

Engineering Standard

SAES-H-002

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Internal and External Coatings for Steel Pipelines and Piping

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Saudi Aramco DeskTop Standards

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1 Scope

This Standard defines the minimum mandatory internal and external coating selection requirements for steel pipelines and piping (including associated fittings and appurtenances) and the mandatory performance requirements of these coatings. Excluded from this Standard are temporary coatings. This Standard does not preclude the use of galvanized, alloy, or nonmetallic pipe where allowed by other Saudi Aramco standards.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, codes and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer representative, who shall follow internal company procedure [SAEP-302](#) and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
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Saudi Aramco Engineering Standards

SAES-H-001	<i>Selection Requirements for Industrial Coatings</i>
SAES-H-002V	<i>Saudi Aramco Data Sheets</i>
SAES-H-100	<i>Painting Requirements for Industrial Facilities</i>
SAES-H-101	<i>Approved Protective Coatings System (APCS)</i>
SAES-H-101V	<i>Saudi Aramco Data Sheets</i>

<u>SAES-H-201</u>	<i>General Specification for Over-the-Ditch External FBE Coating of Field Girth Welds</i>
<u>SAES-H-202</u>	<i>Storage, Handling and Installation of Weight-Coated Pipe</i>
<u>SAES-H-203</u>	<i>Hand-applied Tape Wrapping of Buried Pipe</i>
<u>SAES-H-204</u>	<i>General Specification for Applying Heat-Shrink Sleeves to Coated Pipe</i>
<u>SAES-H-204V</u>	<i>Approved Installation Procedures for Heat-Shrink Sleeves</i>
<u>SAES-L-120</u>	<i>Piping Flexibility Analysis</i>
<u>SAES-L-310</u>	<i>Design of Plant Piping</i>
<u>SAES-L-350</u>	<i>Construction of Plant Piping</i>
<u>SAES-L-410</u>	<i>Design of Pipelines</i>
<u>SAES-L-450</u>	<i>Construction of On-Land and Near-Shore Pipelines</i>

Saudi Aramco Materials System Specifications

<u>01-SAMSS-005</u>	<i>Shop Applied, Internal Cement Mortar Lining of Steel Pipe</i>
<u>09-SAMSS-080</u>	<i>Shop-Applied Baked Internal Coatings</i>
<u>09-SAMSS-089</u>	<i>Shop-Applied External FBE Coating</i>
<u>09-SAMSS-091</u>	<i>Shop-Applied Internal FBE Coatings</i>
<u>09-SAMSS-095</u>	<i>Hand-Applied, Pressure Sensitive Tapewrap for Temperatures up to 55°C</i>
<u>09-SAMSS-096</u>	<i>High-Temperature Heat-Shrink Sleeves</i>
<u>09-SAMSS-099</u>	<i>Specialized Coatings Tests</i>
<u>09-SAMSS-105</u>	<i>Heat-Shrink Sleeves for Service Temperatures Less than 55°C</i>
<u>09-SAMSS-113</u>	<i>External Renovation Coating for Buried Pipelines and Piping (APCS-113)</i>
<u>09-SAMSS-114</u>	<i>Shop-Applied Extruded, Three-Layer Polypropylene External Coatings for Line Pipe</i>

3.2 Industry Codes and Standards

Swedish Standards Institution

SIS 05 59 00 Pictorial Surface Preparation Standard for Painting Steel Surfaces

American Water Works Association

AWWA C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines

AWWA C205 Cement Mortar Protective Lining and Coating for Steel Water Pipe - 4 inch (100 mm) and Larger- Shop Applied

AWWA C602 Standard for Cement-Mortar Lining of Water Pipelines - 4 inch (100 mm) and Larger - In Place

American Society for Testing and Materials

ASTM D570 Standard Test Method for Water Absorption of Plastics

ASTM D1002 Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)

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

ASTM G42 Standard Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures

Canadian Standards

CAN/CSA-Z245.20-M92 External FBE Coating for Steel Pipe

German Standards

DIN 30670 Polyethylene Coatings for Steel Pipes and Fittings

4 Definitions

Responsible Standardization Agency Representative (RSA): The coatings engineer designated by the Manager, Consulting Services Department in accordance with Material Supply Organization's instruction MI-350.020.

Approved Product: See the definition in [SAES-H-001](#). Only approved products are allowed for use on Saudi Aramco jobs. Coatings that have exceeded their shelf life shall not be used unless approved in writing by the RSA.

5 Selection Requirements

5.1 General Requirements for External Coatings

5.1.1 All buried, onshore pipe shall be externally coated. All buried coatings shall be 100% holiday checked and all holidays repaired prior to burial.

Exception:

See [SAES-H-203](#), paragraph 12.3.3 for tapewrap.

5.1.2 Pipe in all subsea services shall be externally coated.

5.1.3 Plant piping and other above grade pipelines in industrial or marine atmospheres shall be externally coated as required in this or other Saudi Aramco standards, specifications, mandatory drawings, scopes of work, or similar mandatory documents.

