Sara Sae

Engineering Standards/Specifications

Procedure No.
SES 26-706

Title

MATERIAL SPEC, ALLOY STEEL CASTINGS ASTM A-487 FOR LOW TEMPERATURE SERVICE 75K, STANDARD AND H_2S SERVICE (HB 197-235)

V.P. of Manufacturing	V.P. of Engineering	V.P. of QA/QC	V.P. of Sales/ Marketing	Revision Description	Release Date	Rev. Ltr

Written By	Revised By	

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1.0 SCOPE

1.1 This Specification covers low alloy steel castings suitable for pressure containing parts of quality suitable for low temperature, standard and H_2S service in conformance with NACE MR-01-75, and for assembly with other castings or wrought steel parts by fusion welding. This material shall be used for API Spec 6A or 16A material designation 75K. This material may have third party inspection requirements.

1.2 Materials purchased to this Specification require magnetic particle/liquid dye penetrant inspection of all critical areas of the casting as indicated in Sections 14.0 and 15.0.

1.3 Weld repair of castings is permitted per Paragraphs 9.2.2 for critical areas and 9.2.3 for non-critical areas.

2.0 APPLICABLE SPECIFICATIONS AND REQUIREMENTS

2.1 Specifications applicable:

2.1.1 ASTM A-487 Class 9 to the latest revision as modified herein.

2.1.2 ASTM A-703, General Requirements for Steel Castings.

2.1.3 API Spec 6A or 16A.

2.1.4 NACE MR-01-75, Material for Hydrogen Sulfide Service.

2.1.5 UNS J13345.

2.1.6 ASME B & PV Code, Section VIII, Div. 1, Appendix 7.

2.1.7 ASME B & PV Code, Section V, Article 3.

2.1.8 ASME B & PV Code, Section V, Article 5.

2.1.9 MSS-SP-55, Quality Standard for Steel Castings.

2.1.10 ASTM E94-77, Radiographic Testing.

2.1.11 ASTM E142, Radiographic Inspection for First Article.

2.1.12 ASTM E-709, Wet Magnetic Particle Examination.

2.1.13 ASME Boiler and Pressure Vessel Code, Section IX.

2.1.14 Chemtron 4130LN or equivalent, SMAW Electrode.

2.1.15 AWS E10018-D2, SMAW Electrode.

3.0 BASIS OF PURCHASE

3.1 The material chemistry shall meet the requirements of Paragraph 4.1.

3.2 Purchase Order shall include the following:

3.2.1 SARA SAE Engineering Specification.

3.2.2 SARA SAE drawing number and revision letter.

3.2.3 Radiographic inspection of First Article per ASME Section VIII, Div. 1, Appendix 7.

3.2.4 Certification specified in Section 11.0.

3.2.5 Third party inspection requirements, if any.

3.2.6 Test temperature and V-notch Charpy values.

3.2.7 The Purchase Order shall specify the grade of material.

3.3 Melting Process:

3.3.1 The material shall be made by the Basic Electric Process. (This process is preferred by SARA SAE). In the molten state, the material must be aluminum deoxidized for fine grain refinement. In addition, it may also be AOD or vacuum treated. Further refining is permitted using vacuum-arc or electroslag remelting.

3.3.2 The Acid Electric Process is an acceptable melting process provided selected raw material is used to maintain the phosphorous and sulfur content of the steel below the .025% maximum specified. The foundry

requires SARA SAE approval to use this process. Aluminum deoxidation is required.

3.4 Vendor shall be required to upgrade non-conforming material. However, SARA SAE reserves the right to correct inefficiencies and "back charge" the vendor in the event the delivery schedule does not allow time for vendor repair of the products submitted.

3.5 Whenever third party inspection is to be performed at the foundry, these requirements shall be stated on the Purchase Order. The foundry will submit an approximate production schedule to SARA SAE in order to plan third party inspection visits.

4.0 CHEMISTRY REQUIREMENTS

4.1 The chemistry shall conform to ASTM A-487 Grade 9 as modified below:

	Grade 9 Mod.
Carbon, %	.22/.30
Phosphorous, %	.025 Max.
Sulfur, %	.025 Max.
Manganese, %	.60/1.00
Silicon, %	.30/.60
Nickel, %	.50 Max.
Chromium, %	.70/1.20
Molybdenum, %	.15/.35
Aluminum, %	.05 Max.
Vanadium, %	.10 Max.
Copper,%	.50 Max.

