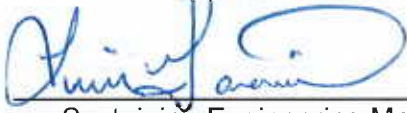


TAM International Incorporated

160 KSI MYS 4140 Seamless Tubing and Forgings for High Strength Stress Rings

ESMA-2008

Approval of Document <u>ESMA-2008</u>	
Signature	 Sustaining Engineering Manager
	<u>June 24, 2020</u> Date



 TAM INTERNATIONAL	Document Title	160 KSI MYS AISI 4140 Seamless Tubing and Forgings for High Strength Stress Rings				
	Document No.	ESMA-2008	Rev	B	Page	1 OF 7
	CAUTION: Check for latest revision of this document before use. Information contained in copied or printed material may be superseded.					

Table of Contents

1.0 SCOPE	3
2.0 CHEMISTRY	3
3.0 MECHANICAL PROPERTIES	3
4.0 CONDITION	4
5.0 QUALITY	5
6.0 COUNTRY OF ORIGIN	5
7.0 REPORTS	5
8.0 MATERIAL ACCEPTANCE	5
9.0 DOCUMENT REVISION	6

Uncontrolled Document

	Document Title	160 KSI MYS AISI 4140 Seamless Tubing and Forgings for High Strength Stress Rings				
	Document No.	ESMA-2008	Rev	B	Page	2 OF 7
	CAUTION: Check for latest revision of this document before use. Information contained in copied or printed material may be superseded.					

1.0 Scope

- 1.1 This document provides specifications for AISI 4140 seamless tubing or forgings with 160,000 psi minimum yield strength for use in TAM Stress Rings.
- 1.2 Material specified by this document is **not** compliant with NACE MR-01-75 and are susceptible to Sulfide Stress Cracking (SSC) in H₂S environments.

2.0 Chemistry

- 2.1 Materials specified by this document shall conform to the following compositional requirements:

ELEMENT	SYMBOL	WEIGHT %
CARBON	(C)	0.38 - 0.43
MANGANESE	(Mn)	0.75 – 1.00 MAX
SILICON	(Si)	0.15 – 0.35
PHOSPHOROUS	(P)	0.035 MAX
SULFUR	(S)	0.040 MAX
MOLYBDENUM	(Mo)	0.15 – 0.25
CHROMIUM	(Cr)	0.80 – 1.10

- 2.2 Compositional testing shall be performed in accordance with the latest revision of ASTM A751, or by any commonly accepted technique routinely employed for chemical analysis of steels which provides equivalent results to the practices contained in ASTM A751. Reports shall include quantitative results for specified elements of each heat of material.

3.0 Mechanical Properties

- 3.1 Mechanical testing shall be performed in accordance with the latest revision of ASTM A370 on a prolongation which has undergone the same heat treatment and mechanical processing as the finished product. Test specimens shall be machined from a prolongation removed from the product only after completion of all thermal processing. Testing shall be performed for each heat and lot of raw material.
- 3.2 The tensile and hardness properties of this material shall conform to the following requirements:


Yield Strength	160,000 psi min
Tensile Strength	173,000 psi min
Yield/Tensile Ratio	92% max
Hardness	38 – 42 HRC
Elongation	14% min
Reduction of Area	45% min

- 3.3 Tensile testing shall be performed on a 4D round specimen. Yield strength shall be determined using the 0.2% offset method.

- 3.4 Hardness testing shall be performed on each forging after final heat treatment and performed on the tensile test specimens (prior to tensile testing) in accordance with ASTM E10, E18, or E110. Unmachined outer diameters shall have 1/16" to 1/8" of material removed by light grinding or buffing to produce a "flat" for testing.
- 3.5 Charpy V-Notch Impact testing must be performed in accordance with ASTM E23 at ambient temperature on full size 10mm x 10mm coupons. A minimum of three specimens shall be tested to qualify a heat of material. The minimum average impact value of the three specimens is 31 ft-lbs (42 J) with no individual impact value falling below 25 ft-lbs (34 J). Testing may be performed on either longitudinal or transverse specimens.
- 3.6 Test specimens shall be taken from mid-wall (1/2 T).
- 3.7 Field Metallographic Replication (FMR) testing per ASTM E 1351 shall be performed on the remains of the prolongation for each heat and lot.

