



Engineering Standard

SAES-X-300

27 February 2013

Cathodic Protection of Marine Structures

Document Responsibility: Cathodic Protection Standards Committee

Saudi Aramco DeskTop Standards

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Revised paragraphs are indicated in the right margin

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1 Scope

- 1.1 This standard prescribes the minimum mandatory requirements governing the design and installation of cathodic protection systems for both offshore and shore side sections of marine structures exposed to soil, seabed, or seawater environments. The standard applies to both coated and uncoated structures.
- 1.2 Typical marine structures include but are not limited to the following:
- | | |
|--|---------------------------------|
| Pumping Platforms | Sea Islands |
| Auxiliary Platforms | Breasting Dolphins |
| Utility Platforms | Trestles |
| Metering Platforms | Flare Support Structures |
| Mooring Dolphins | Break Waters |
| Tie-in Platforms | Pipe Supports |
| Gas/Oil Separator Platforms (GOSP) | Loading/Mooring Buoys |
| Living Quarter Platforms | Piers |
| Gas Compression Platforms | Piling (including sheet piling) |
| Well Platforms (including jackets & casings) | Wharves |
| Pipelines | Single Point Mooring (SPM) |
| Pipeline Markers | |
- 1.3 This standard may not be attached to or made a part of purchase orders.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Company Engineering Standards, Material Specifications, Standard Drawings, or forms shall be resolved in writing by the Design Agency representative through the Company Cathodic Protection (CP) Subject Matter Expert (SME).
- 2.2 Requests to deviate from this standard shall be submitted electronically through the SAP Waiver Process in accordance with [SAEP-302](#), "Instructions for Obtaining a Waiver."

3 References

Referenced standards and specifications shall be the latest edition/revision unless stated otherwise.

The Saudi Aramco Engineering e-Standards intranet website (<https://standards.aramco.com.sa:10009/>) contains the latest revisions of all standards and standard drawings.

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-303</u>	<i>Engineering Reviews of Project Proposal and Detail Design Documentation</i>
<u>SAEP-332</u>	<i>Cathodic Protection Commissioning</i>
<u>SAEP-333</u>	<i>Cathodic Protection Monitoring</i>

Saudi Aramco Engineering Standards

<u>SAES-X-400</u>	<i>Cathodic Protection of Buried Pipelines</i>
<u>SAES-X-600</u>	<i>Cathodic Protection of Plant Facilities</i>

Saudi Aramco Materials System Specifications

<u>17-SAMSS-004</u>	<i>Conventional (Tap Adjustable) Transformer/Rectifiers for Cathodic Protection</i>
<u>17-SAMSS-006</u>	<i>Galvanic Anodes for Cathodic Protection</i>
<u>17-SAMSS-007</u>	<i>Impressed Current Anodes for Cathodic Protection</i>
<u>17-SAMSS-008</u>	<i>Junction Boxes for Cathodic Protection</i>
<u>17-SAMSS-012</u>	<i>Photovoltaic Power Supply for Cathodic Protection</i>
<u>17-SAMSS-017</u>	<i>Impressed Current Cathodic Protection Cables</i>
<u>17-SAMSS-018</u>	<i>Remote Monitoring System (RMS) for Cathodic Protection Applications</i>

Saudi Aramco Standard Drawings

<u>AA-036108</u>	<i>Offshore Negative Terminal Junction Box</i>
<u>AD-036132</u>	<i>Cathodic Protection Cable Identification Termination Detail</i>
<u>AA-036335</u>	<i>Half Shell Bracelet Type Anode for Pipe Sizes 4-60 Inch</i>
<u>AA-036350</u>	<i>2 Terminal Bond Box</i>
<u>AB-036378</u>	<i>Onshore Rectifier Installation Details (Sheets <u>1</u> & <u>2</u>)</i>

[AD-036785](#)

Symbols for Cathodic Protection

[AB-036907](#)

Cathodic Protection Test Stations for Buried Pipelines

Saudi Aramco General Instruction

[GI-0428.001](#)

