Materials System Specification

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CRA Clad Pipe Spools

Document Responsibility: Materials and Corrosion Control Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

This Specification covers fabrication of corrosion resistant alloy (CRA) clad pipe spools. This specification does not apply for girth welding of clad line pipe.

Commentary Note:

Manufacturing of clad piping components (fittings, flanges, valves and spool pieces) required for fabrication of clad pipe spools is covered in 02-SAMSS-012.

2 Conflicts and Deviations

2.1 Any conflicts between this specification and other applicable Saudi Aramco Materials System Specifications (SAMSSs), Engineering Standards (SAESs), or industry standards, codes, and forms shall be resolved in writing by the Company or Purchaser Representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from this specification in writing to the Company or Purchaser 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 manufacture and purchase of material covered by this specification shall comply with the latest edition (as per the purchase order date) of the references listed below, as noted.

A. Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Materials System Specifications

01-SAMSS-010	*Fabricated Steel Piping*
01-SAMSS-048	*CRA Clad or Lined Steel Pipe*
02-SAMSS-012	*Weld Overlayed Fittings, Flanges and Spool Pieces*

Saudi Aramco Inspection Requirements

Form 175-011100	*Fabricated CRA Clad Piping Spool*

B. Industry Codes and Standards

American Petroleum Institute

API SPEC 6A	*Specification for Wellhead and Christmas Trees Equipment*

American Society of Mechanical Engineers

ASME SEC IIC	*Welding Rods, Electrodes and Filler Metals*
ASME SEC IX	*Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators*
ASME B31.3	*Process Piping*
ASME B31.4	*Pipeline Transportation Systems for Liquid Hydrocarbons and Other Hydrocarbons*
ASME B31.8	*Gas Transmission and Distribution Piping Systems*

American Society for Nondestructive Testing, Inc.

ASNT CP-189	*Standard for Qualification and Certification of Nondestructive Testing Personnel*

ASNT SNT-TC-1A *Recommended Practice for Personnel Qualification and Certification*American Society for Testing and Materials

ASTM A923	*Standard test Methods for Detecting Detrimental Intermetallic in Duplex Austenitic/Ferritic Stainless Steel*
ASTM A380	*Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*
ASTM G48	*Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution*
ASTM E92	*Standard Test Method for Vickers Hardness of Metallic Materials*

International Standardization Organization

ISO 9000 - 9004	*Quality Management and Quality Assurance Standards*

European Standard

EN 473	*Non-Destructive Testing - Qualification and Certification of NDT Personnel - General Principles*

National Association of Corrosion Engineers

NACE MR0175/ISO 15156	*Petroleum and Natural Gas Industries-Materials for use in H_2S-Containing Environments in Oil and Gas Production*

4 Definitions

Spool Pieces: Double random length pipes or cut length of pipes intended for fabrication of clad pipe spools.

5 Information to be supplied by the purchaser

a. If the clad pipe spool is intended for sour service, the following statement shall be included in the purchase order: "The clad pipe spool shall be suitable for sour service and NACE MR0175/ISO 15156 shall apply."

b. Type of corrosion resistant weld overlay

c. Hydrostatic test pressure

d. The applicable code of construction (ASME B31.3, B31.4, or B31.8)

e. Detailed isometric drawings or piping detail (see paragraph 6.2)

f. Materials to be supplied by the vendor

g. Materials to be supplied by the buyer to the vendor, if any

h. Surface preparation and paint or coating requirements

6 Manufacture

6.1 All piping components required for fabrication of clad pipe spools shall be in compliance with 02-SAMSS-012.

Commentary Note:

It is acceptable to use CRA clad pipes or spool pieces cut from pipes manufactured in accordance to 01-SAMSS-048.

6.2 If the piping spool is to be designed by the contractor, the detailed isometric drawings, in accordance with the applicable code and 01-SAMSS-010 (only

design requirements apply), must be submitted to the piping engineer, CSD for approval. The design shall ensure that carbon steel is not exposed to service fluid (particularly with reference to set-in and set-on branch connections).

6.3 The bevel edges, including 25mm from both ends, shall be cleaned with acetone or appropriate solvent (free of chlorides) before carrying out tack welding for assembly and subsequent girth welding.

6.4 Complete girth welding shall be carried out using appropriate corrosion resistant alloy welding consumable. It is not acceptable to weld a buffer layer with pure iron welding consumable followed by carbon steel welding consumables. The root and hot passes shall be deposited by GTAW process only. It shall be ensured that no fusion of carbon steel backing material occurs during welding the root pass.

