant tension brake system, which travel on the pipe and apply both the innerwrap and outerwrap automatically. Line travel dispensing machine can also be used for cleaning, blasting and priming the pipe automatically.
- (b) For pipelines of less than 500 meters in length and for pipe branches, manual methods can be used in tape application.

- (c) An additional rolling "spreader" bar, just prior to application onto the pipe is recommended to produce a smooth coating.
- (d) The dispensing equipment shall have a pressure read-out meters for measurable quality control. This is to ensure that uniform, even tension is applied to spirally welded pipe surface.
- (e) The applicator shall make sure that all manual or mechanical adjustments necessary to acquire a uniform, tightly adhered, spirally wrapped coating.

9.4.3 Application of Innerwrap Tape

- (a) The inner layer tape shall be applied directly onto the primed steel pipe surface with dispensing machine described under clause 9.4.2 above. The tape shall be spirally applied wrinkle free with a sufficient tension to neck down the tape 3.2 mm (1/8") - 5.3 mm (1/4") less than the original width at a tension of 8.2 Kg (18 lbs) to 13.6 kg (30 lbs) per inch width.
- (b) The Inner layer wrap tape shall be spirally applied with approx. 5.3 mm (1/4") to 25 mm (1") overlap. When applied to spirally welded pipe, the direction of the tape spiral shall be generally parallel to the weld spiral. The minimum overlap shall not be less than 25 mm (1").
- (c) When a new roll of tape is started, the ends shall be located to ensure the continuity of the inner layer tape using the same type of mechanical tape dispensing machine.
- (d) A tight and smooth coating shall be maintained throughout the application with no puckers, voids, breaks, wrinkles or folds.

9.4.4 Application of Outerwrap Tape

- (a) After holiday detection of the applied innerlayer, the outerlayer shall be spirally applied directly onto the innerlayer. A tight, smooth, wrinkle free outer layer shall be applied with dispensing machine described under clause 9.4.2. Primer may be applied over the innerlayer and before outerwrap application, if proven by the contractor to achieve the required adhesion.
- (b) The outerlayer shall be applied under tension as specified in clauses 9.4.3a. The overlap of the outerlayer tape shall not coincide with the overlap of the inner layer tape. The minimum overlap of the applied tape and the minimum end lap of two rolls shall be the same for the innerwrap.

9.4.5 Cutbacks

Cutbacks shall be a minimum of 6 inches (150 mm) from the ends of the pipe. The cutbacks may be tapered or straight edge for the total thickness of the coating.

9.5 Field Joints \ Pipe Attachments Coating Application

9.5.1 Application of Heat-Shrinkable Wraparound Sleeve for Field Grith Welds

- (a) Cut and remove any coating material not firmly bonded to pipe, and remove the outer wrap around the pipe, up to 150 mm from edge of coating.**
- (b) Feather-trim, clean and dry the adjacent tape coating.**
- (c) Remove loose particles, weld spatters and other foreign material and grease or oil before any blast cleaning.**
- (d) Weld zone surface area shall be thoroughly cleaned using grit blasting to near white metal finish (Sa 2½) in accordance with the requirements of clause 8.4 of this Standard. Precautions shall be taken to protect the adjacent coating from abrasive blasting. Manufacturer's recommendations should be followed for surface preparation.**
- (e) The clean and dry prepared weld zone area shall be primed with one thin continuous coat of quick-drying primer, recommended by sleeve manufacturer, and allowed to dry.**
- (f) Fit the heat-shrinkable wraparound sleeve on the primed area and 150 mm (6 inches) over the pipe coating with the required tension. Wrinkles are not permitted.**
- (g) Field application of " heat shrinkable" sleeve shall be made by only tools which are recommended by sleeve manufacturer. The application procedure shall be submitted to KOC for approval prior to commencing.**
- (h) The sleeve shall be applied to the grith weld joint strictly in accordance with the manufacturer's recommendation.**

9.5.2 Application of Joint Wrap Tape Coating for Pipe Fittings/Attachments

- (a) The field joint/attachment area from the edge of coating and including the exposed coating shall be thoroughly cleaned free of all rust, weld spatter, dirt, and dust.**
- (b) The clean and dry prepared surface shall be brush/spray primed with one thin continuous coat of quick-drying primer, recommended by tape manufacturer, and allowed to dry. The priming shall extend over the already wrapped surface for at least 150 mm (6 inches).**
- (c) The primed surface shall then be applied spirally with a pipe joint-wrap having 50% overlap and using sufficient tension to ensure complete conformability. End laps between adjoining rolls to be a minimum of 150 mm (6 inches).**

- (d) Hand applied cold putty, recommended by tape manufacturer, shall be moulded around bolted flanges/valves (see Appendix 2 Fig. 1) to provide suitable profile for wrapping.

