1. Scope & Purpose

1.1 These specifications cover the heat shrinkable wraparound sleeves with primer and define the material characteristics and functional properties, qualification tests and quality control program for these sleeves, to be achieved by the manufacturer of product.

1.2 The sleeves shall be applied for corrosion protection on field weld joints of pre-coated pipes (3-Layer Polyethylene/Fusion Bonded Epoxy Coating, comprising of first layer of epoxy primer, second layer of copolymer adhesive and an outer layer of extruded radiation cross-linked heat shrinkable polyethylene for operating temperatures not exceeding 80°C in wet conditions (as verified by hot water immersion testing). The specifications are applicable to sleeves for line pipe of nominal diameter 6" - 56". The maximum steel pre-heat temperature for sleeve installation shall not exceed 110 °C to avoid damage to the 3LPE mainline coating.

1.3 The type and grade of heat shrinkable sleeves and epoxy shall be fully compatible with the factory applied pipeline coatings of 3-Layer Polyethylene/Fusion Bonded Coating. The sleeve shall be suitable for pipes which shall be subjected to Black Bulb temperatures up to 80 °C.

2. Materials Requirements

All materials supplied shall be strictly in accordance with this specification. The heavy-duty high-performance shrinkable sleeves shall be manufactured from the cross-linked high-density **polyolefin** sheet coated from the inside with a formulated adhesive and bonding primer or other ingredients compatible with the 3-Layer Polyethylene or Fusion Bonded Epoxy Coating System. It shall meet the requirements detailed in Table 1.

Bidder shall submit independent Lab Test Reports of all the parameters in Table-1 from reputable Laboratories certifying the test carried out confirming compliance to ISO 21809-3 and UV resistance according to EN12068 Annex F and ASTM/DIN standards, along with their bid proposal. Test reports shall be from one of the following Independent Test Laboratories, which shall have valid ISO/IEC 17025 (General requirements for the competence of testing and calibration laboratories) certification. These tests shall be a requirement for consideration of the bids for evaluation purposes.

a. DVGW, Germany
b. Element, North America, Europe, UAE
c. TGM, Austria
d. TUV Nord, Europe
e. DNV, Europe
f. iCoatek, China
g. Acuren, USA

Testing of all parameters of the ISO 21809-3 (Table 17 Type 14B-2 for Tmax = 80 °C) standard shall be done simultaneously on the same batch of materials at the same time. The annual inspection reports of selected surveillance test results (Peel strength to pipe surface at 23°C, Indentation resistance at 80°C Impact resistance at 23°C) shall be conducted by same test lab and shall not be older than two years from the bid submission date. Tests from in house laboratory shall not be considered.

The required Independent Test Lab Reports (of all the parameters ISO21809-3) should correspond to the backing and adhesive thicknesses of the offered sleeve.

3. Quality System

The MANUFACTURER, which definition shall include Manufacturer's, Sub Manufacturers, and suppliers, shall have in effect at all times a QA/QC program certified according to the latest issue of ISO 9001. A

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copy of the valid ISO certificate verifying conformance to the ISO standards shall be submitted by MANUFACTURER with his offer. Persons performing quality functions shall have sufficient and well-defined authority to enforce quality requirements that initiate, identify, recommend, and provide solutions to quality problems and verify the effectiveness of the corrective action.

The MANUFACTURER shall identify in purchase documents to its SUB-MANUFACTURERS all applicable QA/QC requirements imposed by the MANUFACTURER, and shall ensure compliance thereto. On request, MANUFACTURER shall provide objective evidence of its QA/QC surveillance of its SUB-MANUFACTURER's activities.

The MANUFACTURER shall submit certified reports of production tests with the materials delivered.

The PURCHASER reserves the right to inspect materials and workmanship at all stages of manufacture and to witness any or all tests. The MANUFACTURER shall provide the PURCHASER on demand with a copy of its Manufacturing and Inspection Plan for review and inclusion of any mandatory PURCHASER witness points 15 days after award but prior to the pre-inspection meeting.

4. Shrink Sleeve Thickness and Width:

The heat shrink sleeve shall provide mechanical protection to the epoxy layer and shall seal onto the epoxy layer and the adjacent line coating. It shall have the following minimum thickness and shall meet the requirements of ISO 21809-3 (Table 17 Type 14B-2) and UV resistance requirement of EN12068.

