


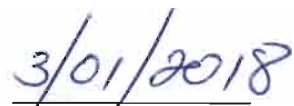
TAM International Incorporated

Engineering

Specifications for Chemical and Physical Properties of Metals Used in TAM Products

ES-7.3-05

Approval of Document *ES-7.3-05*

Signature	 <hr style="width: 100%; border: 0.5px solid black;"/> Engineering Manager - Sustaining	 <hr style="width: 100%; border: 0.5px solid black;"/> 03/01/2018
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1 PURPOSE

- 1.1 These specifications define the requirements for standard metal chemistry and physical properties for TAM products.

2 SCOPE

- 2.1 Scope of this document extends to TAM locations.

3 REFERENCE


- 3.1 EI-7.3-03 Instructions for the Control of Engineering Drawings
 3.2 SOP-009 Document Control
 3.3 SOP-010 Records Control

4 RECORDS

- 4.1 The design criteria defined in the Material Specifications shall be maintained, changed or otherwise modified using the procedures defined in EI-7.3-03 Instructions for the Control of Engineering Drawings.

5 STANDARD MATERIALS SPECIFICATIONS

- 5.1 All metal materials included in TAM's products shall meet or exceed material specifications as follows:
- * Carbon steel materials shall be as specified in Page [5](#).
 - * Alloy steel materials shall be as specified in Page [6](#).
 - * Stainless steel materials shall be as specified in Page [7](#).
 - * Super alloys shall be as specified in Page [8](#).
 - * Strip steel materials shall be as specified in Page [9](#).
 - * Aircraft cable shall be as specified in Page [10](#).
 - * All casing and tubing accessories defined as API grade equivalent shall be manufactured using materials as specified in Page [11](#).

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- * Brass and bronze materials shall be as specified in Page [12](#).
 - * Standard allowable material substitutions Page [13](#).
 - * Aluminum materials shall be as specified in Page [14](#).
 - * Cast Iron materials shall be specified in Page [15](#).
- 5.2 All casing used for manufacturing casing annulus packers shall be in accordance with API specifications for chemistry and physical strengths.
- 5.3 Line pipe or couplings for such shall be Grade B unless specifically defined by the Engineering drawing.
- 5.4 For proprietary casing material grades, the chemical and mechanical performance requirements provided by the specific manufacturer shall be the acceptance criteria.

Click on the links below for appendices associated with this file.

[APPENDIX 1 - Characteristic of API Casing Specifications](#)

[APPENDIX 2 – Raw Material Specifications for VascoMax® C-250 metal](#)

[APPENDIX 3 – Inspection Criteria of Raw Materials](#)


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**MATERIAL SPECIFICATIONS
CARBON STEEL**

MATERIAL

	1018	1018 CF	1026	1026-40	A105	A106	A36	DOM 520 TUBING	1018 thru 1026 DOM TUBING
Element	****MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED****								
C	0.14/0.22	0.14/0.22	0.22/0.28	0.22/0.28	0.035	0.25/0.35	0.25/0.29	0.18	0.15/0.28
Mn	0.6/0.9	0.6/0.9	0.6/0.9	0.6/0.9	0.60/1.05	0.27/1.06	0.6/0.9	1.6	0.3/0.9
P	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.025	0.04
S	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.01	0.05
Si	0.3	0.3	0.3	0.3	0.35	0.35	0.28	0.15/0.35	0.3
Al	-	-	-	-	-	-	-	.020/0.075	-
Fe	*	*	*	*	*	*	*	*	*
	****MINIMUM STRENGTH UNLESS OTHERWISE SPECIFIED****								
YIELD STRENGTH	40 KSI	70-75 KSI	60 KSI	40 KSI	40 KSI	40 KSI	36 KSI	75 KSI	70 KSI
TENSILE STRENGTH	55 KSI	85-90 KSI	70 KSI	55 KSI	70 KSI	60 KSI	58 KSI	85 KSI	80 KSI
HARDNESS	22 MAX	22 MAX	22 MAX	22 MAX	22 MAX	22 MAX	22 MAX	22 MAX	22 MAX

* Iron content calculated as balance.

