



Engineering Standard

SAES-H-002

22 February 2018

Internal and External Coatings for Steel Pipelines and Piping

Document Responsibility: Paints and Coatings Standards Committee

Contents

1	Scope.....	2
2	Conflicts and Deviations	2
3	References.....	2
4	Definitions	4
5	Selection Requirements.....	5
6	Description and Uses of Approved Protective Coating System (APCS).....	12
	Revision Summary.....	13

1 Scope

- 1.1 This standard defines the minimum mandatory requirements of the internal and external coating material selection and application for carbon steel pipelines and piping (including associated fittings and appurtenances). This standard is not applicable for the use of galvanized, alloy, or nonmetallic pipe where allowed by other Saudi Aramco standards.
- 1.2 For projects reviews, all coating requirements, specifications, and selection, per SAEP-303, shall be consolidated in Index H.
- 1.3 This standard shall be attached to, and made part of, purchase orders when required.

2 Conflicts and Deviations

Any conflicts between this document and other applicable Mandatory Saudi Aramco Engineering Requirements (MSAERs) shall be addressed to the EK&RD Coordinator.

Any deviation from the requirements herein shall follow internal company procedure SAEP-302.

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 Procedures

<u>SAEP-302</u>	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
<u>SAEP-316</u>	<i>Performance Qualification Requirements of Coating Personnel</i>

Saudi Aramco Engineering Standards

<u>SAES-H-001</u>	<i>Coating Selection and Application Requirements for Industrial Plants and Equipment</i>
<u>SAES-H-002V</u>	<i>Saudi Aramco Data Sheets</i>
<u>SAES-H-004</u>	<i>Protective Coating Selection and Application Requirements for Offshore Structures and</i>

Facilities

<u>SAES-H-101V</u>	<i>Saudi Aramco Data Sheets</i>
<u>SAES-H-201</u>	<i>General Specification for Over-the-Ditch Internal and External FBE Coating of Field Girth Welds</i>
<u>SAES-L-120</u>	<i>Piping Flexibility Analysis</i>
<u>SAES-L-133</u>	<i>Corrosion Protection Requirements for Pipelines, Piping, and Process Equipment</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-035</u>	<i>API Line Pipe</i>
<u>09-SAMSS-089</u>	<i>Shop-Applied External Fusion Bonded Epoxy Coating for Steel Line Pipes</i>
<u>09-SAMSS-091</u>	<i>Shop-Applied Internal Fusion Bonded Epoxy Coating for Steel Line Pipes</i>
<u>09-SAMSS-113</u>	<i>External Renovation Coating for Buried Pipelines and Piping (APCS-113)</i>

Saudi Aramco Best Practice

<u>SABP-H-004</u>	<i>Robotic Coating Application on Internal Girth Welds of Pipe Strings</i>
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3.2 Industry Codes and Standards

National Association of Corrosion Engineers

<u>NACE SP0490</u>	<i>Holiday Detection of Fusion-Bonded Epoxy External Pipeline Coating</i>
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Canadian Standards

<u>CAN/CSA-Z245.20-M92</u>	<i>External FBE Coating for Steel Pipe</i>
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International Organization for Standardization

<u>ISO 12944-2</u>	<i>Corrosion Protection of Steel Structures by Protective Paint Systems - Part 2: Classification of Environments</i>
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ISO 21809-3*External Coatings for Buried or Submerged Pipelines
Used in Pipeline Transportation Systems*

SSPC - The Society for Protective Coatings

SSPC-Vis 1*Guide to Vis 1 - 89 - Visual Standard for Abrasive
Blast Cleaned Steel*SSPC-PA 2*Procedure for Determining Conformance to Dry
Coating Thickness Requirements*

4 Definitions

Approved Procedure: Procedure referred to in this specification that has been approved by CSD/Paints and Coating Standards committee. Approved procedures do not require re-approval in new purchase orders.