Backing Thickness:	0.75 – 1.00 mm (as supplied)
Adhesive Thickness:	1.00 – 1.5 mm (as-supplied)
Coating Thickness (Backing + Adhesive):	1.75 – 2.5 mm (as supplied)
Pipeline Operating Temp. Range:	80°C Max.
Suitable for cut-back lengths:	150 mm

The sleeves on the weld joint shall be wide enough so as to overlap onto the mainline coating by a minimum of 50mm on each side once installed.

5. Corrosion Coating Properties

5.1. Epoxy and Sleeve Properties

The joint anti-corrosion coating shall be suitable for an operating temperature not exceeding 80°C in wet conditions.

5.2 Epoxy Primer:

The heat shrinkable sleeve coating system shall incorporate application of epoxy primer to bond steel surface and the adhesive sealant. **The first layer of the joint coating system preferably be 100% solids isocyanate-free and shall be two component epoxy of a minimum dry-film thickness of 200 microns (app. 8 mils) when applied on the steel surface.** The epoxy layer shall be the primary anti-corrosion barrier and shall be capable of corrosion protecting the steel surface on a stand-alone basis. The epoxy primer shall be compatible with the 3-Layer Fusion Bonded Epoxy Polyethylene (High Density) Coating System and Heat Shrink Sleeves. Epoxy Primers Type 'A' & 'B' (Base & Cure) must be from the fresh stock, providing 2 years clean Shelf-Life at point in time of shipment. The Epoxy Primer B (Cure) should be packed in a packing of one liter (net volume). The Epoxy Primer A (Base) should be packed in exactly same volume, which is recommended as mixing ratio. If, for example, recommended mixing ratio is 5:1 (Base : Cure) on volume : volume basis, the Epoxy base should be supplied in 5 (five) liters packing and Epoxy Cure should be packed in 1 (One) liter packing. **Rugged metal container of Epoxy Base and Cure should be packed in one carton, which would be considered as package in correct ratio,** whereas in the bid, the manufacturer shall specify

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diameter wise usage/consumption of the epoxies for joint coating of 6" – 56" diameter pipelines along with percentage of wastage of primer.
Alternately, the bidders may quote and provide standard packing for epoxies along with smaller empty containers at no additional cost, according to offered ratios, for repacking at Company's Stores.

5.3 Adhesion Sealant:

The inner surface of the polyolefin sleeve shall be coated with the controlled/specified thickness of the adhesive sealant and shall meet the requirements of Table-1. The adhesive layer shall be free of inclusions, holes, bare patches, gouges or other defects which could adversely affect the performance of the system. The adhesive of the heat shrinkable sleeve coating system should be sufficient to fill the step-down on either side of weld bead and at the coating chamfer edge without requiring any additional adhesive or sealant.

5.4 Polyolefin Backing:

The sleeve backing shall be fabricated from a thermally stabilized, ultraviolet resistant, high density polyethylene (HDPE) and shall be radiation cross linked. The backing of the sleeve shall be homogeneous and free from flaws, defects, pinholes, bubbles, cracks and inclusions. It shall meet the requirements of Table-I. Unless otherwise mentioned, the color shall be Black.

6. Performance Requirements

6.1.1 The epoxy and sleeves shall, as a minimum, meet the requirements of Table1. Bidder shall submit with their bid, detailed characteristics of the Heat Shrink sleeves and epoxy to be supplied.

6.1.2 Manufacturer shall ensure that all material proposed for field joint coating have been tested and have met the requirements as agreed with PURCHASER for physical, chemical and electrical properties.

6.1.3 Manufacturer shall ensure that test certificates are provided for all accepted materials, detailing the information as required in this Specification.

6.1.4 The self-adhesive layer of the coating adopted shall be homogeneous, free from flaws, defects, pinholes, bubbles, cracks and inclusions.

6.1.5 The corrosion coat shall be resistant to bacterial attack and shall not deteriorate during the design life of the pipeline.

6.1.6 The sleeve shall be resistant to high Ultraviolet light of the Pakistani summer without requiring any sort of painting or covering. To confirm suitability, the sleeve shall be tested for UV resistance as per EN12068 standard and shall meet the requirements of table 1.

6.1.7 To ensure that the sleeve is applicable in the high ambient temperature and Black Body temperatures of Pakistan in the summer, the backing and adhesive shall be of a high enough temperature rating such that it shall be fully installable without damage. It shall not be necessary, nor will it be allowed, to paint or cover the installed shrink sleeve with any protective cover during the peak of the summer. At this time, under the direct sun in the summer and without any protective coating, the sleeve and adhesive shall not become soft and the adhesive shall not flow. Any sleeve which exhibits such softness or flow of adhesive when directly exposed to the sun shall be considered unsuitable and rejected.