Cathodic Protection Responsibilities

Saudi Aramco Best Practice

[SABP-X-003](#)

Cathodic Protection Installation Requirements

Saudi Aramco Library Drawing

[DA-950035](#)

2" High Pressure Access System Chemical Injection and Corrosion Monitoring

3.2 Industry Codes and Standards

National Association of Corrosion Engineer (NACE)

National Fire Protection Association

[NFPA 70](#)

National Electrical Code (NEC)

4 Definitions and Abbreviations

This standard uses the following terminologies:

Bond Cable: A cable installed between two metallic structures to provide electrical continuity between the structures for the purpose of cathodic protection.

Calcined Petroleum Coke Breeze: A carbonaceous backfill used as a conductive backfill media for impressed current anodes in soil.

Coated Casing: The term “coated casing” as used in this engineering standard describes a well casing with an external non-conductive coating (typically Fusion Bond Epoxy or FBE). The coating must be applied to all sections of the casing in contact with soil or formation, from surface to the bottom of the casing or to a depth determined to facilitate external corrosion mitigation with cathodic protection through the relevant down hole corrosive aquifers. Casings that have been coated over the upper two or three joints of casing only are not “coated casings”. Coating applied to well casings is not applied as a corrosion barrier. It is applied to reduce the total amount of CP required or to extend the influence of the applied CP.

CP: Cathodic Protection

CP Assessment Probe: A CP assessment probe is a multi-electrode probe designed to enable measurement of the soil resistivity in addition to representative polarized and depolarized potentials for the pipeline or other buried or immersed metallic structure at the probe location.

CP Coupon: A CP coupon is a single electrode coupon that has been designed to enable measurement of representative potentials, current densities, or corrosion rates on a pipeline or other buried or immersed metallic structure at the coupon location.

CP System Operating Circuit Resistance: The total effective resistance seen by the output terminals of the cathodic protection power supply, or the total working resistance in a galvanic anode system.

CP System Rated Circuit Resistance: The cathodic protection power supply rated output voltage divided by the rated output current. For photovoltaic power supplies, the rated output current for this calculation is the design current for commissioning.

Cross-Country Pipeline: A pipeline between; two plant areas, another cross-country pipeline and a plant area, or between two cross-country pipelines.

CSD: Consulting Services Department

Deep Anode Bed: Anode or anodes connected to a common CP power supply installed in a vertical hole (typically 25 cm diameter) with a depth exceeding 15 m (50 ft.).

Design Agency: The organization or company contracted by Saudi Aramco for the design of a CP system. The Design Agency may be the Design Contractor, the Lump Sum Turn Key Contractor or an in house design organization of Saudi Aramco.

Drain Point: The location on the cathodically protected structure where the negative cable from the T/R or negative junction box is fastened to the structure.

Flow-line: A pipeline connected to a well.

Galvanic Anodes: Anodes fabricated from materials such as aluminum, magnesium or zinc that are connected directly to the buried structure to provide cathodic protection current without the requirement for an external cathodic protection power supply. Galvanic anodes are also referred to as sacrificial anodes.

GOSP: Gas and Oil Separation Plant

Hazardous Areas: Those areas where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or filings (see NEC Article 500). Hazardous areas when referred to in cathodic protection standards, unless stated otherwise designate Class I Division 2 (Zone 2) areas.

HDD: Horizontal Directional Drilled

ICCP: Impressed Current Cathodic Protection

Impressed Current Anodes: Anodes fabricated from materials such as High Silicon Cast Iron (HSCI) or Mixed Metal Oxide (MMO) that are immersed or buried and are connected to the positive terminal of a DC power supply to provide cathodic protection current.

Megger: A four terminal meter designed to measure ground resistivity, or can be connected to measure resistance in a format that excludes the resistance of the test wires.

