Technical Datasheet

CarTech® Custom 630 Project 70®+ Stainless

Identification

UNS Number

- S17400

AISI Number

- 630

Type Analysis

Single figures are nominal except where noted.

Carbon (Maximum)	0.07 %	**Manganese (Maximum)**	1.00 %
Phosphorus (Maximum)	0.040 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	15.00 to 17.50 %
Nickel	3.00 to 5.00 %	**Copper**	3.00 to 5.00 %
Columbium + Tantalum	0.15 to 0.45 %	**Iron**	Balance

General Information

Description

CarTech Custom 630 Project 70+ Stainless (17Cr-4Ni) stainless is an improved-machining version of conventional Stainless Type 17Cr-4Ni.

This alloy is a martensitic precipitation/age-hardening stainless alloy offering high strength and hardness along with excellent corrosion resistance. It has good fabricating characteristics and can be age hardened by a single-step, low temperature treatment.

Customers have reported that CarTech Custom 630 Project 70+ stainless offers significantly improved machinability characteristics over generic stainless type 17Cr-4Ni. This includes up to 15% and higher machining speeds with improved finishes and longer tool life.

CarTech Custom 630 Project 70+ PDB® stainless combines the superior machinability of CarTech Project 70+ stainless with improved straightness and half-standard or ISO h9 dimensional tolerances. This drawn bar has been used successfully in a variety of machining operations including CNC Swiss-type screw machines.

Applications

CarTech Custom 630 Project 70+ stainless has been used for a variety of applications including oil field valve parts, chemical process equipment, aircraft fittings, fasteners, pump shafts, nuclear reactor components, gears, paper mill equipment, missile fittings, and jet engine parts.

Elevated Temperature Use

Project 70+ Custom 630 stainless shows excellent resistance to oxidation up to approximately 1100°F (539°C).

Long-term exposure to elevated temperatures can result in reduced toughness in precipitation hardenable stainless steels. The reduction in toughness can be minimized in some cases by using higher aging temperatures. Short exposures to elevated temperatures can be considered, provided the maximum temperature is at least 50°F (28°C) less than the aging temperature.

Corrosion Resistance

Project 70+ Custom 630 stainless has withstood corrosive attack better than any of the 400 series hardenable stainless steels, and, in most corrodents, its corrosion resistance closely approaches that of Stainless Types 302 and 304.

Good resistance to stress-corrosion cracking is gained by hardening at temperatures of 1025°F (552°C) and higher. The alloy also withstands erosion-corrosion well due to the combination of good corrosion resistance and high hardness.

The alloy has acceptable resistance to sulfide stress cracking at Rockwell C 33 maximum hardness per NACE MR-01-75, "Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment." Refer to the current document for details on acceptable conditions.

For optimum corrosion resistance, surfaces must be free of scale, lubricants, foreign particles, and coatings applied for drawing and heading. After fabrication of parts, cleaning and/or passivation should be considered.

Important Note: *The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Nitric Acid	Good	Sulfuric Acid	Restricted
Phosphoric Acid	Restricted	Acetic Acid	Moderate
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Good
Sea Water	Restricted	Sour Oil/Gas	Restricted
Humidity	Excellent		

Comparative Corrosion Rates–Project 70+ Custom 630 Stainless and Other Alloys
Mils Per Year

Corrodents	Type 410		Type 431		Project 70+ Custom 630		
	Hardened and Tempered 300°F (150°C)	Hardened and Tempered 1200°F (650°C)	Hardened and Tempered 500°F (260°C)	Hardened and Tempered 1200°F (650°C)	H 900	H 1025	H 1150
5 w/o H_2SO_4 at 75°F (24°C)	1732[(1)]	1218	1402[(1)]	2325[(1)]	2	3	14[(1)]
20 w/o HNO_3 at 200°F (93°C)	8	59[(2)]	3	3	2	2	2
50 w/o Acetic Acid Boiling	266[(1)]	1627	43[(1)]	54	3	3	4

Notes: Corrosion rates for one 48-hour period
(1) Several or all of subsequent 48-hour test periods showed nil rates.
(2) Rates increased to 200 mpy by 3rd 48-hour test period.