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**MATERIALS SPECIFICATIONS
ALLOY STEEL**

MATERIAL


	UNS G41XX0 ●◆	4340	E.T.D 150	8620	9% CHROME	13% CHROME	HP2- 13CR 110	4330M
ELEMENT	****MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED****							
C	0.25/0.47	0.37/0.43	0.40 Min	0.18/0.23	0.15	0.15/0.22	.04	.290/ .340
Mn	0.70/1.00 **	0.7	0.70/1.10	0.7/0.9	0.3/0.6	0.25/1.0	.60	.75/ 1
P	0.035	0.035	0.035	0.04	.025 MAX	0.02	.02	.015
S	0.040 ●	0.04	0.04	0.04	.025 MAX	0.01	.005	.010
Si	0.15/0.35	0.23	0.15/0.30	0.15/0.35	1.0	1.0	.50	.15/ .35
Mo	0.15/0.25	0.2/0.3	0.15/0.25	0.15/0.25	0.9/1.1	-	1.8/2.5	.400/ .500
Cr	0.80/1.10	0.7/0.9	0.80/1.20	0.4/0.6	8.0/10.0	12.0/14.0	12.0/14.0	.8/ 1.1
NI	---	---	---	---	---	---	4.5/5.5	1.7/ 2.0
MINIMUM YIELD	*	*	130 KSI	50 KSI	80 KSI	80 KSI	110 KSI	150 KSI
MINIMUM TENSILE	*	*	150 KSI	70 KSI	95 KSI	95 KSI	120 KSI	160 KSI
Rc – MAX	*	*	32	20	23	23	32	40

* Specifications found on page 11, 4140 heat treat & casing strength equivalent specifications for manufactured parts.

** Manganese (Mn) will be .40-.60 % for 4130 material.

◆ Materials ending with an "F" designation are forged materials. They are still required to meet chemical and mechanical properties of steel shown.

● Per NACE (ISO 15156) for heat treated material (and all steels used in a H2S environment), max. Sulfur content = 0.003% for plate, 0.010% for seamless and 0.025% for forged material and max. Nickel content = 0.99% for all.

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MATERIALS SPECIFICATIONS STAINLESS STEEL

MATERIAL

	304 ● ▲	303 ▲	316 ● ▲	410	416	17-4 Ph	NITRONIC 50	SUPER 13 CR◆
UNS DESIGNATION	UNS S30400 ANNEALED	UNS S30300 ANNEALED	UNS S316000 ANNEALED	UNS S41000 ANNEALED	UNS S41600 ANNEALED	UNS S17400 ANNEALED	UNS S20910 ANNEALED	UNS S41425
ELEMENT	****MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED****							
C	0.08	0.15	0.08	0.15	0.15	0.08	-	0.05
Mn	2.0	2.0	2.0	1.0	1.25	1.0	5.0	0.50-1.00
P	0.045	0.2	0.045	0.04	0.06	0.04	-	0.02
S	0.15	0.15	0.15	0.15	0.15	0.04	-	0.005
Si	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.05
Mo	-	0.6	2.5	-	0.6	-	2.25	1.50-2.50
Cr	18.0/20.0	18.0	17.0	12.5	13.0	15.0/17.5	22.0	12.0-15.0
Ni	8.0/10.5	9.0	12.0	0.75	-	3.0/5.0	12.5	4.0-7.0
Cu	-	-	-	-	-	3.0/5.0	-	0.30
N	-	-	-	-	-	-	-	0.06-.012
Fe	*	*	*	*	*	*	*	*
MINIMUM YIELD	38 KSI**	33 KSI**	38 KSI**	40 KSI**	38 KSI**	100 KSI**	55 KSI	95 KSI
MINIMUM TENSILE	85 KSI**	85 KSI**	70 KSI**	70 KSI**	70 KSI**	140 KSI**	100 KSI	105 KSI
HARDNESS Rc	-	-	-	-	-	-	-	28 MAX


* Iron content calculated as balance.

