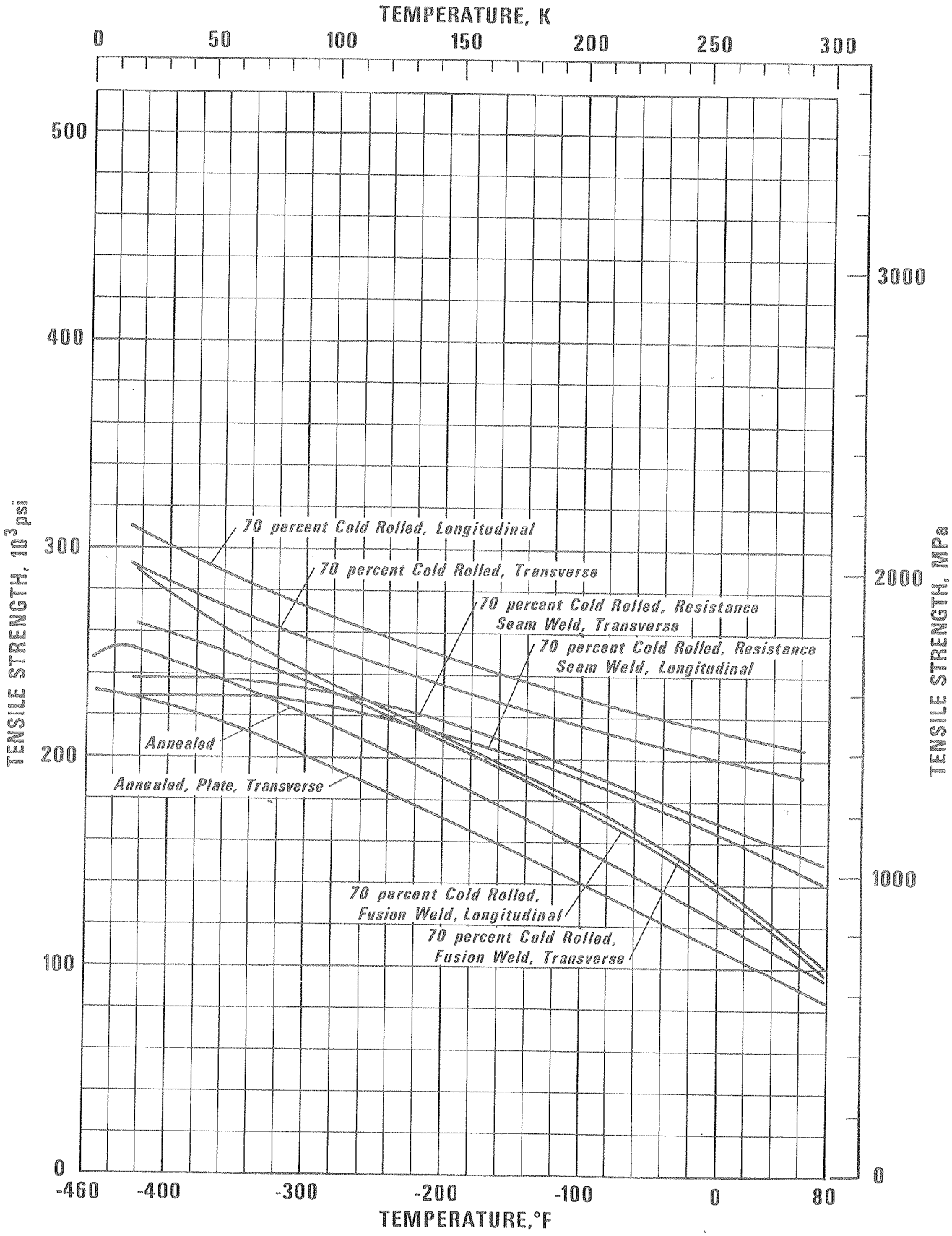
LNG Materials & Fluids Data

304 STAINLESS STEEL
Tensile Strength



Fracture and Deformation Division, NBS-NML, Boulder, Colorado

Chart 1125 (6-1-79)

304 STAINLESS STEEL: TENSILE STRENGTH

SOURCES:

V. N. Kivobok, Properties of austenitic stainless steels at low temperatures, in Mechanical Properties of Metals at Low Temperatures, NBS Circular 20, (1952), pp. 112-136.

J. H. McConnell and R. V. Brady, Austenitic stainless steels, thousands of tons in -300 to -425 F service, *Chem. Eng.* 67, 125-128 (1960).

T. S. DeSisto and L. C. Carr, Low-temperature mechanical properties fo 300-series stainless steel and titanium, in Advances in Cryogenic Engineering, (Plenum, New York, 1961), pp. 577-586.

