MATERIAL STANDARD

FOR

HEAT-SHRINKABLE CROSS-LINKED

POLYETHYLENE COATINGS

(TWO LAYERS)

ORIGINAL EDITION

OCT. 1996

This standard specification is reviewed and updated by the relevant technical committee on Dec. 2003(1) and Aug. 2013(2). The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

Standards and Research department

No.17, Street14, North kheradmand

Karimkhan Avenue, Tehran, Iran.

Postal Code- 1585886851

Tel: 021-88810459-60 & 021-66153055

Fax: 021-88810462

Email: Standards@nioc.ir

GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

CONTENTS: PAGE No.

1. SCOPE 1
2. REFERENCES 1
3. DEFINITIONS AND TERMINOLOGY 2
4. UNITS 4
5. CLASSIFICATION 4
6. MATERIALS AND MANUFACTURE 4
7. REQUIREMENTS 5
8. STORAGE LIFE, PACKAGING AND SAMPLING 7
9. INSPECTION AND TESTING 7
10. MARKING 8
11. INSTRUCTION FOR USE 9

1. SCOPE

This Standard specification covers the minimum requirements for heat-shrinkable cross-linked Polyethylene coatings for external protection of joints of underground and underwater steel pipelines which are coated with three Layer extruded Polyethylene and fusion bonded epoxy.

This Standard treats only heat-shrinkable coatings which consist of a Polyethylene backing that has been cross-linked by radiation (electron beam) and coated with a Mastic or Hot melt type adhesive.

The heat shrinkable sleeve shall be used for the pipeline with

- Maximum operating temperature of up to 50 C (Mastic)
- Maximum operating temperature of up to 60 C (Hot melt)
- Maximum operating temperature of up to 80 C (Hot melt)

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Dec. 2003. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 209 on Dec. 2003. These modifications are included in the present issue of IPS.

Note 2:

This standard specification is reviewed and updated by the relevant technical committee on Aug. 2013. The approved modifications by T.C. were sent to IPS users as amendment No. 2 by circular No. 387 on Aug. 2013. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

D 149	“Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Material at Commercial Power Frequencies”
D 257	“Standard Test Method for DC Resistance or Conductance of Insulating Materials”
D 570	“Standard Test Method for Water Absorption of Plastics”
D 903	“Standard Test Method for Peel or Stripping Strength of Adhesive Bonds”
D 1000	“Standard Test Method for Pressure-Sensitive Adhesive Coated Tapes Used for Electrical and Electronic Applications”
D 2671	“Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use”
ASTM E 28	“Test Method for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus”
E 96M	“Standard Test Method for Water Vapor Transmission of Materials”

ASTM G14 "Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)"

AWWA (AMERICAN WATER WORKS ASSOCIATION)

AWWA C 216 "Heat-Shrinkable Cross- Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fitting for Steel Water Pipelines"

BSI (BRITISH STANDARDS INSTITUTION)

BS EN 12068 "Cathodic Protection-External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection-Tapes and Shrinkable Materials"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-TP-270 "Engineering Standard for Protective Coatings for Buried and Submerged Steel Structures"

IPS-E-GN-100 "Engineering Standard For Units"

(Not Applicable for Procurement)

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 21809-3 "Materials, Equipment and Offshore Structures for Petroleum, Petrochemical and Natural Gas Industries"

MILITARY STANDARDS:

MIL-T-5624 "Turbine Fuel, Aviation, Grades JP4 and JP5"

MIL-L-7808 "Lubricating Oil, Aircraft, Turbine Engines, Synthetic Base"

MIL-L-23699 "Lubricating Oil, Aircraft, Turbine Engines, Synthetic Base"

NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)

NACE RP 0303 "Field-Applied Heat-Shrinkable Sleeves for Pipelines: Application and Quality Control"

3. DEFINITIONS AND TERMINOLOGY

For this Standard the following definitions shall apply:

ADHESION STRENGTH

The force necessary to remove the coating from a prescribed surface when measured in accordance with specific conditions of test.

COATING REPAIR MATERIAL

Pre–manufactured patches, fillers, etc., compatible with and made from similar materials as the heat shrinkable sleeve.

COATING SYSTEM

The complete number and types of coats applied to a substrate in a predetermined order.

