

Engineering Standard

SAES-H-003

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Protective Coatings for Industrial Concrete Structures

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Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This standard covers the minimum mandatory requirements for surface preparation, coatings application, and coatings materials selection for the concrete surfaces in industrial facilities both onshore and offshore.

Exception:

Coating of above ground/atmospheric concrete structures is not required, unless otherwise specified in other standards and project documents.

- 1.2 This standard shall not cover water-proofing materials designed to slow or prevent chloride ion attack or carbonation, or to address the decorative finishes utilized for concrete buildings. It does not cover the concrete repair materials prior to coating such as sealers and synthetic membranes sheets.
- 1.3 The objectives of concrete coatings are as follows:
- a) Protection from chemicals.
 - b) Protection from wear, abrasion and impact.
 - c) Mitigation of steel reinforcement corrosion.
 - d) Mitigation of fouling.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), related Materials System Specifications (SAMSSs), Codes, Forms, Standard Drawings (SASDs), and industry standards, shall be resolved in writing through the Manager, Consulting Services Department (CSD) of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Saudi Aramco 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

<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 of Coating Personnel</i>

Saudi Aramco Engineering Standards

<u>SAES-A-113</u>	<i>Geotechnical Engineering Requirements</i>
<u>SAES-B-006</u>	<i>Fireproofing for Plants</i>
<u>SAES-B-055</u>	<i>Plant Layout</i>
<u>SAES-B-068</u>	<i>Electrical Area Classifications</i>
<u>SAES-B-069</u>	<i>Emergency Eyewashes and showers</i>
<u>SAES-L-440</u>	<i>Anchor for Buried Pipelines</i>
<u>SAES-O-100</u>	<i>General Requirements Safety and Security</i>
<u>SAES-Q-001</u>	<i>Criteria for Design and Construction of Concrete Structures</i>
<u>SAES-Q-005</u>	<i>Concrete Foundations</i>
<u>SAES-Q-007</u>	<i>Foundations and Supporting Structure for Heavy Machinery</i>
<u>SAES-Q-009</u>	<i>Concrete Retaining Walls</i>
<u>SAES-S-020</u>	<i>Industrial Drainage and Sewers</i>

Saudi Aramco Materials System Specifications

<u>09-SAMSS-067</u>	<i>Qualification Requirements for Epoxy Coatings for Immersion Service</i>
<u>09-SAMSS-068</u>	<i>Qualification Requirements for Coal Tar Epoxy In Buried or Immersion Services (APCS-3)</i>
<u>09-SAMSS-069</u>	<i>Qualification Requirements for Epoxy Coatings for Atmospheric Service</i>
<u>09-SAMSS-075</u>	<i>Caulking Compound (Joint Sealant)</i>
<u>09-SAMSS-097</u>	<i>Ready-Mixed Portland cement Concrete</i>
<u>09-SAMSS-106</u>	<i>Epoxy Coating of Steel Reinforcing Bar</i>

3.2 Industry Codes and Standards

American Concrete Institute

<i>ACI 201.1R</i>	<i>Guide for Making a Condition Survey of Concrete</i>
<i>ACI 228.1R</i>	<i>Manual of Concrete Inspection</i>
<i>ACI 311.4R</i>	<i>Guide for Concrete Inspection</i>

International Concrete Repair Institute (ICRI)

<i>Technical Guide 03730</i>	<i>Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion</i>
<i>Technical Guide 03732</i>	<i>Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays</i>
<i>Technical Guide 03733</i>	<i>Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces</i>

Steel Structure Painting Council

<i>SSPC-12/NACE 4</i>	<i>"Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating"</i>
<i>SSPC-SP13/NACE 6</i>	<i>Surface Preparation of Concrete</i>

American Society Testing Materials

<i>ASTM D4541</i>	<i>"Test Method for Pull-Off Strength of Coating Using Portable Adhesion Testers"</i>
<i>ASTM D4138</i>	<i>"Test Method for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means"</i>
<i>ASTM D4752</i>	<i>"Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub"</i>
<i>ASTM D3363</i>	<i>"Test Method for Film Hardness by Pencil Test"</i>

4 Definitions

Approved Product: Coating material that has been approved by the RSA after meeting the requirements of the applicable APCS or SAMSS. If there is no applicable APCS or SAMSS, the product must be certified and approved in writing by the RSA

confirming that the selected product is suitable for the intended service. Only approved products are allowed for use by Saudi Aramco jobs.