5.1.4 At changes from buried to above ground service in locations where sand accumulation is likely, (including camel and road crossings) an external coating suitable for buried service shall extend above ground as follows:

- a) For sharp angle risers (46 to 90 degrees), the coating shall extend at least 1 m measured along the pipe above grade.
- b) For shallow angle risers (45 degrees or less) the coating shall extend at least 8 m measured along the pipe above ground. For maintenance coatings, if a support on an existing line is encountered at a distance less than 8 m along the pipe, and it cannot be removed, the coating shall terminate at the support. (Above-ground portions of APCS-105 and APCS-115 must be protected from direct sunlight. See the APCSs for details.)

Commentary Note:

Where sand accumulation is not likely, the below-ground coating system only needs to be carried up to grade level.

5.1.5 Over-the ditch, machine-applied tapewrap shall not be used.

5.1.6 Paint systems shall not be used as the primary external coating on buried pipelines (including field girth welds).

Exceptions:

See Paragraphs 5.4 and 5.6 for the use of renovation coatings in accordance with APCS-113 on items such as fittings, road crossings, spool pieces, and in-plant piping.

- 5.1.7 Hand-applied tapes of the "primer activated" type shall not be used. Hand-applied tape wraps shall be of the "pressure sensitive" type, meaning they can be applied over dry primer or no primer without adverse effect on adhesion.
 - 5.1.8 Ditch preparation and sand padding requirements for onshore buried pipe are given in [SAES-L-350](#) and [SAES-L-450](#).
 - 5.1.9 At road crossings the minimum allowable surface preparation prior to coating shall be near white metal Sa2-1/2 even if the APCS for the selected coating specifies a lesser degree of cleanliness.
 - 5.1.10 Cast iron pipe that has been shop-coated with enamel (or similar) does not require additional external coating prior to burial. Bare cast iron pipe shall be externally coated prior to burial in subkhas or other frequently wetted ground.
 - 5.1.11 Buried stainless steel lines shall be externally coated with APCS-105, APCS-113A, APCS-113B, or with a suitable heat shrink tubing or liquid coating approved by the RSA.
 - 5.1.12 Pipe to be thrust bored shall be coated with APCS-104 or APCS-105.
 - 5.1.13 Coating systems listed in paragraphs 5.4 through 5.6 below shall not be used under conditions that violate service limitations or other requirements given in the applicable APCS data sheets. Only approved products shall be used. (See definitions in [SAES-H-001](#)).
 - 5.1.14 For new construction, buried carbon steel piping in diameters 3 inches and smaller that are not externally coated with APCS-104 or APCS-105 shall be coated with a suitable heat shrink tubing approved by the RSA. The wrap-around heat shrink tubing in SAMS stock numbers 14-266-370-00 through 14-266-382-00 and the tubular heat shrink tubing in SAMS stock numbers 14-266-400-00 through 14-266-440-00 are acceptable. The maximum temperature limitation for these stock numbers is 70°C.
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5.2 General Requirements for Internal Coatings

- 5.2.1 Internal coatings are not mandatory unless required in other Saudi Aramco Standards, specifications, scopes of work, mandatory drawings, or other similar mandatory documents. When internal coatings are required, the selections given in paragraph 5.3 shall be used.
- 5.2.2 Internal coatings used in potable water service must meet FDA or equivalent requirements for suitability for use in contact with drinking water.
- 5.2.3 For internal girth weld area coatings, contact the RSA for approved coating systems.
- 5.2.4 Internal coatings in dead-leg areas shall be holiday free.
- 5.2.5 When a liquid coating, approved for immersion service, is applied as an internal coating in pipe, the holiday requirements shall be the same as for internal FBE coatings in [09-SAMSS-091](#).

5.3 Internal Coatings, Various Services

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Constr.	Maintenance	
5.3.1 Water Potable	APCS-103 APCS-100 APCS-101 APCS-102 APCS-2B	APCS-103 APCS-102 APCS-2B	APCS-100, 101, and 102 must be certified suitable for potable water services.
5.3.2 Water, Oil, or Gas	APCS-100 APCS-101 APCS-102 APCS-103 APCS-2A	APCS-103 APCS-2A	For APCS-2A the allowable pH range is 5.0 to 12.0, the maximum allowable service pressure is 6890 KPa (ga) (1000 psig), and the maximum allowable partial pressures of H ₂ S and CO ₂ are each 345 KPa (abs) (50 psia).

5.4 External Pipe Coatings, Cross-Country

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Constr.	Maintenance	
5.4.1 Buried (Pipe Body)	APCS-104 APCS-105 APCS-106 APCS-115	APCS-107 APCS-109 APCS-113A/B/C	APCS-106 may only be used in cases where subsequent field bending will not be required, e.g., cement-lined pipe. APCS-113A/B may be used on new construction to (1) repair damaged FBE, (2) coat already lined pipe, and (3) coat short runs of pipe (60 meters or less) that will not require subsequent bending.
5.4.2 Buried (Field Girth Welds)	APCS-104 APCS-110 APCS-111 APCS-112 APCS-115 APCS-113C	APCS-113A/B/C APCS-107 APCS-109 APCS-22 APCS-110 APCS-111 APCS-112 APCS-115	Use APCS-22 if the surface is slightly damp or has oil/salt contamination. APCS-113A/B may be used on new construction for (1) tie-in welds (2) girth welds on thrust bored pipe, and (3) occasional, isolated welds. See APCS-115 for field girth weld coating options.
5.4.3 Buried Fittings, Appurtenances and Spool Pieces	APCS-104 APCS-113A/B APCS-19B APCS-115	APCS-113A/B/C APCS-19B APCS-22 APCS-10 APCS-23 APCS-115	Use APCS-22 if the surface is slightly damp or has oil/salt contamination. Tapewrap (APCS-107 or APCS-109) is acceptable for maintenance on tapewrapped or P2-coated lines. Use APCS-115 when this coating system is used on the pipe body. Heat-shrink sleeves suitable for the service temperature are also acceptable.