Approved Product: A coating material that meets the requirements of the applicable APCS or SAMSS. Only approved products are allowed for use in Saudi Aramco. These requirements apply to all standards under the SAES-H-series.

Buyer: Saudi Aramco Purchasing Department representative

Buyer's Representative: The person or persons designated by the Purchasing Department to monitor / enforce the contract. Normally, this is the on-site inspector.

Corrosive Service: Generally, everything except treated seawater and refined products.

Custom Coated Pieces: All pipes not coated by automated in-plant equipment. Generally, fittings, short spools and fabricated spools.

Cut-back: The length of pipe left uncoated at each end for joining purposes.

Corrosive Industrial Atmosphere: High humid areas, downwind from sea shore or surrounded by Sea Islands, causeway, process area near water spray and fumes and polluted gases, equivalent to C5-I (80–200 micron metal loss/year) as per ISO 12944-2.

Maintenance Coating/Painting: Application of coating to preserve the useful state of an existing coating. Repairing is the most common method to maintain a coating. Replacing completely an existing coating is not maintenance coating.

Maximum Operating Temperature: Maximum temperature that can be reached during operation of pipeline.

Mild Atmosphere: Areas not affected by either marine or industrial environments, but receive enough moisture in the air to cause corrosion if the carbon steel is not coated, equivalent to C3 (25–50 micron metal loss/year) as per ISO 12944-2.

New Construction Coating: Term to designate a coating that is applied over new and bare facilities, equipment or machineries. Coating applied on completely bare substrates during maintenance is also designated as new construction coating in this standard.

Transition Section: Segment of pipeline or piping where the service changes from buried to atmospheric.

5 Selection Requirements

5.1 General Requirements for External Coatings

- 5.1.1 All buried onshore pipes shall be externally coated.
- 5.1.2 Pipes in all subsea services shall be externally coated.
- 5.1.3 Plant piping and other above grade pipelines in industrial or marine exposure shall be externally coated.
- 5.1.4 All onshore buried and subsea coated pipes shall be 100% holiday free and all holidays shall be repaired prior to burial. If the pipe is bent, it should be holiday tested again to determine any damage to the coating during bending.
- 5.1.5 All transition areas (buried to above ground pipe sections, including camel and road crossings) shall be protected with the buried service coating and supplemented with an approved protective system such as APCS-113A or APCS-113C (with UV resistant outer wrap). This system shall start at least 1m below ground and extend above ground as follows:
 - a) For sharp angles (46 to 90 degrees), the protection coating shall extend at least 1 m above ground.
 - b) For shallow angles (45 degrees or less), the protection coating shall extend at least 8 m above ground. If a support on an existing pipe is encountered at a distance less than 8 m along the pipe, and it cannot be removed, the protection coating shall terminate at the support. In-active sand control, pipeline coating may stop at the first weld, provided that the pipe is 3-pipe diameter above the grade level where the plant coating will take over.
- 5.1.6 Hand-applied tapes of all types shall not be used except for the PVC outer wrap of APCS-113C.

- 5.1.7 The APCS-113C can also be used over an existing coating that is sound and has good adhesion on the steel substrate. This procedure is normally applicable on isolated steel valves, spools, and fittings that are not protected with cathodic protection.
- 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 Sa 2-½ except for APCS-113C.
- 5.1.10 Steel pipe encased in concrete shall have additional coating extending beyond the concrete to approximately 300 mm.
- 5.1.11 Bare cast iron pipe shall be externally coated prior to burial.
- 5.1.12 Buried stainless steel lines shall be externally coated with FBE, halide-free liquid coating, APCS-113A, or viscoelastic coating APCS-113C depending on operating temperature.
- 5.1.13 Pipes to be thrust bored in soft soil shall be coated with APCS-104A, APCS-104B, or APCS-104C as first layer and APCS-113A as top layer for sandy, soft soil. For thrust-boring in hard, rocky soils, same APCS-104A/B or C shall be applied as first layer and over-coated with an approved abrasion resistant overlay (ARO) composite system to protect the FBE coating.
- 5.1.14 Coating systems listed in sections [5.3](#) 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.
- 5.1.15 Pre-heating pipe prior to FBE coating application on the internal girth welds shall be done by heat induction coils only.
- 5.1.16 Wellhead components shall be coated in accordance to [SAES-H-001](#) and [SAES-H-004](#).
- 5.1.17 Casing for carrier pipes (welded or isolated from the carrier pipe) shall be protected with FBE coating.
- 5.2 General Requirements for Internal Coatings
- 5.2.1 Internal coating is required when there is a potential problem with corrosion that could have an impact in the process such as for water, gas,

