Armco NITRONIC 40 Stainless Steel Bar and Wire

OUTSTANDING VERSATILITY

- **High Strength**
- **Excellent Cryogenic Properties**
- **Good Corrosion Resistance**

Applications Potential

Because of its high strength and good fabricability, Armco NITRONIC 40 Stainless Steel is used extensively in a wide variety of aircraft applications. Substantial weight-savings have been made for parts such as ducting and bellows systems, clamps, fasteners and flanges.

The combination of high strength and toughness at temperatures down to -423 F (-254 C) also makes Armco NITRONIC 40 Stainless Steel ideal for cryogenic applications especially where low magnetic formability is also a requirement. In addition, it has good resistance to high-temperature oxidation in air.

Baltimore Specialty Steels Corporation

A SUBSIDIARY OF ARMCO INC. ARMCO®

ARMCO NITRONIC 40 STAINLESS STEEL BAR AND WIRE

(UNS S21900 AND UNS S21904, XM-10 AND XM-11)

ARMCO

Product Data Bulletin No. S-19

ARMCO NITRONIC 40 STAINLESS STEEL PRODUCT DESCRIPTION

Armco NITRONIC 40 stainless steel is one of the most versatile stainless steels. It combines high yield strength with good corrosion resistance. Room temperature yield strength is about twice that of Types 304, 321 and 347. In addition, it provides remarkably good elevated temperature properties and retains high strength and toughness at sub-zero temperatures.

Although it has higher yield strength than conventional 18-8 stainless steels, the same fabricating equipment and techniques can be used successfully in forming Armco NITRONIC 40 stainless steel. It is readily forgeable and can be welded by conventional welding methods.

AVAILABLE FORMS

Armco NITRONIC 40 stainless steel is available in bar, wire and forging billets. In addition it is available in standard finishes in annealed or high-tensile temper sheet and strip, and in plate form. It can be cast or extruded.

COMPOSITION

The following compositions are acceptable for specifications covering Armco NITRONIC 40 stainless steel

	UNS S21900	UNS S21904
	%	%
Carbon	0.08 max	0.040 max
Manganese	8.00-10.00	8.00-10.00
Phosphorus	0.060 max	0.060 max
Sulfur	0.030 max	0.030 max
Silicon	1.00 max	1.00 max
Chromium	19.00-21.50	19.00-21.50
Nickel	5.50-7.50	5.50-7.50
Nitrogen	0.15-0.40	0.15-0.40

The 0.040% maximum carbon composition must be specified when Armco NITRONIC 40 stainless steel is required to meet the $CuSO_4$-H_2SO_4 test as defined in the requirements of Federal Test Methods Standards 151b, Method ASTM A 393 (A 708) for stabilized or extra-low carbon stainless steels.

METALLURGY

Armco NITRONIC 40 is a stable austenitic stainless steel and is not hardenable except by cold working. Even after 60% cold reduction, it is still essentially nonmagnetic.

The information and data in this product data bulletin are accurate to the best of our knowledge and belief, but are intended for general information only. Applications suggested for the materials are described only to help readers make their own evaluations and decisions, and are neither guarantees nor to be construed as express or implied warranties of suitability for these or other applications.

Data referring to mechanical properties and chemical analyses are the result of tests performed on specimens obtained from specific locations of the products in accordance with prescribed sampling procedures; any warranty thereof is limited to the values obtained at such locations and by such procedures. There is no warranty with respect to values of the materials at other locations.

METRIC PRACTICE

The values shown in this bulletin were established in U.S. customary units. The metric equivalents of U.S. customary units shown may be approximate. Conversion to the metric system, known as the International System of Units (SI), has been accomplished in accordance with the American Iron and Steel Institute Metric Practice Guide, 1978.

The newton (N) has been adopted by the SI as the metric standard unit of force as discussed in the AISI Metric Practice Guide. The term for force per unit of area (stress) is the newton per square metre (N/m^2). Since this can be a large number, the prefix mega is used to indicate 1,000,000 units and the term meganewton per square metre (MN/m^2) is used. The unit (N/m^2) has been designated a pascal (Pa). The relationship between the U.S. and the SI units for stress is: 1000 pounds/in^2 (psi) = 1 kip/in^2 (ksi) = 6.8948 meganewtons/m^2 (MN/m^2) = 6.8948 megapascals (MPa). Other units are discussed in the Metric Practice Guide.