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Constr.	Maintenance	
5.4.4 Buried Road Crossings	APCS-104 APCS-105 APCS-113A/B APCS-19B APCS-115	APCS-113A/B/C APCS-19B APCS-107 APCS-109 APCS-115	On sleeved crossings, the carrier pipe shall be coated with APCS-104, APCS-105, APCS-19B, APCS-113A/B/C or APCS-115. The casing shall be externally coated with any of these systems or with APCS-3.
5.4.5 Above Ground	Not Required	Not Required	
5.4.6 Buried Anchors	See Comments	See Comments	Coat concrete anchors in accordance with Standard Drawing AA-036531. Steel anchors shall be coated with APCS-113A/B, APCS-22, or APCS-19B. Coat the portion of pipe covered by ring girders or saddles per SAES-L-120 , SAES-L-310 and SAES-L-410 .

5.5 External Pipe Coatings, Subsea

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Constr.	Maintenance	
5.5.1 Pipe Body	APCS-104 APCS-105 APCS-106	APCS-104 APCS-105 APCS-106 APCS-107 APCS-19B	When required for negative buoyancy, APCS-104 and APCS-105 shall be cement weight coated by the compression method. APCS-19B shall only be used for short repairs.
5.5.2 Field Girth Weld Area	APCS-107	APCS-107	The joint coating shall be protected by a heavy plastic mesh or by a hot marine mastic or foam infill. See SAES-H-202 .
5.5.3 Fittings Appurtenances & Spool Pieces	APCS-104 APCS-107 APCS-3 APCS-19B	APCS-104 APCS-107 APCS-3 APCS-19B	APCS-19A shall only be used for subsea repairs.
5.5.4 Risers	APCS-104 APCS-105 APCS-107 APCS-3 APCS-19B	Same as new Construction	APCS-107 shall not be used in the wave action zone or in strong tidal areas. Free ends shall be securely and permanently fastened by mechanical means to prevent unwrapping. Bare risers protected in the submerged zone by galvanic anodes are acceptable if both the Proponent Organization and the RSA concur. In the splash zone, risers shall be Monel sheathed up to the first flange. On sealed deck constructions, unless the design allows ready access to the risers to allow maintenance coating, the risers shall be Monel clad for a distance of 0.3 m above and below the deck penetrations. See also SAES-H-001 , paragraph 4.2.
5.5.5 Conductors	APCS-22	APCS-22	For conductors for wells on platforms, APCS-22 may be used in the splash zone. For free-standing conductors, use Monel sheathing in the splash zone.

5.6 External Pipe Coatings, In-Plant

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Constr.	Maintenance	
5.6.1 Buried (All services except insulated)	See Remarks	See Remarks	Same as for cross-country pipe. <i>Exceptions:</i> <i>APCS-107 and APCS-109 shall not be used on buried hydrocarbon lines on plot.</i>
5.6.2 Insulated (Cold System)	APCS-104 APCS-2A APCS-10 APCS-105 APS-108 APCS-115	Same as new Construction	Applies to pipe that will be operated continuously or intermittently below the atmospheric dew point. Cover with polyurethane or foam glass insulation. (See Std. Dwg. AA-036913). For APCS-2A, contact RSA if applied onto cold surfaces. Use APCS-17A or APCS-17B for temperatures less than minus 40°C.
5.6.3 Insulated (Hot System)	See Remarks	See Remarks	No coating required when continuous operating temperatures exceed 70°C and the facility is in service at least 90% of the time. Otherwise, obtain coating requirements from the RSA.
5.6.4 Mild Atmospheric Exposure	APCS-4 APCS-6 APCS-26 APCS-26T	APCS-4 APCS-6 APCS-26 APCS-26T	When using APCS -26 on new construction, minimum DFT should not be less than 200 microns.
5.6.5 Industrial and/or High Humidity Atmospheric Exposure	APCS-1A APCS-1B APCS-22 APCS-26 APCS-26T	APCS-26 APCS-26T APCS-1B APCS-1C APCS-22	When using APCS -26 on new construction, minimum DFT should not be less than 200 microns.