** Tensile Strength must be a least 10% greater than yield strength. If not engineering approval is required.

◆ SUPER 13 CR is a trade mark for Sumitomo. Equivalent material is acceptable.

● Per NACE (ISO 15156), when material is to be used in an H2S environment, the following limits shall apply: C 0.08% max, Cr 16.0% min, Ni 8.0% min, P 0.045% max, S 0.04% max, Mn 2.0% max, and Si 2.0% max.

▲ All Material to be non-magnetic.

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MATERIALS SPECIFICATIONS SUPER ALLOYS

MATERIAL

	MARAGING C-250 Replaces T-250	HASTELLOY C-276	INCONEL 718
ELEMENT	** MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED **		
C	SEE APPENDIX 2 For Actual C-250 Material and Specification	.02	As Per API STANDARD 6A718 LATEST VERSION
Mn		-	
P		-	
S		.01	
Si		-	
Nb		-	
Mo		17	
Cr		16.5	
Ni		BAL	
Al		.10	
B		-	
Co		2.5	
Fe		7.0	
Ti		.10	
Zr		-	
MINIMUM YIELD (Heat Treated Condition)		47 KSI	
MINIMUM TENSILE (Heat Treated Condition)		100 KSI	
HARDNESS RANGE FOR 718	N/A		

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SLAT MATERIALS SPECIFICATIONS


	1008	1010	301-1/2 Hd**	INCONEL 625
ELEMENT	*MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED*			
C	0.1	.05/.13	0.15	0.1
Mn	.3/.5	.3/.6	2	0.5
P	0.04	0.04	0.045	0.015
S	0.05	0.05	0.03	0.015
Cr	-	-	16/18	20/23
Ni	-	-	6/8	58 MIN
Al	-	-	-	0.4
Co	-	-	-	1
Fe	*	*	75	5
Mo	-	-	-	8/10
Nb	-	-	-	3.15/4.15
Si	-	-	0.75	0.5
Ti	-	-	-	0.4
N	-	-	0.1	-
MINIMUM TENSILE	40 KSI	40 KSI	150 KSI	150 KSI
MAXIMUM TENSILE	-	-	175 KSI	-
MINIMUM YIELD	-	-	115 KSI	120 KSI
MAXIMUM HARDNESS	-	-	-	35 HRC
WIDTH TOLERANCE	± 0.005	± 0.005	± 0.005	± 0.005
THICKNESS TOLERANCE	± 0.0015	± 0.0015	± 0.0015	± 0.0015

- EDGE FILED AFTER SLITTING, FREE FROM BURRS
- MATERIAL SHALL BE BRIGHT & REFLECTIVE
- COILED IN 30" MINIMUM DIAMETER
- CERTIFICATES OF COMPLIANCE TO BE INCLUDED IN SHIPMENT

* IRON CONTENT TO MAKE UP REMAINDER

****SPECIAL FINISH REQUIREMENTS:**

- CAMBER 1/2" PER 8'
- SKIVE EDGE TO #1 ROUND EDGE. PASS THRU THE SKIVE IN BOTH DIRECTIONS TO INSURE BOTH SIDES ARE SKIVED.
- 2 B FINISH
- COIL SIZE & WEIGHT: 250# MAX COIL WT, COIL ID- 16" – 20"

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MATERIALS SPECIFICATIONS CABLE