10.0 INSPECTION & TESTING

10.1 General Requirements

- 10.1.1** The contractor shall perform all inspections and tests that are necessary to assure that the coating complies with the requirements of this Standard.

- 10.1.2** Surface preparation, priming and tape coating application will be subjected to inspection and approval at any stage by KOC to ensure the compliance with clauses 8.0 and 9.0 of this Standard.

- 10.1.3** KOC inspector shall have the right to inspect at all times any tools, materials or equipment used in the performance of surface preparation and coating wrapping application to ensure compliance of this Standard.

10.2 Material Inspection

- 10.2.1** All coating and wrapping materials shall be inspected to ensure conformance with the requirements of clause 7.0 of this Standard. Samples of primer, wrap tape and sleeve shall be submitted to KOC, for approval, prior to application.

- 10.2.2** Independent test certificates for the coating/wrapping materials shall be provided by the contractor for KOC review and approval. All tests shall be in accordance with ASTM Standards as specified in the material properties tables (sub-clauses 7.4.5c, 7.4.6d, 7.5.2 and 7.5.3a).

10.3 Inspection with Holiday Detector

- (a) All tape coated pipe shall be 100% electrically tested for flaws, pores etc. in the coating with a suitable holiday detector as recommended by the coating's manufacturer. The inspection procedure and voltage levels of the holiday detection shall be in accordance with NACE RP-0274.
- (b) The holiday inspection shall be performed on the coating system prior to the outer layer application. The voltage setting for the inner-layer and the total coating system shall be 1250 times the square root of the coating thickness in mils $\pm 20\%$ or as recommended by the coating manufacturer.
- (c) The contractor shall perform Holiday inspection for the coated pipe, under the witness /surveillance of KOC, before bedding and trench backfilling is performed.
- (d) All holidays electrically detected shall be repaired, immediately after detection, in accordance with clause 11. The defective areas shall be electrically inspected after the defect has been repaired.

10.4 Coating Adhesion (Bond) Test

10.4.1 After the pipe has been coated for at least 24 hours, a bond test shall be performed to assure that a minimum bond is developed. The testing shall be in accordance with ASTM D1000, the frequency of testing shall be subjected to KOC approval.

10.4.2 Adhesion to the total system when tested with a fish scale (180° peel) shall give a minimum value of 2.8 Kg/cm (15 lbs/inch) when pulled slowly at 180° from the pipe after. Adhesion between inner and outer layer shall get minimum value of 0.9 Kg/cm (5 lbs/inch). The test conditions and procedure shall be in accordance with the manufacture's instructions.

10.5 Coating Thickness Test

Coating system thickness (primer, innerlayer, total coating) shall be measured in accordance with ASTM G12. The thickness of the coating system shall be in accordance with 7.4.1 and shall be checked as and when required by KOC.

10.6 Field Joints\Fittings Coating Inspection

- (a)** Visual examination shall be conducted to ensure that the protective coating has been applied in a manner representing quality workmanship, particularly in the areas around any cut-back of the coating.
- (b)** Protective coating shall be 100% inspected for continuity with a detector to check for holidays, pinholes and discontinuities. The inspection shall be as per the manufacturer's recommendation, and NACE RP-0274. All holidays and imperfections shall be repaired as per procedures recommended by the manufacturer.
- (c)** For Heat shrinkable sleeve, the first sleeve for each crew shall be destructive tested: tear test (ASTM D624) and peel test (ASTM D1000).
- (d)** The applied Heat-shrinkable sleeve shall be checked for full recovery and proper adhesion in accordance with the manufacturer's instructions.
- (e)** The applied joint coating shall be checked for thickness in accordance with ASTM G12. The thickness of joint coating shall be as shown in clauses 7.5.2 and 7.5.3.

11 REPAIR OF COATING DAMAGES / DEFECTS

11.1 Repair should be made to all portions of protective coating suffering visual damages or that fail field inspection/testing.

11.2 All coating materials used in repairs work (primer, inner-layer, outer-layer and) shall be in accordance with the original standard as specified in clauses 7.4.5, 7.4.6, 7.5.2 and 7.5.3.