Carbonation: Carbonation is the process of carbon dioxide reaction with calcium hydroxide within the cement, neutralizing it to form calcium carbonate.

Construction Joint: A joint placed in a concrete slab at the end of an individual placement. These joints can be planned and correspond with the overall slab joint layout, or the result of an unplanned stoppage of the placement in progress.

Curing compound: A liquid that can be applied on the surface of newly placed concrete to retard the loss of water or, in the case of pigmented compound, also to reflect heat so as to provide an opportunity for the concrete to develop its properties in a favorable temperature and moisture environment.

DFT: Dry film thickness.

Film Forming Sealer: liquid materials that penetrates into minor surface imperfections but not into the pores of the concrete. They are basically low-solids coatings with low molecular weight film forming binders.

Heavy Duty Surface: Concrete subject to continuous immersion, frequent spillage, heavy chemical fumes, severe abrasion and/or physical abuse.

Holiday: Pinhole, skips, discontinuity, or void in a coating film that expose the substrate.

Laitance: A layer of weak and nondurable material containing cement and fines from aggregates that bleeding water brings to the top of over-wet fresh concrete. Laitance must be removed before coating applications on concrete.

Light Duty Surface: Concrete subject to salt laden environments, occasional chemical spillage, moderate industrial fumes or other mild attack.

Moisture Vapor Transmission: the rate at which moisture vapor moves through a membrane.

Pop-Out: Shallow, typically conical, depressions resulting from localized internal pressure of concrete

RSA: Responsible Standardization Agency Representative - Coating Engineer designated by the Manager of the Consulting Services Department. RSA is responsible for product approvals and is the CSD contact for matters involving interpretation and application of this specification.

5 Health, Safety and Environment

5.1 Fire and Explosion Prevention

- 5.1.1 Smoking and/or the use of open flames shall be permitted only in designated safe areas and never inside confined areas. Any hot works such as welding and the use of heating coils are prohibited in areas where coating is in progress.
- 5.1.2 All electrical lighting, equipment, and connections shall conform to National Electric Code (NEC), Class I, Division 1, Group D explosion proof requirements (NEC Article 500) as per [SAES-B-068](#).
- 5.1.3 All electric power driven tools shall be certified for use inside Class 1/Zone 1/Gas group IIA classified area.
- 5.1.4 Solvents and paints shall not be applied to surfaces warmer than 80°C if practical alternatives exist.
- 5.1.5 Work Permits for hot work, cold work, and confined space entry shall be obtained in accordance with GI-0002.100.

5.2 Ventilation

- 5.2.1 Forced ventilation shall be used in confined spaces whenever abrasive blasting, solvent cleaning, and/or painting are in progress to prevent excessive building up of dust and flammable fumes that can be detrimental on human health and safety.
 - 5.2.1.1 Forced ventilation shall continue until the coating is fully cured and ready for service.
 - 5.2.1.2 Natural ventilation (through opened manholes, etc.) shall not be substituted for forced ventilation in confined spaces.
 - 5.2.2 Ventilation shall ensure good air circulation with no dead air pockets in the confined space.
 - 5.2.2.1 The fresh air inlet shall be located near the top of the confined space whenever practical.
 - 5.2.2.2 The discharge opening shall be located near the bottom of the confined space.
 - 5.2.2.3 Supplementary fans shall be used if necessary to ensure adequate air circulation in low spots or dead spaces.
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- 5.2.3 Ventilation requirements for various sizes of confined spaces are given in Table 5-1.

Table 5-1 – Ventilation Requirements for Confined Spaces

Volume of Confined Area		Required Air Mover Capacity	
M ³	Bbl	L/s	cfm
16	100	472	1000
80	500	1180	2500
160	1000	2360	5000
800	5000	4720	10000
1600	10000	7080	15000
4000	25000	9440	20000

- 5.2.4 Air-line respirator hoods shall be worn by all personnel inside confined spaces whenever:

5.2.4.1 Blasting or spray painting is in progress.

5.2.4.2 Solvent cleaning or brush painting is in progress in a confined space having a volume of less than 16 m³.

5.3 Health Hazards

5.3.1 If alkaline catalysts (such as used in many epoxy paints) come in contact with the skin, they shall be immediately washed off with water to avoid chemical burns and the manufacturers' recommended first aid shall be followed.