5.0 MECHANICAL PROPERTIES

5.1 The material shall have the following minimum mechanical properties, which are obtained from a cast coupon as indicated below. The test coupon shall be made

from the same heat as the castings it represents. The test coupon shall receive the equivalent heat treatment specified for the casting grade and class it represents in conformance with Section 6.0.

The QTC for RAM BODY CASTINGS shall be cast as an integral part of the body or, it shall be cast separately and attached to the bore or inside compartment prior to heat treatment.

In any case, it must be a part of the body casting throughout the entire heat treat cycle (austenitize, quench and temper). A minimum of two Brinell hardness tests shall be performed on the QTC after the final heat treatment.

Tensile Strength, psi min.	95,000
Yield Strength, psi min.	75,000
Elongation in 2" gauge length, % min.	18
Reduction in area, % min.	35
Hardness, HB	197-235

5.1.1 For material thicknesses equal or greater than 4", the size of the API QTC shall be 4" x 4" x 8", representing an ER=5.

5.1.2 For material thicknesses less than 4", the size of the API QTC shall be T" x T" x 6", where "T" is the maximum wall thickness of the casting or the maximum thickness of the flange (for valve bodies).

5.1.3 The test specimens should be sampled from a t/4 location where "t" is the thickness of the test coupon.

5.2 Impact Properties

5.2.1 Test temperature, V-Notch Charpy values, and lateral expansion requirements shall be:

Temperature	Charpy V-Notch (Avg. of 3 Specimens)	Min. Requirements for One Specimen Only	Lateral Expansion Min.
-32°C	31 ft.-lbs.	24 ft.-lbs.	0.015"

5.2.2 The test specimens should be sampled from a t/4 location where "t" is the thickness of the test coupon.

5.2.3 Unless otherwise specified, the Charpy V-Notch specimens are to be oriented in the longitudinal direction with the notch machined such that it is perpendicular to the material surface from which t/4 is measured.

6.0 HEAT TREATMENT

6.1 All castings shall be normalized at 1800°F, ± 25°F, before removing the gates and risers or before any additional heat treatment. Enough time must be allowed at temperature for the center of the thickest casting section to reach 1800°F.

6.2 All castings shall then be austenitized at 1650°F, ± 25°F, and held at temperature for a minimum of one hour per inch of material thickness, water quenched, and tempered to HB 197-235. The minimum tempering temperature shall be 1200°F.

6.3 The temperature of water used as quench media shall not exceed 100°F at the start of the quench. The temperature of the water shall not exceed 120°F at any time during the quench process. If a quench media other than water is used, the temperature of the quench media shall meet manufacturer's written specification.

6.4 Stress relieving after weld repairs shall be at 1150-1190°F.

7.0 MARKING

7.1 All castings shall be marked with part number, heat number, and vendor identification symbol as shown on the casting drawing. Location of markings must be approved by SARA SAE.

8.0 INSPECTION

8.1 After removal from the mold and during the course of normal cleanup, the casting shall be visually inspected per MSS-SP-55.

8.2 Areas defined as critical in Sections 14.0 and 15.0 shall be inspected by magnetic particle/dye penetrant inspection. No linear defects greater than 1/16" are acceptable on the cast surfaces. All defects, whether linear or non-linear, shall not remain on the critical surfaces after machining. SARA SAE will MPI and LPI all castings received.

9.0 SPECIAL REQUIREMENTS

9.1 Repair of Defects

9.1.1 Defects shall be removed by grinding, machining, or any mechanical means. Scarfing or air arcing to remove defects is permitted. However, preheating to 350-400°F is mandatory to avoid casting cracking.

9.1.2 When surface defects are removed by grinding and the wall thickness is not reduced below that specified on the drawing, the defective area may be blended smooth. To assure that all defects have been removed, re-inspect the affected zone by MPI per ASTM E709/ASME SE709.

9.2 Welding

9.2.1 General

Welding for repair and upgrading is permitted and shall be done by welders using a welding procedure submitted and approved by SARA SAE. Procedure and welders should be qualified to ASME B&PV Code Section IX and SARA SAE Specification A-X100016.

