



Materials System Specification

01-SAMSS-046

17 July 2010

Stainless Steel Pipe

Document Responsibility: Materials and Corrosion Control Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

This Specification covers welded and seamless austenitic stainless steel and duplex and super duplex stainless steel pipes. This specification is applicable for in-Plant piping in accordance with applicable ASTM standards. The requirements stated in this specification are supplementary to the applicable ASTM standard. This specification is not applicable for procurement of heat exchanger tubes.

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.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

[SAEP-302](#)

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

Saudi Aramco Inspection Requirements

Form [175-010800](#)

Pipe: Beveled End, Seamless or Welded, Straight Seam, Stainless Steel Pipe

3.2 Industry Codes and Standards

American Society of Mechanical Engineers

[ASME SEC IX](#)

Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

American Society for Nondestructive Testing, Inc.

- [ASNT SNT-TC-1A](#) *Recommended Practice for Personnel Qualification and Certification*
- [ASNT CP-189](#) *Standard for Qualification and Certification of Nondestructive Testing Personnel*

American Society for Testing and Materials

- [ASTM A262](#) *Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels*
- [ASTM A312](#) *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*
- [ASTM A358](#) *Standard Specification for Electric-Fusion Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications*
- [ASTM A370](#) *Standard Test Method and Definitions for Mechanical Testing of Steel Products*
- [ASTM A380](#) *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*
- [ASTM A409](#) *Standard Specification for Welded Austenitic Steel Pipe for Corrosive or High-Temperature Service*
- [ASTM A790](#) *Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe*
- [ASTM A923](#) *Standard test Methods for Detecting Detrimental Intermetallic in Duplex Austenitic/Ferritic Stainless Steel*
- [ASTM A928](#) *Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe*
- [ASTM A999](#) *Standard Specification for General Requirements for Alloy and Stainless Steel Pipe*
- [ASME B16.25](#) *Butt Welding Ends*
- [ASTM E562](#) *Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count*
- [ASTM G48](#) *Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and*
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Related Alloys by Use of Ferric Chloride Solution

International Standardization Organization

[ISO 15156](#)

Petroleum and Natural Gas Industries-Materials for use in H₂S-containing Environments in Oil and Gas Production

NACE International

[NACE MR0103](#)

Material Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments

European Standard

[EN 473](#)

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

4 Definitions

Lot: For the purpose of corrosion tests and micrographic examination, the term “lot” applies to all pipes, prior to cutting to length, of the same nominal diameter and wall thickness, produced from the same heat of steel and annealed in a continuous furnace at the same temperature, time at temperature, and furnace speed. When final heat treatment is in a batch-type furnace, a lot shall include only those pipes of the same size and the same heat which is heat treated in the same furnace charge.

5 Information to be Supplied by the Purchaser

Indicate on the purchase order only when required:

- (i) Suitable for sour service ([ISO 15156](#) shall apply)
- (ii) Suitable for services where Polythionic Acid Stress Corrosion Cracking (PASCC) is a possibility (see paragraph 7.2)

6 Manufacture

- 6.1 Gas Tungsten Arc Welding, Gas Metal Arc Welding, Flux Cored Arc Welding, Plasma Arc Welding, Laser Beam Welding, Submerged Arc Welding (SAW) and Electron Beam Welding are acceptable welding processes. Shielded Metal Arc Welding shall not be used even for carrying out weld repairs.
 - 6.2 High frequency welding (HFI or ERW) is not an acceptable welding process.
 - 6.3 Welding consumables shall be procured with appropriate chemistry to meet the
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corrosion properties of the weld as required by this specification.

- 6.4 Welding procedure for pipes manufactured by batch process shall be qualified as per [ASME SEC IX](#). For SAW process, flux trade name shall be considered as an essential variable.
- 6.5 Welding qualification requirements (Procedure Qualification Record and Welding Procedure Specification) for Duplex Stainless Steels as specified in [NACE MR0103](#) shall apply for UNS S31803, S32205 and S32750.
- 6.6 All pipes ordered to [ASTM A358](#) and [ASTM A928](#) shall be made to Class 1 or Class 3 requirements unless stated otherwise in the purchase order.
- 6.7 Repair procedures and welders employed for repairs shall be qualified as per [ASME SEC IX](#).
- 6.8 Weld repairs on seamless pipes and autogenously welded pipes are not permitted. Weld repairs on the pipe body of pipes welded with addition of filler metal are not permitted.
- 6.9 Weld repair procedures for duplex, super duplex and super austenitic stainless steels shall be submitted to Materials & Corrosion Control Standards Committee for approval.
- 6.10 All weld repairs must be followed by re-heat treatment and re-hydrotest.
- 6.11 The finished pipe shall not include welds used for joining together lengths of the hot rolled or cold rolled strip prior to forming.