11.3 Repair of Pipeline Coating Defects

- 11.3.1** All holiday areas shall be prepared by carefully removing the inner and outer layers from the defected surface, then cleaned with a power wire brush to the steel surface. Edges of the area should be tapered to increase strength of the patch.
- 11.3.2** The exposed holiday area shall be primed with the original primer, covering the bare steel only. The primer shall not overlap onto the applied coating system. The primer must be dry prior to application of the repair coating.
- 11.3.3** The repair innerlayer coating shall be hand applied over the primed steel surface and shall overlap onto the surrounding applied coating system by a minimum of 100 mm (4 inches) in all directions.
- 11.3.4** The repaired area (innerlayer) shall be tested with a holiday detector after the repair is completed. If holidays are not found, the repair outerlayer shall be hand applied over the repair innerlayer patch with a minimum of 100 mm (4 inches) beyond the innerlayer patch. Where the defective area exceeds half the pipe circumference, the outerlayer repair patch shall be completely cover the circumference. Primer shall be applied between the inner and the outerlayer.
- 11.3.5** Damage that penetrates the applied outerlayer but does not test positive for holidays shall also be repaired. The damaged coating shall be smooth and free of abraded coating. The repair outerlayer in this case shall overlap the damaged coating area by a minimum of 50 mm (2 inches) width. The outerlayer must be tight and wrinkle free. All repairs shall be examined using the holiday detector.

11.4 Repair of Field Joints Coating Defects

- 11.4.1** Field joints coating repairs shall be made either as patch, in the case of wrap tape system for fittings/attachment, or by replacement, in the case of Heat Shrinkable Sleeve.
- 11.4.2** The coating manufacturer's recommendations on repairs to the joint coating should be followed in all cases.
- 11.4.3** The repaired areas to the protective coating should be inspected in the same manner recommended for the original coating (see clause 10.6).

12.0 COATED PIPE INSTALLATION PROCEDURES

During all construction works of pipeline, the contractor shall use all necessary precautions to prevent any damage to protective coating on the pipe. Any damage to the pipe or the protective coating from any cause during installation of the pipeline and before final acceptance by KOC shall be repaired in accordance with clause 11 and at the expense of the contractor.

12.1 Pipe Hoisting

Pipe shall be hoisted by means of wide belt type nylon slings or equivalent. The use of cables, tongs, metal chains or other equipment likely to cause damage to

the coating shall not be acceptable nor shall dragging or skidding of the pipe be permitted. The contractor shall allow inspection of the coating on the underside of the pipe while the pipe is suspended from the slings.

12.2 Protection During Welding

To avoid any damage to the coating by hot weld spatter during welding, a 460 mm (18 inches) wide strip of heat resistant material shall be draped over the top half of the pipe on each side of the coating hold-back. The welder grounding clamp shall not be attached to the coated part of the pipe.

12.3 Test Post Lead/CP Cable Connections

12.3.1 The removal of coating, to the bare metal, for test lead/CP cable attachment shall be limited to the minimum area required for good connection. The contractor shall use a suitable tools and method in cutting and peel back the coating to avoid any damage to surrounding coating.

12.3.2 Following the attachment of the test lead/CP cable, the entire area surrounding the connection shall be primed and coated. A mouldable butyl material with an over-wrap of field joint or repair tape coating material shall be used. The coating system employed shall be selected for its adhesive ability and compatibility with the original coating system used.

12.4 Pipe Bedding and Trench Backfill

Pipe bedding and backfill material shall be installed so as to avoid abrasion or other damage to the coating on the pipe. Unless otherwise specified by KOC, the following requirements shall be met:

- (a) Where the trench traverses rocky ground containing hard objects that could penetrate the protective coating, a layer of screened sand, not less than 150 mm (6 inches) thick, or other suitable bedding shall be placed in the bottom of the trench before installation of the pipe.
- (b) Placement of the backfill around the exterior of the coated pipe shall be done only after KOC inspector has made a final inspection and has accepted the exterior coating.
- (c) Compaction of bedding and backfill in the trench shall be by a method agreeable to KOC and contractor. Roding with metal rods will not be permitted.

13.0 QUALITY ASSURANCE

The coating manufacturer and contractor shall operate quality system to ensure that the requirements of this Standard are achieved. The quality system shall preferably be based on ISO 9000 series of standards and the manufacturer and contractor shall demonstrate compliance by providing a copy of the accredited certificate or the manufacturer's/contractor's quality manual. Verification of a

manufacturer's/contractor's quality system is normally part of the pre-qualification procedure, and is therefore not detailed in the core text of this Standard.

14.0 DOCUMENTATION

14.1 General

14.1.1 All correspondences, drawings, instructions, data sheets, design calculations, or any other information shall be in English language.