6 Description and Uses of Approved Protective Coating System (APCS)

6.1 Index

Specification	Title
APCS-100	Shop-Applied Baked Phenolic or Baked Phenolic Epoxy
APCS-101	Shop-applied Baked Modified Polyurethane
APCS-102	Shop or Field-Applied Fusion Bonded Epoxy (Internal)
APCS-103	Shop or Field-Applied Cement Mortar
APCS-104	Shop or Field-Applied Fusion Bonded Epoxy (External)
APCS-105	Shop-Applied, Spirally-extruded, Fused Polyethylene
APCS-106	Shop-Applied Coal Tar Enamel
APCS-107	Pressure-Sensitive, Hand-Applied Tapewrap for Temperatures up to 55°C.
APCS-108	Hand-Applied Petrolatum Tapewrap
APCS-109	Pressure-Sensitive Hand-Applied Tapewrap for Elevated Temperature Service

Specification	Title
APCS-110	High Temperature Heat-shrink Sleeves Primarily for Use on FBE-coated Pipe at Temperatures up to 100°C
APCS-111	High Temperature Heat-shrink Sleeves Primarily for Use on Polyethylene-coated Pipe and FBE-Coated Pipe at Temperatures up to 80°C
APCS-112	Heat Shrink Sleeves for Temperature up to 55°C
APCS-113A/B/C	Renovation and Repair Coatings (External) for Buried Services
APCS-114	Epoxy Phenolic System for Treated Seawater, High Pressure Immersion Service
APCS-115	Shop-Applied, Extruded, Three-layer Polypropylene External Coatings for Line Pipe
APCS-116	High Temperature Heat-shrink Sleeves Primarily for Use on FBE-coated Pipe at Temperatures up to 120°C

6.2 References to Specialized Tests

Two specialized tests are referred to in some of the APCS sheets:

- a) TMA (Thermal Mechanical Analysis)
- b) Aleyeska Tape Shear Test

These tests are described in detail in [09-SAMSS-099](#), "Specialized Coatings Tests."

- 6.3 Service condition limitations for the APCS's assume continuous service. For intermittent service, contact the RSA.
- 6.4 For APCSs referred to, but not described in this Standard, refer to [SAES-H-101](#).
- 6.5 The APCS coating systems shall not be used under conditions that violate service limitations or other requirements in the applicable APCS data sheets. Only approved products shall be used. (See definitions in [SAES-H-001](#).)
- 6.6 In cases where a coating appears otherwise acceptable but has been applied at thickness greater than the specified maximum, consult the RSA, who will determine if the intent of the standard has been violated and what corrective action, if any, is needed.

APCS-100

I. TYPE OF COATING

Shop-Applied Baked Phenolic or Baked Phenolic Epoxy.

II. GENERAL DATA

a) Uses: Internal coating for water, oil, or gas service. Primarily used for oil country tubular goods and for plant piping spools not requiring field bending and fittings.

b) Service Limitations:

Temperature: Min. 0°C

Max. 120°C

Other: pH range 3.5 to 12. Maximum allowable service pressure is 34,475 KPa (ga) (5000 psig). Maximum allowable partial pressures of H₂S and CO₂ are each 1725 KPa (abs) (250 psig).

c) Not Suitable For: Any service where bending is required after the coating has been applied. All pipe shall be stenciled "Do Not Bend" on external surface.

d) SAMS S/N: 09-697-805.

e) Purchase Specification: [09-SAMSS-080](#) System A.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per [09-SAMSS-080](#).

b) Field Girth Weld Area: Not suitable for field applications.

c) Compatible Repair Coatings: None

APCS-101

I. TYPE OF COATING

Shop-Applied Baked Modified Polyurethane

II. GENERAL DATA

a) Uses: Internal coating for water, oil, or gas service. Primarily used for cross-country pipelines and for oil country tubular goods.

b) Service Limitations:

Temperature: Min. 0°C
Max. 120°C

Other: pH range 3.5 to 12. Maximum allowable service pressure is 34,475 kPa (ga) (5000 psig). Maximum allowable partial pressures of H₂S and CO₂ are each 1725 kPa (abs) (250 psia).

c) SAMS S/N: 09-697-800.

d) Purchase Specification: [09-SAMSS-080](#) System B.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per [09-SAMSS-080](#).

b) Field Girth Weld Area: Not suitable for field application.

c) Compatible Repair Coatings: None

APCS-102

I. TYPE OF COATING

Shop or Field-Applied Fusion Bonded Epoxy (Internal)

II. GENERAL DATA

a) Uses: Internal coating for water, oil, and gas service. Primarily used for cross-country pipelines and for oil country tubular goods and for plant piping spools not requiring field bending and fittings.

b) Service Limitations:

Temperature: Min. 0°C
Max. 90°C

Other: pH range 3.5 to 13. Maximum allowable service pressure is 20,685 kPa (ga) (3000 psig). Maximum partial pressures of H₂S and CO₂ are each 345 kPa (abs) (50 psia).

c) SAMS S/N: 09-697-815.

d) Purchase Specification: [09-SAMSS-091](#).

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per [09-SAMSS-091](#).

b) Field Girth Weld Area: White metal abrasive grit blast, Sa3. Profile 50 to 100 microns. Use abrasive grit; sand is not acceptable. Crawler-applied FBE. Preheat area to be coated with induction heaters only.

c) Compatible Repair Coatings: Contact RSA.