condensate, and crude oil. When internal coating is required, the selection table given in Section 5.3 shall be used.

- 5.2.2 Internal coatings used in potable water service must meet Food and Drugs Administration (FDA), National Sanitation Foundation (NSF) or equivalent requirements for suitability for use in contact with drinking water. The certificate shall be renewed every 5 years.
- 5.2.3 Application of phenolic primer prior to the application of FBE shall not be controlled manually. A machine shall be used to ensure that the travel of application is constant and that the DFT will not exceed one mil (25 microns) in all areas. One mil is exceeded if the “peaks” of steel substrate are no longer visible.
- 5.2.4 For onshore application, the robotic crawler (consisting of blasting and coating equipment, dry film thickness gauge, holiday detector and online video camera) shall be used for internal field girth welds of pipe strings with diameters ranging from 8 to 36". Real time inspection with a video camera must be conducted to ensure that blast cleaning and coating application are done properly. A copy of the video record must be provided to the proponent for documentation and future investigation. For pipe diameters larger than 36", the coating application can be done manually by qualified contractors.
- 5.2.5 The holiday detector for field girth weld coating shall be grounded properly on the launcher end of the pipe string with the aid of a clamp. If the pipe end is coated, the coating shall be removed to expose the metal and allow metal-to-metal contact. The ground wire shall be flexible and thin but strong enough to reach long distances without snapping/breaking.
- 5.2.6 In the offshore, a semi-robotic system shall be used in the application of specialty liquid coating on internal girth welds by qualified and experienced contractors. This is applicable for sub-sea pipelines with diameters ranging from 8" and above.
- 5.2.7 For sour gas and Wasia water services, field application of FBE shall not be used for internal protection of girth welds for both onshore and offshore pipelines.
- 5.2.8 Deadlegs and jump-over piping sections of corrosive services such as wet crude and non-stabilized crude shall be internally coated. Coating shall be 100% holiday-free.
- 5.2.9 Liquid coating, APCS-120, shall be used on internal girth welds that

are post weld heat treated (PWHT). During the PWHT process, the induction heater shall be placed around the girth weld area to minimize damage of the existing pipe body coating. Prior to actual coating application, the coating contractor must demonstrate his capability in coating the new cutback resulted from PWHT.

- 5.2.10 The internal coating shall be extended up to the face of flat- and raised-face flanges that will not be in contact with the gasket. The coating applied shall be machined and ground to ensure that the surface is levelled properly and to avoid misalignment of gasket. Only approved coatings that can be machined after application shall be used.
- 5.2.11 Use only approved abrasive materials that can achieve the required surface cleanliness and profile requirements.
- 5.2.12 The DFT of the internal coating shall be checked within one meter from the end of the pipe.
- 5.2.13 Liquid coatings shall be applied by airless spray equipment.

5.3 Internal Coatings, Various Services

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Construction	Maintenance	
5.3.1 Pipelines for treated seawater and potable water Service, excluding girth welds	APCS-102A	APCS-117	1) Only approved girth weld FBE coatings for APCS-102A or APCS-120 shall be used on field girth welds for both onshore and offshore applications. 2) Use robotic crawler for internal coating of field girth welds of pipe strings with diameters of 8" and above. 3) All internal coatings on the field girth welds must be 100% holiday free.
5.3.2 Pipelines for formation water, Wasia water and wet crude service,	APCS-102B	APCS-117	1) Only approved girth weld FBE coatings for APCS-102B or APCS-120 shall be used for formation water/wet crude pipelines, and APCS-120 for Wasia water.