MSAER: Mandatory Saudi Aramco Engineering Requirements

NEC: National Electric Code

NEMA: National Electrical Manufacturers Association (USA)

Negative Cable: A cable that is electrically connected (directly or indirectly) to the negative output terminal of a cathodic protection power supply or to a galvanic anode. This includes bond cables to a cathodically protected structure.

Off-Plot: Off-plot refers to any area outside of the plot limits.

On-Plot: On-plot refers to any area inside the plot limit.

Perimeter Fence: The fence which completely surrounds an area designated by Saudi Aramco for a distinct function.

Photovoltaic Module: A number of solar cells wired and sealed into an environmentally protected assembly.

Pipeline: The term “pipeline” is used generically in this standard and can be used to refer to any type of pipeline.

Plant Area: A plant area is the area within the plot limits of a process or storage facility. Scraper traps and launcher areas are not plant areas.

Plot Limit: The plot limit is the boundary around a plant or process facility. The plot limit may be physical such as a fence, a wall, the edge of a road or pipe rack, chains and posts or a boundary indicated on an approved plot plan.

Positive Cable: A cable that is electrically connected (directly or indirectly) to the positive output terminal of an ICCP power supply, including impressed current anode cables.

PMT: Project Management Team used as a truncated version of Saudi Aramco Project Management Team or SAPMT.

Process Pipeline: A pipeline typically associated with a plant process and typically above ground within a plant facility.

Production Pipeline: A pipeline transporting oil, gas or water to or from a well. These include flow-lines, test-lines, water injection lines and trunk-lines.

Reference Electrode: An industry standardized electrode used as a common reference potential for cathodic protection measurements. A copper/copper sulfate (Cu/CuSO_4) reference electrode is typically used for soil applications. A silver/silver chloride ($\text{Ag}/\text{AgCl}/0.6\text{M Cl}$) reference electrode is typically used for aqueous applications.

RSA: Responsible Standardization Agent - usually the Saudi Aramco CSD cathodic protection Subject Matter Expert or the Supervisor of the CSD Cathodic Protection Team.

SAES: Saudi Aramco Engineering Standard

Soil Transition Point: The on grade location where a pipeline enters or exits the soil, i.e., above grade to below grade transition, or below grade to above grade transition.

Subject Matter Expert (SME): For the purposes of this standard, the SME shall be the assigned Consulting Services Department cathodic protection specialist.

Surface Anode Bed: Anode or anodes connected to a common CP power supply, installed either vertically or horizontally at a depth of less than 15 m (50 ft.). A surface anode bed may also be referred to as a Shallow Anode Bed.

Test-line: A pipeline that is used for testing an individual well or group of wells.

Thermite Weld: An exothermic process for use in making electrical connections between two pieces of copper or between copper and steel.

T/R: Transformer/Rectifier - A cathodic protection power supply that transforms and rectifies AC power into an adjustable output DC power for cathodic protection applications. Typically abbreviated or truncated as “T/R” or “Rectifier”.

Transmission Pipeline: A cross country pipeline transporting product between GOSPs WIPs or other process facilities.

Trunk-line: A pipeline designed to distribute or gather product from two or more wells, typically connecting flow-lines or injection lines to the respective GOSP or WIP.

Uncoated Casing: The term “uncoated casing” when used in this engineering standard describes a well casing that is either bare (no external coating), or may have an external coating applied to the shallow sections of casing to minimize corrosion in the landing base or surface soils.

Utility-line: A pipeline designed to deliver a service product (typically water, gas or air).

WIP: Water Injection Plant

5 Design

5.1 Contractor/Designer Qualifications

- 5.1.1 Cathodic protection designs shall be completed by Engineers with a minimum of five years verifiable cathodic protection design experience and a minimum industry qualification of NACE CP Level 3.
- 5.1.2 Field measurements required for the design shall be collected by an Engineer or Technician with a minimum industry certification level of NACE CP Level 2.

Commentary Note:

As noted in GI-0428.001, PMT may request assistance from CSD for the verification of the qualifications of the Design Contractor's engineer responsible for designing the CP systems.