9.2.2 Castings shall be preheated to 350/450°F prior to any weld repair.

9.2.3 Weld repairs of critical areas as defined in Section 14.0 must be performed prior to liquid quench and temper.

9.2.3.1 Weld repairs carried out prior to liquid quench and temper shall be done utilizing Chemtron 4130LN electrode, ESAB Atom Arc

4130-LN, or an equivalent electrode. The electrode used must meet the mechanical properties of this Specification in the liquid quenched and tempered condition. It also must meet the requirements of 1.0% maximum in Ni content.

9.2.4 Weld repair in sections other than the shaded area shown in Section 14.0 may be repaired (after LQ&T) using E10018-D2 electrode followed by stress relief as specified in Paragraph 6.4. The stress relief time shall be the equivalent of one hour per inch of metal thickness.

9.2.5 All weld repairs shall be inspected per ASTM E709 (magnetic particle).

9.3 Radiographic Inspection

9.3.1 The first casting made from a new or altered pattern shall be subjected to radiographic inspection to verify its soundness and integrity. Radiographic examination shall be in accordance with ASME Section V, Article 3. Acceptance criteria shall be per ASME Section VIII, Div. 1, Appendix 7, Paragraphs 7-3(a)(1) or 7-3(b)(3). Radiographic film and report shall be submitted to SARA SAE QA for evaluation and approval.

The same casting will be used to perform dimensional inspection per Paragraph 10.1.

9.3.2 All wall thicknesses that exceed 12 inches or cannot be radiographically inspected because of geometry, shall be ultrasonically inspected in accordance with Article 5 of Section V of the ASME B & PV Code. Acceptance criteria shall be per ASME Section VIII, Division 1, Appendix 7, Paragraph 7-3(b)(3).

9.3.3 SARA SAE, at its option and expense, may request that periodic radiographic inspection be conducted on production components. If castings are found to be in nonconformance with the requirements of Paragraph 9.3.1, no new castings will be accepted by SARA SAE until the nonconformance has been corrected and defect removal substantiated by radiographic examination.

9.4 Aluminum Nitride Embrittlement

9.4.1 Castings shall be free from the presence of conchoidal fracture or aluminum nitride embrittlement. It is the foundry's responsibility to provide castings that are free from aluminum nitride embrittlement or conchoidal fracture. SARA SAE, at its option, will conduct random inspections for aluminum nitride embrittlement by the use of bend test and/or room temperature Charpy V-Notch Impact Test.

10.0 DIMENSIONAL INSPECTION

10.1 The first casting made from a new or altered pattern shall be subjected to dimensional inspection to determine that it conforms to the dimensions and tolerances specified on the drawing furnished and approved by SARA SAE at the time of order. This casting must be marked as First Article when shipped to SARA SAE. No additional shipments shall be made until this casting is approved.

10.2 Once approved per paragraph 10.1, a complete dimensional inspection on the subsequent castings will not be necessary. However, normal QA checks will be made at any time and any dimensional non-conformance will be cause for rejection.

10.3 SARA SAE must be informed prior to any foundry practice or pattern change. Traceability of castings affected by the change shall be maintained by the foundry. In addition, another First Article re-inspection shall be submitted for approval to SARA SAE after the change and prior to proceeding with the production of additional castings.

11.0 CERTIFICATION

11.1 A certification must be provided to SARA SAE with each shipment. In addition, the original and a copy will be provided to the SARA SAE Purchasing Department.

11.2 The following information is required on the certification:

11.2.1 Purchase Order number and SARA SAE Specification number.

11.2.2 Statement of the melting process used.

11.2.3 Chemical analysis and heat number.

11.2.4 Statement of heat treatment, including time/temperature cycle, cooling media, and hardness of the casting and coupon separately.

11.2.5 Statement of the actual values of the mechanical properties to include Charpy V-Notch impact values which were obtained from the API QTC, as stipulated in Paragraph 5.1 and size of QTC used for testing.

11.2.6 **For RAM BOP body castings:**
Statement that the QTC was heat treated as part of the body (integrally cast or attached to bore/compartment).

11.2.7 The number of castings submitted from each heat.

11.2.8 Statement of heat treating furnace type (batch or continuous).

11.2.9 Statement of acceptance or rejection of radiographic inspection of First Article.

11.3 In the event of partial shipment, each shipment shall be accompanied by a certification covering each heat involved in the shipment.

