Engineering Standard

SAES-H-002 29 January 2008

Internal and External Coatings
for Steel Pipelines and Piping

Paints and Coatings Standards Committee Members
Barouky, Fikry Fouad, Chairman
Hammad, Bakr Sulaiman, Vice Chairman
Suller, Abraham A
Seba, Zaki Ahmed
Mansour, Mana Hamad
Khashram, Maher Saud
Homayed, Mohammed Ali
Nujaim, Salah Ahmed

Saudi Aramco DeskTop Standards

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Primary contact: Barouky, Fikry Fouad on 966-3-8746129

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1 Scope

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). Excluded from this Standard all temporary coatings. This Standard is not applicable for 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 Procedures

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*
SAEP-361	*Storage, Handling and Installation of Weight-Coated Pipe*

Saudi Aramco Engineering Standards

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

SAES-H-101V	*Saudi Aramco Data Sheets*
SAES-H-201	*General Specification for Over-the-Ditch Internal & External FBE Coating of Field Girth Welds*
SAES-L-120	*Piping Flexibility Analysis*
SAES-L-310	*Design of Plant Piping*
SAES-L-350	*Construction of Plant Piping*
SAES-L-410	*Design of Pipelines*
SAES-L-450	*Construction of On-Land and Near-Shore Pipelines*

Saudi Aramco Materials System Specifications

01-SAMSS-005	*Shop Applied, Internal Cement Mortar Lining of Steel Pipe*
09-SAMSS-080	*Shop-Applied Baked Internal Coatings*
09-SAMSS-089	*Shop-Applied External FBE Coating*
09-SAMSS-090	*Shop-Applied Extruded P.E. External Coating System for Line Pipe*
09-SAMSS-091	*Shop-Applied Internal FBE Coatings*
09-SAMSS-099	*Specialized Coatings Tests*
09-SAMSS-113	*External Renovation Coating for Buried Pipelines and Piping (APCS-113)*
09-SAMSS-114	*Shop-Applied Extruded, Three-Layer Polypropylene External Coatings for Line Pipe*

3.2 Industry Codes and Standards

National Association of Corrosion Engineers (NACE)

RP0198 -2004	*The Control of Corrosion Under Thermal Insulation and Fireproofing*

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*

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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	*Polyethyline 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.

Transision Lines: Pipeline or piping changes from buried conditions to above grade conditions, either in or off Plant.

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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 All onshore buried and subsea coated pipes shall be 100% holiday free and all holidays shall be repaired prior to burial.

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

5.1.5 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.

5.1.6 Liquid coating systems shall not be used on new projects as the primary external coating on buried pipelines. For field girth welds consult with the coating RSA to use liquid coating if other systems given in item 5.4.2 deemed impractical.

Exception:

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

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5.1.7 Hand-applied tapes of all types shall not be used.

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 2.5 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 halide-free liquid coating approved by the RSA.

5.1.12 Pipe to be thrust bored shall be coated with APCS-104 and top coated with APCS-113A to 1000 microns (40 mils) 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 4 inches and smaller shall be coated with APCS-113A, APCS-113C, or other systems with prior approval from RSA.

5.1.15 Preheating pipe substrate for FBE coating application on the girth welds shall be done by heat induction coils only. The RSA must approve any other preheating methods in case there are difficulties and impractical to use the heat induction coils.

5.2 General Requirements for Internal Coatings

5.2.1 Internal coatings are not mandatory in this Standard unless required in other Saudi Aramco Standards, specifications, scopes of work, 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 The robotic crawler shall be used for internal girth welds coating of

pipe with diameters from 10" to 20". Pipe diameters with 24" and larger shall be coated with other conventional methods subject to prior approval from the Coating RSA, refer to SAES-H-201.

5.2.4 Internal coatings in dead-leg and jump-over piping sections shall be 100% 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.

5.2.6 Preheating pipe substrate for FBE coating application shall be done by heat induction coils only. The RSA must approve any other preheating methods in case there are difficulties and impractical to use the heat induction coils.