4.0 Condition

- 4.1 Material shall be in the Normalized, Austenitized, Quenched, and Tempered condition.
 - 4.1.1. Normalize at 1600-1650°F (870-900°C) for a minimum of 2 hours, air cool. Hold at this temperature for one hour per inch of wall thickness with a minimum of 2 hours.
 - 4.1.2. Austenitize at 1600-1650°F (870-900°C) for a minimum of 2 hours, water quench. Hold at this temperature for one hour per inch of wall thickness with a minimum of 2 hours.
 - 4.1.3. Temper at 950-1000°F (510-538°C) for a minimum of 4 hours and a maximum of 5 hours, air cool.
 - 4.1.4 Avoid slow cooling or heating between 660-1060°F (350-570°C) at all times (no more than 30 minutes allowed in this temperature range during thermal cycles).
- 4.2 All material shall be uniform in composition, clean, and free from foreign materials.
- 4.3 Material shall be free of macro-segregation and banding.
- 4.4 Steel shall be fully worked without evidence of residual cast ingot structure. Use of cold work or cold finishing operations is prohibited. Material shall be free of piping, cracks, folds, segregation, internal and external imperfections, and other injurious defects.
- 4.5 Prior to heat treat, material shall be rough machined to within 0.200" ± .030" of finished dimensions on diameters. Material shall be descaled unless otherwise stated on purchase order.

	Document Title	160 KSI MYS AISI 4140 Seamless Tubing and Forgings for High Strength Stress Rings				
	Document No.	ESMA-2008	Rev	B	Page	4 OF 7
	CAUTION: Check for latest revision of this document before use. Information contained in copied or printed material may be superseded.					

5.0 Quality

5.1 No weld repair is permitted.

6.0 Country of Origin

6.1 Acceptable countries of origin are United States, Canada, Mexico, United Kingdom, Italy, Spain, France, Germany, Japan, and South Korea. Other countries can be accepted with approval from TAM.


7.0 Reports

7.1 Material ordered to this specification shall be accompanied by a Material Test Report. Reports shall reference the final condition of the material and shall contain the following minimum information which will be subject to inspection upon receipt:

1. Statement of material condition
2. Dimensions
3. Chemical Analysis and Governing Specification
4. Yield Strength and Governing Specification
5. Tensile Strength and Governing Specification
6. % Elongation and Governing Specification
7. Reduction of Area and Governing Specification
8. Hardness and Governing Specification
9. Impact Values, Temperature and Governing Specification
10. Location of Testing and Test Samples
11. "No Weld Repair" statement
12. FMR results
13. Material Identification Number
14. Furnace charts including Heat Treatment times, temperatures and quench media and Tempering time and temperature.
15. County of Origin

8.0 Material Acceptance


- 8.1 All requirements of this specification are subject to verification at the discretion of TAM International.
- 8.2 TAM Engineering Manager or designee is ultimately responsible for accepting or rejecting material that does not conform to any portion of this specification.
- 8.3 Any material deviations must be submitted in writing and approved before machining can begin.

	Document Title	160 KSI MYS AISI 4140 Seamless Tubing and Forgings for High Strength Stress Rings				
	Document No.	ESMA-2008	Rev	B	Page	5 OF 7
	CAUTION: Check for latest revision of this document before use. Information contained in copied or printed material may be superseded.					

9.0 Document Revision


9.1 Document revisions will be handled in accordance with SOP-009 Document Control.

Uncontrolled Document

 TAM INTERNATIONAL	Document Title	160 KSI MYS AISI 4140 Seamless Tubing and Forgings for High Strength Stress Rings				
	Document No.	ESMA-2008	Rev	B	Page	6 OF 7
	CAUTION: Check for latest revision of this document before use. Information contained in copied or printed material may be superseded.					

Uncontrolled Document

Rev	Date	Description	Prepared By:	Reviewed By /	Date
A	12/20/2019	New Release	Jeffery Dinkel	C. Kelly, L. Garcia, J. Dinkel, G. Fletcher	1/21/2020
B	5/28/2020	Revise 4.1.3 temp. Remove MPI from raw material and move to machined part level (dwg) Changes in RED	Luis Garcia	C. Kelly, L. Garcia, J. Dinkel, D. Gregory / G. Fletcher	6/15/2020

 TAM INTERNATIONAL	Document Title	160 KSI MYS AISI 4140 Seamless Tubing and Forgings for High Strength Stress Rings				
	Document No.	ESMA-2008	Rev	B	Page	7 OF 7
	CAUTION: Check for latest revision of this document before use. Information contained in copied or printed material may be superseded.					