C. J. Gunter and R. P. Reed, The effect of experimental variables including the martensitic transformation on the low-temperature mechanical properties of austenitic stainless steels, *Trans. ASM* 55, 399-419 (1962).

J. L. Christian, C. T. Yang, and W. E. Witzell, Physical and mechanical properties of pressure vessel material for application in a cryogenic environment, part II, General Dynamics/Astronautics report GD/A (1964). NTIS order no.AD443851.

K. Fushimi, H. Yonemitsu, H. Okamoto, and E. Fukushima, Tensile properties of various materials at cryogenic temperatures, in Advances In Cryogenic Engineering, Vol. 15 (Plenum, New York, 1970), pp. 102-108.

R. L. Tobler, R. P. Mikesell, R. L. Durcholz, and R. P. Reed, in Semiannual report on materials research in support of superconducting machinery, Nat. Bur. Stds. (U.S.) NBSIR 74-359 (1974).

UNITS:

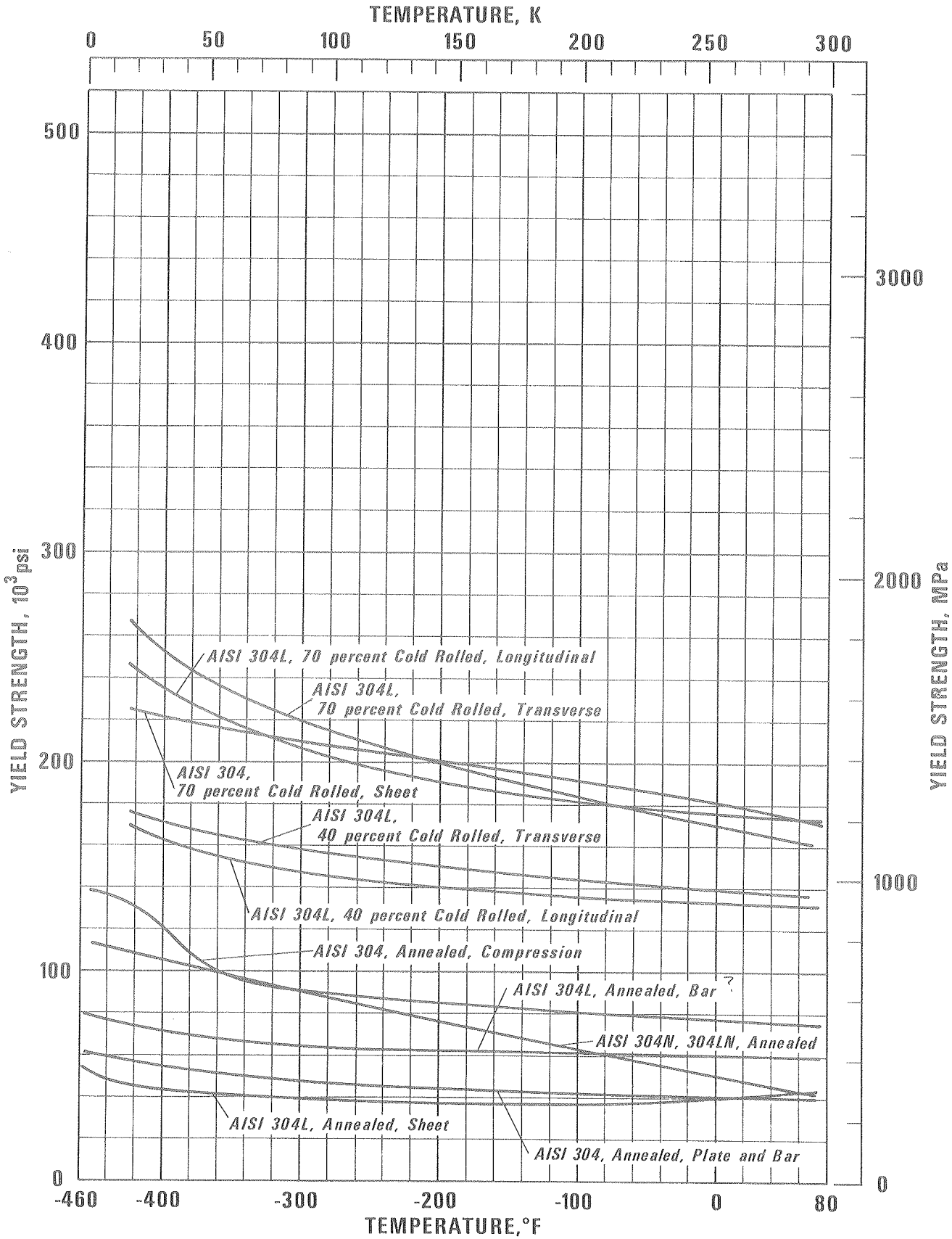
to convert	*to*	multiply by
°F	*K*	$T_K = (t_{°F} + 459.67)/1.8$
10^3 psi	*MPa*	6.8948

COMMENTS:

(1) The annealed curve represents about seventy measurements, and the cold-worked and weld-metal curves each represent about fifteen measurements. Minimum annealed values are about 15 percent below plotted curves, while minimum values for the cold-worked and weld-metal cases are at most 3 percent below the curves.