APCS-103

I. TYPE OF COATING

Shop or Field-Applied Cement Mortar

II. GENERAL DATA

- a) Uses: Internal coating for water services, including oily water.
- b) Service Limitations:
 - Temperature: Min. 0°C
 - Max. 120°C
 - Other: pH range 5.5 to 12. Maximum fluid velocity 3 m/s. Service pressures up to 34,475 kPa (ga) (5000 psig) allowed as long as pipe does not yield, flex, or vibrate. Maximum allowable partial pressures of H₂S and CO₂ are each 13 kPa (abs) (2 psia).
- c) Not Suitable For: (1) Applications where a subsequent external coating requires preheating a cement-lined pipe must be used. In these cases, the external coating (normally FBE) must be applied first. (**Note:** Hot-applied coal tar enamel per APCS-106 can be applied over cement-lined pipe.) (2) Soft waters such as steam condensate and boiler feedwater. Also some waters formed by desalination or reverse osmosis.
- d) Purchase Specification:
 - Shop-applied: [01-SAMSS-005](#)
 - Field-applied: AWWA C602
- e) In potable water service, joint compounds shall be certified suitable for contact with drinking water. For coupling joint use S/N 09-239-660.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Per [01-SAMSS-005](#) for shop application and AWWA C602 for in situ field application.
 - b) Field Girth Weld Area: Hand-tool cleanliness, SIS.St2 minimum.
 - c) Compatible Repair Coatings: Cement mortar or grout; APCS-19A (in non-potable water service); S/N 09-239-660 (in potable water service).
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APCS-104

I. TYPE OF COATING

Shop or Field-Applied Fusion Bonded Epoxy (External)

II. GENERAL DATA

a) Uses: External coating for onshore buried and above ground services. Suitable for subsea services if weight coating is not used or if weight coating is applied by the compression method. Also suitable for over-the-ditch coating of the field girth welds on FBE-coated pipe.

b) Service Limitations:

1) Conventional FBE (T_g up to 93°C)

Temperature:

Min. -20°C

Max. (in subkha or immersion): 65°C

Max. (in dry ground): 93°C

2) High Temperature FBE (T_g greater than 93°C and up to 135°C)

Temperature:

Min. -20°C

Max. (in subkha or immersion): 110°C

Max. (in dry ground): 125°C

c) SAMS S/N: Conventional FBE: 09-697-820

High Temperature FBE: 09-000-449

d) Purchase Specification: [09-SAMSS-089](#)

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per [09-SAMSS-089](#).

Commentary Note:

For high temperature FBE application, film thickness is 22 mils minimum and 30 mils maximum.

- b) Field Girth Weld Area: Per [SAES-H-201](#).
- c) Compatible Repair Coatings:
 - Conventional FBE: Melt sticks, epoxy patch compounds, APCS-113A/B.
 - High Temperature FBE: Epoxy patch compounds

APCS-105

I. TYPE OF COATING

Shop-Applied, Spirally-extruded, Fused Polyethylene.

II. GENERAL DATA

- a) Uses: External coating for onshore buried and above ground services. Suitable for subsea services if weight-coating is not used or if weight coating is applied by the compression method. (**Note:** Above-ground coating must be protected from direct sunlight by a coat of white urethane paint, S/N 09-612-366-00, or other system approved by the RSA.)
- b) Service Limitations:
 - Temperature: Min. 0°C
 - Max. 80°C
- c) Not Suitable For: Burial in oil-contaminated ground water or heavily oil soaked ground due to the lack of compatible, practical field girth weld coating system.
- d) SAMS S/N: 09-697-830.
- e) Purchase Specification: 09-SAMSS-090.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Per 09-SAMSS-090.
- b) Field Girth Weld Area: Not suitable for field application.
- c) Compatible Repair Coatings: Heat shrink patches or heat shrink sleeves.

APCS-106

I. TYPE OF COATING

Shop-Applied Coal Tar Enamel

II. GENERAL DATA

a) Uses: External coating for subsea pipelines (used in conjunction with concrete weight coating). Also suitable as an external coating on buried, onshore pipe that has been cement lined.

b) Service Limitations:

Temperature: Min. 0°C

Max. 70°C onshore,

80°C subsea

Other: No continuous contact with hydrocarbons if service temperature exceeds 50°C.

c) Not Suitable For: Any service requiring bending after the coating has been applied.

d) SAMS S/N: None.

e) Purchase Specification: None.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per AWWA C203, with total coating and outerwrap thickness equal to 4mm minimum.

b) Field Girth Weld Area: Not applicable to field applications.

c) Compatible Repair Coatings: Hot enamel dope.

APCS-107

I. TYPE OF COATING

Pressure-Sensitive, Hand-Applied Tape-wrap for Temperatures up to 55°C

II. GENERAL DATA

- a) Uses: For onshore buried and for subsea services. Primarily used for pipeline coating renovation and on field girth welds of subsea pipelines.
- b) Service Limitations:
 - Temperature: Min. -20°C
 - Max. 55°C
 - Other: Maximum temperature limitation for subsea service is 80°C.
- c) Not Suitable For: Continuous contact with hydrocarbons, including oil-contaminated ground water.
- d) SAMS S/N: Primer: 09-937-902
Tape: 09-967-466/469/472 depending on width
- e) Purchase Specification: [09-SAMSS-095](#).