ELEVATED TEMPERATURE EXPOSURE

The effects of heating Armco NITRONIC 40 stainless steel at temperatures of 600 to 1600 F (316 to 871 C) for times up to 100 hours on the precipitation of grain boundary carbides are shown in the following table:

Carbide Formation

Temperature F (C)	Carbide Formation Rating* Time, hrs. 1	9	25	100
600 (316)	None [1]	None [1]	None [1]	None [1]
800 (427)	None [1]	None [1]	None [1]	None [1]
900 (482)	None [1]	None [1]	None [1]	None [1]
1000 (538)	None [1]	None [1]	None [1]	None [1.4]
1100 (593)	None [1]	Trace [1.6]	Light [3.2]	Heavy [5]
1200 (649)	Trace [1.6]	Medium [3.6]	Heavy [4.8]	Very Heavy [5.6]
1400 (760)	Light [3]	Light [3]	Medium [3.8]	Medium [3.8]
1600 (871)	Trace [1.6]	Trace [2]	Trace [2]	Trace [2.5]

*Carbide Rating — Solar Aircraft Co., San Diego, California

None - (1 to 1.4)
Trace - (1.5 to 2.5)
Light - (2.6 to 3.4)
Medium - (3.5 to 4.5)
Heavy - (4.6 to 5.4)
Very Heavy - (5.5 to 6)

Numbers in [ ] are average Solar Carbide Ratings of 5 heats of NITRONIC 40 stainless — 0.040% max carbon.

The effects of heating Armco NITRONIC 40 stainless steel in the annealed condition at temperatures of 600 to 1600 F (316 to 871 C) for times up to 100 hours on sigma formation are shown in the following table:

Sigma Formation

Temperature F (C)	Sigma Formation Rating* Time, hrs. 1	9	25	100
600 (316)	None [1]	None [1]	None [1]	None [1]
800 (427)	None [1]	None [1]	None [1]	None [1]
900 (482)	None [1]	None [1]	None [1]	None [1]
1000 (538)	None [1]	None [1]	None [1]	None [1.2]
1100 (593)	None [1.2]	None [1.2]	None [1.2]	Trace [1.6]
1200 (649)	None [1.2]	None [1.2]	Trace [2]	Light [2.6]
1400 (760)	None [1.4]	Light [2.8]	Light [3.4]	Medium [3.6]
1600 (871)	Trace [1.6]	Trace [2.4]	Light [3]	Light [3.4]

*Sigma Rating
None - (1 to 1.4)
Trace - (1.5 to 2.5)
Light - (2.6 to 3.4)
Medium - (3.5 to 4.5)
Heavy - (4.5 to 5)
Numbers in [ ] are average rating of 5 heats of NITRONIC 40 — 0.040% max carbon.

MECHANICAL PROPERTIES

Properties Acceptable for Material Specifications

Table I
Minimum Mechanical Properties*
Annealed

Condition	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong, % in 2" (50.8 mm)	Red. of Area %
Bar - Condition A	90 min (620)	50 min (345)	40 min	60 min

*Longitudinal direction through 12" (304.8 mm) section. On sizes over 12" (304.8 mm), please inquire.

Typical Properties

Table II
Room Temperature Properties
Annealed Bar

Section Size, in.* (mm)	Test Direction	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong % in 2" (50.8 mm)	Red. of Area %
6 x 6 (152.4 x 152.4)	Longitudinal	99 (683)	65 (448)	48	70
6 x 6 (152.4 x 152.4)	Transverse	97 (669)	54 (372)	32	47
4 x 4 (101.6 x 101.6)	Longitudinal	98 (676)	58 (400)	55	75
2-1/2 x 4-1/2 (63.5 x 114.3)	Longitudinal	100 (690)	68 (469)	48	70
1" Rd. (25.4)	Longitudinal	100 (690)	57 (393)	53	75

*Annealed in full section

Table III
Properties of
Cold Drawn Wire

Final Cold Reduction, %	Stress Relieving Heat Treatment	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong, % in 4xD	Red. of Area %	Hardness R_C	Relaxation* (% Loss in Load)
15	none	128 (882)	108 (745)	56	70	—	—
15	1000 F - 2 hr AC (538 C)	128 (882)	102 (703)	56	68	21	10.2
15	1150 F - 2 hr AC (621 C)	125 (862)	92 (634)	45	67	20	10.0
15	1300 F - 2 hr AC (704 C)	122 (841)	93 (641)	60	65	20	6.8
30	none	179 (1234)	162 (1117)	28	57	40	—
30	1000 F - 2 hr AC (538 C)	179 (1234)	162 (1117)	28	57	39	9.1
30	1150 F - 2 hr AC (621 C)	166 (1145)	149 (1027)	28	54	33	6.8
30	1300 F - 2 hr AC (704 C)	159 (1096)	140 (965)	40	57	30	7.3