7 Heat Treatment

- 7.1 All pipes shall be supplied in solution annealed condition except as stated in 7.2 below.
 - 7.2 All stabilized grades shall be given a stabilization heat treatment subsequent to solution annealing. Stabilization heat treatment shall be carried out at 900°C for a minimum period of 2 hours. If stabilization heat treatment is being carried out in a continuous furnace, a lower soaking time can be considered for pipes with wall thickness less than 3.2 mm. Stabilization heat treatment is not required for applications where polythionic acid stress corrosion cracking (PASCC) is not a possibility.
 - 7.3 Batch-type furnaces shall be equipped with recording pyrometers and automatically controlled within a 10°C or lesser range. Temperature monitoring by attaching thermocouples to the pipe is acceptable.
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8 Chemical Composition

- 8.1 UNS S31803 pipes dual certified as S31803/S32205 are acceptable. Dual certified 304/304L and 316/316L pipes are acceptable if the design temperature is less than 538°C. Dual certification for all other grades (e.g., 304/304H and 316/316H) is acceptable.
- 8.2 All non 'L' grades (e.g., 304, 316) shall have a minimum carbon content of 0.04%. This requirement is not mandatory if the design temperature is less than 538°C.
- 8.3 Pitting Resistance Equivalent (PRE) ($\%Cr+3.3\%Mo+16\%N$) for the base material and weldmetal for the grades listed below shall be greater than or equal to that shown in Table 1 below.

Table 1

Grade	PRE
316/316L	24
317/317L	29
N08904	34
S31254 ⁽¹⁾	42
S32050	50
S31803	35
S32205	35
S32750	42

⁽¹⁾ UNS N08367 and N08926 are acceptable substitutes to UNS S31254. If UNS N08367 or N08926 is offered in lieu of UNS S31254, all the requirements of UNS S31254 stated in this specification shall apply.

9 Mechanical Tests

- 9.1 Hardness testing shall be carried out on all grades for each lot. The mechanical testing lot definition as stated in applicable ASTM standard shall apply.
- 9.2 A minimum of three indentations shall be taken on the inside and the outside surfaces. For welded pipes at least three readings shall be taken on the cross section of the weld.
- 9.3 Acceptance criteria shall be as specified in the Table 3 below.

Table 3

UNS No.	Hardness (maximum)
S31803	25 HRC
S32205	28 HRC
S32750	32 HRC
S31254	22 HRC

9.4 Hardness for all other grades not specified in the Table 3 above shall not exceed 22 HRC.

10 Corrosion Tests

10.1 All austenitic stainless steel grades except those specified in Table 4 shall be subjected to intergranular corrosion test as per [ASTM A262](#) Practice E. Requirement for sensitization of samples shall be as specified in [ASTM A262](#) except that sensitization heat treatment is not required for grades having more than 3% Mo.

10.2 Intergranular Corrosion test specified in paragraph 10.1 above is not required for heats having less than 0.020% carbon as shown in product analysis.

10.3 The following grades shall be subjected to the corrosion testing as specified in Table 4 below.

Table 4

Steel Grade	Corrosion Test	Test Conditions	Acceptance Criteria
UNS N08904 (904L)	ASTM G48 Method A	Test temperature: 25°C Test duration : 24 hours	No pitting at 20X magnification. Weight loss shall be less than 4.0 g/m ² .
UNS S31254	ASTM G48 Method A	Test temperature: 50°C Test duration : 48 hours	No pitting at 20X magnification Weight loss shall be less than 4.0 g/m ² .
UNS S31803	ASTM A923 Method C	As per ASTM A923	As per ASTM A923
UNS S32205	ASTM A923 Method C	As per ASTM A923	As per ASTM A923
UNS S32750	ASTM A923 Method C	As per ASTM A923	As per ASTM A923

Notes:

- a. The internal and external surfaces of the specimens shall be in the "as delivered" condition (pickling or bright annealed) unless stated otherwise in the applicable standard.

- b. Cut edges shall be prepared according to [ASTM G48](#), and the whole specimen shall be pickled if the tubes are to be delivered after pickling.
- c. For welded pipes the sample for corrosion test shall include the weld at the centre of the sample.
- d. Rapid screening test ([ASTM A923](#) Test Method A) shall not be used as an acceptance test.