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Construction	Maintenance	
excluding girth welds			2) Use robotic crawler for internal coating of field girth welds of pipe strings with diameters of 8" and above. 3) All internal coatings on the field girth welds must be 100% holiday free.
5.3.3 Pipelines for Sour/Sweet Gas Service, excluding girth welds	APCS-102C	APCS-117	1) The need for coating shall be determined by corrosion rate calculation based on simulation model and chart as per <u>SAES-L-133</u> Section 7. 2) Only approved girth weld FBE coatings for APCS-102C or APCS-120 shall be used for girth weld coating.
5.3.4 Spools, Valves, Pumps, Flanges, and Other Fittings for Water (all types), Wet Crude Oil and Gas Services	APCS-102A/B/C APCS-117 APCS-28	APCS-117 APCS-28	1) Selection shall be based on the resistance of the coating to process temperature, pressure, corrosivity of the media, mechanical inspection, and pigging equipment. 2) For valves, pumps, flanges and other fittings, coating application shall be in accordance with the concerned APCS and relevant SAES-H standard's requirements. Refer to para. 6.1.8 of SAES-H-001 when considering manufacturer's standard coating system. 3) The coating for girth welds can be APCS-120 or same coating for the piping and fittings. 4) APCS-102A/B/C shall not be used on the girth welds of any piping and fittings coated with either APCS-28, or APCS-117.

5.4 External Coatings for Onshore and Cross-Country Pipelines

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Construction	Maintenance	
5.4.1 Buried Pipelines and Piping	APCS-104A APCS-104B APCS-104C	APCS-113A APCS-113C	1) APCS-113A/C can be used on new construction to: <ol style="list-style-type: none"> Repair damaged FBE. Coat already cement lined pipe. Coat single short run of pipes (60 meters or less) that will not require subsequent bending. 2) Coating selection shall be based on operating temperature and service conditions.
5.4.2 Buried Field Girth Welds	APCS-104A/B/C APCS-113A APCS-113C	APCS-113A APCS-113C	1) APCS-113A must be applied using Airless spray equipment. 2) Coating selection shall be based on operating temperature and service conditions.
5.4.3 Buried Fittings, Appurtenances and Spool Pieces	APCS-104A/B/C APCS-113A/C	APCS-113A/C	
5.4.4 Buried Road Crossings	APCS-104A/B/C plus APCS-113A or APCS-113C or ARO	APCS-113A/C	1) APCS-113A or APCS-113C shall be applied over APCS-104A/B/C for open cut excavations. 2) APCS-104A/B/C surface shall be properly cleaned and roughened according to specification prior to application of APCS-113A or APCS-113C 3) Approved abrasion resistant overlay (ARO) composite wrap system shall be applied over the APCS-104A/B/C coated pipes

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Construction	Maintenance	
			subjected to thrust-boring in hard, rocky soils. 4) See <u>paragraph 5.1.13</u> for thrust-bored road crossing.
5.4.5 Above Ground	Select the appropriate external coating in the table list of <u>SAES-H-001</u>		External coating requirement and selection shall depend on pipeline location and exposure conditions. These conditions shall be determined prior to coating selection.
5.4.6 Buried Anchors	See Comments	See Comments	Coat concrete anchors in accordance with Standard Drawing <u>AA-036531</u> . Steel anchors shall be coated with APCS-113A. Coat the portion of pipe covered by ring girders or saddles per <u>SAES-L-120</u> , <u>SAES-L-310</u> , and <u>SAES-L-410</u> .
5.4.7 Casing for carrier pipes	APCS-104A/B/C	APCS-113A	Casing for carrier pipes (welded or isolated from the carrier pipe) shall be protected with FBE coating.
5.4.8 Transition areas			As specified in <u>Section 5.1.5</u>

5.5 External Pipeline Coatings, Offshore - (Refer to SAES-H-004)

5.6 External Pipe Coatings, In-Plant (Also refer to SAES-H-001)

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Construction	Maintenance	
5.6.1 Buried (All services except insulated)	APCS-104A/B/C	APCS-113A APCS-113C	1) APCS-113A/C can be used on new construction to: a) Repair damaged FBE. b) Coat already cement lined pipe.