304, 304L, 304N, 304LN STAINLESS STEELS

Tensile Yield Strength



Fracture and Deformation Division, NBS-NML, Boulder, Colorado

Chart 1107 (6-1-79)

SOURCES:

J. L. Christian, C. T. Yang, and W. E. Witzell, Physical and mechanical properties of pressure vessel material for application in a cryogenic environment, part II, General Dynamics/Astronautics Report GD/A 63-0801-3 (May 1964), NTIS order number AD 443851.

C. A. Swenson, The mechanical properties of some technical metals in compression between 4.2° and 300°K, in Advances in Cryogenic Engineering, Vol. 1 (Plenum, New York, 1954), p. 251.

C. A. Schwanbeck, Effects of nuclear radiation on metals at cryogenic temperatures, Lockheed Nuclear Products Dept. Report LAC ER-8673, NASA Report CR-72056 (August 1966).

Cryogenic Materials Data Handbook (1970). Available from National Technical Information Service, Springfield, VA 22161, order numbers AD 713619, AD 713620.

Materials Properties Data Book, Vol. 1, NERVA Program Report 2275 (Aerojet Nuclear Systems Co., Sacramento, CA, 1970).

Handbook on Materials for Superconducting Machinery (Metals and Ceramics Information Center, Battelle, Columbus, OH, Jan. 1977).

D. T. Read and R. P. Reed, Toughness, fatigue crack growth, and tensile properties of three nitrogen-strengthened stainless steels at cryogenic temperatures, in Metal Science of Stainless Steels (TMS–AIME, New York, 1979).

C. E. Spaeder, Jr., and W. F. Domis, Cryogenic and elevated-temperature mechanical properties of a high-nitrogen type 304 stainless steel, U.S. Steel Corp. report (April 1969).

F. R. Fickett and R. P. Reed (Eds.), Materials studies for magnetic fusion energy applications at low temperatures – I, Nat. Bur. Stand. (U.S.) NBSIR 78-884 (1978).

D. T. Read and R. P. Reed, Fracture and strength properties of selected stainless steels at cryogenic temperatures, in Materials studies for magnetic fusion energy applications at low temperatures – II, Nat. Bur. Stds. (U.S.) NBSIR 79–1609 (1979).

UNITS:

to convert	*to*	multiply by
°F	*K*	$T_K = (t°_F + 459.67)/1.8$
10^3 psi	*MPa*	6.8948

COMMENTS:

(1) AISI-304 curves are best fits of about 100 low-temperature measurements of annealed bar specimens and about 30 low-temperature measurements of annealed sheet or plate specimens. Minimum values range 10 to 20 percent below the plotted values. The cold-rolled curve is an average fit of both longitudinal and transverse data from one source (about 20 low-temperature measurements).

(2) The AISI-304 compression-yield-strength curve was best fitted to data from two studies. Minimum values of these data are about 5 percent below the plotted values.

(3) The AISI-304L curve for the annealed condition was best fitted to about 75 low-temperature measurements. Minimum values range up to 5 percent lower for the annealed bar and 10 to 40 percent lower for the annealed sheet (0.040-0.125-in thick). The cold-rolled data are from 0.063-in sheet, from one study.

(4) The AISI–304N curve was best fitted from two data sources. Minimum values are about five percent below plotted values. Samples of Read and Reed had transverse orientations. AISI–304LN data were from a single source.

(5) The AISI–304N alloy contained 0.12 weight percent nitrogen and 304LN, 0.13 percent.

