
 <small>A JOULON COMPANY</small>	SARA SAE ENGINEERING SPECIFICATION		
	Section: SES 26 – 848		
	Issue: “A”	Rev No.: “1”	
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AISI 4140 LOW ALLOY STEEL FORGED OR WROUGHT
1,00,000 MINIMUM YIELD TO NACE 0175/ ISO 15156-2,
API 6A, API 16A, API 16C FOR SOUR SERVICE,
IMPACT TESTED AT-29 °C (-20 °F) OR LOWER.

Rev	Reason of Change	Date	Made By	Reviewed By	Approved By	Status
0	Initial release	23-08-2018	MN	AS	KKD	Released
1	Tensile, Yield, elongation values amended and second tempering process added	08-08-2019	MN	AS	KKD	Released

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1.0 SCOPE

- 1.1 AISI 4140 low alloy steel forgings and wrought shapes heat-treated to 100000 PSI minimum yield strength for sour service.
- 1.2 Product forms covered by this specification are closed die; open die and ring forgings, bar and mill shapes.


2.0 REQUIREMENTS

- 2.1 The requirements of specification SES 26-590 (General Requirements for Forged or Wrought Materials PSL 1 through 4), SES 26-740 (Specification for general requirements of heat treatment of alloy steels for use in well head, Christmas tree, manifold and related equipment) & SES 26-744 (General requirements of raw material) shall also apply in addition to the following specific requirements.
- 2.2 It is the responsibility of raw material/metal supplier/machined parts supplier of carbon, low alloy and martensitic stainless steel to have practices and procedures in place to assure that raw materials/parts delivered to Sara Sae do not have excessive amounts of residual magnetism. Excessive residual magnetism is defined as greater than 3 gauss. (Residual magnetism can occur due to factors such as lifting with magnets, magnetic particle inspection or stray welding current).
The supplier's procedures/testing methods will be subject to verification during supplier audits.
- 2.3 The raw material supplier shall assure that Sara Sae does not receive material with greater than background level of radioactivity. Background levels of radioactivity vary depending on the location. As a minimum, scrap used for melting of materials shall be checked for radiation prior to melting. The melt contractor shall assure the material is free from radiation greater than applicable background levels. It is the responsibility of the raw material contractor to ensure that this requirement is met.

3.0 CHEMICAL COMPOSITION: Chemical composition limits are listed below. An analysis of each heat of steel be made by the manufacturer, preferably from a ladle sample taken at or near the time of pouring. The listed elements shall be reported in weight percent.

ELEMENT	COMPOSITION	ELEMENT	COMPOSITION
CARBON (C)	0.38 - 0.43	SILICON (Si).	0.15- 0.35
MANGANESE (Mn).	0.75 - 1.00	CHROMIUM	0.80-1.10
PHOSPHORUS (P).	0.015 (max.)	MOLYBDENUM	0.15 – 0.25
SULPHUR (S).	0.010 (max.)		

3.1 Melt practice: The steel shall be made by the electric furnace process with subsequent vacuum treatment (EFVD). Steel made by vacuum induction melting (VIM) or vacuum arc remelting (VAR), or electroslag remelting (ESR) shall also be acceptable provided the properties. Additional may be performed

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by ladle refining, vacuum degassing. Grain size and inclusions are properly controlled.

3.2 Condition: All products shall be normalized (N) then quenched (Q) and tempered (T) (N+Q&T), except that normalizing shall not be required for the following:

- Forgings with a forging reduction of 3:1 or greater;
- Rolled tubing or extruded tubing with a wall thickness of 3” or less;
- Bar stock with a diameter of 8” or less;

4.0 Mechanical Properties: Mechanical property requirements are listed below. Each heat shall be tested and the listed mechanical properties shall be reported.

<u>MECHANICAL PROPERTIES</u>	<u>RANGE</u>
TENSILE STRENGTH, PSI	1,20,000 Min.
YIELD STRENGTH, PSI	1,00,000 Min.
ELONGATION IN 2” GAGE LENGTH	15% Min.
REDUCTION IN AREA	35% Min.
BRINELL HARDNESS	271-301 BHN


4.1 Charpy V-notch Impact testing: Impact testing shall be performed at -29 °C (- 20 °F) or lower as applicable. The average value of 27 joules each set of three specimens with minimum of 18 joules of one specimen shall be acceptable. Similarly, no more than one of the three test results shall be below the required minimum average. Charpy V-notch impact testing will be carried out as per ASTM A-370.

