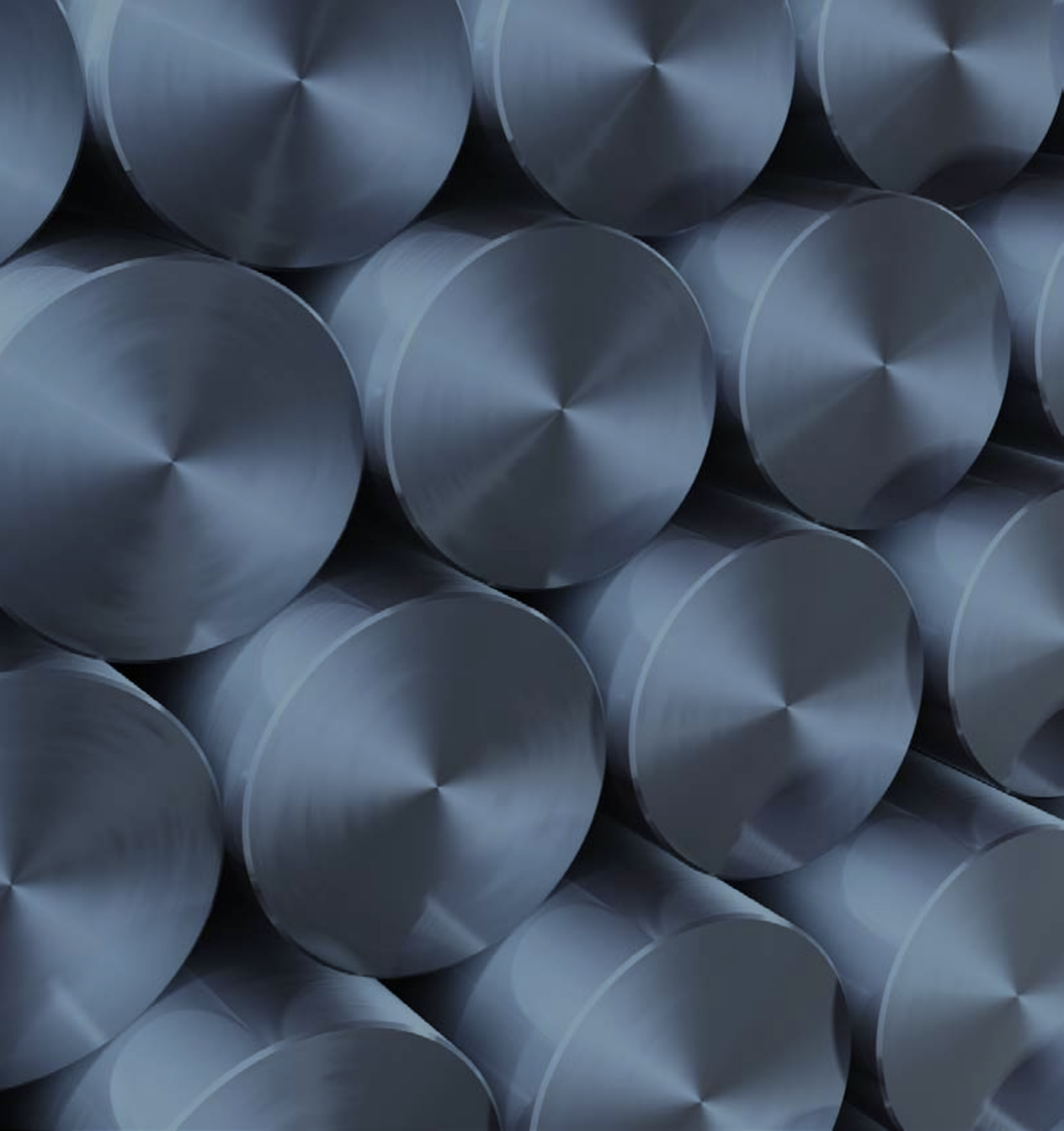
PARAGON STEEL

Resource Guide

PRECIPITATION HARDENING TYPES

WEIGHTS & TYPES



17-4 - AISI 630

Precipitation Hardening Stainless Bars and Billets

Color Markings

Ends painted Blue and Yellow

This is a chromium-nickel grade of stainless steel that may be hardened by a single low temperature precipitation-hardening heat treatment. Excellent mechanical properties at a high strength level may be obtained by such treatment. Scaling and distortion are minimized.