* Compression springs stressed at 40,000 psi (276 MPa) (room temp) exposed at 850 F (454 C) for 5 days

Table IV
Typical Properties at Cryogenic Temperatures*
4-3/4" (118 mm) Thick Slab — Annealed

Test Temp F (C)	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong, % in 1" (25.4 mm)	R/A %	Charpy Impact V-Notch ft-lbs (J)	Charpy Impact Keyhole ft-lbs (J)
75 (24)	103 (710)	58 (400)	50	70	205 (294)	—
-110 (-79)	134 (924)	87 (600)	59	71	146 (196)	60 (80)
-320 (-196)	203 (1400)	150 (1034)	—	24	65 (87)	37 (50)
-423 (-253)	245 (1689)	196 (1351)	15	20.5	53 (71)	34 (46)

* Tested in transverse direction

Table V
Typical Charpy Impact
1" (25.4 mm) Round Bar
(.040 max carbon)

Test Temperature	Charpy V-Notch Impact—ft-lbs (J)	
	Annealed	Simulated HAZ*
Room Temperature	Over 240 (324)	Over 240 (324)
-100 F (-73 C)	Over 230 (310)	175-186 (236-251)
-320 F (-196 C)	112-118 (151-159)	20-21 (27-28)

*Heat treated at 1250 F (677 C) for 2 hours to simulate heat-affected zones of weldments. These data strongly support the use of Armco NITRONIC 40 in cryogenic applications, especially in view of the excellent toughness in the heat-affected zone of weldments.

Table VI
Short-Time Cryogenic and Elevated Temperature Tensile Properties
Hot-Rolled and Annealed Bar*

Test Temperature F (C)	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elongation % in 4 x Diameter	Reduction of Area %
-320 (-196)	216 (1489)	119 (820)	36	45
-200 (-129)	157 (1082)	104 (717)	46	72
-100 (-73)	136 (938)	79 (545)	51	75
75 (24)	104 (717)	54 (372)	55	78
200 (93)	94 (648)	41 (283)	54	79
300 (149)	88 (607)	36 (248)	52	79
400 (204)	84 (579)	32 (221)	52	79
500 (260)	80 (552)	29 (200)	52	77
600 (316)	79 (545)	27 (186)	52	77
700 (371)	78 (538)	27 (186)	51	76
800 (427)	76 (524)	27 (186)	50	76
900 (482)	72 (496)	26 (179)	52	77
1000 (538)	69 (476)	24 (165)	52	77

*Annealed 4" square, 1950 F (1066 C) ½-hour, water quenched.

Values are the average of six tests from three heats, rounded to the nearest whole number.

FIG. 1 - STRESS-STRAIN CURVE (LONGITUDINAL)