Properties

Physical Properties

Specific Gravity		
Condition A	7.75	
Condition H 1075	7.81	
Condition H 1150	7.82	
Condition H 900	7.80	
Density		
Condition A	0.2800	lb/in³
Condition H 900	0.2820	lb/in³
Condition H 1075	0.2820	lb/in³
Condition H 1150	0.2830	lb/in³
Mean Specific Heat		
32 to 212°F, Condition A	0.1100	Btu/lb/°F
32 to 212°F, Condition H 900	0.1000	Btu/lb/°F

Mean CTE		
70 to 200°F, Condition A	6.00	x 10^{-6} in/in/°F
70 to 400°F, Condition A	6.00	x 10^{-6} in/in/°F
70 to 600°F, Condition A	6.20	x 10^{-6} in/in/°F
70 to 800°F, Condition A	6.30	x 10^{-6} in/in/°F
-100 to 70°F, Condition H 900	5.80	x 10^{-6} in/in/°F
70 to 200°F, Condition H 900	6.00	x 10^{-6} in/in/°F
70 to 400°F, Condition H 900	6.10	x 10^{-6} in/in/°F
70 to 600°F, Condition H 900	6.30	x 10^{-6} in/in/°F
70 to 800°F, Condition H 900	6.50	x 10^{-6} in/in/°F
70 to 200°F, Condition H 1075	6.30	x 10^{-6} in/in/°F
70 to 400°F, Condition H 1075	6.50	x 10^{-6} in/in/°F
70 to 600°F, Condition H 1075	6.60	x 10^{-6} in/in/°F
70 to 800°F, Condition H 1075	6.80	x 10^{-6} in/in/°F
-100 to 70°F, Condition H 1150	6.10	x 10^{-6} in/in/°F
70 to 200°F, Condition H 1150	6.60	x 10^{-6} in/in/°F
70 to 400°F, Condition H 1150	6.90	x 10^{-6} in/in/°F
70 to 600°F, Condition H 1150	7.10	x 10^{-6} in/in/°F
70 to 800°F, Condition H 1150	7.20	x 10^{-6} in/in/°F
Thermal Conductivity		
300°F, Condition H 900	124.0	BTU-in/hr/ft²/°F
500°F, Condition H 900	135.0	BTU-in/hr/ft²/°F
860°F, Condition H 900	156.0	BTU-in/hr/ft²/°F
900°F, Condition H 900	157.0	BTU-in/hr/ft²/°F
Poisson's Ratio		
Condition H 900	0.272	
Condition H 1075	0.272	
Condition H 1150	0.272	
Modulus of Elasticity (E) (73°F, Condition H 900)	28.5	x 10^{3} ksi
Modulus of Rigidity (G)		
73°F, Condition H 900	11.2	x 10^{3} ksi
73°F, Condition H 1075	10.0	x 10^{3} ksi
73°F, Condition H 1150	10.0	x 10^{3} ksi
Electrical Resistivity		
73°F, Condition A	589.0	ohm-cir-mil/ft
73°F, Condition H 900	463.0	ohm-cir-mil/ft

Condition	A		H 900		H 1075		H 1150	
Specific gravity	7.75		7.80		7.81		7.82	
Density—lb/in³	0.280		0.282		0.282		0.283	
kg/m³	7750		7800		7810		7820	
Mean Specific Heat	Btu/lb•°F	J/kg•K	Btu/lb•°F	J/kg•K				
32 to 212°F (0 to 100°C)	0.11	460	0.10	419	—		—	
Electrical resistivity (RT)								
ohm-cir mil-ft	589		463		—		—	
microhm-mm	980		770		—		—	
Mean Coefficient of Thermal Expansion	10^{-6}/°F	10^{-6}/K	10^{-6}/°F	10^{-6}/K	10^{-6}/°F	10^{-6}/K	10^{-6}/°F	10^{-6}/K
-100 to 70°F (-73 to 21°C)	—	—	5.8	10.4	—	—	6.1	11.0
70 to 200°F (21 to 93°C)	6.0	10.8	6.0	10.8	6.3	11.3	6.6	11.9
70 to 400°F (21 to 204°C)	6.0	10.8	6.1	11.0	6.5	11.7	6.9	12.4
70 to 600°F (21 to 316°C)	6.2	11.2	6.3	11.3	6.6	11.9	7.1	12.8
70 to 800°F (21 to 427°C)	6.3	11.3	6.5	11.7	6.8	12.2	7.2	13.0

