AISI 4130 LOW ALLOY STEEL FORGED OR WROUGHT 75,000 PSI MINIMUM YIELD FOR HIGH PRESSURE HAMMER UNION IMPACT TESTED AT -29 º C (-20 ºF) OR LOWER AVRAGE IMPACT VALUE 27 J

Rev	Reason of Change	Date	Prepared By	Reviewed By	Approved By	Status
2	Revised Mechanical Properties for Elongation & Charpy	29-09-2012	KKM	USR	K.C. Raturi	Released
3	Revised Mechanical Properties for Brinell Hardness in Table 4	30-04-2016	MN	AS	KKD	Released
4	Electric induction furnace- bottom poured & Argon purged added to melt practice.	23-04-2019	MN	AS	KKD	Released

1.0 SCOPE

***1.1 AISI 4130 low alloy steel forgings and wrought shapes heat-treated to 75,000 PSI minimum yield strength for standard service & For non API Marked Hammer Union, For API Marked Hammer Union refer SES 26-604 of low Sulpher Phosphorus AISI-4130**

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, SES 26-740 & SES 26-744 shall apply in addition to the following specific requirements.

2.2 The raw material supplier shall assure that Sara Sae does not receive material with greater than background level of radioactivity.

3.0 Chemical composition: Chemical composition limits are listed below. An analysis of each heat of steel is 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. Reporting of residual elements is not required, but total residuals must not exceed 1%.

ELEMENT	COMPOSITION	ELEMENT	COMPOSITION
CARBON (C)	0.28 – 0.33	CHROMIUM	0.80-1.10
MANGANESE (Mn).	0.40 – 0.60	MOLYBDENUM	0.15– 0.25
SILICON (Si).	0.15- 0.30	NICKEL	0.50 (max.)
SULPHUR (S).	0.025 max.	VANADIUM	0.10 (max.)
PHOSPHORUS (P).	0.025 max.	IRON	Balance

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 (VAC), or electroslag remelting (ESR) or electric arc furnace (EAF) or electric induction furnace- bottom poured & Argon purged shall also be acceptable.

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

a. Forgings with a forging reduction of 3:1 or greater;
b. Rolled tubing or extruded tubing with a wall thickness of 3" or less;
c. 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.

MECHANICAL PROPERTIES	RANGE
TENSILE STRENGTH, PSI	95,000 (655 MPa) Min.
YIELD STRENGTH, PSI	75,000 (517 MPa) Min.
ELONGATION IN 2" Gage Length	18 % Min.
REDUCTION IN AREA	35% Min.
BRINELL HARDNESS	197-237 BHN

Note: - A minimum of two Brinell hardness tests shall be performed on QTC for API 16C Products

4.1 Charpy V-notch Impact testing: Impact testing shall be performed at -29 ºC (-20 °F) Average 27 joules each set of three specimens with minimum of 20 joules of one specimen. Similarly, no more than one of the three test results shall be below the required minimum average. Acceptance for charpy V-notch impact testing is per ASTM A-370.

5.0 Heat treatment:

PROCESS	ATMOSPHERE/MEDIA	TEMPERATURE	TIME AT TEMPERATURE
Normalized	Air or Nitrogen	1598 ºF – 1697 º (870 ºC – 925 ºC)	30 Minutes/inch of thickness. Minimum time 30 minute.

Still air cool to below 400 ºF (204 ºC) before further processing

Austenitize	Air or Nitrogen	1562 ºF - 1652 ºF (850 ºC – 900 ºC)	30 Minutes/inch of thickness. Minimum time 30 minute.

Quench	Water	100 ºF (38 ºC) maximum before quenching 120 ºF (49 ºC) maximum after quenching
	Polymer	50 ºF (10 ºC) minimum before quenching (See note 2.1.e.2)
	Oil	----------

Temper	Air or Nitrogen	1184 ºF – 1300 ºF (640 ºC – 700 ºC)	1 hour per inch of maximum through thickness. One hour Minimum.

Cooling after tempering shall be air cooling or faster (By Water). 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 minimum tempering temperature for bar stock under 6 inches (152mm) in diameter may be 1150ºF (620ºC).

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 Documentation required

6.1 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.

6.2 Mechanical properties certification as per section 4.0
6.3 Impact testing certification as per section 4.1
6.4 Certification of heat treatment including cycle time, temperature, cooling media, hardness and graphs.
6.5 Calibration certificate of furnace.
6.6 Ultrasonic test report certification of raw material.

7.0 Testing to be carried out by Sara Sae

7.1 At the time of lifting forgings re-verification of chemical properties.
7.2 Recheck of tensile strength, yield strength, elongation, reduction in area, hardness, impact testing and UT testing (if required).