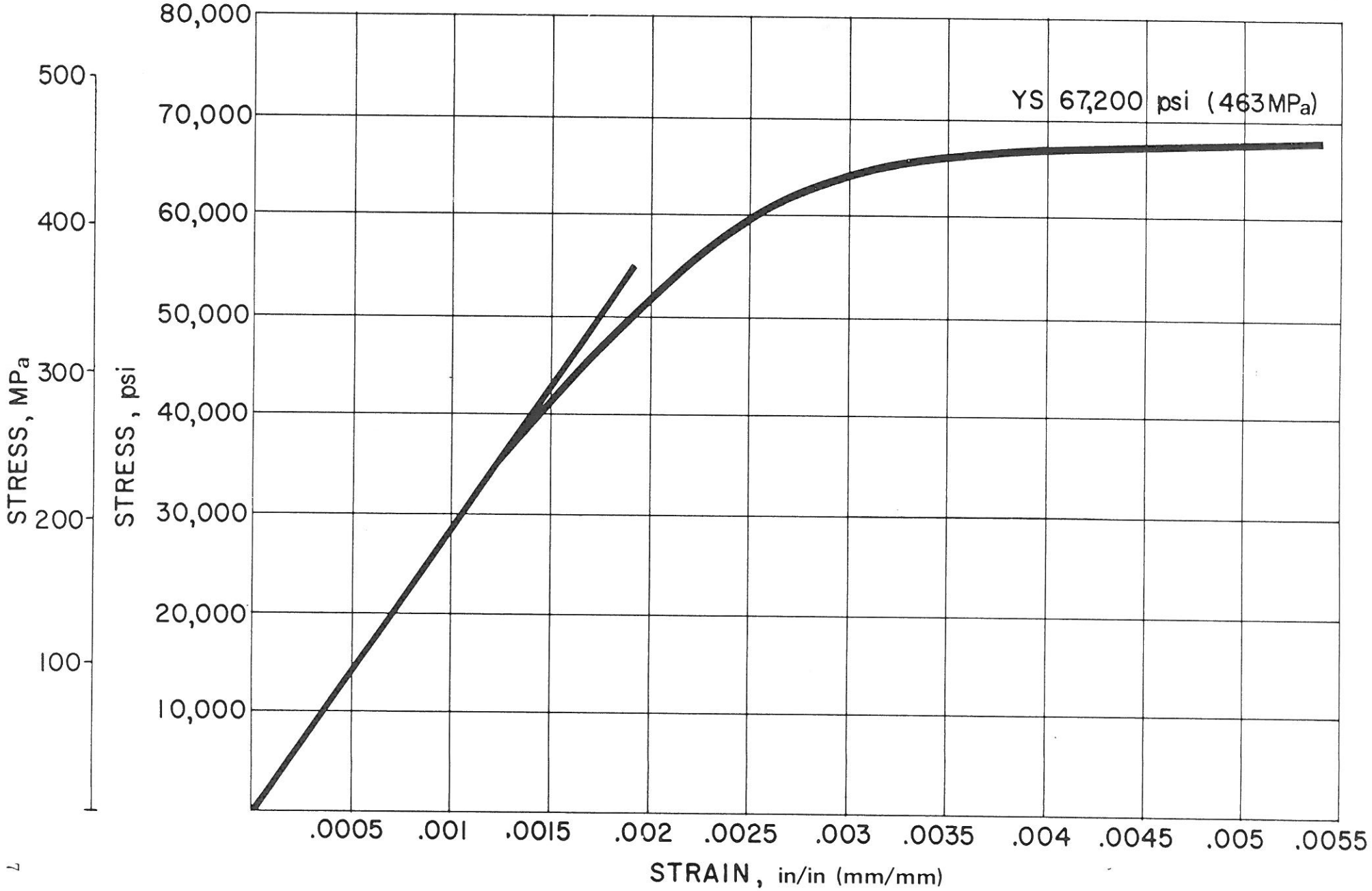


FIG. 2 – STRESS-STRAIN CURVE (TRANSVERSE)