The strength and corrosion resistance properties of 17-4 hold up well in service temperatures up to 800°F.

Fabrications techniques for this steel are similar to those established for the regular stainless steel grades. This material machines well, has excellent welding characteristics and forges easily. The combinations of excellent mechanical and processing properties makes this grade adaptable to a wide variety of applications.

Analysis

C Max.	Mn Max.	P Max.	S Max.	Si Max.	Cr	Ni	Cu	Cb+Ta
.07	1.00	.04	.03	1.00	15.50/17.50	3.00/5.00	3.00/5.00	5xC/.45

Specifications

AMS-5643 and ASTM A 564 Type 630 are generally applicable.

Applications

Used where high strength and good corrosion resistance are required, as well as for applications requiring high fatigue strength, good resistance to galling, seizing and stress corrosion. Suitable for intricate parts requiring machining and welding, and/or where distortion in conventional heat treatment is a problem.

Corrosion Resistance

The corrosions resistance of 17-4 is superior to that of hardenable straight chromium grades such as Type 410. It approaches the corrosion resistance of the chromium nickel grades. In many corrosive media, it is equal to such grades as Type 302. Corrosion resisting properties will be affected by such conditions as surface finish and aging heat treatment.

Mechanical Properties

The following may be considered as average or typical room-temperature properties:

Condition	Tensile Strength (psi)	Yield Strength (psi)	Elongation in 2"	Reduction of Area	Rockwell "C" Hardness
A (Annealed)	150,000	110,000	10%	40%	34
H 900 (Hardened at 900º)	200,000	185,000	14%	50%	44
H 1150 (Hardened at 1150º)	145,000	125,000	19%	60%	33

AMS-5643 requires the following after precipitation heat treating at 900ºF:

Tensile Strength (psi)	Yield Strength (psi)	Elongation in 2"	Reduction of Area	
			3" Thick & Under	3" Thick to 8" Thick
190,000 Min.	170,000 Min.	10% Min.	40% Min.	35% Min.

Machinability

This grade has a machinability rating of 48% in the annealed condition (Condition A), with surface cutting speed of 80 feet per minute. In the over-aged condition (H 1150-M), the machinability rating is 76%, with surface cutting speed of 125 per minute.

Weldability

Readily weldable by all the commercial processes. Preheating and post-heating practices used for the standard hardenable stainless grades are not required.

Forging

Forge between 2050°F and 2150°F. Do not forge below 1850°F. Forgings are air cooled to 90°F or lower. Large or intricate forgings should be equalized at some temperature between 1900°F and the forging temperature before air-cooling.

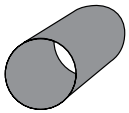
Annealing (Conditions A)

The annealing (solution treatment) temperature is 1900°F. Material under 3" in thickness may be oil quenched. Material over 3" thick should be air cooled. Maximum Brinell hardness on sections 3" is 341; over 3", 363.

Hardening

Condition H 900 -900°F for 1 hour, air cool. Rockwell “C” 44 Average.
Condition H 1025 -1025°F for 4 hours, air cool. Rockwell “C” 38 Average.
Condition H 1150 -1150°F for 4 hours, air cool. Rockwell “C” 33 Average.