5.3.2 The appropriate personnel protection equipment listed in Table 5-2 shall be worn. In addition, safety belts and lines shall always be used by personnel working from unguarded platforms or in confined spaces where a manhole accessed by a ladder is the only exit.

Table 5-2 – Personal Protective Equipment to be Worn or Used during Surface Preparation & Paint Application

Key: O = Outdoors
 C = Confined Spaces

Type of Work to be Performed	OSHA-Approved Respirable Airfed Hood And Filger 21-444-934 21-443-500		Respirator; Chemical Cartridge 21-370-800 21-370-810 21-370-820				Dust Respirator 21-370-600		Face Shield ⁽¹⁾ 21-426-121 21-426-125 21-426-142							
	O	C	O		C		O	C	O		C					
Surface Preparation Wire Brushing, Chipping, Scrapping and Grinding							x	x		x	x					
Sandblasting - operator - other workmen	x	x							x		x					
Paint Removing						x					x	x				
Solvent Cleaning						x					x	x				
Paint Application	Brush		Spray		Brush		Spray		Brush		Spray		Brush		Spray	
	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C
Epoxy and Coal/Tar Epoxy				x		x							x	x	x	
Alkyd						x	x									
Inorganic Zinc				x										x		
Chlorinated Rubber						x	x									
Bituminous						x	x									

Note: ⁽¹⁾ Face shields shall always be used when working overhead.

Table 5-2 - Personal Protective Equipment to be Worn or Used during Surface Preparation & Paint Application (Cont'd)

Key: O = Outdoors
 C = Confined Spaces

Type of Work to be Performed	Goggles Safety Impact 21-434-249		Gloves; Leather 21-432-353		Gloves; Rubber 21-432-630		Hearing Protection 21-327-100/ 105/110/272	
	O	C	O	C	O	C	O	C
Surface Preparation Wire Brushing, Chipping, Scrapping and Grinding	x	x	x	x				
Sandblasting - operator - other workmen - in vicinity		x	x	x				x x
Paint Removing						x		
Solvent Cleaning						x		
Paint Application	Brush		Spray		All			
	O	C	O	C				
Epoxy and Coal/Tar Epoxy					x			
Alkyd			x	x	x			
Inorganic Zinc			x	x	x			
Chlorinated Rubber			x	x	x			
Bituminous			x	x	x			
Polyurethane			x	x	x			

- 5.3.3 Adequate washing facilities shall be readily available so that paints and solvents splashed on the body or in the eyes can be immediately removed.
- 5.3.4 Safety shoes and coveralls shall always be worn and safety hats shall be worn as required by proponent organizations.
- 5.3.5 Compressed air from any source shall not be used by personnel for cleaning or cooling themselves.
- 5.3.6 Solvents shall not be used for any personnel cleaning purposes to remove paint spots on clothes or for washing paint contaminated hands.
- 5.3.7 Materials Safety Data Sheets for all coatings, solvents, and cleaners in use shall be readily available on-site.

5.4 Equipment Hazards

- 5.4.1 Power tools

- 5.4.1.1 Electrically driven power tools shall be properly grounded to prevent shock.
 - 5.4.1.2 Power equipment shall be operated at the speeds recommended by the manufacturer and shall have proper safety guards.
 - 5.4.1.3 Hearing protection shall always be worn whenever chipping guns or pneumatic hammers are in use.
 - 5.4.1.4 Vessels such as air receivers that are used as a surge tank between the compressor and the blasting pot shall be manufactured and stamped in accordance with ASME SEC VIII D1, Unfired Pressure Vessels. They shall be hydro tested at a pressure of 1.3 to 1.5 times the maximum operating pressure stamped on the vessel, dependant on the year of construction, at ambient temperature using clean water. These vessels shall be revalidated by hydro testing at least annually and the test certificates shall be submitted to the Saudi Aramco Inspector for verification.
 - 5.4.1.5 All pressure relief valves, gauges, and devices shall be tested annually and tagged with the expiration date. The test certificates shall be submitted to the Saudi Aramco Inspector for verification.
 - 5.4.1.6 All blasting and coating equipment and associated attachments shall be adequately earthed to avoid electrostatic discharges.
 - 5.4.2 Abrasive Blasting Equipment
 - 5.4.2.1 All Blasting machines shall be equipped with a "deadman" shut-off controls.
 - 5.4.2.2 The blast nozzle shall be electrically connected to an external ground in order to prevent static electrical discharges or shocks to operating personnel. Grounding wire shall be AWG-4 or larger.
 - 5.4.2.3 The blasting hose shall be the static dissipating type with external couplings.
 - 5.4.2.4 Respirable air-fed abrasive blasting hoods and OSHA-approved in-line respirable air filters shall be utilized at all times by abrasive blasting personnel.
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5.4.2.5 Compressor hoses, air lines, and blast hoses shall be safety locked at each coupling using proper safety pins.