DIELECTRIC BREAKDOWN (DIELECTRIC STRENGTH)

The dielectric breakdown is the voltage at which a single layer of coating will show electrical failure under specific conditions of test. The dielectric breakdown of a coating is an indication of its ability to withstand electrical stress.

ELONGATION

The increase in length at break when the coating is tested under specific conditions of test.

FILLER MATERIAL

Compatible material used under a heat shrinkable sleeve or repair patch to fill voids if any hot melt maximum operating temperature of up to 80 °C

HEAT-SHRINKABLE COATINGS

Coatings that will reduce in dimensions from an expanded size to a predetermined size by the application of heat.

HOT MELT ADHESIVE

A family of adhesive based on semi-crystalline polymers

INSULATION RESISTANCE

The insulation resistance between two electrodes that are in contact with, or embedded in, a specimen, is the ratio of the direct voltage applied to the electrodes to the total current between them.

LAMINATE

A product made by bonding together with two or more layers of material or materials.

LOW TEMPERATURE FLEXIBILITY

The resistance to cracking of heat-shrinkable coatings when wrapped around prescribed mandrel at specified temperatures.

MASTIC ADHESIVE

A family of adhesive based on butyl-rubber, polyisobutylene, synthetic rubber and asphalt, with amorphous structure.

NOMINAL PARAMETERS

The nominal parameters are the parameters (e.g.,weight, thickness, density, etc.) specified on product labels, invoices, sales literature, and the like. The actual parameters shall not be less than 95 percent of nominal parameters.

RELEASE PAPER

A sheet, serving as a protectant or carrier, or both, for an adhesive film or mass, which is easily removed from the film or mass prior to use.

TENSILE (BREAKING) STRENGTH

The force required, per unit width, to break the coating when tested under specific conditions of test.

Breaking strength of coating is of importance as a measurement of its uniformity, quality, and ability to withstand stress in application.

WATER VAPOR TRANSMISSION RATE

The steady water vapor flow in unit time through unit area of a body, normal to specific parallel surfaces, under specific conditions of temperature and humidity at each surface.

4. UNITS

This standard is based on international system of units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. CLASSIFICATION

The prefabricated heat-shrinkable Polyethylene coating, as will be specified by the Purchaser, may be one of the following types:

Type 1: Tubular-Type coatings-These are installed before joining the pipe ends by sliding the coating from a free end of the pipe onto the area to be coated.

Type 2: Wraparound-type coatings-these are wrapped circumferentially around the pipe area to be coated. Each wraparound coating is provided with either a separate or a built-in closure to secure the overlap during shrinking. The closure shall meet all the technical requirements of a Type 3 heat-shrinkable coating as given in Table 2.

Type 3: Tape-Type coatings-these are helically wrapped around the pipe area to be coated, with an overlap per the manufacturer's recommendation.

6. MATERIALS AND MANUFACTURE

6.1 Heat-Shrinkable coatings consist of materials fabricated from cross-linked Polyethylene sheets or tubings precoated with an adhesive and, after installation, shall conform to all surface contours of the pipe.

6.2 The heat-shrinkable coating shall be a laminate that consists of a cross-linked Polyethylene backing and a homogeneous adhesive layer.

The base Polymer of this backing shall consist substantially of Polyethylene or a Polyethylene copolymer.

The adhesive may be either a Mastic adhesive type with Maximum operating temperature of up to 50 °C (mastic) Hot melt adhesive type with Maximum operating temperature of up to 60 °C and 80 °C.

6.3 The Polymers used in the manufacture of heat-shrinkable coatings shall be virgin material, that is, material that has been through the manufacturing process only once, and the finished compound shall be free of all foreign matter other than antioxidants, flame retardants, processing aids, cross-linking agents, and pigments as appropriate.

6.4 The heat-shrinkable Polyethylene coating shall be extruded, cross-linked, and then expanded to

the required dimensions.

6.5 Hot melt adhesive two component solvent free (100% solid) liquid epoxy primer must be use.

6.6 Accessories

- For mastic adhesive type

  Applicator pad

  Mixing stick

  Mixing cups

  Epoxy dosing pumps

  Digital thermometer with probs

  Hand roller

- For Hot melt adhesive type

  Digital thermometer with probs

  Hand roller

7. REQUIREMENTS

7.1 Chemical Requirements

The material should conform to the chemical requirements specified in Table 1 or as per purchaser requirement.