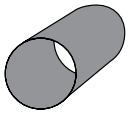
17-4 Rounds ~ Condition A or H 1150-M



Size in Inches	Est. Wt. Lbs.		Size in Inches	Est. Wt. Lbs.	
	Per Sq. Foot	12-Ft. Bar		Per Sq. Foot	12-Ft. Bar
	Ground			Ground (Contd.)	
1/8	.0418	.5012	3/8	5.053	60.64
5/32	.0653	.7831	7/16	5.523	66.28
3/16	.0940	1.128	1/2	6.014	72.17
7/32	.1279	1.535	9/16	6.526	78.31
1/4	.1671	2.005	5/8	7.058	84.70
9/32	.2114	2.537	11/16	7.612	91.34
5/16	.2610	3.132	3/4	8.186	98.23
11/32	.3158	3.790	13/16	8.781	105.4
3/8	.3759	4.510	7/8	9.397	112.8
13/32	.4411	5.293	15/16	10.03	120.4
7/16	.5116	6.139	**2**	10.69	128.3
15/32	.5873	7.048	1/16	11.37	136.4
1/2	.6682	8.019	1/8	12.07	144.8
9/16	.8457	10.15	1/4	13.53	162.4
19/32	.9423	11.31	5/16	14.29	171.5
5/8	1.044	12.53	3/8	15.08	180.9
11/16	1.263	15.16	7/16	15.88	190.6
3/4	1.504	18.04	1/2	16.71	200.5
13/16	1.765	21.17	5/8	18.42	221.0
7/8	2.046	24.56	11/16	19.31	231.7
15/16	2.349	28.19	3/4	20.21	242.6
1	2.673	32.07	7/8	22.09	265.1
1/16	3.017	36.21	15/16	23.06	276.8
1/8	3.383	40.59	**3**	24.06	288.7
3/16	3.769	45.23	1/8	26.10	313.2
1/4	4.176	50.12	1/4	28.23	338.8
5/16	4.604	55.25	3/8	30.45	365.3

Note: Stock Lengths 10' to 14'

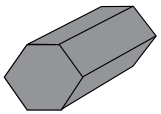
17-4 Rounds (Continued)



Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar	Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar
Ground (Contd.)			**Rough Turned (Contd.)**		
1/2	32.74	392.9	3/4	88.37	1060
5/8	35.12	421.5	**6**	96.22	1155
3/4	37.59	451.0	1/4	104.4	1253
4	42.77	513.2	1/2	112.9	1355
Rough Turned			**7**	131.0	1572
4 1/4	48.28	579.3	1/2	150.4	1804
1/2	54.13	649.5	**8**	171.1	2053
3/4	60.31	723.7	1/2	193.1	2317
5	66.82	801.9	**9**	216.5	2598
1/4	73.67	884.0	1/2	241.2	2895
1/2	80.86	970.2	**10**	267.3	3207

Note: Stock Lengths 10' to 14'

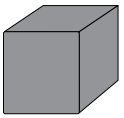
17-4 Hexagons ~ Condition A. Annealed & Cold Drawn



Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar	Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar
1/2	.7368	8.842	**1** 1/4	4.605	55.26
5/8	1.151	13.82	5/16	5.077	60.93
11/16	1.393	16.72	3/8	5.572	66.87
3/4	1.658	19.89	1/2	6.631	79.60
13/16	1.946	23.35	5/8	7.783	93.39
7/8	2.257	27.08	3/4	9.026	108.3
1	2.947	35.37	**2**	11.79	141.5
1/8	3.730	44.76	1/4	14.92	179.0

Note: Stock Lengths 10' to 14'

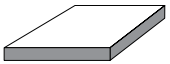
17-4 Squares ~ Hot Rolled, Annealed & Pickled



Size in Inches	Est. Wt. Lbs.		Size in Inches	Est. Wt. Lbs.	
	Per Sq. Foot	12-Ft. Bar		Per Sq. Foot	12-Ft. Bar
3/8	.4786	5.743	**2**	13.61	163.4
1/2	.8508	10.21	1/2	21.27	255.2
3/4	1.914	22.97	**3**	30.63	367.5
1	3.403	40.84	**4**	54.45	653.4
1/2	7.657	91.89			