Categories	Approved Coatings System		Area to be Coated/Other Remarks
	New Construction	Maintenance	
			c) Coat single short run of pipes (60 meters or less) that will not require subsequent bending. 2) Coating selection based on operating temperature and service condition.
5.6.2 Insulated equipment	See remark	See remark	See <u>SAES-H-001</u> (paragraph 7.1.C)
5.6.3 Above Ground	Select the appropriate external coating in the table list of <u>SAES-H-001</u> .		External coating requirement and selection shall depend on pipeline location and exposure conditions. These conditions shall be determined prior to coating selection.
5.6.4 Buried Stainless Steel	APCS-113A	APCS-113A	Service/operating/exposure temperature involved shall not exceed the limit of APCS-113A.

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

- 6.1 Service condition limitations for the APCSs assume continuous service.
- 6.2 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.
- 6.3 If FBE approved coating is manufactured in a different manufacturing facility, it shall be prequalified even when it is manufactured by the same company.
- 6.4 Any approved coating that is subjected to modifications and/or reformulations, or replacement including change of names or re-branding shall be requalified.
- 6.5 SSPC PA2 shall be utilized in measuring coating dry film thickness.
- 6.6 Index of all coating systems used in this standard.

Specification	Title
APCS-102A	Shop-Applied Fusion Bonded Epoxy for Internal Coating of

Specification	Title
	Treated Seawater and Potable Water Pipelines
APCS-102B	Shop-Applied Fusion Bonded Epoxy for Internal Coating of Formation Water and Wet Crude Pipelines
APCS-102C	Shop-Applied Fusion Bonded Epoxy for Internal Coating of Sour/Sweet Gas Pipelines
APCS-103	Shop or Field-Applied Cement Mortar
APCS-104A	Shop-Applied External Fusion Bonded Epoxy (93°C-Dry, 65°C-Immersed)
APCS-104B	Shop-Applied External Fusion Bonded Epoxy (110°C-Dry, 90°C-Immersed)
APCS-104C	Shop-Applied External Fusion Bonded Epoxy (130°C-Dry / Immersed)
APCS-113A	Liquid Epoxy Coatings with 85 to 100% Volume Solids for Renovation of Buried Pipelines
APCS-113C	Visco Elastic Coating System for Buried Pipeline Rehabilitation
APCS-117	Field or Shop-Applied, Thick Liquid Coating for Piping
APCS-120	Field or Shop Applied Internal Girth Weld Liquid Coating for Piping
APCS-28	Field or Shop-Applied, Thick Liquid Coating for Valves and Pumps

Revision Summary

- 2 June 2012 Major revision.
- 1 August 2017 Major revision. This document was revised to remove old coating systems, APCS-100 and APCS-105, and add new technologies, APCS-104C. In Addition, APCS-113A was accepted for girth weld coatings. Mandate providing a copy of girth weld inspection video record to the proponent. Specify APCS-113A/C for the pipe transition section.
- 22 February 2018 Editorial revision to modify paragraph (4), (5.2.4), (5.2.10), (5.3.4 Remark2), (5.4.4 Remark3), (5.6.4 Remark1), and (2.d of APCS-102C)

APCS-102A

I. TYPE OF COATING

Shop-Applied Fusion Bonded Epoxy for Internal Coating of Treated Seawater and Potable Water Pipelines.