CABLE SIZE – OD

	1/32"	3/64"	1/16"	3/32"	1/8"	5/32"	3/16"
CONSTRUCTION	1 x 19	1 x 19	7 x 7	7 x 7	7 x 19	7 x 19	7 x 19
MIN. BREAKING STRENGTH	170#	375#	440#	880#	1,900#	2,400#	3,900#
DIAMETER TOLERANCE	±.005	±.005	±.007	±.007	±.007	±.007	±.007
CHEMICAL PROPERTIES	**** NONE SPECIFIED****						

- FREE FROM BURRS.
- MATERIAL SHALL BE BRIGHT GALVANIZED AND FREE FROM ALL OTHER SURFACE CONTAMINATES INCLUDING: OIL, GREASE, DIRT AND WAX
- CERTIFICATES OF COMPLIANCE TO BE INCLUDED IN SHIPMENT.

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4140 HEAT TREAT & CASING STRENGTH EQUIVALENT SPECIFICATION FOR MANUFACTURED PARTS


HEAT TREAT CALLOUT	ALTERNATE CONDITION CALLOUT	MATERIAL	HARDNESS Rc	YIELD STRENGTH PSI **	MINIMUM TENSILE PSI **
	ANN	UNS G41XX0	22 Rc MAX	50,000 MIN	80,000
H40*		UNS G41XX0	N/A	40,000 – 80,000	60,000
J55*		UNS G41XX0	N/A	55,000 – 80,000	75,000
K55*		UNS G41XX0	N/A	55,000 – 80,000	95,000
L80*	Q&T	UNS G41XX0	22 Rc MAX	80,000 – 95,000	95,000
N80*		UNS G41XX0	N/A	80,000 MIN	100,000
N80Q♦		UNS G41XX0	22 Rc MAX	80,000 – 110,000	100,000
C90 *•		UNS G41XX0	22 Rc MAX	90,000-105,000	100,000
C95*		UNS G41XX0	N/A	95,000 – 110,000	105,000
C-110•	C11	UNS G41XX0	27 Rc MAX	110,000-120,000	120,000
T95* •		UNS G41XX0	25.4 Rc MAX	95,000 – 110,000	105,000
P110*	CHT	UNS G41XX0	30-36	110,000 – 140,000	125,000
Q125*	Q12	UNS G41XX0	30-36	125,000 – 140,000	135,000
S135		UNS G41XX0	30-36	135,000 – 150,000	150,000
C140		UNS G41XX0	32-40	140,000 - 160,000	150,000

* See **APPENDIX 1** for actual API casing specifications

** Note: Tensile strength must be **at least** 10% greater than yield strength. If not contact Engineering

♦ Material must meet API N80-Q specification impact requirements: (At 32 °F: 10 FT-LB min transverse, 20 FT-LB min longitudinal)

• Per NACE (ISO 15156), each batch of material must be qualified for all SSC regions. See page 6 for material requirements


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MATERIALS SPECIFICATIONS

BRASS/BRONZE

MATERIAL


	BRASS	BRASS	BRASS	BRONZE	BRASS
TRADE NAME	BRASS	FREE CUTTING OR MACHINING	RED BRASS	BEARING BRONZE	NAVAL BRASS
UNS DESIGNATION	C26000	C36000, H02 (COLD DRAWN 20%) TEMPER	C23000	C93200	C46400, H02 (COLD DRAWN 20%) TEMPER
ALLOY	260	360	230	320	464
ELEMENT		*MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED*			
Cu	71.50	60/63	85	83	59/62
Fe	0.05	-	-	-	-
Sn	-	-	-	6.3 MIN.	.5/1.0
Pb	0.07	2.5/3.7	-	7	.20
Zn	31.50	35.25	15	3	39.25 Nominal
MIN / MAX YIELD	-	45 KSI / 50 KSI	18 KSI MIN	18 KSI MIN	50 KSI / 55 KSI
MIN / MAX TENSILE	57 KSI / 67 KSI	58 KSI / 64 KSI	44 KSI MIN	35 KSI MIN	70 KSI / 77 KSI