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6.2 Materials Supply

The coating materials shall be handled and stored in accordance with Manufacturer's instructions or as directed by an authorized representative of the coating Manufacturer

TABLE – 1

Performance requirements of Heat Shrink Sleeve System for maximum continuous pipe operating temperature up-to 80 °C

HEAT SHRINKABLE WRAPAROUND SLEEVES

Item #	Performance Parameters	Test Methods	Specification Value
1	Full compliance with ISO 21809-3 Type 14B-2 at 80°C and UV resistance according to EN12068 Ann. F	ISO 21809-3 EN12068 Ann. F	Results of all parameters shall meet requirement of standard.
2	Adhesion of cured epoxy to bare steel	ASTM D-4541	≥ 2000 psi
3	Tensile strength of backing @ 23°C	ASTM D-638	≥ 2200 psi
4	Elongation to break of backing @230C	ASTM D-638	≥ 400 %
5	Density of backing	ASTM D792	> 0.95 gm/cc
6	Hardness	ASTM D-2240	≥ 55 Shore D
7	Volume Resistivity @ 23°C	ASTM D-257	≥1 x 1015 Ohm-cm
8	Ring and Ball Softening Point of adhesive	ASTM E-28	115°C, -10°C + 25°C
	Holiday Detection	ISO 21809-3	5kV/mm + 5kV (max 25kV)
9	Impact Resistance at 23°C Holiday detection at 5 KV/mm + 5KV (max 25kV)	ISO 21809-3	≥ 7 J/mm (min. 15J)
10	Indentation Resistance @ 80°C - 10 N/mm2	ISO 21809-3	
	- residual thickness		≥ 0.6 mm
11	Cathodic disbondment resistance	ISO 21809-3	
	- @ 23°C		≤ 5 mm
	- @ 80°C		≤ 10 mm
12	Peel strength after 100 day hot water immersion at 80°C	ISO 21809-3	
	- to pipe surface		P100/P0 ≥ 0.75
	- to PE plant coating		P100/P0 ≥ 0.75
13	Peel strength to pipe surface	ISO 21809-3	
	- @ 23°C		≥ 5.0 N/mm
	- @ 80°C		≥ 0.3 N/mm
	Peel strength to PE plant coating		
	- @ 23°C		≥ 5.0 N/mm
	- @ 80°C		≥ 0.3 N/mm
14	Lap Shear Strength	ISO 21809-3	
	- @ 23°C		≥ 3.0 N/mm2
	- @ 80°C		≥ 0.2 N/mm2

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15	Ultraviolet irradiation resistance ratio of	EN12068 Annex F	
	- elongation at break		1.25 ≥ Ex/E0 ≥ 0.75
	- tape strength		1.25 ≥ Sx/S0 ≥ 0.75
16	Resistance to Thermal Ageing (100d/100°C)	ISO 21809-3	
	ratio of		
	- elongation at break		E100/E70 ≥ 0.75
	- Peel strength to pipe surface		P100/P70 ≥ 0.75
17	Dielectric Breakdown at 23°C	ASTM D-149	≥ 17 kV
18	Moisture Vapor Transmission of sleeve at 38°C, 90% RH	ASTM E-398	≤ 0.08 gm/24hr/100 sq.in
19	Holiday detection	ISO 21809-3	pass at 20kV

NOTE: The bidders, quoting the sleeving material of brands and manufacturers other than that already in use of the company, shall provide the results of offered products against specific values as required in Table 1 from an independent laboratory.

7. Test Methods

7.1 Applicable Standards:

The following standards as applicable form part of the specification.