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Commercial blast, Sa2 (desert sand acceptable).
 - Exception:*
 - Hand tool cleaning to St2 on pipes less than 10 m long.*
 - Road crossings: Near white metal, Sa2-1/2. Refer to [SAES-H-203](#) for application requirements.
 - b) Field Girth Weld Area: Onshore: Commercial blast, Sa2 (desert sand acceptable). Subsea: Power tool cleaning to S.I.S. St3. Road crossings: Near-white metal, Sa2-1/2. Refer to [SAES-H-203](#) for application requirements.
 - c) Compatible Repair Coatings: APCS-107.
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APCS-108

I. TYPE OF COATING

Hand-Applied Petrolatum Tape-wrap

II. GENERAL DATA

- a) Uses: Primarily for maintenance work on aboveground pipe where application over moist surfaces is required, such as on chilled water lines that are coated while in service.
- b) Service Limitations:
 - Temperature: Min. -5°C
 - Max. 50°C
- c) Not Suitable For: (1) Contact with hydrocarbons (2) Direct burial, unless covered with outerwrap SAMS S/N 09-966-251 through 260.
- d) SAMS S/N: Paste: 09-938-000
Tape: 09-967-300
- e) Purchase Specification or Other Product/Performance Requirements:
 - Petrolatum-impregnated, non-woven fabric tape.
 - Minimum thickness = 1.0 mm.
 - Minimum weight = 1.4 kg/m²
 - Maximum water absorption per ASTM D570 = 0.13%.
 - Minimum breaking strength per ASTM D1000 = 4 kg/cm.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Hand tool cleaning, SIS St.2 minimum. Use minimum 55% overlap.
- b) Field Girth Weld Area: Hand tool cleaning, SIS St.2 minimum. Use minimum 55% overlap.
- c) Compatible Repair Coatings: APCS-108

APCS-109

I. TYPE OF COATING

Pressure-Sensitive, Hand-Applied Tape-wrap for Elevated Temperature Service

II. GENERAL DATA:

- a) Uses: For onshore buried services. Primarily used for in-plant piping and for pipeline coating renovation on lines operating in the temperature range 55 to 100 °C.
- b) Service Limitations:
Temperature: Min. -30°C
Max. 100°C
- c) Not Suitable For: Continuous contact with hydrocarbons, including oil-contaminated ground water.
- d) SAMS S/N: Primer 09-937-920
Tape 09-967-700/702 depending on width
Outerwrap 09-966-251/254/257 depending on width
- e) Purchase Specification or Other Product/Performance Requirements: Minimum tape thickness = 0.64 mm. Polyethylene backing. Butyl rubber adhesive with minimum TMA softening point per [09-SAMSS-099](#) equal to 100°C. Minimum allowable 180 degrees peel strength per ASTM D1000 is 1 kg/cm for both tape-to-tape and 2 kg/cm for tape-to-steel when applied over dry primer. Maximum allowable slippage in Aleyeska Tape Shear Test per [09-SAMSS-099](#) is 15 mm at 21°C.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Commercial blast, Sa2 (desert sand acceptable). Road crossings: Near-white metal, Sa2-1/2, Double wrap required. Refer to [SAES-H-203](#) for application requirements. Outer wrap required for all services.
 - b) Field Girth Weld Area: Commercial blast, Sa2 (desert sand acceptable) Road crossings: Near-white metal, Sa2-1/2. Double wrap required. Refer to [SAES-H-203](#) for application requirements. Outer wrap required for all services.
 - c) Compatible Repair Coatings: APCS-109.
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APCS-110

I. TYPE OF COATING

High Temperature Heat-shrink Sleeves Primarily for Use on FBE Coated Pipe at Temperatures Up to 90°C.

II. GENERAL DATA

- a) Uses: External field girth weld area coating for FBE-coated pipe. Not normally specified for service temperatures less than 55°C.
- b) Service Limitations:
Temperature: Min. -40°C
Max. 90°C
- c) Not Suitable For: Contact with hydrocarbons including oil-soaked sand and oil-contaminated ground water.
- d) SAMS S/N: 09-960-100 (Heat-activated adhesive).
- e) Purchase Specification: [09-SAMSS-096](#) (Type 1 sleeves).

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Not applicable.
- b) Field Girth Weld Area: Near white metal, Sa2-1/2. Sleeves with heat-activated adhesives shall be applied to pipe larger than 30 inches nominal diameter only by the induction heater post-heating method. [SAES-H-204](#) and [SAES-H-204V](#) apply.
- c) Compatible Repair Coatings: APCS-110 (full sleeve or patch).

APCS-111

I. TYPE OF COATING

High Temperature Heat-shrink Sleeves Primarily for Use on Polyethylene-coated Pipe and FBE-coated Pipe at Temperatures up to 80°C.

II. GENERAL DATA

- a) Uses: External field girth weld coating, primarily for use on polyethylene-coated and FBE-coated line pipe operating at temperatures in the range 55 to 80°C. Not normally specified for service temperatures less than 55°C.
- b) Service Limitations:
Temperature: Min. -20°C
Max. 80°C
- c) Not Suitable For: Contact with hydrocarbons, including oil-soaked sand and oil-contaminated ground water.
- d) SAMS S/N:
09-961-100 (Heat-activated adhesive)
09-961-105 (Primer-activated adhesive)
- e) Purchase Specification: [09-SAMSS-096](#) (Type 2 sleeves).

