



# Engineering Standard

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SAES-W-019

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Girth Welding Requirements for Clad Pipes

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Document Responsibility: Welding Standards Committee

## Saudi Aramco DeskTop Standards

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## 1 Scope

- 1.1 This standard specifies the girth welding requirements for CRA clad pipelines and piping for both onshore and offshore application. These requirements are in addition to the requirements of ASME SEC IX.
- 1.2 This standard does not apply to:
- a) Weld overlaying of pipes and piping components
  - b) Fabrication of clad piping spools

## 2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials Systems 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

Unless stated otherwise, all Codes, Standards, and Drawings referenced in this Standard shall be of the latest issue (including revisions, addenda, and supplements) and are considered a part of this Standard.

### 3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302

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

SAEP-324

*Ceryification Review and Registration of Project Welders*

### 3.2 Industry Codes and Standards

American Society of Mechanical Engineers

*ASME SEC IIC*

*Welding Rods, Electrodes and Filler Metals*

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*ASME SEC V Nondestructive Examination*  
*ASME SEC IX Welding and Brazing Qualifications*

American Society for Testing and Materials

*ASTM E92 Vickers Hardness of Metallic Materials*

American Welding Society, Inc.

*AWS A5.32 Specification for Welding Shielding Gases*

NACE International/International Standardization Organization

*NACE MR0175/ISO 15156 Petroleum and Natural Gas Industries-  
Materials for use in H<sub>2</sub>S-Containing  
Environments in Oil and Gas Production*

#### **4 Approved Welding Processes**

The following processes are approved for use with the restrictions and requirements as listed below:

- 4.1 SMAW, GTAW and GMAW are approved welding processes. Other welding processes can be used if approved by CSD.
- 4.2 Root pass welding shall be carried out using GTAW process. Alternative welding processes can be used if approved by CSD.
- 4.3 It is acceptable to use GMAW process for the root pass subject to the following conditions:
  - (i) Mode of metal transfer is restricted to modified short circuit transfer
  - (ii) It is demonstrated that root pass can be made without spatter
  - (iii) The range of welding parameters (I, V, Pulsing Parameters and Travel Speed) used in the PQR's are considered essential variables
  - (iv) Type and make of welding machine is considered an essential variable

#### **5 Welding Procedure Qualification**

- 5.1 All welding procedures shall be qualified in accordance with latest edition of ASME SEC IX.
  - 5.2 Welding procedures shall be qualified for each project using the pipes intended for the project.
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- 5.3 Qualification of the welding procedures must be carried out during the presence of welding engineer from CSD. A minimum of 4 weeks' notice shall be given to CSD. CSD may delegate this responsibility to project inspection or third party inspection agency.
- 5.4 The following welding variable shall be considered as essential variables:
- Bevel design, with tolerance, intended for the production welds
  - Increase in mismatch from that used in the PQR test coupon
  - Brand name of welding consumables, unless approved by CSD
  - Diameter, wall thickness and grade of the test coupon
  - Heat input of root pass and hot pass (range of heat input can be qualified by qualifying multiple PQRs)
  - Minimum number of layers for which purging is to be maintained (see paragraph 7.4)

*Commentary:*

*See paragraph 4.3 (ii) and (iii) for additional essential variable.*

- 5.5 All welding consumables used shall be classified as per AWS/ASME SEC IIC or equivalent classification if approved by CSD. Welding consumable selection shall be as per Table 1 below. Other welding consumables can be used if approved by CSD.

**Table 1**

Clad Type Pass	Root Pass and Hot Pass		Rest of the Passes	
	Bare Wire	Covered Electrode	Bare Wire	Covered Electrode
316L	ER316L	NA	ER309LMo	E309MoL
316L	ER309LMo/ERNiCrMo-3	NA	ER309LMo/ERNiCrMo-3	E309MoL/ENiCrMo-3
825	ERNiCrMo-3	NA	ERNiCrMo-3	ENiCrMo-3
625	ERNiCrMo-3	NA	ERNiCrMo-3	ENiCrMo-3

- 5.6 Complete girth welding shall be carried out using corrosion resistant alloy (CRA) welding consumable. It is not acceptable to weld a buffer layer with pure iron welding consumable followed by welding with carbon steel electrodes/filler wire.