II. GENERAL DATA

a) Uses: Primarily used for treated seawater and potable water pipelines excluding girth welds. For potable water service, the coating shall have approval from National Sanitation Foundation (NSF) or equivalent.

b) Service Limitations:

Temperature: Min. 0°C

Max. 90°C

Other: pH range 3.5 to 11. Maximum allowable service pressure is 20,685 kPa (ga) (3,000 psig). Maximum partial pressures of H₂S and CO₂ are each 345 kPa (abs) (50 psia).

c) SAP M/N: Refer to SAES-H-002V

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 (2–4 mils). Use either garnet or steel grit abrasive for blast cleaning. Sand is not acceptable. Crawler-applied approved FBE or liquid coating under APCS-120 for internal girth welds of pipe strings. Preheat area to be FBE coated with induction heaters only. Refer to SAES-H-201 for coating on post weld heat treated pipes.

c) Compatible Repair Coatings: Approved repair coatings.

APCS-102B

I. TYPE OF COATING

Shop-Applied Fusion Bonded Epoxy for Internal Coating of Formation Water and Wet Crude Pipelines.

II. GENERAL DATA

a) Uses: Primarily used for formation water, Wasia water, disposal water, slope oil, and wet crude pipelines excluding girth welds.

b) Service Limitations:

Temperature: Min. 0°C

Max. 95°C

Other: pH range 3.5 to 11. Maximum allowable service pressure is 20,685 kPa (ga) (3,000 psig). Maximum partial pressures of H₂S and CO₂ are each 345 kPa (abs) (50 psia).

c) SAP M/N: (Refer to [SAES-H-002V](#))

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 (2–4 mils). Use either garnet or steel grit abrasive for blasting. Sand is not acceptable. Crawler-applied approved FBE or liquid coating under APCS-120 for internal girth welds of pipe strings. Preheat area to be FBE coated with induction heaters only. Refer to [SAES-H-201](#) for coating on post weld heat treated pipes.

c) Compatible Repair Coatings: Approved repair coatings.

APCS-102C

I. TYPE OF COATING

Shop-Applied Fusion Bonded Epoxy for Internal Coating of Sour/Sweet Gas Pipelines.

II. GENERAL DATA

a) Uses: Primarily used for sour and sweet gas pipelines excluding girth welds.

b) Service Limitations:

Temperature: Min. 0°C

Max. 95°C

Other: pH range 3.5 to 11. Maximum allowable service pressure is 20,685 kPa (ga) (3,000 psig). Maximum partial pressures of H₂S and CO₂ are each 345 kPa (abs) (50 psia).

c) SAP M/N:

d) Purchase Specification: 09-SAMSS-091. The coating shall be tested against the operating conditions involved.

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 (2 – 4 mils). Use either garnet or steel grit abrasive for blast cleaning. Crawler-applied approved FBE or liquid coating under APCS-120 for internal girth welds of pipe strings. Refer to SAES-H-201 for coating on post weld heat treated pipes.

c) Compatible Repair Coatings: Approved repair coatings.

APCS-103

I. TYPE OF COATING

Shop or Field-Applied Cement Mortar Internal Coating for Pipelines and Piping

II. GENERAL DATA

a) Uses: Internal coating for most water services.

b) Service Limitations:

Temperature: Min. 0°C
Max. 90°C

Other: Minimum pH 5.5. Maximum fluid velocity 3 m/s.
Service pressures up to 34,475 kPa (ga) (5,000 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. In such cases, the external coating (normally FBE) must be applied first.
- 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 SAP M/N: 1000187426 (old SAMS S/N: 09-239-660-00).

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); SAP M/N: 1000187426 (old SAMS S/N: 09-239-660-00) (in potable water service).

APCS-104A

I. TYPE OF COATING

Shop-Applied External Fusion Bonded Epoxy (93°C-Dry, 65°C-Immersed)

II. GENERAL DATA

a) Uses: External coating for onshore buried service. Also, suitable for subsea service in conjunction with weight coating.

b) Service Limitations:

Temperature:

Min. -20°C

Max. (In Subkha or immersion): 65°C

Max. (In dry ground): 93°C

c) Conventional FBE: SAP M/N: 1000197745 or SAES-H-002V

d) Purchase Specification: 09-SAMSS-089.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per 09-SAMSS-089.

b) Field Girth Weld Area: Per SAES-H-201.

c) Compatible Repair Coatings: Use melt sticks or approved epoxy coating in the shop and only use epoxy coating in the field.