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Not applicable.
- b) Field Girth Weld Area: Near white metal, Sa2-1/2. Sleeves with heat-activated adhesives shall be applied to pipe larger than 30 inches nominal diameter only by the induction heater post-heating method. [SAES-H-204](#) and [SAES-H-204V](#) apply.
- c) Compatible Repair Coatings: APCS-111 (full sleeve or patch).

APCS-112


I. TYPE OF COATING

Heat-shrink Sleeves for Temperatures up to 55°C.

II. GENERAL DATA

- a) Uses: External field girth weld area coating for use with FBE, polyethylene, or coal tar enamel coated pipe.
- b) Service Limitations:
Temperature: Min. -20°C
Max. 55°C
- c) Not Suitable For: Contact with hydrocarbons, including oil soaked sand and oil contaminated ground water.
- d) SAMS S/N: 09-962-100
- e) Purchase Specification: [09-SAMSS-105](#)

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Not applicable.
 - b) Field Girth Weld Area: Commercial blast, Sa2. [SAES-H-204](#) and [SAES-H-204V](#) apply.
 - c) Compatible Repair Coatings: APCS-112 (full sleeve or patch).
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APCS 113A

I. TYPE OF COATING

Renovation and Repair Coatings (Liquid Type) for Buried Services

II. GENERAL DATA

Uses: Primarily for repair or renovation of external epoxy coating on buried piping, pipelines, and associated fittings and appurtenances.

- a) This system may also be used for shop-coating of casing, pipeline fittings and appurtenances, and stainless steel pipe.
- b) SAMS S/N:
 - 1) For Coatings with solid contents up to 85%: 09-697-831/833/837/839 depending on size
 - 2) For Coatings with solid contents greater than 85%: 09-000-497-00
- c) Maximum Service Temperature Limitations:
 - 1) For Coatings with solid contents up to 85%
 - a. 100°C in dry terrain.
 - b. Not recommended for immersion in Subkha conditions
 - 2) For Coatings with solid contents greater than 85%
 - a. 125°C in dry terrain
 - b. 110°C for immersion in Subkha conditions
- d) Generic Information: This APCS covers a variety of liquid coating systems. For generic information, see the stock number descriptions in the SAMS catalog or in the Saudi Aramco Data Sheets, [SAES-H-002V](#).
- e) Purchase Specification: [09-SAMSS-113](#)

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Cleanliness: Near white metal blast, Sa2.5.
Profile: 50 - 100 micrometers (2.0 - 4.0 mils)
Use abrasives S/N 08-220-865 and 08-202-900
-

- b) Dry Film Thickness:
 - 1) 500 - 750 microns for coatings with solid contents up to 85%
 - 2) 600 - 1000 microns for coatings with solid contents higher than 85%
- c) Compatible Repair Coatings: APCS-113A.
- d) Immediately prior to coating application in subkha and other areas where chloride contamination is possible, test the steel substrate for chlorides. Residual chloride on the surface shall not exceed 40 mg/m².
- e) The required voltages for holiday detection of the coating prior to burial are 2400 + 50 volts DC

Commentary Note:

Mandatory technical properties and storage, mixing, and application requirements shall be as given in the Saudi Aramco Data Sheets, [SAES-H-002V](#).

APCS-113B

I. TYPE OF COATING

Renovation and Repair Coatings (Putty Type) for Buried Services

II. GENERAL DATA

Uses: Primarily for repair or renovation of external epoxy coating on buried pipeline fittings and appurtenances, particularly those with exposed bolts (such as flanges or Weld + Ends) or sharp changes in dimension (such as split sleeves with butt straps). These coatings are essentially splash zone coatings that have been qualified for use up to 100°C.

- a) SAMS S/N: 09-697-835
- b) Maximum Service Temperature Limitation: 100°C
- c) Purchase Specification: 09-SAMSS-070 modified as follows: (1) the dry film thickness shall be as given below (2) immersion and cathodic disbonding tests shall be conducted at $90 \pm 2^\circ\text{C}$.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Cleanliness: Near white metal blast, Sa2.5.
Profile: 75 micrometers (3 mils) minimum.
Abrasive: S/N 08-220-850, 08-220-890 or 08-202-910
- b) Dry Film Thickness: 1000-1625 micrometers
- c) Compatible Repair Coatings: APCS-113B.
- d) Immediately prior to coating application in subkha and other areas where chloride contamination is possible, test the steel substrate for chloride. Residual chloride on the surface shall not exceed 40 mg/m².
- e) The required voltage for holiday detection of the coating prior to burial is 5000 + 100 volts DC

Commentary Note:

Mandatory technical properties and storage, mixing, and application requirements shall be as given in the Saudi Aramco Data Sheets, [SAES-H-002V](#).