Thermal Conductivity		A	H 900		H 1075	H 1150
°F	°C		Btu-in/ft²•h•F	W/m•K		
300	149	—	124	17.9	—	—
500	260	—	135	19.5	—	—
860	460	—	156	22.5	—	—
900	482	—	157	22.6	—	—
Poisson's Ratio		—	0.272		0.272	0.272

Modulus of Elasticity and Rigidity—See Mechanical Properties.

Typical Mechanical Properties

Typical Creep Strength—Project 70+ Custom 630 Stainless

Condition H 900

Test Temperature		Stress for creep in 0.1% in 1000 hrs.		Stress for creep in 0.01% in 1000 hrs.	
°F	°C	ksi	MPa	ksi	MPa
600	316	135	931	125	862
700	371	105	724	100	689
800	427	60	414	43	296
900	482	23	159	—	—

Typical Cryogenic Charpy V-Notch Impact Strength–Project 70+ Custom 630 Stainless

Test Temperature		Impact Strength H 925		H 1025		H 1150		H 1150M			
°F	°C	ft-lb*	J	ft-lb*	J	ft-lb*	J	ft-lb*	J	ft-lb**	J
75	24	30	41	75	102	95	129	105	142	95	129
10	-12	16	22	58	79	93	126	—	—	85	115
-40	-40	9	12	40	54	76	103	—	—	75	102
-110	-79	5	7	15	20	48	65	—	—	65	88
-175	-115	—	—	—	—	—	—	—	—	35	47
-250	-157	—	—	—	—	—	—	—	—	18	24
-320	-196	3	4	4	6	6	8	28	38	5	7

*Test samples from 1" (25.4 mm) Rd. Bar—Longitudinal Direction
**Test samples from 4" (102 mm) Rd. Bar—Longitudinal Direction

Typical Cryogenic Tensile Properties—Project 70+ Custom 630 Stainless

Condition H 1100

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)
°F	°C	ksi	MPa	ksi	MPa	
75	24	135	931	150	1034	17
32	0	183	1262	193	1331	16
-40	-40	189	1303	203	1440	16
-80	-62	196	1351	209	1441	15
-320	-196	243	1675	248	1710	8

Typical Elevated Temperature Tensile Properties—Project 70+ Custom 630 Stainless

Condition H 900

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area
°F	°C	ksi	MPa	ksi	MPa		
RT	RT	183	1262	198	1365	15	52
600	316	145	1000	172	1186	13	46
800	427	132	910	160	1103	13	51
900	482	118	814	138	952	13	55
1000	538	94	648	115	793	17	64

Typical Room Temperature Mechanical Properties–Project 70+ Custom 630 Stainless

Condition	0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Hardness		Charpy V-Notch Impact Strength		Modulus of Rigidity (R)	
	ksi	MPa	ksi	MPa			Rock-well C	Brinell	ft-lb	J	ksi	MPa
A	–	–	–	–	–	–	36	352	–	–	–	–
H 900	183	1262	198	1365	15	52	44	420	16	21	11.2×10^6	77×10^6
H 1025	162	1117	168	1158	16	58	38	352	40	54	–	–
H 1075	148	1020	164	1131	17	59	36	341	45	61	10×10^6	69×10^6
H 1150	126	869	144	993	20	60	33	311	55	75	10×10^6	69×10^6
H1150M	87	600	123	848	22	66	29	293	100	136	–	–