SANDMEYER STEEL COMPANY

STAINLESS STEEL PLATES AND PLATE PRODUCTS

10001 SANDMEYER LANE • PHILADELPHIA, PA. 19116 • 215-464-7100

CERTIFIED MATERIAL TEST REPORT

CERTIFICATE OF TEST

WE CERTIFY THAT THE CHEMICAL ANALYSIS AND MECHANICAL TEST RESULTS APPEARING IN THIS CERTIFICATE ARE CORRECT AND TRUE TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

SANDMEYER STEEL COMPANY

QUALITY CONTROL DEPARTMENT

MILL ORDER NO. 1978-41

DATE March 25, 1981

Material for second cryostat outer ring

MATERIAL SPECIFICATION

ASME SA 240 HRAP

DESCRIPTION

HEAT NO.	QTY.	SIZE	GRADE	PLATE NUMBERS
657260	1	2-1/4" x 100" x 263"	304	4405

CHEMISTRY

HEAT NO.	C	MN	P	S	Si	Ni	CR	MO	CU	CO	N
657260	.063	1.71	.026	.003	.55	8.44	18.34	.32	.29	.190	.080

PHYSICALS

Heat No.	Yield	Tensile	Elong.	Red%	Hardness	Hardenability	Bend
657260	38,300 lbs/2"	85,[illegible]00 lbs/[illegible]"	71[illegible] In [illegible]"		RB/85		

REMARKS

SOLUTION ANNEALED AT 1[illegible]00°F, MINIMUM, THEN WATER QUENCHED.

MATERIAL MELTED BY CRUCIBLE STEEL INC. RECORDS OF ALL TESTS ARE MAINTAINED AT SANDMEYER STEEL COMPANY.

C-7445
Ser # 2

G.O. CARLSON Inc.
Producers of St[illegible]s Steel, Nickel Alloys and Titanium
THORNDALE, PA. 19372

C#	DATE
11423	10-17-80

CUSTOMER ORDER NUMBER	T/R CODE	CUSTOMER MARK
9445-1	S	9445-1

SOLD TO

THE YOUNGSTOWN WELD & ENGR CO
3700 OAKWOOD AVE
YOUNGSTOWN, OH44509

TYPE AND SPECIFICATIONS

304 HRAP ASTM A 240-79

Material for first cryostat outer ring

ITEM	DESCRIPTION	HEAT	TEST	YIELD STR. P.S.I. .2 % OFFSET	TENSIL STR. P.S.I.	% ELONG. IN 2"	% RED OF AREA	BRINELL HARDNESS	BEND TEST	COND.
1	2.2500 X 11.0000 X 225.5000 P/C	30334 -1B	TT	36500	83000	58	67	150		A
	Melter's Ladle Analysis Attached.									

**** LADLE ANALYSIS ****

C	MN	P	S	SI	CR	NI	N
.057	1.71	.024	.022	.54	18.66	8.36	.056

ITEM	QTY	HEAT
1	2	30334 1B

LEWIS M. WILFORD, Notary Public
Contesville, Chester Co.
My Commission Expires Nov. 27, 1983

Lewis M. Wilford

Sworn to and subscribed before me this 17 day of October 1980

I hereby certify the above figures are correct as contained in the records of the corporation.

T.J. McConnell
Certification Analyst.

C-9445
Ser # 1

Properties of 316L SMA welds from Reference 8

Table 3. Tensile Properties of the AWS E316L Weldments.

Weldment No.	Ferrite %	Temp. K	Yield Strength, 0.2% Offset MPa(ksi)	Ultimate Tensile Strength MPa(ksi)	Elongation in 4-d %	Reduction of Area %
1	.13	295	392 (56.9)	535 (77.6)	38	58
	"	76	659 (95.6)	983 (143)	19	28
	"	4	694 (101)	1222 (177)	20	28
2	4.1	295	396 (57.5)	552 (80.1)	35	57
	"	76	657 (95.3)	1064 (154)	30	32
	"	4	798 (116)	1331 (193)	38	42
3	8.5	295	452 (65.6)	578 (83.9)	45	63
	"	76	753 (109)	1183 (172)	20	42
	"	4	886 (129)	1294 (188)	28	32
4	10.1	295	429 (62.3)	590 (85.6)	38	66
	"	76	725 (105)	1203 (175)	40	32
	"	4	881 (128)	1373 (199)	38	47
5*	1.2	295	405 (58.8)	555 (80.6)	32	56
	"	76	680 (98.7)	914 (133)	12	24
	"	4	924 (134)	1364 (198)	32	40
6	6.5	295	509 (73.9)	609 (88.4)	26	52
	"	76	793 (115)	1261 (183)	55	34
	"	4	936 (136)	1325 (192)	36	32
7	9.7	295	441 (64.0)	564 (81.9)	46	64
	"	76	736 (107)	1179 (171)	58	48
	"	4	817 (119)	1369 (199)	39	54
8	7.3	295	412 (59.8)	585 (84.9)	51	51
	"	76	678 (98.4)	1175 (171)	57	48
	"	4	792 (115)	1263 (183)	40	46
9	.67	295	343 (49.8)	514 (74.6)	48	59
	"	76	639 (92.7)	996 (145)	30	30
	"	4	745 (108)	1157 (168)	26	26
10*	2.2	295	417 (60.5)	597 (86.6)	44	55
	"	76	711 (103)	1250 (181)	46	29
	"	4	847 (123)	1158 (168)	26	26

*AWS E316 electrode.