5.4.2.6 Hearing protection shall be worn in confined spaces where abrasive blasting is in progress.

5.4.3 Solvent Cleaning

Benzene, gasoline, carbon tetrachloride, and chlorinated hydrocarbons with low threshold limit values (less than 20) shall not be used

5.4.4 Paint Preparation and Equipment Cleaning

5.4.4.1 Coatings shall be mixed outside or in an adequately ventilated area. Use eye protection (goggles) and protective gloves.

5.4.4.2 Electrically driven power mixers shall be grounded.

5.4.4.3 Avoid splash or spillage during mixing. Clean spilled paints immediately using proper cleaning solvent.

5.4.5 Airless Spray Paint Application

5.4.5.1 Airless spray guns shall never be pointed at anyone or at any part of the body.

5.4.5.2 The tip guard shall always be in place on the airless gun while spraying.

5.4.5.3 Leather gloves shall be worn by the operator whenever the airless spray gun is in use.

5.4.5.4 The trigger safety catch shall be engaged whenever the airless gun is left unattended.

5.4.5.5 Hoses, pumps, and accessories shall never be operated at pressures exceeding their rated pressure. In no case shall the working pressure in the paint line exceed 34.5 MPa (5000 psi). Safety pressure relief valves shall be used on discharge side of the pressure pump(s).

5.4.5.6 The pump shall be shut down and the fluid pressure in the system relieved before servicing or cleaning any components, including clogged spray tips.

5.4.5.7 Hoses shall be grounded, anti-static type.

- 5.4.5.8 Airless spray equipment shall not be operated unless all grounds (earths) are in place, connected, and in good condition. Grounding wire shall be AWG-4 or larger.
- 5.4.5.9 Airless spray equipment shall not be operated if any of the pressure system components is not in good condition.
- 5.4.5.10 Solvents shall not be flushed into containers that are hotter than 50°C.
- 5.4.5.11 Emergency medical care shall be obtained immediately if any high pressure fluid from the airless equipment penetrates the skin. (High pressure fluid injection injuries can be extremely serious, including the need for amputation).

6 Coating Material Selection for Concrete Structures

6.1 Foundation, Columns, Walls

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Above Ground	APCS-1B APCS-1E	APCS-1B APCS-1E	1) Do not use primer. 2) Use APCS-1E for chalking resistance and color retention
Buried	APCS-3 APCS-10 APCS-113A	APCS-3 APCS-10 APCS-113A	1) Coat buried concrete surfaces up to 1 ft above the grade level. 2) APCS-10 is not suitable for direct sunlight and hydrocarbon. 3) Use APCS-113A (with high solid volume products more than 85%)

6.2 Equipment Base

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Acid & Caustic Pumps	APCS-2G	APCS-2G	
Compressor and Turbine Skid	APCS-1B	APCS-1B	
Chemical Injections Skid	APCS-2G	APCS-2G	

6.3 Concrete Floor

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Chemicals Storage Area	APCS-2F	APCS-2E	
Battery Rooms	APCS-9 APCS-2F	APCS-9 APCS-2E	