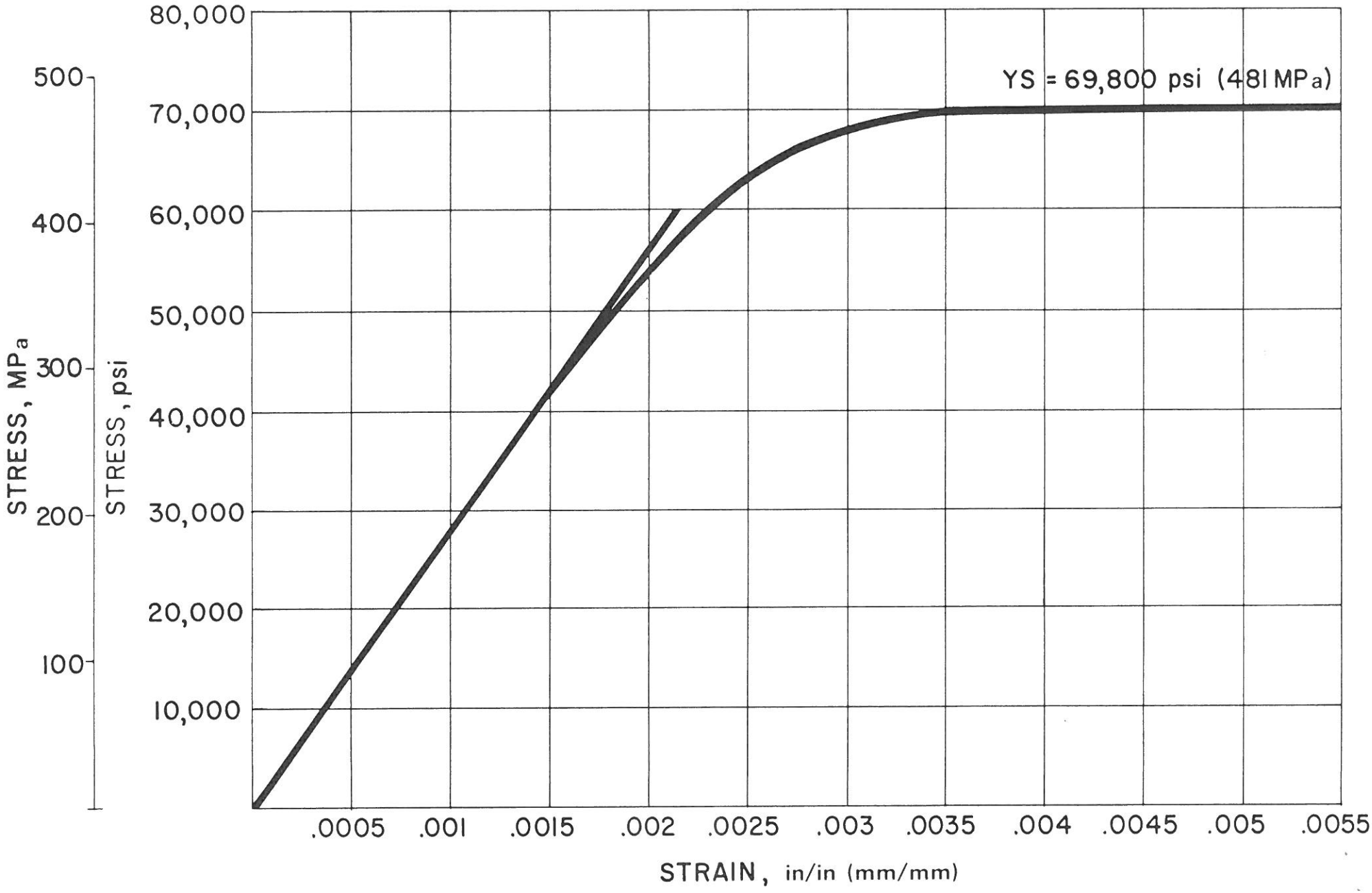


Table VII
Stress-Rupture Strength
Annealed Bar

Temperature F (C)	Stress to Rupture, ksi (MPa)					
	100 hrs			1000 hrs		
	NITRONIC 40	Type 347*	19-9 DL**	NITRONIC 40	Type 347*	19-9 DL**
1200 (649)	33.5 (231)	25/37 (172/255)	32/42 (221/290)	27.5 (190)	20/25 (138/172)	35 (241)
1350 (732)	21.0 (145)	18 (124)	21 (145)	13.5 (93)	—	12 (83)
1500 (816)	10.2 (70)	8/10 (55/70)	7 (48)	6.1 (42)	3/5 (21/34)	—

*Reference: ASTM Special Technical Publication No. 124

**Reference: ASTM Special Technical Publication No. 160

Table VIII
Creep Strength
Annealed Bar

Temperature F (C)	Stress in ksi (MPa) for Creep Rate of			
	0.1% in 1000 hrs		0.01% in 1000 hrs	
	NITRONIC 40	Type 347*	NITRONIC 40	Type 347*
1200 (649)	14.4 (99)	12/22 (83/152)	10.2 (70)	6/10 (41/69)
1300 (704)	—	8/12 (55/83)	—	5/6 (34/41)
1350 (732)	6.3 (44)	—	4 (28)	—

*Reference: ASTM Special Technical Publication No. 124

Endurance Limit

The endurance limit of Armco NITRONIC 40 stainless steel annealed bar stock is approximately 49,000 psi (338 MPa) at 100,000,000 cycles. This information was developed using smooth specimens machined from 1" (25.4 mm) diameter bar stock and stressed as rotating beams on the R. R. Moore testing machine. The ratio of the endurance limit to tensile strength is approximately 0.49.