APCS-104B**I. TYPE OF COATING**

Shop-Applied External Fusion Bonded Epoxy (110°C-Dry, 90°C-Immersed)

II. GENERAL DATA

a) Uses: External coating for onshore buried service. Also, suitable for subsea service in conjunction with weight coating.

b) Service Limitations:

Temperature:

Min. -20°C

Max. (Subkha or immersion): 90°C

Max. (Dry ground): 110°C

c) High Temperature FBE: SAP M/N: 1000628582 or SAES-H-002V

d) Purchase Specification: 09-SAMSS-089.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per 09-SAMSS-089.

b) Field Girth Weld Area: Per SAES-H-201.

c) Compatible Repair Coatings: Use melt sticks or approved epoxy coating in the shop and only use epoxy coating in the field.

APCS-104C**I. TYPE OF COATING**

Shop-Applied External Fusion Bonded Epoxy (130°C Dry/Immersed)

II. GENERAL DATA

a) Uses: External coating for onshore buried service. Also, suitable for subsea service in conjunction with weight coating.

b) Service Limitations:

1) High Temperature FBE (T_g greater than 140°C)

Temperature:

Min. -20°C

Max. (Dry/ Subkha or immersion): 130°C

c) High Temperature FBE: SAES-H-002V

d) Purchase Specification: 09-SAMSS-089.

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe: Per 09-SAMSS-089.

b) Field Girth Weld Area: Per SAES-H-201.

c) Compatible Repair Coatings: Use melt sticks or approved epoxy coating in the shop and only use epoxy coating in the field.

APCS 113A

I. TYPE OF COATING

High-Build Liquid Epoxy Coatings for Renovation of Pipelines buried in Subkha and dry soils

II. GENERAL DATA

Uses: Primarily used as a renovation coating for the external of buried piping, pipelines, and associated fittings and appurtenances.

- a) This system can also be used as a shop coating for pipeline spools, fittings, and appurtenances. The solids content is 97% (± 3) by volume.
- b) SAP M/N: 1000686070
- c) Maximum Service Temperature Limitations:
 - 1) 120°C in dry soil.
 - 2) 90°C in Subkha soil.
- d) Generic Information: This APCS covers a variety of high build epoxy liquid coatings with or without reinforcing fillers. For generic information, check approved 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 (SSPC-SP10)
Surface Profile: 50 to 100 microns (2 to 4 mils)
Use abrasives SAP M/N 1000161068 and 1000160374.
- b) Test the steel substrate for chloride salts contamination. Substrates with residual chlorides exceeding 20 mg/m² shall be decontaminated by fresh water high-pressure wash.

- c) Dry Film Thickness:
600–1,000 microns (24–40 mils) applied in wet-on-wet single coat application.
- d) Shop coating application on pipes shall be done, using an automated process. The pipe can be rotated while the spray gun moves at a constant speed with the aid of a motor.
- e) Compatible Repair Coatings: APCS-113A.
- f) The required voltages for holiday detection of the coating prior to burial are $2,400 \pm 50$ 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-113C

I. TYPE OF COATING

Non-curing (Visco-elastic) Mastic-based Coating System with a Backing Tape for Renovation of Buried Pipelines

II. GENERAL DATA

- a) Uses: Primarily used as an external protective coating system for renovation of buried pipelines. It can be used, as a corrosion protection, for field girth weld on both new and old pipelines. If it is used on offshore girth weld, outer-wrap for mechanical protection shall be used.

When used under direct sunlight, polyester sheathing (SAP M/N 1000600010) shall be utilized as the final layer.

- b) Service Limitations:

Temperature: Min. 10°C

Max. 70°C. Approved high temperature type can be used up to 80°C.