6.4 Basin, Sump, Trench, Pit (Interior)

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Potable Water	APCS-2B	APCS-2B	
Raw water	APCS-2A/2B	APCS-2A/2B	Use APCS-2B for domestic raw water.
Sea Water/Cooling tower basins	APCS-2E APCS-2F		
Waste Water, Sewage Treatment and API Hydrocarbon Separator	APCS-3 APCS-2A APCS-2E APCS-2F	APCS-2A	1) For APCS-3, use the polyamine cured type
Chemical Neutralization Pits	APCS-2E APCS-2F APCS-2G	APCS-2E	
Molten Sulfur	APCS-2E	APCS-2E	
AMINES	APCS-27	APCS-27	

6.5 Primary containments

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Concrete Floors for Sulfuric Acid and Caustic Soda	APCS-2G	APCS-2E	

6.6 Secondary containments

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Concrete floors for Sulfuric Acid and Caustic Soda	APCS-2G	APCS-2E	

6.7 Cementitious Fireproofing

COATING SYSTEM			
DESCRIPTION	NEW (During Construction and complete re-coat application)	MAINT (Remedial work during the useful life of coating)	REMARKS
Cementitious Fireproofing	Top-coat of APCS-1B	APCS-1B	Refer to Saudi Aramco Engineering Standard SAES-B-006 for more details.

7 Concrete Surface Preparation Requirements

7.1 General Requirements

- 7.1.1 The purpose of surface preparation is to remove laitance, contaminants and others adhered compounds on the concrete like the curing agents, and to create an anchoring for coatings to be well adhered with the concrete structures.
- 7.1.2 Concrete surfaces shall be prepared for coating after they are adequately cured. The surface preparation methods of concrete structures can be done by mechanical cleaning, abrasive blasting, acid etching and water-jetting.

- 7.1.3 Concrete surface preparation prior to coating application shall include but not limited to: Repair of cracks, spalls, pop outs, and other irregularities, Removal of surface contaminants that inhibit coating adhesion or induce early coating deterioration, Roughen the smooth surfaces to improve coating adhesion, and Eliminating any weak surface layers to establish the strong base required for many coating system.
 - 7.1.4 For surface profile use ICRI Guideline 03732 or equivalent document, which shall identify distinct profile levels for different generic coatings at different dry film thicknesses when a specific surface profile is required.
- 7.2 Surface Preparation Requirements for New Concrete
- 7.2.1 Light Duty Service
 - 7.2.1.1 Scour the surface to remove any protrusions and sharp edges by using an abrasive brick (carborundum), power grinding, or power brushing. Check the overall surface soundness by scratching a screwdriver or pocket knife across the surface. If the metal object rides over the surface without loosening any particles and leaves only a shiny mark, the surface is sound. Otherwise, continue scouring.
 - 7.2.1.2 Surface contaminants such as laitance and form oils must be removed. Form oils, grease, etc. shall be removed by steam cleaning with a water emulsifying detergent added. Laitance shall be removed by wire brushing.
 - 7.2.1.3 Hydrochloric acid shall be used acid etching at dilution 10/90 to 20/80 with water. Acid etching shall be applied at the rate of 1.0 liter/m². Let the acid react with the concrete surface for 5 to 10 minutes and then flush with water while scrubbing. Check the adequacy of the flushing by placing Litmus or pH paper on the wet surface to ensure that it is fully neutralized. Allow the surface to dry completely before applying any coating.
 - 7.2.1.4 If the concrete surface is quite smooth such as "formed" surfaces, use dry and light sweep blasting to roughen the surface. The surface of the new concrete shall be roughened to the texture of medium grit sandpaper. High pressure (3000 psi at the nozzle) water rinse injected with abrasive can be used subject to prior CSD approval.
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- 7.2.1.5 After cleaning is completed ensure that surfaces are free of voids which may be exposed or enlarged during blasting process. Repair the voids if necessary.

Note: Surfaces with a "broom" finish and free from laitance, oil, grease and other contaminants normally do not require additional surface preparation prior to coating.

7.2.2 Heavy Duty Service

Prepare the surfaces as stated in item 7.2.1 for light duty service. Measure the tensile strength of the concrete surface in accordance with ASTM D4541. The "pull-off" shall meet or exceed 175 psi for immersion service and 260 psi for industrial floors. If the 'pull-off" test is not met, contact the CSD Civil Engineering unit, Dhahran.