Properties of 316L SMA welds from Reference 10

McKAY Stainless Steel Electrodes (continued)

McKay Grade AWS Grade Identification (1)	Typical Mechanical Properties and Ferrite Level of Weld Deposit	Typical Deposit Analysis %	Major Specifications (2)	Application Data
McKay 310 AWS E310 Coatings: AC-DC DC Lime	Tensile Strength 86,000 psi Yield Strength 63,000 psi Elongation in 2" 40% Ferrite Number 0	C— 0.13 Mn— 2.25 Si— 0.50 Cr—26.2 Ni—21.0	AWS A5.4 Army 57-203-6A AMS 5695 Mil-E 22200/2 Mil-E-6844A ASME SFA 5.4	For Type 310, and straight chromium stainless and dissimilar metals. The high alloy content will withstand normal dilution and retain austenitic structure.
McKay 310 H AWS E310H Coatings: AC-DC DC Lime (3)	Tensile Strength 118,000 psi Yield Strength 90,000 psi Elongation in 2" 28% Ferrite Number 0	C— 0.40 Mn— 2.25 Si— 0.40 Cr—26.2 Ni—21.4	AWS A5.4 ASME SFA 5.4	High carbon modification of the Type 310 analysis used for casting repair.
McKay 310 Cb E 310 Cb Coatings: AC-DC (3) DC Lime (3)	Tensile Strength 90,000 psi Yield Strength 65,000 psi Elongation in 2" 35% Ferrite Number 0	C— 0.10 Mn— 2.10 Si— 0.45 Cr—26.0 Ni—21.0 Cb— 0.85	AWS A5.4 ASME SFA 5.4	Applications similar to those of Type 310 except that columbium addition improves corrosion resistance.
McKay 310 Mo AWS E 310 Mo Coatings: AC-DC DC Lime (3)	Tensile Strength 90,000 psi Yield Strength 65,000 psi Elongation in 2" 39% Ferrite Number 0	C— 0.10 Mn— 2.10 Si— 0.45 Cr—26.0 Ni—21.0 Mo— 2.25	AWS A5.4 ASME SFA 5.4	Applications similar to Type 310. Molybdenum addition improves high temperature creep properties.
McKay 312 AWS E312 Coatings: AC-DC DC Lime (3)	Tensile Strength 115,000 psi Yield Strength 95,000 psi Elongation in 2" 25% Ferrite Number 25FN Min.	C— 0.10 Mn— 1.30 Si— 0.60 Cr—29.0 Ni— 9.0	AWS A5.4 AMS 5785 Mil-E-6844A Mil-E-22200/2 ASME SFA 5.4	Welding Type 312 materials. Excellent for dissimilar metal joining.
McKay 312 Mo AWS None Imprinted: 312 Mo Coatings: AC-DC (3) DC Lime (3)	Tensile Strength 120,000 psi Yield Strength 95,000 psi Elongation in 2" 29% Ferrite Number 25FN Min	C— 0.10 Mn— 1.70 Si— 0.60 Cr—29.0 Ni— 9.0 Mo— 2.0		Similar to McKay 312 except that the molybdenum content increases the strength and creep resistance of the deposit. Often used for joining dissimilar metals.
McKay 316 AWS E316 Coatings: AC-DC DC Lime	Tensile Strength 85,000 psi Yield Strength 68,000 psi Elongation in 2" 45% Ferrite Number 1FN	C— 0.05 Mn— 1.85 Si— 0.35 Cr—18.0 Ni—13.0 Mo— 2.15	AWS A5.4 AMS 5691 DuPont 819D Mil-E-22200/2 ASME SFA 5.4	For welding Type 316 steel. Applies where increased high temperature corrosion resistance of molybdenum-bearing steels are necessary.
McKay 316 HF AWS E316 Coatings: AC-DC (4) DC Lime (3) DCT	Tensile Strength 85,000 psi Yield Strength 65,000 psi Elongation in 2" 40% Ferrite Number 8FN DCT 8FN	C— 0.04 Mn— 1.20 Si— 0.35 Cr—19.3 Ni—11.5 Mo— 2.35	AWS A5.4 ASME SFA 5.4	Specially balanced chemistry for use in those applications where engineering specifications require Ferrite Number in excess of 5.
316L DC Lime Same product as Kryokay 316L except untested **McKay 316L** AWS E316L Coatings: AC-DC -16 DC Lime -15	Tensile Strength 82,000 psi Yield Strength 61,000 psi Elongation in 2" 42% Ferrite Number 0FN	C— 0.03 Mn— 1.60 Si— 0.35 Cr—18.0 Ni—13.2 Mo— 2.25	AWS A5.4 Mil-E-22200/2 DuPont 820/M ASME SFA 5.4	Welding Type 316L material. Properties similar to Type 316 with added corrosion resistance.
Kryo-Kay 316L AWS E316L Coating DC Lime 50¢/lb more than 316L	Charpy V-Notch Properties at -320F (-196C) Impact Strength 35 ft. lbs Lateral Expansion 22 mils 0 →	C— 0.025 Mn— 2.1 Si— 0.030 Cr—17.7 Ni—13.6 Mo— 2.1	N AWS A5.4 ASME SFA 5.4	Specially selected and processed lots. Weld metal exhibits more than 15 mils lateral expansion when tested at -320F (-196C).
McKay 316L-HF AWS E316L Coatings AC-DC (4) DC Lime (3) DCT	Tensile Strength 85,000 psi Yield Strength 66,000 psi Elongation in 2" 41% Ferrite Number 10FN DCT 9FN	C— 0.03 Mn— 1.0 Si— 0.35 Cr—19.5 Ni—11.6 Mo— 2.25	AWS A5.4 ASME SFA 5.4	Specially balanced chemistry for use in those applications where engineering specifications require Ferrite Number in excess of 5.
McKay 317 AWS E317 Coatings: AC-DC DC Lime (3) DCT (3)	Tensile Strength 95,000 psi Yield Strength 70,000 psi Elongation in 2" 33% Ferrite Number 4FN	C— 0.06 Mn— 1.80 Si— 0.45 Cr—18.4 Ni—13.6 Mo— 3.3	AWS A5.4 DuPont 819C & 822B ASME SFA 5.4 Mil-E-22200/2	Increased molybdenum content results in higher tensile strength, better corrosion resistance and improved high temperature creep strength.