Note: Stock Lengths 10' to 14'

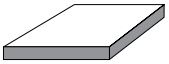
17-4 Flats ~ Hot Rolled, Annealed & Pickled



Size in Inches		Est. Wt. Lbs.		Size in Inches		Est. Wt. Lbs.	
		Per Sq. Foot	12-Ft. Bar			Per Sq. Foot	12-Ft. Bar
3/16 x	1/2	.3191	3.829		1	1.276	15.31
	1	.6381	7.657		1 1/2	1.914	22.97
	2	1.276	15.31		2	2.552	30.63
	3	1.914	22.97		2 1/2	3.191	38.29
1/4 x	1/2	.4254	5.105		3	3.829	45.94
	3/4	.6381	7.657		4	5.105	61.26
	1	.8508	10.21	1/2 x	3/4	1.276	15.31
	1 1/4	1.064	12.76		1	1.702	20.42
	1 1/2	1.276	15.31		1 1/2	2.552	30.63
	1 3/4	1.489	17.87		2	3.403	40.84
	2	1.702	20.42		2 1/2	4.254	51.05
	3	2.552	30.63		3	5.105	61.26
	4	3.403	40.84		4	6.806	81.68
3/8 x	1/2	.6381	7.657	5/8 x	1	2.127	25.52
	3/4	.9572	11.49		1 1/4	2.659	31.91

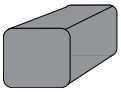
Note: Stock Lengths 10' to 14'

17-4 Flats (Continued)



Size in Inches			Est. Wt. Lbs.		Size in Inches			Est. Wt. Lbs.	
			Per Sq. Foot	12-Ft. Bar				Per Sq. Foot	12-Ft. Bar
5/8	x	1 1/2	3.191	38.29			3 1/2	11.91	142.9
		1 3/4	3.722	44.67			4	13.61	163.4
		2	4.254	51.05			5	17.02	204.2
5/8	x	3	6.381	76.57			6	20.42	245.0
		4	8.508	102.1	1 1/4	x	1 1/2	6.381	76.57
3/4	x	1	2.552	30.63			2	8.508	102.1
		1 1/4	3.191	38.29			4	17.02	204.2
		1 1/2	3.829	45.94	1 1/2	x	2	10.21	122.5
		2	5.105	61.26			2 1/2	12.76	153.1
		2 1/2	6.381	76.57			3	15.31	183.8
		3	7.657	91.89			4	20.42	245.0
		4	10.21	122.5	2	x	2 1/2	17.02	204.2
		5	12.76	153.1			3	20.42	245.0
		6	15.31	183.8			4	27.23	326.7
1	x	1 1/4	4.254	51.05	2 1/2	x	3	25.52	306.3
		1 1/2	5.105	61.26			4	34.03	408.4
		2	6.806	81.68	3	x	4	40.84	490.1
		2 1/4	7.657	91.89			5	51.05	612.6
		3	10.21	122.5					

Note: Stock Lengths 10' to 14'



17-4 Billets

Refer to Page 99

15-5 PH VAR

(Consumable Electrode Vacuum Arc Remelt)
Precipitation Hardening Stainless Bars and Billets

Color Markings

Ends painted Gold with Blue Stripe

15-5 PH VAR is a new improved version of the highly successful 17-4. It possesses the advantages of 17-4, in that high strengths can be developed by a single low temperature thermal treatment. In addition it offers excellent transverse toughness and ductility, better mechanical properties in larger sections and better forgeability.

The composition of 15-5 PH VAR results in an essentially ferrite-free microstructure, which accounts for the improved properties.

Fabrications practices for 15-5 PH VAR are generally the same as those established for 17-4.