- c) The PVC outer wrap is not suitable for continuous contact with liquid hydrocarbons, including oil-soaked soil.

- d) Suitable for both dry and Subkha soil.

- e) SAP M/N:

Visco-elastic Coating: 1000600006, 1000600007, and 1000600011 depending on width

Outer Wrap: 1000600006, 1000600007, 1000600008, 1000600009, and 1000600011 depending on width

Adhesive/Paste: 1000600012

Sheathing: 1000600010

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).

Cathodic Disbonding Test (ASTM G42): No disbonding @ 70°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) is used.
Wire brushing is acceptable on small areas (less than 1 meter long).
Wrapping can be applied over existing, sound coating after the removal of
loose paints and debris.

b) Surface Profile: Not critical

c) Over lapping:

For the visco-elastic layer, the overlap shall be 20% of the width of the
tape for pipes with diameters up to 10", and 15 mm for pipes with
diameters larger than 10". For the outer wrap, the overlap shall be 50% of
outer wrap width.

d) For girth weld application:

For pipe diameter up to 12", the overall bandwidth of the visco-elastic
coating system shall be 3 times the bandwidth of the girth weld bare area
(if the bandwidth of the girth weld is 4" (2 cutbacks), the total visco-elastic
coating is 12"). For pipe diameter more than 12", the overall bandwidth of
the visco-elastic coating system shall be 4 times the bandwidth of the girth
weld bare area, in this case the total visco-elastic coating will be 16" based
on a bandwidth of 4" as an example.

e) Compatible Repair Coatings: APCS-113C

APCS-117

I. TYPE OF COATING

Field or Shop-Applied, Thick Liquid Coating for Piping

II. GENERAL DATA

a) Uses: Internal coating for water, oil or gas service. For spools, elbows, tees, wyes, nozzles, flanges and other associated pieces of piping systems. When the coating is glass fiber/flake reinforced, a final coat of flow coating should be used to ensure a good flow property.

b) Service Limitations:

Temperature: Depends on the temperature limitation of the coating product

Other: Depending on the coating product: pH range 2 to 13, maximum allowable service pressure 20,684 kPa (ga) (3,000 psig), and maximum partial pressures for H₂S and CO₂ of 345 kPa (abs) (50 psia).

c) SAP M/N: 1000180021, 1000180023, 1000180276, 1000180279, 1000180328, and 1000180337.

d) Purchase Specification: 09-SAMSS-067

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe Joints and Girth Weld Areas: Near white metal blast, ISO 8501 Sa 2-½ (SSPC SP 10), surface profile 50–125 microns (2–5 mils). Use garnet or coal slag abrasives in SAP M/N 1000160377 or 1000161063.

b) Dry Film Thickness

500 to 1,000 microns (20–40 mils) depending on product specification

c) Compatible Repair Coatings: APCS-117

APCS-120

I. TYPE OF COATING

Field or Shop Applied Internal Girth Weld Liquid Coating for Piping

II. GENERAL DATA

a) Uses: Internal coating for water, oil, or gas service in the girth weld area applied by special semi-robotic machines.

b) Service Limitations:

Temperature: Depends on the temperature limitation of the coating product.

Other: Depending on the coating product: pH range 2 to 13, maximum allowable service pressure 20,684 kPa (3,000 psig), and maximum partial pressures for H₂S and CO₂ of 345 kPa (abs) (50 psia).

c) SAP M/N: N/A

d) Purchase Specification: 09-SAMSS-067

III. SURFACE PREPARATION AND COATING APPLICATION REQUIREMENTS

a) Pipe Joints and Girth Weld Areas: Typically, near white metal blast, SIS Sa 2-½, surface profile 50–125 microns (2–5 mils). Use garnet or coal slag abrasives in SAP M/N 1000160377 or 1000161063.

b) Dry Film Thickness

500 to 1,000 microns (20–40 mils) depending on product specification

c) Compatible Repair Coatings: Use the same selected coating for the girth weld area.