7.2 Physical Property Requirements

Table 2 shows the requirements for the physical properties for heat-shrinkable coatings.

7.3 Workmanship

The product shall be homogeneous and essentially free of flaws, defects, pinholes, bubbles seams, cracks, or inclusions.

7.4 Color

The color of the coatings may be black.

7.5 Dimensions

Precut coatings shall be provided by the manufacturer in standard widths. Manufacturer's recommendations should be followed with regard to appropriate overlap and coverage considerations, unless specified otherwise by the Purchaser.

7.6 Width Deviation

The width deviation shall not exceed 10 percent of the coating width or 6 mm, whichever is smaller, as determined by the following test method:

For type 1 and type 2 coatings: three discrete product sleeves shall be selected at random and placed on a smooth, flat surface. For type 3 coatings, a specimen that is at least 1m long shall be

removed from each of three randomly selected rolls of material. The width of the specimen shall be measured at several points along the length of the sample to the nearest 1.6 mm.

7.7 Thickness

Type 1 and type 2 heat-shrinkable coatings shall have a minimum thickness of 1.5 mm, as supplied. Type 3 coatings shall have a minimum thickness of 1.1 mm, as supplied. The thickness of the coating shall be measured at not less than 10 locations on each of the three specimens used in subclause 7.7. The measurement shall be made with a micrometer calibrated to read in units of 0.025 mm (thousandths of an inch) and having contact feet of not less than 6 mm (¼ in.) in diameter. The average of 10 measurements shall be as set forth in Table 2. No single measurement shall deviate more than 20 percent from the average value. The thickness of the adhesive shall be at least equal to, but no more than three times, the thickness of the cross-linked Polyethylene backing.

7.8 Dielectric Strength

The heat-shrinkable coatings shall be tested for dielectric breakdown in accordance with ASTM D149 using a 25 mm (1 in.) diameter electrode and 500 V/S voltage rise. A value below the limit specified in Table 2 shall constitute a failure of the coating to meet the dielectric strength requirement.

7.9 Heat Shock

The heat-shrinkable coatings shall be tested for heat shock (test to determine if the backing of the heat-shrinkable coating is cross-linked) by removing the adhesive from the coating before performing the test and hanging a strip of the prepared backing in a 200°C oven for 4 hour. The backing will shrink but shall show no dripping, flowing, or cracking as specified in Table 2.

Note:

The manufacturer shall provide details for removing the adhesive and for performing this test.

7.10 Thermo Chromic Property

The polyethylene backing of the heat-shrinkable coatings shall be laminated with appropriate temperature sensitive paint to be able to change the color when heated.

TABLE 1 - CHEMICAL REQUIREMENTS

PROPERTY	REQUIREMENT	TEST METHOD
Solvent resistance, 24 h at 24 ±3°C JP - 4 Fuel, MIL -T-5624 Lubricating oil, MIL -L-7808 Lubricating oil, MIL -L-23699		ASTM D 2671
Followed by tests for:		
Dielectric strength, min, KV/mm	12	See 7.9
Tensile strength, min, MPa	11	ASTM D 1000
Water absorption, 24 h at 23 ±2°C, max., %	0.2	ASTM D 570

TABLE 2 - PHYSICAL PROPERTIES OF HEAT-SHRINKABLE COATINGS (AS SUPPLIED)

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Width deviation		±10 % width or 6 mm whichever is smaller	See 7.7
Thickness (min) Type 1 Type 2 Type 3	mm	 1.5 1.5 1.1	See 7.8
Dielectric strength (min)	KV/mm	15	ASTM D 149
Volume resistivity (min)	Ω cm	10^{14}	ASTM D 257
Adhesion to steel (min)	Kg/cm	1	ASTM D 903
Adhesion to PE (min)	Kg/cm	1	ASTM D 903
Heat shock (test for crosslinking of backing)		No visual cracking, Flowing, or dripping	See 7.10
Tensile strength (min)	Mpa	14	ASTM D 1000
Elongation (min)	%	300	ASTM D 1000
Water vapor transmission (max.)	g/24 h/m²	0.01	ASTM E 96 (Method B)
Low-Temperature flexibility, -20°C, 25.4 mm (1") mandrel		No cracking	ASTM D 2671 (Procedure C)

8. STORAGE LIFE, PACKAGING AND SAMPLING

8.1 Storage Life

The product shall meet the requirements of Clause 7 after storage for 24 months from the date of delivery, in a tightly covered container at temperatures between -20 to +50°C.