5.2 Design Review and Approval

- 5.2.1 Proposed construction drawings and related cathodic protection design information in accordance with [SAEP-303](#) shall be submitted to the Proponent cathodic protection organization (as defined by GI-0428.001) and to Saudi Aramco's Consulting Services Department (CSD) for review and approval.
- 5.2.2 The design agency shall not issue drawings for construction until the design has been reviewed and approved in writing by CSD and the Proponent cathodic protection organization.
- 5.2.3 The design package submitted for review shall contain at minimum:
 - a. The scope of work.
 - b. Professionally drafted full size Index "X" CP drawings that:
 - Detail each CP item by description and stock number if applicable
 - Detail the proposed location for each piece of CP equipment including but not limited to T/Rs, anodes, junction boxes and test stations

- Detail and specifically identify all cathodic protection cables including all anode, structure, bond, and T/R cables
 - Clearly identify the specific and individual cable routing and termination points within the respective junction boxes, bond boxes, and T/Rs
 - Detail all cathodic protection equipment using the cathodic protection symbols shown on Standard Drawing AD-036785 “Symbols for Cathodic Protection”
- c. All calculations and applicable field data required to verify design compliance with Saudi Aramco Cathodic Protection Engineering Standards.
- d. CP equipment details (including the requirement for remote monitoring).

5.3 Design General

- 5.3.1 Provide cathodic protection for all submerged and buried metallic marine structures, equipment and pipelines using galvanic anode systems, impressed current anode systems, or a combination of an impressed current and galvanic anode system.
- 5.3.2 An impressed current cathodic protection system shall be designed for cathodic protection where AC power is available.
- 5.3.3 For calculation purposes, the resistivity of seawater shall be assumed to be 17 ohm-cm unless measurements taken at the design location demonstrate a more accurate value.
- 5.3.4 Design the cathodic protection system to include the equipment that is required for monitoring the protected structures per SAEP-333. Install the equipment in accessible unobstructed locations.
- 5.3.5 Bond offshore structures at appropriate locations to ensure complete electrical continuity.
- 5.3.6 Cathodically protect both submerged sections and buried sections of subsea pipelines that terminate inside onshore facilities, or up to the isolation flange for the onshore-offshore transition.
- 5.3.7 Protect the submerged sections of subsea pipelines with bracelet galvanic anodes according to Standard Drawing AA-036335. For buried sections of subsea pipelines, refer to SAES-X-400 or SAES-X-600, as applicable.

5.4 Design Life

Minimum design life for the cathodic protection systems shall be as follows:

- a. Galvanic anodes only: 25 years
- b. Galvanic anodes if accompanied by an impressed current system: 5 years
- c. Impressed current anodes: 20 years

5.5 Current Density Criteria

5.5.1 The CP system design shall provide the minimum current detailed in [Table 1](#).

Table 1 - Design⁽¹⁾ Current Requirement for Offshore Structures

Offshore Structure	Type of Cathodic Protection	Coated		Bare	
		Seawater	Mud/Soil	Seawater	Mud/Soil
Platform only	ICCP plus/or Galvanic	10 mA/M ²	4 mA/M ²	50 mA/M ²	20 mA/M ²
Platform with Well Casing(s) (Current for platform surfaces)	ICCP plus Galvanic	10 mA/M ²	4 mA/M ²	50 mA/M ²	20 mA/M ²
	Galvanic only ⁽²⁾	15 mA/M ²	6 mA/M ²	75 mA/M ²	30 mA/M ²
Oil Well Casing (Current for each well)	Galvanic, or ICCP plus Galvanic	10 amps		35 amps	
Gas Well Casing (Current for each well)	Galvanic, or ICCP plus Galvanic	50 amps		50 amps	
HDD installed Pipeline (coating thickness less than 1600 microns (63 mils))	ICCP, Galvanic ⁽³⁾ , or ICCP plus Galvanic	6 mA/M ²		Not Applicable	
HDD installed Pipeline (coating thickness more than 1600 microns (63 mils))	ICCP, Galvanic ⁽³⁾ , or ICCP plus Galvanic	0.10 mA/M ²		Not Applicable	
Pipeline installed by open cut trench method	ICCP, Galvanic ⁽³⁾ , or ICCP plus Galvanic	0.10 mA/M ²		Not Applicable	
Pipeline Laid on Seabed	Bracelet Anodes	Current requirement calculations are not applicable. See Standard Drawing AA-036335 for bracelet galvanic anode requirements.			
Other	ICCP plus/or Galvanic	10 mA/M ²	4 mA/M ²	50 mA/M ²	20 mA/M ²