7.3 Surface Preparation Requirements for Old Concrete - All Services

- 7.3.1 Remove all loose concrete, surface contaminations, sealants, and old coatings by abrasive blasting (or other mechanical means) and/or hot water high pressure washing as appropriate, prior to making concrete repairs and coating application.
- 7.3.2 Chemically contaminated surfaces shall be neutralized and repaired prior to the coating application as follows:
- a) Remove all loose concrete, sealants, and old coatings by abrasive blasting prior to the neutralizing process.
 - b) Neutralize acidic surfaces with an alkaline cleaner followed by a high pressure fresh water rinse. Concrete surfaces that have been in prolonged contact with acids require a minimum soak of 24 hours at a pH of 7-8, agitating the solution during soaking. After rinsing, force air dry surfaces for at least 24 hours prior to making any repairs to the concrete. Surface pH verification is required after alkaline treatment.
 - c) Neutralize alkaline surfaces by steam cleaning. Strip of pH Test Paper shall be dipped in the rinse water remaining on the surface. The pH reading obtained shall not be more than 1.0 pH units lower or 2.0 pH units higher than readings taken on the fresh water rinse before being applied to the concrete surface. Surface pH verification is required after acid treatment.
- 7.3.3 For steel reinforced concrete, if the existing steel reinforcement is exposed, locally blast clean and coat with APCS-1C primer or APCS-113A to a minimum distance of 25 mm beyond the repair area.
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7.4 Repair of Cracks, Voids, Joints

- 7.4.1 Cracks less than 10 mm wide and holes not exceeding 10 mm in diameter shall be filled using a qualified epoxy filler or grout before applying primer/sealer to the surface.
- 7.4.2 Cracks subject to movement shall be treated as a movement joint, and shall not only be repaired with grout or filler. Contact the Civil Engineering Unit of CSD, Dhahran, for a proper repair procedure.
- 7.4.3 Expansion and construction joints shall be cleaned and masked off prior to coating. When coating application is completed, remove the masking tape for further civil works by others.
- 7.4.4 All voids shall be prepared, primed and filled using suitable and compatible epoxy filler prior to coating. The epoxy filler materials shall be approved by the Civil and/ or the Coating engineers of the CSD, Dhahran.
- 7.4.5 Surfaces with sharp corners and subject to immersion conditions shall be rounded by forming a fillet with approximately 25 mm radius using an epoxy grout.

8 Concrete Coating Application Requirements

8.1 General Requirements

- 8.1.1 Concrete defects such as voids, bug holes shall be repaired as per item 7.4 prior to the coating application. The concrete joints shall be filled with approved materials in accordance to [09-SAMSS-075](#).
- 8.1.2 A sealer/primer coat shall be applied directly after the concrete surface preparation. The sealer/primer shall be compatible with the coating systems as listed in item 6.
- 8.1.3 Sealer/primer shall be use in accordance with the manufacturer's data sheet and shall be spray applied in a thin coat except for touch-up repairs of small areas [less than 0.1 m²]. Avoid thick film sealer coats on the surface.
- 8.1.4 The coating shall be applied after the full curing time of concrete in accordance to [SAES-Q-001](#). New concrete must have a moisture content of 4% or less before the coating applications commence.

- 8.1.5 The coating contractor's personnel shall be qualified in accordance to the standard procedure [SAEP-316](#), with substantial track records in previous concrete coating applications.
- 8.1.6 The coating contractor shall provide the correct application equipment for the specified coating materials in accordance with the coating manufacturers' recommendations.
- 8.1.7 The coating contractor shall submit a detailed coating application procedure including scope of work, quality and inspection plan before commencing application. The coating contractor shall be responsible to conduct the quality control and inspection works during all concrete coating applications. Saudi Aramco coating inspectors shall assure the contractor's work quality.
- 8.1.8 The applicator shall repair all coating defects in accordance with the repair procedure approved by Saudi Aramco.