PHYSICAL PROPERTIES

Table IX
Coefficient of Thermal Expansion
Annealed Condition

Temperature, F (C)	in/in/°F (mm/mm/°C)
80-200 (27-93)	9.3×10^{-6} (16.7×10^{-6})
80-400 (27-204)	9.6×10^{-6} (17.3×10^{-6})
80-600 (27-316)	10.1×10^{-6} (18.2×10^{-6})
80-1000 (27-538)	10.6×10^{-6} (18.6×10^{-6})
80-1400 (27-760)	11.1×10^{-6} (20×10^{-6})
80-1600 (27-871)	11.2×10^{-6} (20.2×10^{-6})
80-1800 (27-982)	11.4×10^{-6} (20.5×10^{-6})

Thermal Conductivity

Table X
Thermal Conductivity
Annealed Condition

Temperature, F (C)	BTU/hr/ft²/in/°F(W/m•K)
-290 (-179)	54 (7.8)
-100 (-73)	76 (10.9)
200 (93)	96 (13.8)
400 (204)	112 (16.1)
600 (316)	126 (18.2)
800 (427)	140 (20.2)
1000 (538)	156 (22.5)
1200 (649)	172 (24.8)
1400 (760)	186 (26.8)
1600 (871)	200 (28.8)

Young's Modulus of Elasticity

In the annealed condition, Young's modulus in tension is 28,500,000 psi (197 GPa).

Poisson's Ratio is 0.285.

Density

7.83 gm/cm³
0.283 lb/in³

Electrical Resistivity

Electrical Resistivity at room temperature is 73 microhm-cm.

Magnetic Permeability

Armco NITRONIC 40 stainless steel is useful in applications where low permeability is important because it remains nonmagnetic even after severe cold working or exposure to sub-zero temperatures. At a field strength of 500 oersteds, it has a permeability in the annealed condition of 1.002. After approximately 60% cold reduction, the permeability is still less than 1.02.

Table XI
Magnetic Permeability

	Field Strength (Oersteds)			
Condition	50	100	200	500
Annealed	1.005	1.004	1.004	1.002
15% Cold Reduction	1.004	1.004	1.003	—
35% Cold Reduction	1.005	1.005	1.005	—
60% Cold Reduction	1.010	1.010	1.012	<1.02
H.R. & Pickled	1.008	1.007	1.006	—

Table XII
Effect of Sub-Zero Temperature on Magnetic Permeability
Annealed

Test Temperature* F (C)	Field Strength 500 (Oersteds)	
	NITRONIC 40	Type 310
75 (24)	1.002	1.002
-320 (-196)	1.005	1.007
75 (24)	1.002	1.003

*Specimens tested at 75 F (24 C), at -320 F (-196 C) and finally at 75 F (24 C). Last test measured effects of low temperature exposure on room temperature permeability.

OXIDATION RESISTANCE

Armco NITRONIC 40 stainless steel, because of its high chromium content, exhibits good resistance to high temperature oxidation in air.

Table XIII
Oxidation Resistance*

Alloy	Temperature, F (C)	Time Hours	Oxidation Loss	
			Loss gms/sq in	Loss in/yr
NITRONIC 40	1600 (871)	1000	.06	.004
Type 304	1600 (871)	1000	.05	.003
NITRONIC 40	1800 (982)	400	.11	.018
Type 304	1800 (982)	400	.30	.049

*Tests run in electric muffle furnace with small amount of saturated air introduced to prevent stagnant atmosphere from occurring during exposure.

CORROSION RESISTANCE

The corrosion resistance of Armco NITRONIC 40 stainless steel is about like that of Type 304 stainless steel. The 0.040% maximum carbon grade, due to its low carbon content, is resistant to intergranular attack, and usually can be used safely in the as-welded condition. However, like Type 304L, Armco NITRONIC 40 stainless steel can be corroded intergranularly with longer exposure in the carbide precipitation temperature range of 1000-1600 F (583-871 C).

The resistance of Armco NITRONIC 40 stainless steel to stress corrosion cracking in hot chloride solutions is about like that of Types 304 and 304L stainless steels. Annealed, furnace sensitized and cold-rolled specimens of Armco NITRONIC 40 stainless steel have shown excellent resistance to stress corrosion cracking when exposed to marine atmospheres at ambient temperature for over 10 years.

FABRICATION

Annealing and Stress Relieving

In-process annealing may be done between 1950-2050 F (1066-1121 C). The final annealing temperature is 1950 F (1066 C). Cooling practices are the same as those required for Type 304 with rapid air cooling for sheet thicknesses and water or oil quenching for heavier sections.

Welding

Armco NITRONIC 40 stainless steel is readily welded in all forms. Welded joints in the as-welded condition have strengths equivalent to the unwelded base metal. Data on welded joints made by both gas tungsten-arc (TIG) and shielded metal-arc (SMAW) with covered electrodes are shown in the following table.