15-5 PH VAR is produced as a consumable electrode vacuum arc remelted product. Where the ultimate in quality and uniformity of properties, and transverse notch toughness in particular, are required, this product is recommended.

Analysis

C Max.	Mn Max.	P Max.	S Max.	Si Max.	Cr	Ni	Cu	Cb-Ta
.07	1.00	.03	.015	1.00	14.00/15.50	3.50/5.50	2.50/4.50	.15/.45

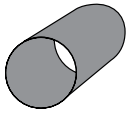
Specifications

Specification AMS 5659 is generally applicable.

Applications, Corrosion Resistance, Mechanical Properties & Fabrications

Similar to 17-4, for which see Page 85 of this section.

15-5 Var Rounds ~ Condition A. Annealed & Ground



Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar	Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar	Size in Inches	Est. Wt. Lbs. Per Sq. Foot	Est. Wt. Lbs. 12-Ft. Bar
3/8	.3759	4.510	3/8	5.053	60.64	**3**	24.06	288.7
7/16	.5116	6.139	1/2	6.014	72.17	1/4	28.23	338.8
1/2	.6682	8.019	5/8	7.058	84.70	1/2	32.74	392.9
5/8	1.044	12.53	3/4	8.186	98.23	3/4	37.59	451.0
11/16	1.263	15.16	7/8	9.397	112.8	**4**	42.77	513.2
3/4	1.504	18.04	**2**	10.69	128.3	1/2	54.13	649.5
7/8	2.046	24.56	1/8	12.07	144.8	**5**	66.82	801.9
1	2.673	32.07	1/4	13.53	162.4	6 1/4	104.4	1253
1/8	3.383	40.59	1/2	16.71	200.5			
1/4	4.176	50.12	3/4	20.21	242.6			

Note: Stock Lengths 10' to 13'

17-7 AISI 631

Precipitation Hardening Stainless Sheets, Plates, Billets

Color Markings (Billets)

Painted Brown and White

17-7 is a chromium-nickel stainless steel that has the easy-to-work advantages of the chromium-nickel stainless grades, and yet is capable of being hardened. In the annealed (Condition A) state, it has excellent fabricating properties, and it can be precipitation hardened by a simple heat treatment.

In the hardened condition, it possesses excellent mechanical properties both at room temperature and elevated temperatures up to 800°F.

Its corrosion resistance is definitely superior to that of the straight chromium grades, and in some environments, it approaches the chromium-nickel grades.

Analysis

C Max.	Mn Max.	P Max.	S Max.	Si Max.	Cr	Ni	Al
.09	1.00	.04	.03	1.00	16.0/18.0	6.50/7.75	.75/1.50

Specifications

The following specifications are generally applicable:

Sheets and Plates: MIL-S-25043, AMS-5528, AMS-5529

Billets: AMS-5644

Applications

17-7 is used for applications requiring high strength and corrosion resistance and/or good mechanical properties at temperatures up to 800°F. It lends itself to fabrication of intricate pars, because they may be formed, drawn or welded and then hardened with a minimum of distortion.

Corrosion Resistance

In the precipitation-hardened condition, the corrosion resistance of 17-7 is superior to such grades as Type 410. It is generally not quite as good as the Type 302. This applies to general atmospheric corrosion as well as corrosive chemical media, and such factors as aging heat treatment and surface condition have an effect.

Mechanical Properties (Sheets and Plates)

Condition	Tensile Strength (psi)	Yield Strength (psi)	Elongation in 2"	Rockwell Hardness
A (Annealed)	150,000 Max.	55,000 Max.	20% Min.	Rb 92 Max.
TH 1050	180,000 Min.	150,000 Min.	6% Min.	Rc 38 Min.
RH 950	210,000 Min.	190,000 Min.	5% Min.	Rc 44 Min.

Machinability

17-7 in Condition A has a machinability rating of approximately 45%, with 1212 rated as 100%. Surface cutting speed approaches 75 feet per minute. When machining material in the annealed condition, allowance must be made for dimensional changes occurring in heat treatment. When machining material in the hardened condition, lower speeds and more power are required.