APCS-113C

I. TYPE OF COATING

Non-Curing (Visco-Elastic) Mastic-based Coating System with a Backing Tape

II. GENERAL DATA

a) Uses: Primarily used as an external protective coating system for repair and renovation of buried pipelines. It can be used, as a corrosion protection, for field girth weld on both new and old pipelines.

b) Service Limitations:

Temperature: Min. 10°C

Max. 70°C

c) Not suitable for continuous contact with liquid hydrocarbons, including oil-soaked soil.

d) Suitable for dry, immersion, and in subkha conditions. Can be applied to slightly damp surfaces.

e) SAMS S/N:

Tape-backed Visco-elastic Coating: 09-000-436/438/442 depending on width

Outer Wrap: 09-000-436/438/439/440/442 depending on width

Adhesive / Paste: 09-000-444

Sheathing: 09-000-441

f) Purchase Specifications:

Impact resistance (ASTM G14): 15 J (minimum)

Peel strength (DIN 30670): 1.0 N/mm² (minimum) @ 1.8 mm film thickness.

Shear strength (ASTM D1002): 0.05 N/mm² (minimum).

Glass transition temperature: not exceed - 20°C.

Cathodic disbonding test (ASTM G42): No disbonding @ 60°C for 30 days

Minimum thickness of the outer wrap and sheathing are 0.8 mm and 1.0 mm, respectively.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Generally, Commercial blast (SSPC-SP 6 or equivalent). Wire brush is acceptable on small areas (less than 1 meter long). Wrapping can be applied over existing, sound coating after the removal of loss paints and debris.
- b) Profile: Not critical
- c) Over lapping:

For Visco-Elastic and adhesive tape: 20% the width of the tape for pipes with diameters up to 10" and 15 mm for pipes with diameters greater than 10". For outer tape: 50% the width of the tape
- d) For girth weld application:

Visco-Elastic coating shall cover 3 times the width of the girth weld bare area for pipe diameter up to 12", and 4 times the width of the girth weld bare area for pipe diameter greater than 12"
- e) Compatible Repair Coatings: APCS-113C

APCS 114

I. TYPE OF COATING

Epoxy Phenolic System for Treated Seawater and High Pressure Immersion Service.

II. GENERAL DATA

- a) Uses: Immersion service for treated seawater injection. Not suitable for potable water services.
- b) SAMS S/N: Primer: 09-612-390/395
 Topcoat: 09-612-400/405
- c) Service Condition Limitations:
 - Maximum Temperature: 65°C
 - H₂S, CO₂ content: None
 - Maximum Pressure: 2500 psig (17.2 MPa abs.)
- d) Purchase Specification: None

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Steel: Near white metal blast, SIS Sa2.5, surface profile 40 - 65 microns (1.5 – 2 mil). Use abrasive grit S/N 08-220-865 or equivalent.
- b) Dry Film Thickness Requirements: Total system 250 – 300 microns, applied in two coats of contrasting colors. Brush-apply two stripe coats on all sharp edges, cutouts, and welds using contrasting colors.
- c) Compatible Repair Coatings: APCS-114.

APCS-115

I. TYPE OF COATING

Shop-Applied, Extruded, Three-layer Polypropylene External Coatings for Line Pipe

II. GENERAL DATA

a) Uses: External coating primarily for onshore buried services, particularly in subkha and for elevated temperatures. (**Note:** Above-ground coating must be protected from direct sunlight by one coat of white urethane paint, S/N 09-612-366-00, or other system approved by the RSA.)

b) Service Limitations:

Temperature: Min. -20°C

Max. 110°C

c) SAMS S/N: None.

Purchase Specification: [09-SAMSS-114](#).

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per [09-SAMSS-114](#).

b) Field Girth Weld Area:

Special heat-shrink sleeves for 3LPP-coated pipe per [09-SAMSS-114](#): Sa2-1/2. Apply in accordance with approved installation procedure in [SAES-H-204V](#).

2-layer or 3-layer flame-sprayed polypropylene system per [09-SAMSS-114](#): Sa2-1/2. Surface roughness 50-100 microns. Apply in accordance with Vendor's work procedure approved by CSD.

c) Compatible Repair Coatings: Polypropylene melt-sticks or flame sprayed powder.

APCS-116

I. TYPE OF COATING

High Temperature Heat-shrink Sleeves Primarily for Use on FBE-coated Pipe at Temperatures Up to 120°C.

II. GENERAL DATA

- a) Uses: External field girth weld area coating for high temperature FBE-coated pipe.
- b) Service Limitations:
Temperature: Min. -40°C
Max. 120°C
- c) Not Suitable For: Contact with hydrocarbons including oil-soaked sand and oil-contaminated ground water.
- d) SAMS S/N: 09-960-102
- e) Purchase Specification: [09-SAMSS-096](#) (Type 1, heat-activated sleeves) modified as follows: (1) Melting temperature of the adhesive shall not be less than 120°C. (2) Test temperature for elevated temperature breaking strength, resistance to shear loads, lap shear adhesive strength, and dimensional stability after heat aging shall be 120°C.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

- a) Pipe: Not applicable.
- b) Field Girth Weld Area: Near white metal, Sa2-1/2. Sleeves shall be applied to pipe larger than 12 inches nominal diameter only by the induction heater post-heating method. [SAES-H-204](#) and [SAES-H-204V](#) apply.
- c) Compatible Repair Coatings: APCS-116 (full sleeve or patch).

26 February, 2003
31 March, 2004

Revision Summary
Major revision.
Minor revision.