Typical Stress Rupture Strength—Project 70+ Custom 630 Stainless

Condition	Test Temperature		Stress for rupture in			
			100 Hours		1000 Hours	
	°F	°C	ksi	MPa	ksi	MPa
H 900	625	329	162	1117	157	1082
H 1075	625	329	137	945	134	924
H 900	700	371	156	1076	150	1034
H 1075	700	371	126	869	123	848
H 900	800	427	140	965	128	883
H 1075	800	427	108	745	103	710

Heat Treatment

Project 70+ Custom 630 stainless is hardened by heating solution-treated material, Condition A, to a temperature of 900°F (482°C) to 1150°F (621°C) for one to four hours, depending on the temperature, then air cooling.

Solution Treatment

Condition A (Solution treated or annealed):
Heat at 1900°F (1038°C) ± 25°F (± 14°C) for 1/2 hour, cool to below 90°F (32°C) so that the material is completely transformed to martensite. Sections under 3" (76.2mm) can be quenched in a suitable liquid quenchant and sections over 3" (76.2mm) should be rapidly air cooled. Do not use this condition without age hardening due to susceptibility to stress-corrosion cracking.

Deformation (Size Change) in Hardening

The precipitation hardening of Project 70+ Custom 630 stainless is accomplished with a slight dimensional change. The amount of contraction in hardening solution-treated (Condition A) material to Condition H 900 is about 0.0004 to 0.0006 in./in. (m/m). Condition A material when hardened to Condition H1150 will contract approximately 0.0009 to 0.0012 in./in. (m/m).

Age

Condition H 900 (Precipitation or Age-Hardened):
Heat solution-treated material at 900°F (482°C) for 1 hour and air cool.

Condition H 925, H 1025, H 1075, H 1100, H 1150:
Heat solution-treated material at specified temperature ± 15°F (± 8°C) for 4 hours and air cool.

Condition H 1150M:
Heat solution treated material at 1400°F (760°C) ± 15°F (± 8°C) for 2 hours, air cool; then treat at 1150°F (621°C) ± 15°F (± 8°C) for 4 hours and air cool.

Workability

Hot Working

Project 70+ Custom 630 stainless (17Cr-4Ni) can be readily forged, hot headed and upset. Material that is hot worked must be solution treated prior to hardening if the material is to respond properly to hardening.

Forging

Heat uniformly to 2150/2200°F (1177/1204°C) and hold one hour at temperature before forging. Do not forge below 1850°F (1010°C). To obtain optimum grain size and mechanical properties, forgings should be cooled in air to below 90°F (32°C) before further processing. Forgings must be solution treated prior to hardening.

Cold Working

Project 70+ Custom 630 stainless can be fabricated by cold working to an extent which is limited to the high initial yield strength.

Machinability

Project 70+ Custom 630 stainless is readily machined in both the solution-treated and various age-hardened conditions. In the solution-treated condition, it machines similarly to Stainless Types 302 and 304. The machinability will improve as the hardening temperature is increased. Condition H 1150M provides optimum machinability.

Having procured Condition H 1150M for best machinability, higher mechanical properties can only be developed by solution treating and heat treating at standard hardening temperatures.

Typical Machining Speeds and Feeds—Project 70+ Custom 630 stainless

The speeds and feeds in the following charts are conservative recommendations for initial setup. Higher speeds and feeds may be attainable depending on machining environment.