8.2 Packaging

All heat-shrinkable coatings purchased according to this Standard specification shall be packaged in suitable containers that ensure acceptance and safe delivery to their destination.

Each heat-shrinkable coating item shall be packaged to prevent adherence to the packaging material or the container.

Individual types and sizes shall be neatly bundled or boxed. Coating shall be packaged in quantities not to exceed the weight limitation of the container specification.

Each container of coating material shall contain application instructions (see 11).

8.3 Sampling

8.3.1 A lot shall consist of all materials which is processed at the same time and under the same conditions and submitted for inspection at one time.

8.3.2 Unless otherwise specified by the Purchaser, the number of samples for testing shall consist of 10 percent of the lot, but in no case shall be less than one or more than ten samples. The results of the tests on four specimens cut from each sample shall be averaged for each test specified in Clause 7 to determine conformance with the specified requirements. The numbers and types of test samples shall be in accordance with the ASTM test method for the specific properties to be determined.

9. INSPECTION AND TESTING

9.1 All materials supplied under this Standard specification shall be subjected to timely inspection by the Purchaser or his authorized representative. The Purchaser shall have the right to reject any material(s) supplied which is (are) found to be defective under this Standard specification. In case of

dispute, the arbitration or settlement procedure, established in the procurement documents shall be followed.

9.2 The supplier shall be responsible for the performance and costs for all laboratory test requirements as specified in this Standard. The supplier shall set up and maintain such quality assurance and inspection systems as are necessary to ensure that the materials comply in all respects with the requirements of this Standard specification.

9.3 Samples of any or all ingredients used in the manufacture of this material may be requested by the Purchaser and shall be supplied upon request, along with the supplier's name and identification for the sample.

9.4 Purchaser's inspector(s) shall have free access to the supplier's work to follow up the progress of the materials covered by this Standard and to check the quality of materials. The supplier shall place free of charge at the disposal of the purchaser's inspector(s) all means necessary for carrying out their inspection: results of tests, checking of conformity of materials with this Standard requirements, checking of marking and packaging and temporary acceptance of materials.

9.5 Samples submitted to the Purchaser and/or collected by the purchaser will be tested in the purchaser's laboratory or in a responsible commercial laboratory including manufacturer's laboratory designated by the purchaser.

9.6 The supplier shall furnish the purchaser with a certified copy of results of tests made by the manufacturer covering physical and performance characteristics of each batch of product to be supplied under this Standard specification. The supplier shall furnish, or allow the Purchaser to collect samples of the material representative of each batch of product. Certified test reports and samples furnished by the supplier shall be properly identified with each batch of product.

9.7 Prior to acceptance of the supplier's and/or manufacturer's materials samples of material submitted by the supplier or collected by the purchaser will be tested by the purchaser. If any of the samples (see 8.3) is found not to conform to this Standard, materials represented by such sample will be rejected. If samples of the supplier's and/or manufacturer's material that have been previously accepted are found not to conform to this Standard, all such material will be rejected.

9.8 Unless otherwise specified in this Standard specification, the methods of sampling and testing shall be in accordance with applicable methods of the International Organization for Standardization (ISO), British Standard Institution (BSI) and German Standard (DIN).

10. MARKING

The carton packaging shall be plainly marked with the following information.

Name	**:Heat-shrinkable cross-linked polyethylene coatings (Two Layers)**
Specification	**: IPS-M-TP-318**
Order No.	**: ----------**
MESC No.	**: ----------**
Type and trade name of material	**: ----------**
Dimensions	**: ----------**
(Expanded and Recovered)	
Max. temperature resistance	**:----------°C**
Application temperature	**:----------°C**
Storage conditions	**:----------**
Color	**:----------**
Batch No.	**:----------**

Stock No. :----------

Date of manufacture :----------

Minimum shelf life : 24 months from the date of delivery

Quantity of material in container : ----------

Information and warning, if required: ----------

Manufacturer name and address : ----------

Design guide : For the guidance on the usage of this material reference shall be made to IPS-E-TP-270.

11. INSTRUCTION FOR USE

The specific application procedure used for each type of coating system shall be described by the manufacturer and furnished to the Purchaser with each batch of product (at least 10 copies).