10.4 The applicable corrosion test shall be conducted on each lot. The definition of lot shall be as stated in paragraph 4 of this specification.

11 Metallographic Examination

Ferrite content for UNS S31803, S32205 and UNS S32750, as determined in accordance with [ASTM E562](#), shall be between 35 to 65%. Examination for welded pipes must include the weldmetal and the heat affected zone for each lot as defined in paragraph 4 of this specification.

12 Non-Destructive Testing

- 12.1 Level 1 personnel may set up the equipment, perform tests, and report the results. Supervision of Level 1 personnel and interpretation of results shall be done by Level 2 employees. The primary Level 3 employee such as company employee, outside consultant, or third party inspector shall be certified in accordance with [ASNT CP-189](#) or [EN 473](#) or [ASNT SNT-TC-1A](#) or by an independent certifying body acceptable to Saudi Aramco.
- 12.2 Each pipe shall be subjected to non-destructive test as per the applicable ASTM specification.
- 12.3 In addition to non-destructive test, each pipe shall be subjected to hydrostatic testing as per [ASTM A999](#).
- 12.4 Chloride content of hydrotest water shall not exceed 50 ppm and the pipes should be dried and cleaned after hydrotest.

13 Pickling

All pipes that are not bright annealed must be subjected to pickling.

14 Dimensional Requirements

Pipes shall be supplied with beveled ends in accordance with Figure 4 of [ASME B16.25](#) irrespective of wall thickness, unless otherwise specified in the Purchase Order.

15 Inspection

Pipes purchased in accordance with this Specification is subject to the requirements of Saudi Aramco Inspection Requirements Form [175-010800](#).

16 Marking

16.1 The marking shall ensure full traceability to melt and heat treatment lot.

Commentary:

Marking of heat treatment lot is not mandatory. However, the marking on the pipe must ensure traceability to the heat treatment lot.

16.2 Marking materials shall be suitable for stainless steels and contain less than 200 ppm halogens and 200 ppm sulfur. When requested, composition certificates of marking materials shall be provided.

17 Positive Material Identification (PMI)

17.1 PMI shall be conducted randomly on finished pipes on each lot before dispatch. A minimum of 5% of pipes in each heat must be tested. Internal company procedure can be followed for conducting PMI.

17.2 Saudi Aramco representative may select the pipes for testing.

17.3 PMI should include the weld for pipes welded with addition of filler metal.

18 Handling, Packing and Transportation

18.1 Stainless steel pipes shall not be manufactured in the same shop or facility where carbon steel pipes are manufactured.

18.2 Iron contamination after heat treatment and pickling/passivation shall be prevented. On suspicion of iron contamination, Saudi Aramco representative can request for Ferroxyl Test for Free Iron as per [ASTM A380](#).

18.3 Pipe ends shall be protected by end caps.

18.4 Pipe bundles shall be wrapped in plastic and packed in fully covered wooden boxes if the pipe size is equal or less than 6-inch OD. Alternative packing can be accepted upon approval by Saudi Aramco Standards Chairman of the Materials & Corrosion Control Standards Committee.

18.5 Pipes shall be stored on wooden bearing strips. Storage and handling practice must ensure that there are no mechanical dents on the pipe surface and that there

is no contamination from carbon steel (crane hooks, etc.).

- 18.6 The pipes, after pickling, shall be suitably protected from environmental contamination (moisture, dirt, etc.) during storage and transportation.
- 18.7 API 5L1 and API 5LW shall be followed for transportation of pipes by rail road and marine transportation respectively.
- 18.8 The following shall be ensured for transportation of pipes by road:
- (i) Truck beds and sides shall be inspected to ensure that there are no projections (rivet heads, etc.) that may cause fretting during transportation.
 - (ii) Pipes must not come in contact with carbon steel truck parts or with carbon steel strips/chains used for securing the load.
 - (iii) Wooden bearing strips shall be used.
 - (iv) Pipe layers must be separated by wooden separators.
 - (v) The packing list for transportation must include the pipe numbers and the truck number on which specific pipes are being transported.

19 Certification

- 19.1 The pipe manufacturer shall furnish the mill test certificate as per [ASTM A999](#).
- 19.2 Solution annealing temperature, soaking time and cooling media shall be reported in the mill test certificate. In case of stabilized grades, the above details for stabilization heat treatment shall also be reported.
- 19.3 Corrosion tests, including weight loss (where applicable) shall be reported in the mill test certificate.
- 19.4 It shall be certified in the test certificate that the radiation levels from the pipes are less than 100 beckerels/gram.

17 July 2010

Revision Summary
Major revision.