6.5 If there is access for welding from the ID side, it is acceptable to cut back the CRA layer and carry out girth welding using a carbon steel electrode. CRA layer can subsequently be deposited by automatic weld overlay after grinding the weld on the backing steel. Weld overlay shall be carried out in accordance to 02-SAMSS-012 and automatic welding is mandatory for the overlay.

6.6 Purging with inert gas shall be carried out until completion of three passes (root hot and fill pass) or 6mm of weld metal, whichever is higher. The effectiveness of purging shall be ensured by measurement of oxygen in the exit of purging gas by using oxygen analyzer. Oxygen content shall not exceed 100 ppm at anytime during welding.

6.7 The fit up of girth welds shall ensure that the mismatch does not exceed 1.0 mm. It is acceptable to correct the dimensions by pressing, grinding or by machining the inside overlayed surface provided the minimum required overlay thickness is not in violation of 02-SAMSS-012.

6.8 Selection of welding consumable for single sided girth welding shall be as per Table 1 below. For alternative welding consumables and for cladding types not covered below, consult Materials and Corrosion Control Standards Committee.

Table 1

CRA Grade	Bare Wire	Coated Electrode
316L	ER309LMo(1)	E309L or E309MoL(1)
N08825	ERNiCrMo-3	ENiCrMo-3
N06625	ERNiCrMo-3	ENiCrMo-3

Note 1. For X60 and X-65 backing steel use ERNiCrMo-3/ENiCrMo-3

6.9 Tack welding shall be performed using a qualified procedure and using the same filler wire to be used for the root pass of the girth welding. Welding procedure qualified for girth welding can be used for tack welding.

7 Qualification of Welding Procedures

7.1 Welding procedures, including procedures for repair, and welders/welding operators shall be qualified as per ASME SEC IX. All welding procedure qualifications shall be witnessed by third party inspection agency.

7.2 All welding procedures, including procedures for repair and tack welding, must be reviewed and approved by Materials and Corrosion Control Standards Committee.

7.3 Welding procedure shall be qualified on clad pipe.

7.4 The brand name for nickel based welding consumables shall be considered as an essential variable.

7.5 Increase in heat input of hot pass shall be considered as an essential variable.

7.6 A separate welding procedure qualification is required by welds between UNS N08825 clad and UNS N06625 clad base material. Acceptance criteria for PREN, chemical analysis and corrosion tests shall be as applicable for UNS N08825.

7.7 Chemical analysis shall be carried out on the ID side of the girth weld at a depth of 2.0mm from the ID surface. The chemistry shall be within the range specified in ASME SEC II Part C or AWS classification. The PREN (%Cr+3.3%Mo+16%N) value shall be as per Table 2 below. In case of alloy 625, the iron content shall not exceed 10%.

Table 2

CRA Grade	PREN (min.)
316/316L	24
N08904	34
S31254	42
S31803	35
S32205	35
S32750	42
N08825	42
N06625	45

Note: For welds between N08825 clad and N06625 clad, the requirements of N08825 shall apply.

7.8 Hardness testing shall be carried out on the weld cross section as per Annex A for sour service. Test shall be carried out using 5 kg or 10 kg loads in accordance with ASTM E92 using the Vickers method. Tests shall be conducted on weld cross sections removed from near the 6 and 12 O'clock positions. The cross sections shall be etched to reveal the weld, HAZ and fusion zone. Hardness of the carbon steel shall not exceed 250 HV10. Hardness of the CRA weld, HAZ and base metal should not exceed the limits specified in NACE MR0175/ISO 15156.

Commentary:

If any hardness readings close to the fusion zone between the carbon steel and CRA weldmetal significantly exceed the acceptance criteria, the test can be considered acceptable if it can be proven that the reading is from a location in the intermediate mixed zone/unmixed zone.

7.9 The following grades shall be subjected to the corrosion testing as specified in Table 3 below.

Table 3

CRA Grade	Corrosion Test	Test Conditions	Acceptance Criteria
UNS N08904 (904L)	ASTM G48[(a)(b)] Method A	Test temperature: 25°C Test duration : 24 hours	No pitting at 20X minimum magnification.
UNS S31254	ASTM G48[(a)(b)] Method A	Test temperature: 50°C Test duration : 48 hours	No pitting at 20X minimum magnification.
UNS S31803	ASTM A923[(a)(c)] Method C	As per ASTM A923	As per ASTM A923
UNS S32205	ASTM A923[(a)(c)] Method C	As per ASTM A923	As per ASTM A923
UNS S32750	ASTM A923[(a)(c)] Method C	As per ASTM A923	As per ASTM A923
UNS N08825[(d)]	ASTM G48[(a)(b)(d)] Method A	Test temperature: 22°C Test duration : 72 hours	No pitting at 20X magnification.
UNS N06625[(e)]	ASTM G48[(a)(b)] [(e)]Method A	Test temperature: 50°C Test duration : 72 hours	No pitting at 20X magnification.