(1) Electrodes are imprinted with the AWS class unless otherwise indicated.
Electrodes produced to Military Specifications are marked as required by the Military Specification.
(2) Some specifications require additional testing and documentation at the time of electrode production.
(3) Available on special order basis. Consult Customer Services for pricing and minimum order quantities.
(4) Bonded (Pretested) Stock Material

MATERIAL TEST REPORT
Welding Products Division

TELEDYNE McKAY
P.O. Box 1509 • 850 Grantley Road • York, Pa. 17405

For Cryostat Closure Weld
root pass and cover pass
except root pass of cryostat #1

FERMI NATL ACCELERATOR LABORATORY
ATTN ACCT DEPT
PO BOX 500
BATAVIA, IL 60510

Your Order No. 29958
Marked For

Our Order No. 04245-01
Date Shipped 1-14-82

Material Description and Specifications

Item	Weight, lb.	Size, in	Classification	Coating
1	60	1/8 x 36	ER316L	Bare Wire
2				
3				
4				
5				
6				

Item	Heat No.	Lot No.	Specification
1	43024	32110	AWS A5.9-77; ASME SFA5.9
2			
3			
4			
5			
6			

Typical Chemistry TYPICAL WELD METAL

Item	% C	% Mn	% P	% S	% Si	% Cr	% Ni	% Mo	%Cu	%V	%Cb+Ta	Ferrite
1	.019	1.70	.020	.010	.45	18.9	12.6	2.2	.20	.05	.03	6.5 FN
2												
3												
4												
5												
6												

Typical Mechanical Properties

Item	Tensile, psi	Yield, psi	% Elong.	Charpy V-Notch Impact, ft.lb.
1				
2				
3				
4				
5				
6				

For Notarization

1m

We hereby certify that the above product has been classified in accordance with the listed specifications and conforms to all applicable requirements thereof.

TELEDYNE McKAY

R.F. Gin

Form TM-410 Rev. A

MATERIAL TEST REPORT

1/11/82

TELEDYNE McKAY

Welding Products Division
P.O. Box 1509
York, Pa. 17405
Telephone: 717-845-7581
Telex: 84-0428

For 30" cryo-shf closure weld root pass and cover pass

Fermi Natl. Acceleratory Laboratory
ATTN: Acct. Dept.
P.O. Box 500
Batavia, IL 60510

Your Order No. 29958
Marked For

Our Order No. 04245-01
Date Shipped 1/5/82

Material Description and Specifications

Item	Weight, lb.	Size, in	Classification	Coating
1	60	1/16" x 36"	ER316L	Bare Wire
2				
3				
4				
5				