14.1.2 All dimensions, units of measurement, physical constants, etc. shall be in SI units, unless otherwise specified.

14.2 Work Proposal

The contractor shall submit his proposal for all aspects of work, for the approval of KOC prior to commencement. This will include the following:

- (a) Information on work location, materials selection, equipments to be used, surface preparation, priming and tape application procedure.
- (b) Manufacturer's technical data sheets, material analysis certificate and material test certificates (as specified in clause 10.2.2) for materials used.
- (c) Materials safety data sheets for primer, solvents and coating materials.
- (d) Evaluation of all hazards and provision of proposals to meet KOC'S HSE requirements.
- (e) Inspection/testing plans, procedures and equipment.
- (f) Specific repair proposal to satisfy the requirements of clause 11 for damage/defects repair.

14.3 Work Records/Reports

The contractor shall operate a comprehensive recording and reporting system on all aspects of the coating wrapping work including inspection/testing. The data shall be set out on a coating wrapping record/data sheet within 24 hours of carrying out a specific work. A sample of this record/data sheet is shown in Appendix 1.

14.4 Final Report

A report shall be submitted on completion of the coating/wrapping works. The final report shall include a summary on all aspects covered e.g., surface preparation, application method and final inspection and testing records performed.

APPENDIX 1

PIPELINE COATING & WRAPPING RECORD/DATA SHEET

Prepared by.....Checked by.....Date:.....
Pipeline to be coated.....Drawing No.....Location.....
Total Surface Area.....
Type of work: ☐ New Construction ☐ Reconditioning/Rehabilitation
Proj./Cont.No.....
Contractor Name.....

A. Pipe Details

Pipe Type : ☐ Electric Welded ☐ SAW Spiral Seam ☐ SAW Long Seam ☐ Seamless
Nominal Pipe Size.....mm (in.). Actual Pipe O.D.....mm (in.).
Pipe Surface Area.....m²(ft²).

B. Surface Preparation

Cleaning Method(s) : ☐ Contaminants Removal ☐ Imperfection Removal
☐ Mechanical Scraper
☐ Mechanical Hand/Power Tool
☐ Blast Cleaning : Abrasive type..... Abrasive Sieve Size.....
Visual Standard..... Surface Profile.....

C. Weather Conditions

Ambient Temperature °C.....
Dew Point.....
Relative Humidity (%).....
Surface Temperature (°C).....
Wet/Dry/Hot Surroundings.....
Other Weather Conditions (e.g., Rain, wind).....

D. Coating & Wrapping Materials**D-1 Line Pipe Coating Material**

Manufacturer.....
Primer..... As per clause 7.4.4
Innerwrap Tape..... As per clause 7.4.5
Tape Width.....
Outerwrap Tape..... As per clause 7.4.6
Tape Width.....

D-2 Field Joint Fittings Coating Material

☐ Heat Shrinkable Sleeve..... As per clause 7.5.2
Sleeve Width.....
Manufacturer.....

APPENDIX 1

PIPELINE COATING & WRAPPING RECORD/DATA SHEET (Cont.)

- ☐ Joint Wrap Tap Coating..... As per clause 7.5.3
Tape Width.....Tape length.....
Manufacturer.....

E. Coating/Wrapping Application**E-1 Line Pipe Coating Application**

Primer Application: ☐ Airless Spray Airless Tip Size/Angle.....Pump Ratio.....

Primer Curing Period.....

Tape Coating(Inner/Outer) Application

Application Temperature.....

Application Equipment.....

Mechanical coupling.....

F. Inspection/Testing**F-1 Prepared Pipe Surface**

Surface Cleanliness.....

Visual Standard.....

Surface Profile.....

F-2 Coated Pipe

Coating Appearance (Visual Inspection).....

Coating Thickness As per ASTM G 12

Holiday Detection Results..... As per NACE RP-0274

Adhesion Test (180° Peel) Results. Total System.....Between Layers.....As per ASTM D1000

F-3 Field Joints

Visual Inspection.....

Coating Thickness As per ASTM G 12

Holiday Detection Results..... As per NACE RP-0274

Adhesion (Peel) Test Results.....As per ASTM D1000

Heat Shrinkable Sleeve Tear Test.....As per ASTM D624

Tested By:

Approved by:

Name:.....

Name:.....

Signature:.....

Signature:.....

REMARKS :

APPENDIX 2**FIGURE 1****WRAP TAPE COATING FOR FLANGES AND VALVES**