Table XIV
Mechanical Properties of Armco NITRONIC 40 Welds

Welding Process	Thickness Inches (mm)	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong, % in 2" (50.8 mm)	Lateral Contraction %	Failed in
Gas Tungsten-Arc (TIG)	0.062 (1.57)	109 (752)	68 (469)	22	17	Weld Metal
Shielded Metal-Arc (SMAW)	2.0 (50.8)	106 (731)	65 (448)	39	—	Base Metal

For the gas tungsten-arc (TIG), gas metal-arc (MIG) and shielded metal-arc (SMAW) weld methods, NITRONIC 40W electrodes should be used. For most applications, use of the NITRONIC 40W matching filler will give as-welded corrosion and mechanical properties equivalent to those of the unwelded base metal. However, in cases where the matching filler may not be readily available, other more common stainless steel electrode types may be substituted. Selection of a substitute electrode should be based on properties required. For example, in heavy joints, a Type 312 electrode will give matching strength, but will not have the toughness needed for cryogenic applications. Types 308L and 309 will give matching 0.2% yield strengths, but will be low in ultimate tensile strengths. In lighter gage materials, (i.e. approximately 1/8" [3.17 mm]) where the Gas Tungsten Arc Process is frequently used, the weld filler comprises only a small part of the weld. Consequently, weld joint properties more nearly match that of the unwelded base metal regardless of the substitute used.

Like the other nitronic grades, NITRONIC 40, and NITRONIC 40W, have high nitrogen. This could interfere with EB welding by severe outgassing of the liquid metal under the vacuum.

As an aid in selecting weld fillers for general applications, typical properties of all-weld deposits made using the NITRONIC 40W filler are compared with several other chrome-nickel weld metals and unwelded base metal in Table XV.

Table XV

Mechanical Properties of Armco NITRONIC 40W All-Weld Metal Deposits Compared with Various AWS Weld Metals and Unwelded Base Metal

AWS Weld Filler Type	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong, % in 2" (50.8 mm)
NITRONIC 40W	107 (738)	86 (593)	30
308L	85 (586)	60 (414)	45
309	90 (620)	60 (414)	45
312	110 (759)	80 (550)	30
Unwelded base metal, heavy sections (4" [102 mm])	103 (710)	58 (400)	50
Unwelded base metal sheet-strip	112 (772)	68 (469)	44

For cryogenic applications, weldments of 1/4" (6.35 mm) or less in thickness made with the NITRONIC 40W exhibit good toughness. Where weldments greater than 1/4" (6.35 mm) in thickness are to be used at cryogenic temperatures, nickel-base fillers are generally suggested. Type 308 stainless steel fillers may be used for all thicknesses providing allowance is made for the lower ultimate tensile strength in heavy joints. More information on the selection of fillers for cryogenic applications will be supplied upon request.

When welding Armco NITRONIC 40 stainless steel using inert gas shielded processes (primarily TIG), the metal should be handled carefully to avoid contamination from other materials such as copper, brass or bronze. Defects resulting from such contamination usually occur as shallow surface cracks in the base metal immediately adjacent to the weld deposit. Copper backup and hold-down fixtures commonly used in welding stainless steels are the principal source of this contamination. In addition to careful handling, the use of chromium-plated copper fixtures is suggested. However, stainless steel fixtures are satisfactory.

Table XVI
Properties of Welded Joints at Elevated Temperatures*
Sheet and Strip

Test Temp, F (C)	UTS ksi (MPa)	0.2% YS ksi (MPa)	Elong, % in 2" (50.8 mm)	Elong, % in 1/2" (12.7 mm)	Location of Fracture
75 (24)	115.2 (794)	66.6 (456)	37.0	36.0	BM [1], HAZ [2]
800 (427)	80.2 (553)	33.5 (231)	37.5	—	BM
900 (482)	77.8 (536)	32.9 (227)	33.0	—	BM [2], HAZ [1]
1000 (538)	73.5 (507)	31.4 (216)	28.5	—	BM
1100 (593)	66.8 (461)	28.9 (199)	24.5	25.0	BM [1], HAZ [2]
1200 (649)	59.2 (408)	27.9 (192)	20.0	20.0	HAZ
1300 (704)	48.2 (332)	26.5 (183)	11.0	12.5	HAZ

*Average of Triplicate Tests
BM = Base Metal Failure
HAZ = Heat-Affected Zone
Number in [ ] = Number of Specimens

Welding Conditions

Current	90 amps	Shielding Gas	He (a) 40 cfh
Voltage	15-1/2	Wire Feed	16 ipm (400 mm/min)
Travel Speed	16 ipm (400 mm/min)	Wire Diameter	.062" (1.57 mm)

Armco NITRONIC 40 bar and wire is readily resistance welded (cross wire and butt welding) using conventional resistance welding equipment.