9 Inspection and Testing

9.1 General Requirements

- 9.1.1 The following constitute inspection hold points:
 - a) Prior to the start of work.
 - b) Immediately following surface preparation.
 - c) Immediately prior to coating or lining application
 - d) Following the application of each coat.
 - e) Following the curing of the coating or lining.
 - 9.1.2 The applicator shall have on site, all times, the necessary proper calibrated and maintained testing and inspection instruments, which are available for the Saudi Aramco inspector to conduct test and surveillance of the work.
 - 9.1.3 Prior to using compressed air, the "Blotter Test" shall be used to check the quality of the air downstream of the compressor. Blow the air onto a clean white blotter or cloth for one minute, without abrasives to check for any contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the air stream shall be retested. Air quality test shall be performed at the beginning of each shift and at a minimum of four hour intervals during the shift. The test shall also be made after any interruption of the air compressor operation or as per required by the Saudi Aramco Inspector. Water separators shall
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be drained continuously. All lines shall be tested individually prior to use. Applications shall be allowed only using air which has been tested as free of contaminants.

9.1.4 Prior to coating application, dew point and relative humidity shall be measured. Readings shall be every four hours or at the time intervals approved in writing by the Aramco Inspector. Alternatively, continuous monitoring may be performed using systems accepted by the Saudi Aramco Inspector. The work shall not proceed if the substrate temperature shall be less than 3°C (5°F) above the dew point.

9.1.5 Defects shall be re-inspected after correction.

9.2 Surface Preparation Inspection

9.2.1 Concrete surfaces to be coated or lined shall meet the requirements of Section 7.

9.2.2 Areas that do not meet the surface cleanliness requirements shall be marked with grease free chalk for correction.

9.3 Coating and Lining Inspection

9.3.1 Surface temperature, humidity, and dew point readings shall be recorded. The work shall not proceed if the substrate temperature shall be less than 3°C (5°F) above the dew point, or any other deviations from the coating manufacturers' data sheet.

9.3.2 The coating or lining shall be visually inspected for defects and shall meet the requirements of the coating or lining manufacturer's data sheets.

9.3.3 If the wet film thicknesses fall below the manufacturer's recommended data sheet, the contractor shall inform Saudi Aramco Inspector and agreed remedial action shall be implemented.

9.4 Documentation

9.4.1 Deviations that are detected during the performance of the work shall be logged and subsequently corrected.

9.4.2 Reports, logs and final acceptance documents shall be reported on the appropriate forms in SAES-H-100, Section 9, Attachment.

9.5 Remedial Work

9.5.1 The Applicator shall repair all defects according to the touch up and

repair procedures accepted by Saudi Aramco Inspector.

9.5.2 All damages from inspections (i.e., adhesion testing, wet film thickness tests etc.), shall be repaired.

9.6 List of inspection and testing requirements

The following inspection steps shall be performed by the assigned quality control inspector from the contractor side in the presence of Saudi Aramco inspector. Saudi Aramco Inspector reserves the right to perform any test at any time to verify and assure the quality of the work being implemented:

9.6.1 Survey the condition of Concrete as per ACI 201.1R or equivalent.

9.6.2 Verify the degree of cured concrete.

9.6.3 Verify the strength of concrete as per ACI 228.

9.6.4 Verify the soundness of Surface by measuring the tensile strength as per ASTM D4541.

9.6.5 Detection Alkali-Silica Reaction in Concrete as per ASTM C295.

9.6.6 Verify removal of protrusion, filling surface indentations, and treat other surface irregularities.

9.6.7 Check the ambient condition and inspecting the surface preparation equipment.

9.6.8 Test for surface contamination from grease, oil and form release agents before and after surface cleaning.

9.6.9 Test for retained moisture in concrete as per plastic sheet method ASTM D4263 or by moisture meter or by calcium chloride dome test in ASTM F1869.

9.6.10 Test for Concrete Surface profile (CSP) as per guide in ICRI 03732.

9.6.11 Inspect coating mixing, thinning, pot lives, and top-coatings interval time.

9.6.12 Measure coating wet film thickness.

9.6.13 Measure coating dry film thickness by Tooke gauge as per ASTM D 4138, or by ultra sonic measurement or by microscopic measurement.

9.6.14 Check coating adhesion by tape test as per ASTM D3359 or by portable adhesion testing devices as per ASTM D4541.

9.6.15 Check for the coating curing by solvent rub test as per ASTM D4752.

9.6.16 Check the coating hardness for the thin film by pencil test as per ASTM D3363 or by Durometer or Barcol impresser instruments for the thick films (greater than 20 mils).

12 October 2005

Revision Summary

Major revision.