- 5.7 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 weld overlay.
- 5.8 Duplex/Super duplex stainless steel consumables shall not be used for girth welding unless approved by CSD.
- 5.9 PQR test coupon should be tested by non destructive testing (RT or UT). The selection of NDT method should be identical (including manual or automatic NDT) to the NDT method proposed for production welds.
- 5.10 Tensile testing on the PQR test coupon shall be carried out after removing the CRA material unless CRA thickness is included in the design calculation for bearing the pressure.
- 5.11 The PQR shall include the following additional tests:
  - a) Chemical composition shall be carried out at a depth of 2.0 and 2.5 mm from the ID CRA surface. The chemistry shall be within the range specified in ASME SEC IIC or AWS specification. In the case of alloy N06625, the iron content shall not exceed 6%. The PREN ( $\%Cr+3.3\%Mo+16\%N$ ) as calculated from the above chemical analysis shall be as per Table 2 below.

**Table 2**

Grade	PREN (min.)
316/316L	24
N08825	42
N06625	45

- b) Hardness testing shall be carried out on the weld cross section as per Annex A for sour service only. 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 248 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*

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*location in the intermediate mixed zone/unmixed zone.*

- c) Corrosion test shall be carried out as per Table 3 below. Corrosion specimens shall be prepared by removing the backing carbon steel by milling or by other means. Specimen shall be taken from the location of maximum mismatch and the thickness of the specimen shall not be less than 2.0 mm.

**Table 3**

Steel Grade	Corrosion Test	Test Conditions	Acceptance Criteria
UNS N08825	ASTM G48 Method A	Test temperature: 22°C Test duration : 72 hours	No pitting at 20X magnification
UNS N06625	ASTM G48 Method A	Test temperature: 50°C Test duration : 72 hours	No pitting at 20X magnification

**Notes:**

- a. The surfaces of the specimens shall be in the “as welded” condition. No surface treatment like grinding, buffing or pickling is allowed.
- b. Cut edges shall be prepared according to ASTM G48.
- c. Weight loss requirement does not apply to weld overlays.
- d. The corrosion test sample shall include the clad base material with weld at the center. The CRA weld reinforcement shall not be ground flush. In case of lined pipe, the CRA liner as well as the weld overlay shall be tested.

5.12 Repair welding procedures shall be qualified separately for both through thickness and partial thickness repairs. Through thickness repairs using SMAW process is not acceptable.

5.13 All welding procedures, including procedures for repair, must be reviewed and approved by Welding Standards Committee. Project welding engineers representing CSD are not authorized to approve welding procedures intended for girth welding of clad pipes.

## 6 Welder and Welding Operator Qualification

- 6.1 All welders/welding operators shall be qualified in accordance with the ASME SEC IX and SAEP-324.
- 6.2 The test records of all welders and welding operators shall be available at all times at the work location for review by Saudi Aramco Inspection. Performance qualification tests shall not be performed on production joints on Saudi Aramco work.

## **7 Production Welds**

- 7.1 The CRA surface shall be adequately protected from cutting debris and contamination with carbon steel during plasma cutting and beveling operation.
- 7.2 The CRA surface shall not directly contact copper-based backing shoe material at any time during the welding or laying process.
- 7.3 The fit-up of the welds may be inspected and cleared by Saudi Aramco project inspection.
- 7.4 Back purging shall be carried out using inert gas conforming to AWS A5.32 until the completion of root and hot pass. It is not acceptable to use nitrogen as a purging gas. The back purge shall reduce the oxygen to a level below 0.05%. An oxygen analyzer should be used for continuous monitoring of the oxygen content inside the pipe during purging. A spray purging system may be used if demonstrated by a PQR.

## **8 Post Weld Heat Treatment**

Post weld heat treatments (PWHT) shall be carried out if required by the applicable codes. A written procedure describing the PWHT requirements shall be submitted to CSD for review and approval.

## **9 Inspection**

- 9.1 Saudi Aramco representatives shall have free access to the work at all times.
- 9.2 Saudi Aramco shall have the right to inspect the fabrication at any state or stage and to reject material or workmanship which does not conform to the specified requirements.
- 9.3 Nondestructive testing (NDT) procedures shall be established in accordance with ASME SEC V. A written procedure for each inspection method and technique, including acceptance criteria, to be used shall be submitted to Inspection Department for approval. Qualification of the procedure by the contractor may be required, as determined by Saudi Aramco Inspection. Inspection procedures in conformance with other standards are acceptable only with the approval of Inspection Department.
- 9.4 All NDT personnel, including personnel for visual inspection, shall be qualified as a minimum to Level II by ASNT or an equivalent certification body.