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STANDARD ALLOWABLE MATERIAL SUBSTITUTIONS

SPECIFIED MATERIAL ♦	ALLOWED SUBSTITUTION ♦
A105, A36, A106, 1018, 1020, 1026-40	1018, 1020, 1026, 1026-40, A106, 1018/1026 DOM TUBING, 520 DOM TUBING
303 SS, 304 SS, 316 SS	316 SS, 304 SS, 303 SS ●
4140**	4130, 4142, 4145, 4340
4130	4140*
T250	C250
1026	1018 /1026 Dom Tubing, 520 Dom Tubing
1018CF	1018/1026 Dom Tubing, 520 Dom Tubing, 4130
4140 C-140	4330M*

- * In non-welding applications only.
- ♦ Substitution material properties **MUST** meet or exceed original specified minimum yield strength & meet any hardness requirements.
- ** Stress Rings, 4140 **ONLY** or as specified. **NO SUBSTITUTION ALLOWED.**
All other substitutions must be noted on the work order as well as traceable via certs.
- **Per NACE (ISO 15156), 303 SS cannot be substituted for 316 SS when used in an H2S environment without meeting specific requirements**


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MATERIALS SPECIFICATIONS

Aluminum

MAXIMUM PERCENT UNLESS OTHERWISE SPECIFIED

	6061-T6
ELEMENT	
Si	0.8
Fe	0.7
Cu	0.15/0.40
Mn	0.15
Mg	0.8/1.2
Cr	0.04/0.35
Zn	0.25
Ti	0.15
MINIMUM YIELD	40 KSI
MINIMUM TENSILE	45 KSI


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MATERIALS SPECIFICATIONS


CAST IRON

	G2 Cast Iron
ELEMENT	
C	2.60-3.75 %
Si	1.80-3.00%
Mn	0.60-0.95%
S	0.07% MAX
Ph	0.12% MAX
Typical Tensile	40 KSI

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Rev	Date	Description	Prepared By:	Reviewed By / Approved By	Date
X	6/26/14	Add Appendix 3, Inspection Criteria for metals, Update Brass and Stainless Chemical and Physical Properties	Doyle Warren	Thomas Young, Mark Wyatt, Doyle Warren	7/14/14
Y	9/19/14	Remove Page 10 due to redundancy Add 3 Letters Designation for C11 & Q12 to Alternate Condition Callout to page 9	Jeff Dinkel	T. Young, G. Fletcher, J. Dinkel, M, Wyatt	9/9/14
Z	04/08/15	Update standards and clarify wording	C, Carlson/ H. Fogle	C. Carlson, H. Fogle, T. Young, G. Fletcher, R. Frisby, J. Dinkel	04/09/15
AA	02/12/18	Revise 17-4 Ph Cr content from 15.5-17.5 to 15.0-17.5	Caleb Kelley	D. Gregory, T. Davis, J. Dinkel / G. Fletcher	02/28/18