Machining

Machining tests indicate that cutting speeds for Armco NITRONIC 40 stainless steel will be somewhat lower than those for other austenitic stainless steels. This is due to the higher work-hardening rates and higher yield strength of Armco NITRONIC 40 stainless steel. The following table indicates comparable cutting rates of Armco NITRONIC 40, Type 304 and Type 316 stainless steels.

Table XVII
Cutting Rates of Armco NITRONIC 40

Machining Operation Single Point Turning	Cutting Rates In Surface Feet Per Minute (m/min) Armco NITRONIC 40	Cutting Rates In Surface Feet Per Minute (m/min) Type 304 Type 316
Carbide Tools		
Roughing	100-150 (30-45)	130-180 (39-54)
Finishing	150-200 (45-60)	150-300 (45-90
High Speed Steel Tools		
Roughing	40-60 (12-18)	60-90 (18-27)
Finishing	60-80 (18-24)	100-120 (30-36)

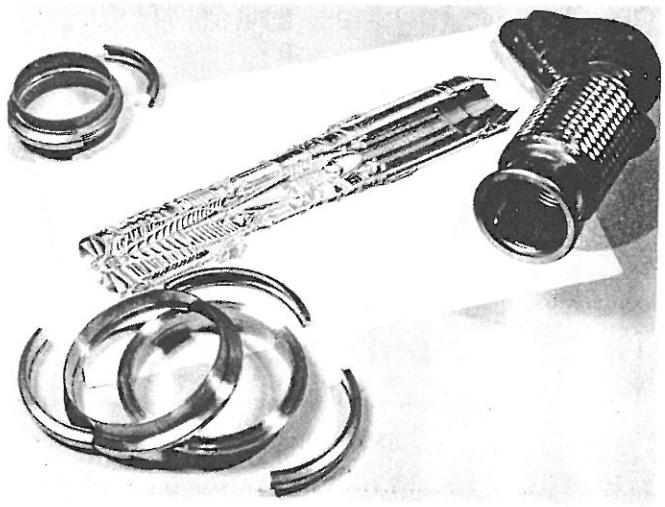
Forging

Armco NITRONIC 40 stainless steel is readily forgeable. It is recommended that products 4" (101.6 mm) and over in diameter or thickness be charged into furnaces operating at or below 1600 F (871 C). After charging, the material should be equalized at 2000 F (1093 C), followed by soaking for 20 minutes per inch of thickness at 2200 F (1204 C). Inherent good hot workability will allow the material to be forged to minimum forging temperature range of 1700-1800 F (927-982 C). Any reheating which is necessary should consist only of equalization at 2200 F (1204 C). On products under 4" (101.6 mm) in diameter or thickness, charging temperature is not critical and equalization at 2000 F (1093 C) may not be necessary. Depending upon the nature of the forging operation, it may be possible to use temperatures lower than 2200 F (1204 C) but the material does become stiff as the temperature drops during forging. Water quenching or air cooling after forging may be used.

Forming

Most fabricating techniques for Armco NITRONIC 40 stainless steel are similar to other austenitic stainless steels. It must be remembered, however, that Armco NITRONIC 40 stainless steel has approximately twice the yield strength of Type 304. This must be considered in choosing equipment for forming Armco NITRONIC 40 stainless steel.

The parts shown in the following photograph demonstrate the good fabricability of Armco NITRONIC 40 stainless steel. Most of them were made without in-process anneals or stress relieving.



SPECIFICATIONS

Armco NITRONIC 40 Bar and Wire is covered by the following specifications. Specifications are listed without the suffix indicating the revision. The issuing agency should be contacted for the latest revision of the specification.

Aerospace Materials Specification (Division of SAE)

AMS 5656 — Bar, Wire, Forgings and Rings

American Society for Testing and Materials (listed as Grades XM10 and XM11 [UNS S21900 and UNS S21904])

ASTM A 276 — Bars and Shapes

ASTM A 314 — Billets and Bars for Forging

ASTM A 479 — Bars and Shapes for Use in Boilers and Other Pressure Vessels

ASTM A 580 — Wire

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