Item	Heat No.	Lot No.	Specification
1	42165	31125	AWS A5.9-77; ASME SFA5.9
2			
3			
4			
5			

Chemical Analysis: TYPICAL WELD METAL

Item	% C	% Mn	% P	% S	% Si	% Cr	% Ni	% Mo	% Cu	%Cb+Ta	% V	
1	.019	1.70	.020	.010	.45	18.9	12.6	2.2	.20	.03	.05	5 FN Ferrite
2												
3												
4												
5												

Typical Mechanical Properties

Item	Tensile, psi	Yield, psi	% El.	% R.A.	Charpy V-Notch Impact, ft. lb.	
1						
2						
3						
4						
5						

dle

We hereby certify that the above product has been classified in accordance with the listed specifications and conforms to all applicable requirements thereof.

TELEDYNE McKAY

Authorized Signature

Sworn and Subscribed before me this _____ day of

_____, 19____ _____
Notary Public

My commission expires _____. Spring Garden Twp. York Co.

Form TM-113 A

MATERIAL TEST REPORT

5/21/81

TELEDYNE McKAY

Welding Products Division
P.O. Box 1509
York, Pa. 17405
Telephone: 717-845-7581
Telex: 84-0428

Fermilab
Attn: Accounting Department
P.O. Box 500
Batavia, IL 60510

Your Order No. 18806
Marked For

Our Order No. 89055
Date Shipped 5/22/81

Material Description and Specifications

Item	Weight, lb	Size, in	Classification	Coating
1	60	5/32"	E316L-15	DC Lime Kryo-Kay
2				
3				
4				

Item	Heat No **	Lot No**	Specification	Lab Test No.
1	35996	2217889	AWS A5.4-78; ASME Section II, Part C SFA5.4 (1980 Edition) Winter 1980 Addenda ANSI B31.*1-78	9076-5092
2				
3				
4				

Chemical Analysis: ACTUAL WELD METAL

Item	% C	% Mn	% P	% S	% Si	% Cr	% Ni	% Mo	% V	% Cb+Ta	%Ti	%Cu
1	.037	2.12	.013	.012	.25	17.95	13.67	2.24	.11	.03	.03	.13
2												
3												
4											Ferrite (Magna Gage)	0 FN

Mechanical Properties

Item	Tensile, psi	Yield, psi	% El.	% R A
1				
2				
3				
4				

CHARPY V-NOTCH IMPACTS @ -320°F (As Welded)

Specimen No.	Ft. Lb.	Lateral Expansion, in.	%Ductile Fracture
1	37.6	.026	95
2	40.5	.028	95
3	37.6	.025	95

*Impact testing was performed to the requirements of ANSI B31.3 @ -320°F on specimens removed from test plates welded in accordance with AWS A5.4-78.

**Each container is identified by heat and lot number.

All Welding Done With DCRP.

rll

We hereby certify that the above material has been tested in accordance with the listed specifications and conforms to all applicable requirements thereof.

TELEDYNE McKAY

Authorized Signature

Sworn and Subscribed before me this _____ day of _____ 19 _____

Notary Public

My commission expires _____ Spring Garden Twp York Co

Form TM-169

MATERIAL TEST REPORT

5/21/81

TELEDYNE McKAY

Welding Products Division
P O Box 1509
York, Pa 17405
Telephone 717-845-7581
Telex: 84-0428

Weld Rod for closure weld of cryostat

Fermilab
Attn: Accounting Department
P.O. Box 500
Batavia, IL 60510

Your Order No. 18806
Marked For

Our Order No 89055
Date Shipped 5/22/81

Material Description and Specifications

Item	Weight, lb	Size in	Classification	Coating
1	60	5/32"	E316L-15	DC Lime Kryo-Kay
2				
3				
4				

Item	Heat No **	Lot No **	Specification	Lab Test No
1	35996	2217889	AWS A5.4-78; ASME Section II, Part C SFA5.4 (1980 Edition) Winter 1980 Addenda ANSI B31.*1-78	9076-5092
2				
3				
4				

Chemical Analysis: ACTUAL WELD METAL

Item	% C	% Mn	% P	% S	% Si	% Cr	% Ni	% Mo	% V	% Cb+Ta	%Ti	%Cu
1	.037	2.12	.013	.012	.25	17.95	13.67	2.24	.11	.03	.03	.13
2												
3												
4											Ferrite (Magna Gage)	0 FN

Mechanical Properties

Item	Tensile psi	Yield, psi	% El	% RA
1				
2				
3				
4				

CHARPY V-NOTCH IMPACTS @ -320°F (As Welded)

Specimen No.	Ft. Lb.	Lateral Expansion, in.	%Ductile Fracture
1	37.6	.026	95
2	40.5	.028	95
3	37.6	.025	95

*Impact testing was performed to the requirements of ANSI B31.3 @ -320°F on specimens removed from test plates welded in accordance with AWS A5.4-78.