5.3 Internal Coatings, Various Services

	Approved Coatings System		
Categories	**New Constr.**	**Maintenance**	**Area to be Coated/Other Remarks**
5.3.1 Water Potable	APCS-103 APCS-100 APCS-101 APCS-102 APCS-2B APCS-2E	APCS-103 APCS-102 APCS-2B ACPS-2E	All FBE products must be certified by FDA or equivalent for potable water services. FBE powder products must have a current certificate from an approved third party lab valid for at least 24 months.
5.3.2 Water, Oil, or Gas	APCS-100 APCS-101 APCS-102 APCS-103 APCS-2E APCS-2F APCS-2G	APCS-103 APCS-2A APCS-2E APCS-2F APCS-2G	When using APCS-2A, 2E, 2F, and 2G the allowable pH range is 4.0 to 12.0, the maximum service pressure is 6890 KPa (ga) (1000 psig), and the maximum partial pressure of H_2S and CO_2 is 345 KPa (abs) (50 psia) each.
5.3.3 Field Girth Weld Areas	APCS-102 APCS-2E APCS-2G	See remarks	1) Use robotic crawler for internal coating of field girth weld of pipe diameters from 10" to 20". 2) Consult RSA for maintenance coating on the girth weld areas for all pipeline diameters. 3) All internal coatings on the field girth welds must be 100% holiday free. 4) Jointing pipes with small diameters less than 10", seek other methods recommended by other Standards, or consult the piping RSA.

5.4 External Coatings for Onshore and Cross-Country Pipelines

	Approved Coatings System		
Categories	**New Constr.**	**Maintenance**	**Area to be Coated/Other Remarks**
5.4.1 Buried (Pipe joints)	APCS-104 APCS-105 APCS-106 APCS-115	APCS-113A/B/C	1) APCS-106 may only be used in cases where subsequent field bending will not be required, e.g., cement-lined pipe. 2) APCS-113A 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. 3) Note the temperature limitation of APCS-113C when used for buried pipeline maintenance.
5.4.2 Buried (Field Girth Welds)	APCS-104 APCS-113C	APCS-113A APCS-113C	1) Use APCS-22 if the surface is slightly damp. 2) APCS-113A may be used on new construction for (1) tie-in welds (2) girth welds on thrust bored pipe, and (3) occasional, isolated welds.
5.4.3 Buried Fittings, Appurtenances and Spool Pieces	APCS-104 APCS-113A/B APCS-19B	APCS-113A/B/C APCS-19B APCS-22B APCS-10	Use APCS-22B if the surface is slightly damp. APCS-113C is acceptable for maintenance to replace old tapewrapped spool.
5.4.4 Buried Road Crossings	APCS-104 APCS-105 APCS-113A/B APCS-19B APCS-115	APCS-113A/C APCS-19B 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	For aesthetic or color coding refer to SAES-H-001.
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-22B, 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.

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5.5 External Pipe Coatings, Subsea

	Approved Coatings System		
Categories	**New Constr.**	**Maintenance**	**Area to be Coated/Other Remarks**
5.5.1 Pipe Joints	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 be used for short repairs.
5.5.2 Field Girth Weld Area	APCS-3	Not applicable	The joint coating shall be protected by a heavy plastic mesh or by a hot marine mastic or foam infill.
5.5.3 Fittings Appurtenances & Spool Pieces	APCS-104 APCS-2E APCS-3 APCS-19B	APCS-104 APCS-2E APCS-3 APCS-19B	APCS-19B and APCS-19C may be used for subsea repairs.
5.5.4 Risers	APCS-104 APCS-105 APCS-3 APCS-19B APCS-19C	Same as new Construction	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-004
5.5.5 Conductors	APCS-22 APCS-19C	APCS-22 APCS-19C	For conductors on platforms, APCS-22 and APCS-19C may be used in the splash zone. For free-standing conductors, use Monel sheathing or APCS-19C in the splash zone.

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