*Commentary:*

*The ASNT term Nondestructive Testing (NDT) has been used in this standard and shall be considered synonymous with the ASME term Nondestructive Examination (NDE).*

- 9.5 Root pass of all welds shall be visually inspected with the aid of a camera or vision sensor. Visual Examination shall ensure uniform and adequate penetration. Weld imperfections in the root such as lack of fusion, porosity, internal spatter, etc., are not acceptable irrespective of the extent or size of the imperfection. The contractor shall submit the visual inspection procedure along with the acceptance criteria to CSD for approval.
- 9.6 All welds shall be 100% inspected using RT or automatic UT. If the contractor proposes to use automatic UT, the procedure and equipment shall be demonstrated to Saudi Aramco NDT specialist preferable during qualification of PQR. This verification can be done at any location convenient to the contractor with prior advanced intimation to Saudi Aramco Inspection Department and CSD.
- 9.7 Acceptance criteria for RT and UT shall be as per the applicable design code. However, no welding imperfections, as revealed by visual inspection are acceptable in the root pass as stated in paragraph 9.5 above.

*Commentary:*

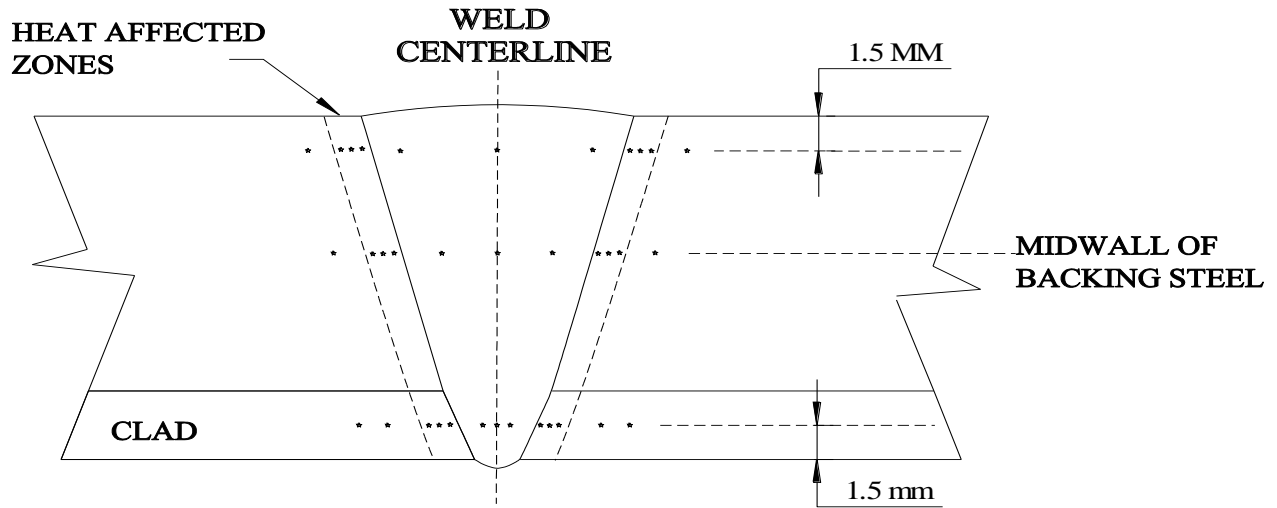
*The contractor may choose to have an intermediate NDT station after the root and hot pass to prevent complete cut off of welds due to root defects detected during final NDT carried out after completion of girth welding.*

- 9.8 In case of lined pipe, the inside of the pipe shall be inspected for possible collapse of liner after completion of girth welding. Inspections shall be carried by passing a scraper (buckle detector) through the pipe.
- 9.9 Positive Material Identification (PMI) shall be conducted on 10% of the girth welds. Acceptance criteria shall be as per AWS/ASME SEC IIC with the exception of iron content as specified in paragraph 5.11 a.



## Annex A

### Hardness Testing for Procedure Qualification



### Orientation and Location of Hardness Indentations