Sr. No.	Standards	Specifications
1.	ASTM-D 149	Standard Test Method for dielectric breakdown voltage and dielectric strength of solid electric insulating materials at commercial power frequencies.
2.	ASTM-D 257	Standard Test Methods for D-C resistance or conductance.
3.	ASTM-D 543	Resistance of plastics to chemical reagents.
4.	ASTM-D 570	Test for water absorption of plastics.
5.	ASTM-D 638	Standard Test Method for tensile properties of plastics.
6.	ASTM-D 746	Test for brittleness temperature of plastics and elastomer by impact.
7.	ASTM-D 792	Standard Method of Test for specific gravity and density of plastics by displacement.
8.	ASTM D870	Test Method for Hot Water Immersion.
9.	ASTM-D 1000	Standard Methods of testing pressure-sensitive adhesive coated tapes used for electrical insulation.
10.	ASTM-D 1002	Standard Test Method for strength properties of adhesives in shear by tension loading (Metal-to-Metal).
11.	ASTM-D 1044	Test for resistance of transparent plastics to Abrasion (Modified).
12.	ASTM-D 1693	Environmental stress cracking of ethylene plastics.
13.	ASTM-D 2240	Indentation hardness of rubber and plastics by means of a durometer.
14.	ASTM D2249	Test Method for Rubber Property (Durometer-hardness)
15.	ASTM-D 2671	Standards methods of testing heat-shrinkable tubing for electrical use.
16.	ASTM-D 28	Standard Test Method for softening point by Ring and ball apparatus.
17.	ASTM-E 96	Test for water vapor transmission of materials in sheet form.
18.	ASTM-E 398	Standard Test Method for water vapor transmission rate of sheet materials using a rapid technique for dynamic measurement.
19.	ASTM-G 6	Abrasion resistance of pipeline coatings.

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20.	ASTM G-10	Standard Test Method for Bend ability of Pipeline Coatings.
21.	ASTM-G 14	Standard Test Method for impact resistance of pipeline coatings (Falling Weight Test).
22.	ASTM-G 17	Standard Test Method for penetration resistance of pipeline coatings (Blunt Rod).
23.	ASTM-G 21	Determining resistance of synthetic polymeric materials to fungi.
24.	ASTM-G 22	Determining resistance of plastics to bacteria.
25.	ASTM-G 42	Standard Test Methods for cathodic disbonding of pipeline coatings subjected to elevated or cyclic temperatures.
26.	DIN – 30672	Polyethylene sheathing of steel tubes and steel shapes and fittings.
27.	EN12068	External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with Cathodic protection – Tapes and shrinkable materials
28.	ISO 9000/9001/9002	Quality Systems.
29	ISO 21809-3:2016	External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 3: Field joint coatings
30	ASTM D - 6677	Standard Test Method for Evaluating Adhesion by Knife
31	ISO 2409	Paints and varnishes — Cross-cut test

8. Qualification Tests:

8.1 Qualification Inspection:

The wraparound shrinkable sleeves furnished to this specification shall have been tested and met the requirements of Tables 1. The supplier is responsible for the performance of all inspection tests specified herein and may use his own or any other lab facility and services acceptable to the BUYER. The inspection/test record shall be kept complete and made available to the BUYER.

8.3 Acceptance Inspection:

The test reports for each batch of production shall be made available with each shipment. The following tests shall be carried out on each batch of the sleeves or upon the sleeve component, where applicable:

a. Visual inspection for defects.
b. Measurement of dimensions.
c. Tensile strength (backing only).
d. Elongation at break
e. Adhesive softening point (ASTM E-28)
f. Physical Shrinkage Test
g. Peel adhesion at 23 Deg C and 80 Deg C to steel
h. Lap shear at 23 Deg C and 80 Deg C
i. Cross Cut – As per ASTM D - 6677
j. Cross Hatch – As per ISO 2409

Any condemned material not conforming to this Specification shall be replaced by the Manufacturer at no expense to the PURCHASER.

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8.3 Rejection/Retesting:

Failure to any of the applicable requirements of the specification shall be cause for rejection of the lot represented. Material rejected shall have to be replaced at the Supplier's/Manufacturer's cost

9. Marking/Traceability:

Manufacturer shall ensure that all materials are supplied in sealed, damage-free, clearly marked containers or pallets and each heat shrink and epoxy box/packing containers shall be clearly marked, for traceability with following information/Data:

- Purchase Order No.
- Manufacturer's name.
- Grade/type of products contained.
- Batch number of the products.
- Shelf Life/Expiry dates where applicable.
- Safety instructions

In addition to the above each sleeve shall be marked as follows:

- Product Identification No.
- Date of manufacture/production
- Purchase Order No.

10. Requirement of Samples:

Bidders, introducing a field joint coating system from a manufacturer that has never been used in SNGPL in the past, shall submit a sizeable sample of their coating system for field performance testing. The sample size should be sufficient for coating minimum 5 joints of 16" Dia and should include HS Sleeves, Closure Patches, Primers and any other component required to satisfactorily install the field joint coating system.

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