Turning—Single-Point and Box tools

Depth of Cut (inches)	Micro-Melt® Powder HS Tools			Carbide Tools (inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed (fpm)		Feed (ipr)
					Uncoated	Coated	
Solution Treated							
.150 .025	M48, T15	90 105	.015 .007	C6 C7	375 425	475 560	.015 .007
Double-Aged H 1150-M							
.150 .025	M48, T15	90 105	.015 .007	C6 C7	375 425	475 560	.015 .007
Aged H 1150 H 1100 H 1075							
.150 .025	T15, M48	70 85	.015 .007	C6 C7	325 375	425 475	.015 .007
Aged H 1150 H 1100 H 1075							
.150 .025	T15, M48	70 85	.015 .007	C6 C7	325 375	425 475	.015 .007
Aged H 1025							
.150 .025	T15, M48	85 80	.015 .007	C6 C7	300 350	375 425	.010 .005
Aged H 900 H 925							
.150 .025	T15, M48	40 55	.010 .005	C6 C7	210 250	275 310	.010 .005

Turning—Cut-Off and Form Tools

Tool Material		Speed (fpm)	Feed (ipr)						
Micro-Melt® Powder HS Tools	Carbide Tools		Cut-Off Tool Width (inches)				Form Tool Width (inches)		
			1/16	1/8	1/4	1/2	1	1½	2
Solution Treated									
M48, T15		75	.001	.0015	.002	.0015	.001	.001	.0005
	C6	225	.003	.003	.004	.003	.002	.002	.002
Double-Aged H 1150-M									
M48, T15		100	.0015	.002	.0025	.002	.0015	.001	.001
	C6	250	.003	.003	.0045	.003	.002	.002	.002
Aged H 1075 H 1100 H 1150									
M48, T15		85	.001	.0015	.002	.0015	.001	.001	.0005
	C6	225	.003	.003	.0045	.003	.002	.002	.002
Aged H 1025									
T15, M48		45	.001	.001	.0015	.0015	.001	.001	.0005
	C6	150	.003	.003	.0045	.003	.002	.002	.002
Aged H 900 H 925									
T15, M48		35	.001	.001	.0015	.0015	.001	.001	.0005
	C6	125	.0025	.0025	.004	.0025	.0015	.0015	.0015

Rough Reaming

Micro-Melt® Powder HS Tools		Carbide Tools		Feed (ipr) Reamer Diameter (inches)					
Tool Material	Speed (fpm)	Tool Material	Speed (fpm)	1/8	1/4	1/2	1	1½	2
Solution Treated									
M48,T15	70	C7	200	.003	.005	.008	.011	.015	.018
Double-Aged H 1150-M									
M48,T15	75	C2	210	.003	.005	.008	.011	.015	.018
Aged H 1075 H 1100 H 1150									
M48,T15	55	C2	160	.003	.005	.008	.011	.015	.018
Aged H 1025									
M48,T15	45	C2	135	.003	.004	.006	.010	.013	.018
Aged H 900 H 925									
M48,T15	40	C2	110	.001	.001	.001	.001	.001	.001

Drilling

High Speed Tools									
Tool Material	Speed (ipr)	Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1½	2
Solution Treated									
M42	55	.001	.002	.004	.007	.008	.010	.012	.015
Double-Aged H 1150M									
M42	65	.001	.002	.004	.007	.009	.011	.013	.016
Aged H 1075 H 1100 H1150									
M42	50	—	.002	.004	.007	.008	.010	.012	.015
Aged H 1025									
M42	40	—	.002	.004	.006	.008	.009	.011	.012
Aged H 900 H 925									
M42	30	—	.001	.002	.003	.004	.004	.004	.004

Die Threading

FPM for High Speed Tools				
Tool Material	7 or less, tpi	8 to 15, tpi	16 to 24, tpi	25 and up, tpi
Solution Treated				
M2, M7, M10	7-13	10-18	12-25	18-30
Aged				
T15, M42	5-10	8-12	10-15	12-18

Milling, End—Peripheral

Depth of Cut (inches)	Micro-Melt® Powder HS Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (inches)				Tool Material	Speed (fpm)	Feed (ipt) Cutter Diameter (inches)			
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2
Solution Treated												
.050	M48, T15	90	.001	.002	.003	.004	C2	280	.001	.002	.004	.006
Double-Aged H 1150M												
.050	M48, T15	95	.001	.002	.003	.004	C2	290	.001	.002	.004	.006
Aged H 1075 H 1150												
.050	M48, T15	85	.001	.002	.003	.004	C2	275	.001	.002	.004	.006
Aged H 1025												
.050	M48, T15	70	.0005	.001	.002	.003	C2	200	.001	.002	.003	.004
Aged H 900 H 925												
.050	M48, T15	65	.0005	.001	.002	.003	C2	100	.001	.002	.003	.004