Notes:

a. The surfaces of the specimens shall be pickled before testing.

b. Cut edges shall be prepared according to ASTM G48.

c. Rapid screening test (ASTM A923 Test Method A) shall not be used as an acceptance test.

d. This is applicable to 825 clad pipe qualifications welded with 625 welding consumables.

e. For welds between N08825 clad and N06625 clad, the requirements of N08825 shall apply.

7.10 Corrosion specimens shall be prepared by removing the backing carbon steel by milling or by other means. The thickness of the specimen shall not be less than 2.0 mm and shall contain the girth weld at the centre of the specimen.

8 Pickling

All girth welds shall be picked as per ASTM A380. Adequate precaution must be taken to prevent carbon steel from coming in contact with the pickling chemical.

9 Non-Destructive Testing

9.1 All NDT operators shall be qualified to ASNT SNT-TC-1A, ASNT CP-189 or EN473 level II or equivalent.

9.2 All groove welds shall be tested by radiographic testing. Ultrasonic testing is allowed only for welds that cannot be tested by radiographic testing. Acceptance criteria for the welds shall be as per ASME B31.3/B31.4/B31.8 as applicable.

9.3 If girth welding is carried as para 6.5, radiographic testing shall be carried out after completion of the weld overlay.

9.4 The root of girth welds shall be inspected by visual inspection with the aid of boroscope or camera. No weld defects based on visual inspection are acceptable in the root of the girth weld.

9.5 The ID of all accessible welds shall be dye penetrant tested. Acceptance criteria shall be as per API Spec 6A PSL3 requirement.

9.6 Positive Material Identification shall be carried on the external surface of all girth welds. If the internal surface is accessible, PMI shall be conducted on this surface also. Acceptance criteria shall be as per the chemistry requirement stated in ASME SEC II Part C or applicable AWS standard with a tolerance of ±10%. Refer to paragraph 7.6 for acceptance criteria of Fe content.

10 Hydrostatic Testing

10.1 All pipe spools, including spools with open ends, shall be hydrostatically tested. For spools with open ends, extended length of bare carbon steel (about 200mm) shall be provided to allow welding of carbon carbon steel caps for the purpose of hydrotesting. No paint or primer shall be applied over the girth welds prior to hydrostatic testing.10.2 Hydrosatic test shall be carried at a pressure indicated in the PO. The test time shall be as specified in ASME B31.3/B31.4/B31.8 as applicable.

10.2 The Vendor shall provide the necessary blind flanges, plugs, caps, or plates etc., required for the hydrotest.

10.3 Chloride content of the water used for hyrotetsing shall not exceed 50 ppm.

11 Inspection

11.1 Clad pipe spools purchased in accordance with this Specification are subject to the requirements of Saudi Aramco Inspection Requirements Form175-011100.

11.2 Saudi Aramco authorized welding inspector may choose to inspect the fit ups prior to commencement of girth welding.

11.3 Straightness of the pipes in the spool shall be within 0.2%.

12 Marking

12.1 The marking shall be carried out by paint stenciling. No marking shall be done on the CRA.

12.2 Each pipe spool shall be marked Saudi Aramco, followed by the spool number as per the drawing, Purchase Order number/Item number and the Saudi Aramco 9COM number.

12.3 The marking shall include the specification number 01-SAMSS-044, material specification of the backing steel and CRA.

12.4 Material ordered for sour service shall be marked with alphabet ‘S’.

13 Handling, Packing and Transportation

All open ends of the spool shall be suitably covered to prevent contamination from dust or moisture during storage and transportation. The flange faces shall be adequately protected to prevent possible damage during transportation.

14 Certification

14.1 All NDT results, PMI readings, visual and dimensional inspection reports and hydrostatic test report shall be supplied.

14.2 It shall be certified that the radioactivity level of the pipes is less than 0.5µSv/hour (on the surface) or 100 beckerels/gram. Certification can be based on measurements conducted by the backing carbon steel manufacturer and as reported in the mill test certificates of the raw material.

Revision Summary

13 December 2011	Major revision after value engineering session.

Annex A

Hardness Testing for Procedure Qualification