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APPENDIX 1

CHARACTERISTICS OF API CASING SPECIFICATIONS

PI 5CT GROUP	API 5CT GRADE	CARBON		MANGANESE		MOLYBDENUM		CHORMIUM		NICKEL	COPPER	PHOS- PHOROUS	SULFUR	SILICON	YIELD	YIELD	TENSILE	HARDNESS HRC	HEAT TREAT	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MAX	MAX	MAX	MAX	MAX	MIN	MAX	MIN	MAX		
1	H-40	•	•	•	•	•	•	•	•	•	•	0.03	0.03	•	40,000	80,000	60,000	•	NONE	
	J-55	•	•	•	•	•	•	•	•	•	•	0.03	0.03	•	55,000	80,000	75,000	•	N,N&T,Q&T	
	K-55	•	•	•	•	•	•	•	•	•	•	0.03	0.03	•	55,000	80,000	95,000	•	NONE	
	N-80	•	•	•	•	•	•	•	•	•	•	0.03	0.03	•	80,000	110,000	100,000	•	N,N&T,Q&T	
2	M-65	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	NONE
	C-75 1 ^f	•	0.50	•	•	•	•	•	•	•	•	0.03	0.03	•	65,000	85,000	85,000	22	N,N&T,Q&T	
	C-75 2 ^f	•	0.43	•	1.90	0.15	0.40	•	•	•	•	0.03	0.03	0.45	75,000	90,000	95,000	•	N & T	
	C-75 3 ^f	0.38	0.48	•	1.50	•	•	•	•	•	•	0.03	0.03	0.45	75,000	90,000	95,000	•	Q & T	
	L-80 1	•	0.43	0.75	1.00	0.15	0.25	0.80	1.10	•	•	0.03	0.03	•	75,000	90,000	95,000	•	N & T	
	L-80 9CR	•	^a	•	1.90	•	•	•	•	0.25	0.35	0.03	0.03	0.45	80,000	95,000	95,000	23	Q & T	
	L-80 13CR	0.15	0.15	0.30	0.60	0.90	1.10	8.00	10.00	0.50	0.25	0.02	0.01	1.00	80,000	95,000	95,000	23	Q & T	
	C-90 1	•	0.22	0.25	1.00	•	•	12.00	14.00	0.50	0.25	0.02	0.01	1.00	80,000	95,000	95,000	23	Q & T	
	C-90 2	•	0.35	•	1.00	0.25 ^b	0.75	•	1.20	0.99	•	0.02	0.01	•	90,000	105,000	100,000	25.4	Q & T	
	C-95	•	0.50	•	1.90	•	NL	•	NL	0.99	•	0.03	0.01	•	90,000	105,000	100,000	25.4	Q & T	
	T-95 1	•	0.45	•	1.90	•	•	•	•	•	•	0.03	0.03	0.45	95,000	110,000	105,000	•	Q & T	
T-95 2	•	^c	•	1.20	0.25 ^d	0.85	0.40	1.50	0.99	•	0.02	0.01	•	95,000	110,000	105,000	25.4	Q & T		
		0.35	•	1.90	•	•	•	•	0.99	•	0.03	0.01	•	95,000	110,000	105,000	25.4	Q & T		
		0.50	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3	P-105 ^f	•	•	•	•	•	•	•	•	•	•	0.03	0.03	•	105,000	135,000	120,000	•	Q & T	
	P-110	•	•	•	•	•	•	•	•	•	•	0.03 ^e	0.03 ^e	•	110,000	140,000	125,000	•	Q & T	
4	Q-125 1	•	0.35	•	1.00	•	0.75	•	1.20	0.99	•	0.02	0.01	•	125,000	150,000	135,000	•	Q & T	
	Q-125 2	•	0.35	•	1.00	•	NL	•	NL	0.99	•	0.02	0.02	•	125,000	150,000	135,000	•	Q & T	
	Q-125 3	•	0.50	•	1.90	•	NL	•	NL	0.99	•	0.03	0.01	•	125,000	150,000	135,000	•	Q & T	
	Q-125 4	•	0.50	•	1.90	•	NL	•	NL	0.99	•	0.03	0.02	•	125,000	150,000	135,000	•	Q & T	

Note: N.L. = No limit. Elements shown must be reported in product analysis.
^a The carbon content for L-80 may be increased to 0.50 percent maximum if the product is oil quenched.
^b The molybdenum content for Grade C-90, Type 1, has no minimum tolerance if the wall thickness is less than 0.700 inch.
^c The carbon content for Grade C-95 may be increased to 0.55 percent maximum if the product is oil quenched.
^d The molybdenum content for Grade T-95, Type 1, may be decreased to 0.15 percent minimum if the wall thickness is less than 0.700 inch.
^e The phosphorous is 0.020 percent maximum and the sulfur is 0.010 percent maximum for EW Grade P110
^f These grades are no longer referenced in current revision.