Notes:

- (1) Total current requirement calculated using [Table 1](#) are for design purposes to determine the number of galvanic anodes and the minimum rated current capacity of the impressed current CP power supply where applicable. Adequate cathodic protection of the platform and associated well casings is expected with the ICCP systems operating at approximately 75% of the minimum design rated current output.
- (2) Current density requirements for a “galvanic anode only” cathodic protection system for “platforms with well casings” is higher than “ICCP plus galvanic”, because ICCP systems use negative drain points connected directly to the well casings, whereas “galvanic only” are not connected immediately to the well casings and therefore experience additional comparative attenuation before protecting the well casings.
- (3) Cathodic protection systems for pipelines or electrically isolated sections of a pipeline that require 2.0 amperes or less may use galvanic anodes.

5.5.2 Impressed Current CP systems for offshore platforms shall provide sufficient current for all submerged surface areas, including the total submerged and buried surface area of the piles, well casings, conductors, plus all submerged and buried sections of other structures associated with the platforms.

5.5.3 The design for the cathodic protection system for electrified platforms with well casings shall provide the currents listed in [Table 1](#) for each well casing in addition to the current required for the surfaces of the platform structure that are submerged and below the mud-line.

5.5.4 Galvanic Anode CP systems for offshore platforms shall provide adequate current for all submerged surface areas, plus:

- the current required for each casing as specified in [Table 1](#),
- the buried surface area of the piles and conductors, and
- all submerged and buried sections of other structures associated with the platform.

5.5.5 The submerged structure surface area is defined as the total area extending from the base of the structure to Lowest Astronomical Tide (LAT) level.

5.6 Protection Criteria

The cathodic protection system shall achieve a minimum structure-to-water potential of negative 0.90 volt with reference to a silver/silver chloride electrode. For buried onshore portions of marine structures, it is required to achieve negative structure-to-soil potentials in compliance with SAES-X-400 and SAES-X-600.

5.7 Circuit Resistance

5.7.1 For a T/R, the CP system **rated** circuit resistance shall be defined as the T/R rated voltage, divided by the T/R rated current. Rated voltages and currents are as detailed on the manufacturer's data sheet/plate.

5.7.2 The CP system **operating** circuit resistance for an ICCP system shall be defined as the total effective resistance seen by the output terminals of the respective ICCP power supply, and for calculation purposes shall include:

- a. Anode resistance to water.
- b. Positive cable resistance from CP power source to anodes.
- c. Negative (cable)s resistance from CP power source to structure.

- d. Effective resistance caused by +0.95 volts anode back emf (for MMO in sea water plus the structure back emf -1.0 volts (example: -1.0 volts casing back emf + 0.95 volts anode bed back emf = 1.95 volts total between the anodes and structure).

5.7.3 ICCP system designs shall take into consideration the calculated operating resistance and shall size the positive and negative cables and voltage rating of the T/R such that the “calculated” operating output of the T/R complies with all of the following:

- a. The target commissioning current shall be achieved at a voltage between 30% and 70% of the T/R rated voltage output.
- b. The normal operating output current shall be achieved with the voltage adjustment set at more than 10% of the available (rated) T/R voltage output.

Commentary Note:

The above section is a mandatory design requirement but is not a mandatory requirement for commissioning acceptance.