Weldability

Easily welded by the arc and resistance techniques applicable to stainless steels. No preheating or other complex welding procedures are required. Excellent properties are obtained in weldments, and the choice of weld metal depends upon the properties desired at the weld.

Forming

17-7 in Condition A has good forming and drawing characteristics.

Forging

Heat to 2150°-2250°F, air cool.

Annealing (Conditions A)

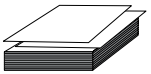
Heat to 1950°F ± 25° and air cool. For forgings, heat to 1900°F ± 25° and water quench.

Hardening

Condition TH 1050
Heat Condition A material to 1400°F and hold for 90 minutes. Cool to 60° within one hour and hold one-half hour. Heat to 1050°F and hold for 90 minutes. Cool in air to room temperature.

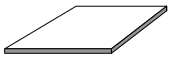
Condition RH 950
Heat Condition A material to Condition A 1750 by heating to 1750°F and holding for 10 minutes. Cool to -100°F and hold for 8 hours. Heat to 950°F and hold for one hour. Cool in air to room temperature.

17-7 SHEETS - No. 2D FINISH ~ Condition A
Dull Cold Rolled, Annealed, & Pickled

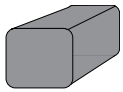


Thickness		Width & Length	Est Wt., Lbs. Per Sq. Ft.	Est Wt., Lbs. Per Sheet	Thickness		Width & Length	Est Wt., Lbs. Per Sq. Ft.	Est Wt., Lbs. Per Sheet
.0161"	(27 Ga.)	36x120	.676	20.3	**.071"**	(15 Ga.)	36x120	2.982	89.5
.020"	(25 Ga.)	36x120	.840	25.2	**.080"**	(14 Ga.)	36x120	3.360	100.8
.025"	(24 Ga.)	36x120	1.050	31.5	**.090"**	(13 Ga.)	36x120	3.780	113.4
.032"	(22 Ga.)	36x120	1.344	40.3	**.100"**	(12 Ga.)	36x120	4.200	126.0
.036"	(20 Ga.)	36x120	1.512	45.4	**.125"**	(11 Ga.)	36x120	5.250	157.5
.040"	(20 Ga.)	36x120	1.680	50.4	**.140"**	(10 Ga.)	48x120	5.880	235.2
.045"	(19 Ga.)	36x120	1.890	56.7			48x144	5.880	281.2
.050"	(18 Ga.)	36x120	2.100	63.0	**.160"**	(9 Ga.)	36x120	6.720	201.6
.063"	(16 Ga.)	36x120	2.646	79.4					