**Each container is identified by heat and lot number.

All Welding Done With DCRP.

rll

We hereby certify that the above material has been tested in accordance with the listed specifications and conforms to all applicable requirements thereof.

TELEDYNE McKAY

Authorized Signature

Sworn and Subscribed before me this _____ day of _____ 19____

Notary Public

My commission expires _____ Spring Garden Twp York Co

Form TM-169

MATERIAL TEST REPORT

5/21/81

TELEDYNE McKAY

Weld Rod for closure weld of cryostat

Welding Products Division
P.O. Box 1509
York, Pa. 17405
Telephone: 717-845-7581
Telex: 84-0428

Fermilab
Attn: Accounting Department
P.O. Box 500
Batavia, IL 60510

Your Order No. 18806
Marked For

Our Order No. 89055
Date Shipped 5/22/81

Material Description and Specifications

Item	Weight, lb	Size, in	Classification	Coating
1	60	1/8"	E316L-15	DC Lime Kryo-Kay
2				
3				
4				

Item	Heat No **	Lot No **	Specification	Lab Test No
1	35996	2217901	AWS A5.4-78; ASME Section II, Part C SFA5.4 (1980 Edition) Winter 1980 Addenda ANSI B31.*1-78	9076-5094
2				
3				
4				

Chemical Analysis: ACTUAL WELD METAL

Item	% C	% Mn	% P	% S	% Si	% Cr	% Ni	% Mo	% V	% Cb+Ta	%Ti	%Cu
1	.028	2.10	.017	.010	.24	17.78	13.84	2.30	.12	.03	.03	.17
2												
3												
4											Ferrite (Magna Gage) 1.2 FN	

Mechanical Properties

Item	Tensile, psi	Yield, psi	% El.	% RA
1				
2				
3				
4				

CHARPY V-NOTCH IMPACTS @ -320°F (As Welded)

Specimen No.	Ft. Lb.	Lateral Expansion, in.	%Ductile Fracture
1	44.8	.028	99
2	52.8	.029	99
3	47.7	.026	99

**Each container is identified by heat and lot number.

All Welding Done DCRP.

*Impact testing was performed to the requirements of ANSI B31.3 @ -320°F on specimens removed from test plates welded in accordance with AWS A5.4-78.

rll

We hereby certify that the above material has been tested in accordance with the listed specifications and conforms to all applicable requirements thereof.

TELEDYNE McKAY

Authorized Signature

Sworn and Subscribed before me this _____ day of

_____ 19____

Notary Public

My commission expires _____. Spring Garden Twp York Co

Form TM-169

MATERIAL TEST REPORT

5/21/81

TELEDYNE McKAY

Welding Products Division
P.O. Box 1509
York, Pa. 17405
Telephone: 717-845-7581
Telex: 84-0428

Fermilab
Attn: Accounting Department
P.O. Box 500
Batavia, IL 60510

Your Order No. 18806
Marked For

Our Order No. 89055
Date Shipped 5/22/81

Material Description and Specifications

Item	Weight, lb	Size, in	Classification	Coating
1	60	1/8"	E316L-15	DC Lime Kryo-Kay
2				
3				
4				

Item	Heat No **	Lot No **	Specification	Lab Test No
1	35996	2217901	AWS A5.4-78; ASME Section II, Part C SFA5.4 (1980 Edition) Winter 1980 Addenda ANSI B31.*1-78	9076-5094
2				
3				
4				

Chemical Analysis: ACTUAL WELD METAL

Item	% C	% Mn	% P	% S	% Si	% Cr	% Ni	% Mo	% V	% Cb+Ta	%Ti	%Cu
1	.028	2.10	.017	.010	.24	17.78	13.84	2.30	.12	.03	.03	.17
2												
3												
4											Ferrite (Magna Gage) 1.2 FN	

Mechanical Properties

Item	Tensile, psi	Yield, psi	% El	% RA
1				
2				
3				
4				

CHARPY V-NOTCH IMPACTS @ -320°F (As Welded)

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rll

We hereby certify that the above material has been tested in accordance with the listed specifications and conforms to all applicable requirements thereof.

TELEDYNE McKAY

Authorized Signature

Sworn and Subscribed before me this _____ day of

_____, 19____ _____
Notary Public

My commission expires _____, Spring Garden Twp York Co

Form TM-159