5.7.4 The CP system “operating” circuit resistance measured during commissioning of a new CP system shall not be greater than 90% of the CP power supply “rated” circuit resistance.

5.8 Anodes

5.8.1 Galvanic Anodes

Use galvanic anodes that comply with the appropriate sections of [17-SAMSS-006](#). Table 2 shows the recommended design parameters for galvanic anode materials.

Table 2 – Design Parameters for Galvanic Anode Materials

Anode Material	Consumption Rate (kg/A-Y)	Open Circuit Potential (-mV) (1)
Aluminum	3.7	1050
Magnesium	10.3	1650
Zinc	11.8	1050

Note: (1) Measured with reference to a silver/silver chloride reference electrode.

5.8.2 Impressed Current Anodes

- 5.8.2.1 Use one of the following impressed current anode materials, according to specification [17-SAMSS-007](#):
- Platinized Niobium (Pt/Nb)
 - Mixed Metal Oxide (MMO)
 - High Silicon Cast Iron (HSCI) for shoreline area only
- 5.8.2.2 Refer to Table 3 for the recommended design parameters for the approved impressed current anode materials.
- 5.8.2.3 If various types of impressed current anode material are used on a structure, connect only anodes of the same material to any one T/R.

Table 3 - Design Parameters for Impressed Current Anode Materials

Anode Material	Consumption (kg/A-Y)	Maximum Current Density (mA/cm ²)	Maximum Voltage (volt)
HSCI	0.45	0.7	No Limit
MMO	See Note 1	60.0	No Limit
Pt/Nb	8.63 x 10 ⁻⁶	40.0	60

Note: (1) Use the consumption rate specified by the manufacturer of the MMO element, to determine the current output capacity and design life of MMO anodes.

5.9 DC Power Source

- 5.9.1 Manufacture T/Rs and photovoltaic systems according to 17-SAMSS-004 and 17-SAMSS-012 respectively.
- 5.9.2 Install the CP power supplies in accordance with Saudi Aramco Library Drawing DA-950035 sheet 1, or Saudi Aramco Standard Drawing AB-036378 sheets 1 and 2.
- 5.9.3 Use oil immersed T/Rs (type ONAN) inside hydrocarbon plant areas, for all outdoor marine environment applications, and for Class I Division 2 (Zone 2) applications.
- 5.9.4 Use air cooled T/Rs (type AA) for indoor or non-classified, non-marine environment applications. T/Rs with NEMA Class 3R enclosures shall

NOT be used inside hydrocarbon plant areas or in marine environments unless installed indoors.

5.9.5 DC power supplies shall have a maximum rated output voltage of no greater than 100 volts. The sizing of the T/R shall be optimized based on the circuit resistance in accordance with [Section 5.7](#) of this standard.

5.9.6 For hazardous areas (maximum Class I, Zone 2), the design agency shall select a cathodic protection DC power supply (and other CP system equipment) that complies with the requirements of NEC Articles 500 to 504 for hazardous (Class I, Zone 2) areas. CP equipment shall not be placed in Class 1 Zone 1 areas.

5.10 Cables

DC cables connected to the T/R shall be AWG #4 (25 mm²) or larger. Size the cables according to the National Fire Protection Association NFPA 70, National Electrical Code (NEC). See [17-SAMSS-017](#) for details of approved cathodic protection cables. Use Table 310-16, Column for 90°C rated cables of the latest NEC Handbook to calculate the ampacity of HMWPE cables, and consider an ambient temperature of 40°C. Cable terminations shall comply with Standard Drawing [AD-036132](#).

5.11 Monitoring Facilities

5.11.1 For the onshore portions of marine pipelines, provide test stations for measuring pipe-to-soil potentials at insulated cased crossings, paved road crossings and other locations outside the SSD fence and plant fence as required by operational needs. Use Standard Drawing AB-036907 as a reference for the design and construction of the test station.