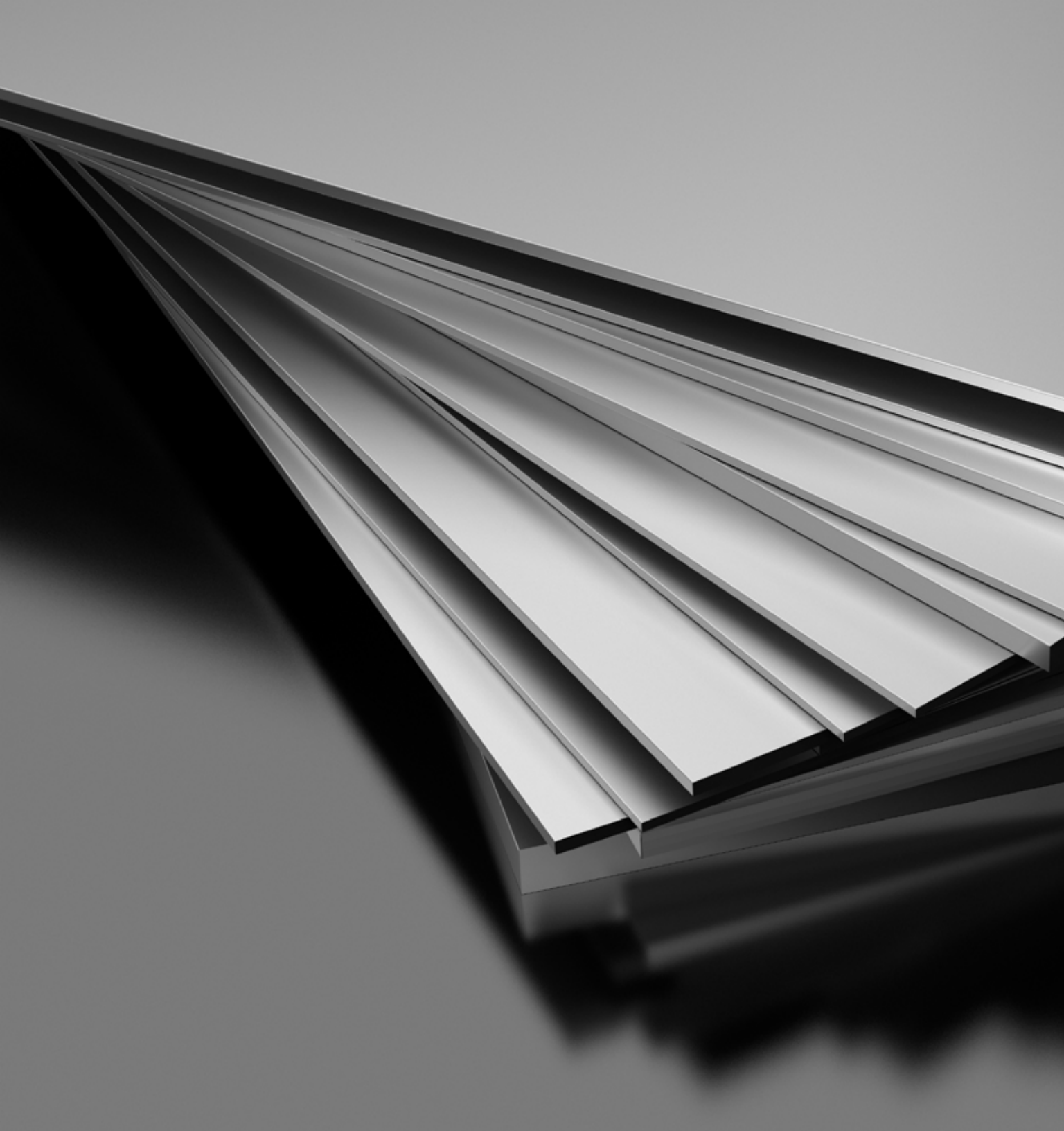
17-7 PLATES ~ Condition A. H.R., Ann. & Pickled



Size in Inches		Estimated Weight, Lbs. Per Sq. In.	Per. Sq. Ft.	Per Plate	Size in Inches		Estimated Weight, Lbs. Per Sq. In.	Per. Sq. Ft.	Per Plate
3/16 x	36x120	.0596	8.579	257.37	3/8 x	36x120	.1146	16.469	494.88
	48x120	"	"	343.16		48x120	"	"	659.84
	72x240	"	"	1029	1/2 x	36x120	.1504	21.663	649.89
1/4 x	36x120	.0775	11.162	334.86		48x120	"	"	866.52
	48x120	"	"	446.48		72x240	"	"	2600
	72x240	"	"	1339		96x240	"	"	3466
5/16 x	36x120	.0955	13.749	412.38	5/8 x	36x120	.1863	26.831	804.93
	48x120	"	"	549.88		48x120	"	"	1073



17-7 Billets
Refer to Page 99



PARAGON
STEEL

7405 E Slauson Ave, Commerce, CA 90040
(562) 216-4000
Toll Free: 800-388-8998
www.paragonsteel.com