12.0 DEVIATION

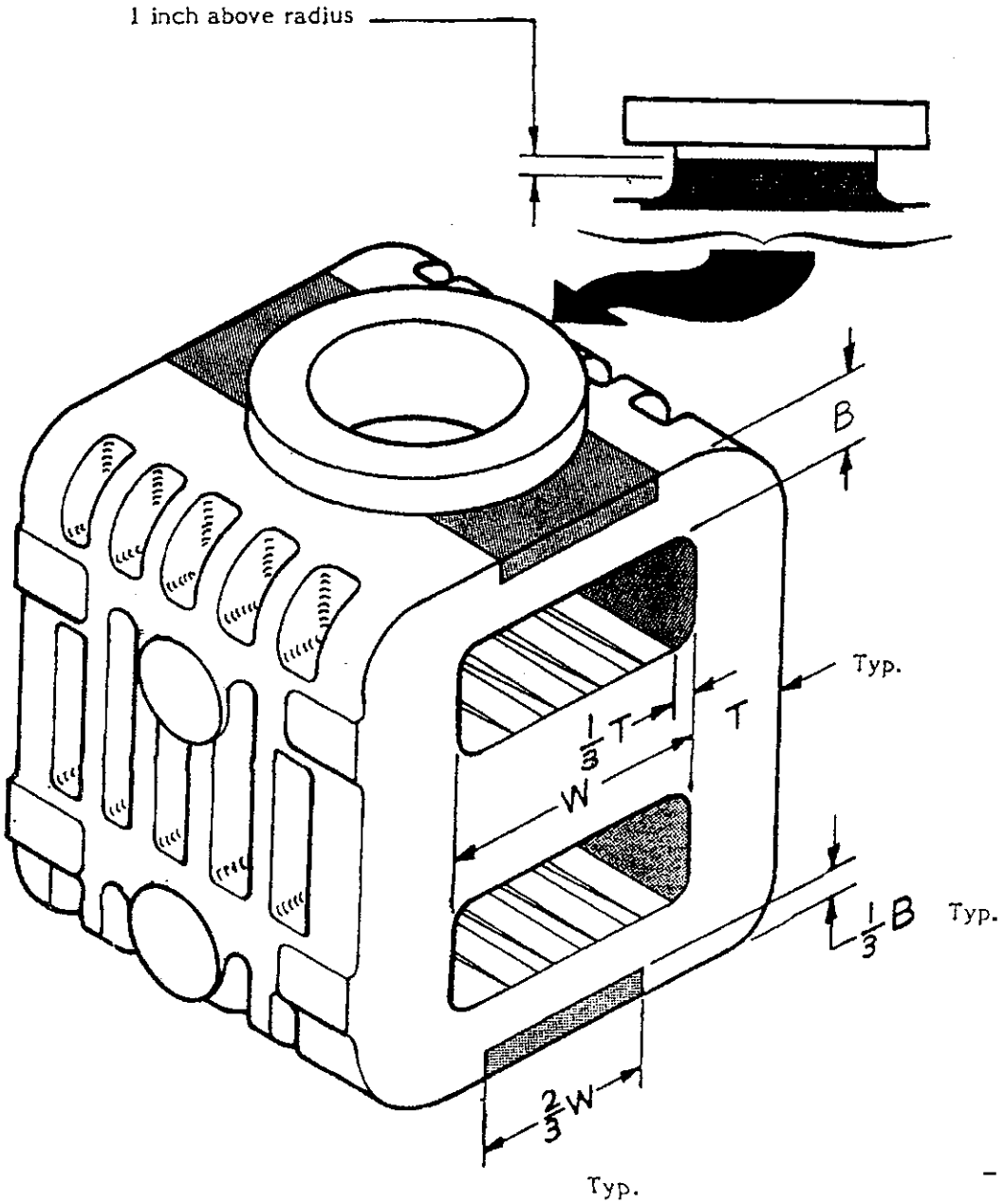
12.1 Any deviation from this Specification shall be permitted only upon prior written approval from SARA SAE. SARA SAE Engineering will be the final authority on any specification or product deviations.