5.11.2 Where a remote monitoring system (RMS) is used, the design details for the RMS shall be submitted to the CP SME in CSD and the CP Proponent organization for review and approval. Mandatory design details include:

- a. A description of the existing CP RMS used by the respective CP Proponent in the respective area (if applicable). The description shall detail existing RMS hardware, software, communication connectivity and protocols.
- b. Confirmation of proposed hardware and software compatibility with the existing CP RMS (if applicable), or written authorization by the CP SME in CSD and the CP Proponent organization to use a non-compatible RMS.

- c. A data flowchart that illustrates the data path from the CP power supply to the CP Proponent's desktop including connectivity details with software requirements and communication protocols.

5.11.3 Remote monitoring systems for offshore cathodic protection power supplies shall be designed and installed at all new CP system installations where an RTU is being installed on the same offshore structure.

- a. The CP RMS shall at minimum use signal transmitters for DC output voltage and current.
- b. The data collected and stored by the CP remote monitoring system shall be accessible by the CP Proponent organization directly from their desktop computer.

5.11.4 At locations where an existing useable RTU is not being installed on the same offshore structure, the need for a remote monitoring system shall be determined by the Project Group and the CP Proponent organization at the Project Proposal stage.

Commentary Note:

Remote monitoring is strongly recommended for all Projects that will be installing cathodic protection in a new field, or in an existing field where monitoring of the new cathodic protection systems in accordance with [SAEP-333](#) will not be practical with the existing cathodic protection technical staff.

5.11.5 Remote Monitoring Units (RMUs) for cathodic protection power supplies shall comply with the requirements of [17-SAMSS-018](#).

5.11.6 Cables and field wiring used for the remote monitoring systems shall comply with [SAES-P-104](#).

5.11.7 Signal Transmitter Requirements for CP Remote Monitoring Systems are as follows:

- a. CP remote monitoring systems using signal transmitters shall utilize two (preferably loop powered) 4-20 mA signal transmitters to monitor the DC voltage and current.
- b. The wiring between the signal transmitters and the RTU must be sized such that the resistance is within the maximum load tolerance of the signal transmitter (typically 600 ohms maximum).

5.12 Bonding

- 5.12.1 Bonding shall be installed as necessary to ensure complete electrical continuity throughout a marine structure. Install steel bond bars or 70 mm² (2/0 AWG) bond cables to ensure electrical continuity between all well casings and between the well casings and the platform. Provide bonding for J-tubes, boat landings, riser guards or other submerged mechanical fittings that are not welded.
- 5.12.2 Platforms with impressed current CP shall have a dedicated negative lead wire to each well casing. Use a negative junction box (AA-036108) to terminate multiple negative leads. Junction and bond boxes used in cathodic protection systems for marine structures shall comply with the design and construction required by 17-SAMSS-008.
- 5.12.3 Use flexible straps or cables to electrically bond walkways connecting two adjacent platforms at both ends of the walkway. Provide at least two bonds at each end. The bond cable size shall not be less than No. 2/0 AWG.

5.13 Electrical Isolation

- 5.13.1 Do not use isolating devices on offshore structures.
- 5.13.2 Do not use isolating devices on submerged or buried portions of pipelines.
- 5.13.3 Provide aboveground electrical isolating devices to isolate pipelines at the onshore-offshore transition.
- 5.13.4 Install a 2-terminal bond box at each isolating device in an accessible location. The bond box design and construction shall comply with Standard Drawing AA-036350.

6 Installation, Records, Commissioning and Inspection

Refer to Saudi Aramco Best Practice [SABP-X-003](#). [SABP-X-003](#) shall be deemed a mandatory document for this Standard.

Revision Summary

27 February 2013

- Revised the "Next Planned Update." Reaffirmed the content of the document, and made several editorial changes:
- Added the requirement for NACE certification for design engineers and field technicians
 - Clarified the resistivity of seawater as 17 ohm-cm
 - Added a section clarifying calculation requirements for circuit resistance
 - Added a section clarifying power supply requirements
 - Added a section to clarify remote monitoring requirements.