5.0 Heat Treatment :

PROCESS	ATMOSPHERE/MEDIA	TEMPERATURE	TIME AT TEMPERATURE
Normalized	Air	1600 °F – 1700 °F (871 °C – 926 °C)	30 Minutes / Inch of T, Minimum Time is 30 Minutes.

Still air cool to below 400 degrees F (204 degrees C) before further processing

Austenitize (Ref. Note 1& 2)	Air	1550 °F - 1600 °F (843 °C – 871 °C)	30 Minutes / Inch of T, Minimum Time is 30 Minutes.
Quench	Oil	140 °F- 176 °F (60 °C- 80 °C) at the initiation of the quench operation.	
	Polymer	60 °F- 110 °F (16 °C- 43 °C) at the initiation of the quench operation.	

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Quench baths shall permit complete immersion of material, provide for adequate circulation of the media or agitation of material, and provide a means for indicating the temperature of the media. Baths shall be adequate to produce the required properties in the most massive material to be quenched. There shall be at least one gallon of quenchant per pound of material quenched. Location of Quenching Equipment - Quenching equipment shall be located in such a manner and handling facilities shall function with sufficient speed to prevent the initiation of transformation or sensitization prior to quenching. Quenching shall take place in less than 60 seconds from the time the heat treatment load exits the furnace.

Temper	Air	1050 °F – 1250 °F (566 °C – 676 °C).	1 hour per inch of maximum through thickness. One-hour Minimum.
Second Temper	Air	961 °F – 1158 °F (516 °C – 626 °C).	1 hour per inch of maximum through thickness. One-hour Minimum.

Cooling after tempering shall be air cooling or faster. Furnace cooling is not permitted. For heavy cross sections, rapid cooling after tempering may improve impact properties. The minimum tempering temperatures must be met in all cases to ensure that later steps of manufacturing,

Note: Maximum holding time shall not exceed Five times (5X) the minimum holding time. In all case, holding time shall not start until parts or materials have reached specified heat treatment temperature. The 5X rule does not apply to the separate QTC (e.g. ER 5”)

Note 1: The short blasting shall be carried out after normalizing & Tempering if applicable.

Note 2: The austenitizing temperature shall be less than the normalizing temperature.


Note 3: The second tempering temperature shall be minimum 50 °C less than first tempering temperature.

5.1 Continuous Heat Treatment

Screw, walking-beam, pusher furnaces, mesh or cast link type furnaces utilized for continuous heat treatment are permitted. Continuous induction, electrical resistance or infra-red heat treatment is not permitted. Times outside the specified ranges may be used, as long as the minimum time at temperature is 15 minutes per inch of thickness. Tempering temperature minimum shall be met. Other thermal operations may use temperatures outside the ranges specified. Mechanical properties shall be met on a prolongation or sacrificial part.

6.0 NDE REQUIREMENTS

6.1 Volumetric NDE- the entire volume of each part shall be volumetrically inspected (ultrasonic) after heat treatment for mechanical properties and prior

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to machining operations that limit effective interpretation of the results of the examination. Ultrasonic examination shall be done as per SES 26- 702/ SES 26-761 and observed results/discontinuities shall be accepted as per SES 26-702/ SES 26-761 respectively

6.2 Surface NDE- Part shall be examined after final machining by surface NDE (Magnetic Particle or Liquid Penetrant examination). MPI and LP examination shall be done as per SSE-QAD-MT-1/97 and SES 26-701 respectively and observed results/ surface discontinuities shall be accepted as per SSE-QAD-MT-1/97 and SES 26-701 respectively

7.0 WELD REPAIR REQUIREMENTS

7.1 Welding repair for base metal is not allowed.

8.0 MATERIAL TRACEABILITY

8.1 Each forging/bar shall be identified by the heat number and heat lot (or equivalent) for traceability.

9.0 DOCUMENTATION REQUIRED

9.1 Each shipment shall be accompanied by material certifications for each lot of material, the certifications must be positively relatable to the lot of material represented.

a) Mill certificate of raw material.

b) Chemical certificate for each lot of forging.

9.2 Mechanical properties certification as per section 4.0

9.3 Impact testing certification as per section 4.1

9.4 Certification of heat treatment including cycle time, temperature, cooling media, hardness and graphs.

9.5 Calibration certificate of furnace.

9.6 Ultrasonic test report certification of raw material.

10.0 TESTING TO BE CARRIED OUT BY SARA SAE

10.1 At the time of lifting forgings re-verification of chemical properties.

10.2 Recheck of tensile strength, yield strength, elongation, reduction in area, hardness, impact testing and UT testing.

10.3 100% MPI testing after machining.