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
Solution Treated	
M7, M10	15-28
Double-Aged H 1150M	
M7, M10	17-32
Aged H 1075 H 1100 H 1150	
M7, M10	15-28
Aged H 1025	
M7, M10	15-22
Aged H 900 H 925	
M7, M10 Nitrided	7-17

Broaching

Micro-Melt® PowderTool Steels		
Tool Material	Speed (fpm)	Chip Load (ipt)
Solution Treated		
T15, M48	12	.002
Double-Aged H 1150M		
T15, M48	15	.002
Aged H 1075 H 1100 H 1150		
T15, M48	10	.002
Aged H 1025		
T15, M48	10	.002
Aged H 900 H 925		
T15, M48	10	.002

Additional Machinability Notes

The use of tool coatings is highly suggested, especially when machining this material in the aged hardened condition. TiCN and TiAlN are two suggestions. See your tool supplier for more information.

Figures used for all metal removal operations covered are starting points. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds or feeds should be increased or decreased in small steps.

This alloy is available in an enhanced precision drawn product. Learn more about the Project 70+ PDB stainless family at Carpenter's www.MachiningZone.com.

Weldability

Project 70+ Custom 630 stainless can be satisfactorily welded by the shielded fusion and resistance welding processes. Oxyacetylene welding is not recommended, since carbon pickup in the weld may occur. When a filler metal is required, AWS E/ER630 welding consumables should be considered to provide welds with properties matching those of the base metal. When designing the weld joint, care should be exercised to avoid stress concentrators, such as sharp corners, threads, and partial-penetration welds. When high weld strength is not needed, a standard austenitic stainless filler, such as E/ER308L, should be considered.

Normally, welding in the solution-treated condition has been satisfactory; however, where high welding stresses are anticipated, it may be advantageous to weld in the overaged (H 1150) condition. Usually, preheating is not required to prevent cracking.

If welded in the solution-treated condition, the alloy can be directly aged to the desired strength level after welded. However, the optimum combination of strength, ductility and corrosion resistance is obtained by solution treating the welded part before aging. If welded in the overaged condition, the part must be solution treated and then aged.

Other Information

Descaling (Cleaning)

Descaling following forging and annealing can be accomplished by acid cleaning or grit blasting. The acid treatment consists of 2 minutes in 50% by volume muriatic acid at 180°F (82°C), followed by 4 minutes in a mixture 15% by volume nitric acid, plus 3% by volume hydrofluoric acid at room temperature. Water rinse and desmut in 20% by volume nitric acid at room temperature. Repeat cleaning procedure as necessary but decrease the times by 50% (i.e., 1 and 2 minutes, respectively).

The heat tint from aging can be removed by polishing, vapor blasting or pickling 4 to 6 minutes in a mixture of 15% by volume nitric acid, plus 3% by volume hydrofluoric acid, followed by a water rinse. Repeat the acid cleaning procedure if necessary but decrease the time by 2 to 3 minutes. Desmut in 20% by volume nitric acid at room temperature.

After acid cleaning, bake 1 to 3 hours at 300/350°F (149/177°C) to remove hydrogen.

Applicable Specifications

- AMS 5643
- ASME SA564
- ASTM A564
- ASTM F899

Forms Manufactured

- Bar-Flats
- Bar-Hexagons
- Bar-Rounds
- Bar-Squares

Technical Articles

- An Evaluation of Alloys for Golf Club Face Plates
- How to Passivate Stainless Steel Parts
- Improved Stainless Steels for Medical Instrument Tubing
- New Ideas for Machining Austenitic Stainless Steels
- Passivating and Electropolishing Stainless Steel Parts
- Steels for Strength and Machinability

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