13.0 LOT NUMBERS

13.1 Materials/parts ordered to this Specification will require a Lot Number issued by SARA SAE Quality Control.

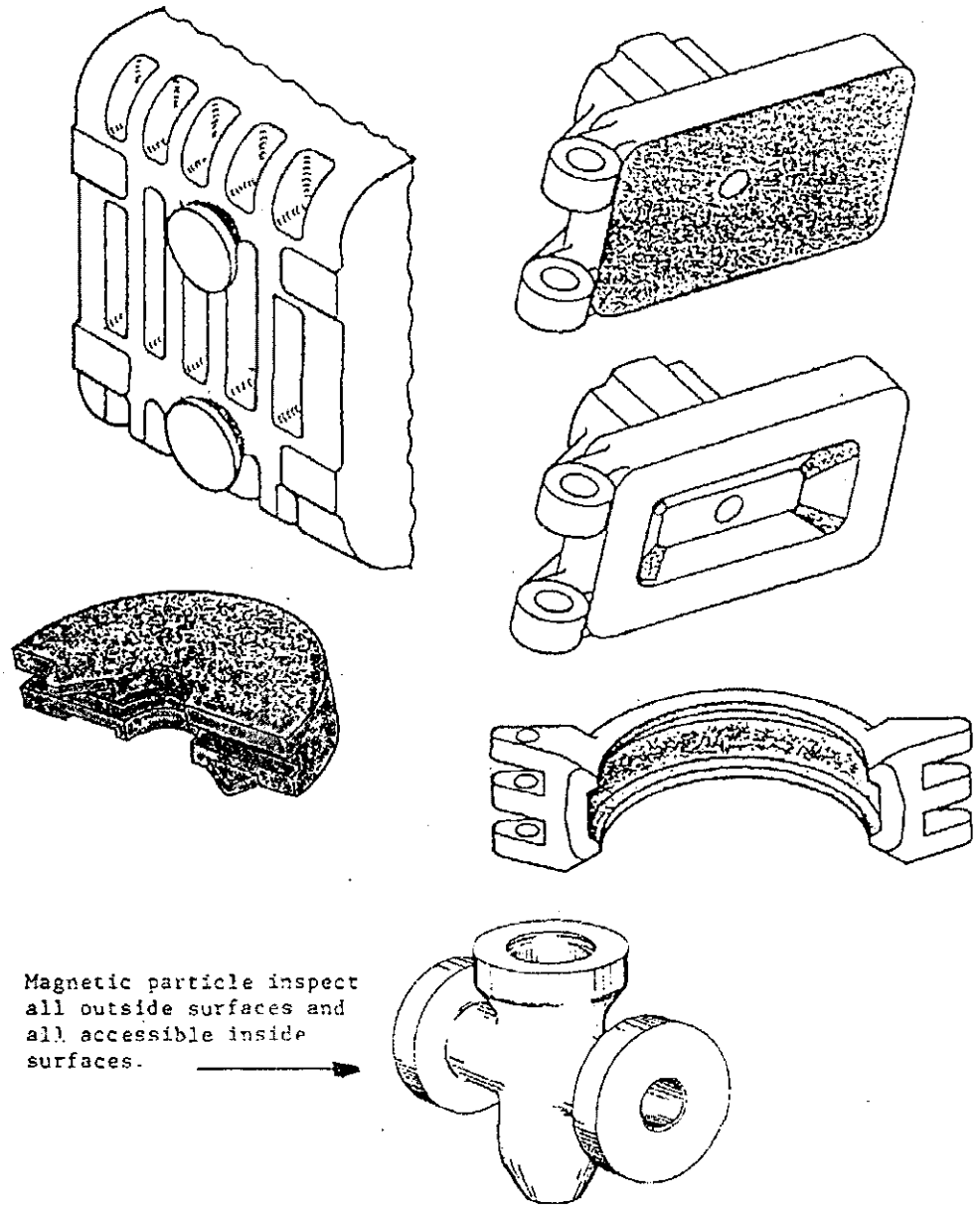
14.0 CRITICAL AREAS

14.1 Areas in casting which require liquid quench and temper after welding. The same areas require magnetic particle and dye penetrant inspection.



15.0 AREAS FOR MAGNETIC PARTICLE INSPECTION

15.1 Areas in castings which require magnetic particle inspection and/or dye penetrant



inspection.