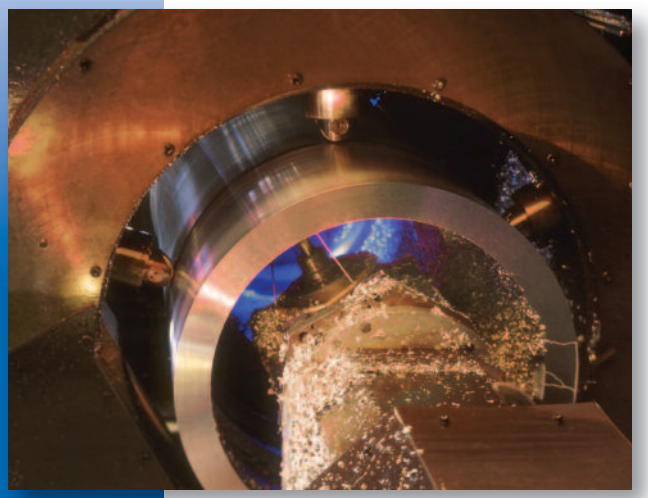
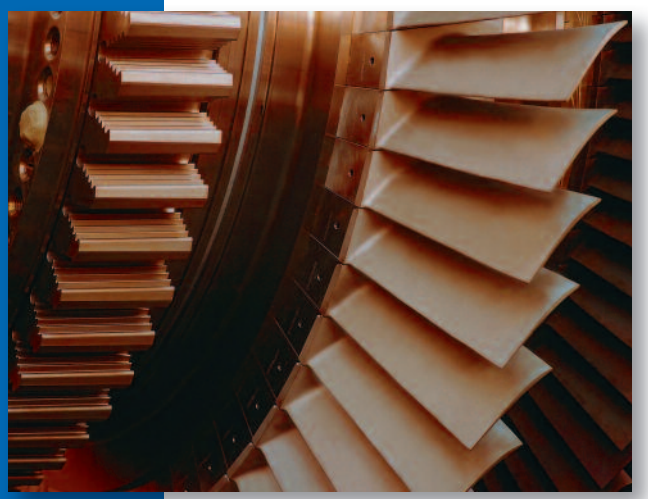
Castle Metals®





Stainless Steel Bars

Quik Guide

Your foremost provider of specialty products, services and solutions

Quik Guide to

TYPE	AISI GRADE Unified Numbering System (UNS)	SPECIFICATION[3] AMS	ASTM	ASME	QQS	CHARACTERISTIC AND TYPICAL APPLICATION[3]	COMPOSITION %[2] Chromium	Nickel	Carbon	Manganese	Sulfur	Others[4]
AUSTENTIC	303 (S30300) Available in CMQ® [17]	5640	A-484 A-582	—	764	Free-machining modification of Type 302/304, for heavier cuts. Screw machine products; shafts; valves; bolts; bushings; nuts.	17.00-19.00	8.00-10.00	.15	2.00	.15 Min.	—
	304[5] (S30400) Available in CMQ® [17]	5639	A-484 A-182 A-276 A-479	SA-182 SA-479	763	Low-carbon modification of Type 302 for restriction of carbide precipitation during welding. Chemical and food processing equipment; brewing equipment; cryogenic vessels; gutters; downspouts; flashings.	18.00-20.00	8.00-10.50	.08	2.00	.03	—
	304-L (S30403) Available in CMQ® [17]	5647	A-182 A-479 A-193 A-484 A-276	SA-182 SA-193 SA-479	763	Extra-low-carbon modification of Type 304 for further restriction of carbide precipitation during welding. Coal hopper linings; tanks for liquid fertilizer and tomato paste.	18.00-20.00	8.00-12.00	.03	2.00	.03	—
	316[5] (S31600) Available in CMQ® [17]	5648	A-182 A-484 A-276 A-193 A-479	SA-182 SA-479 SA-193	763	Higher corrosion resistance than Types 302 and 304; high creep strength. Chemical and pulp handling equipment; photographic equipment; brandy vats; fertilizer parts; ketchup cooking kettles; yeast tubs.	16.00-18.00	10.00-14.00	.08	2.00	.03	Mo 2.00-3.00
	316-L[5] (S31603) Available in CMQ® [17]	5653	A-182 A-484 A-276 A-193 A-479	SA-182 SA-479 SA-193	763	Extra-low-carbon modification of Type 316. Welded construction where intergranular carbide precipitation must be avoided. Type 316 applications requiring extensive welding.	16.00-18.00	10.00-14.00	.03	2.00	.03	Mo 2.00-3.00
	321 (S32100)	5645	A-182 A-193 A-276 A-479	SA-182 SA-479 SA-193		Stabilized for weldments subject to sever corrosive conditions, and for service from 800 to 1600 F. Aircraft exhaust manifolds; boiler shells; process equipment; expansion joints; cabin heaters; fire walls; flexible couplings; pressure vessels.	17.00-19.00	9.00-12.00	.08	2.00	.03	Ti 5X (C+N) Min. to 0.70 Max.
	347 (S34700)	5646	A-182 A-193 A-276 A-479	SA-182 SA-193 SA-479	763	Similar to Type 321 with higher creep strength. Airplane exhaust stacks; welded tank cars for chemicals; jet engine parts.	17.00-19.00	9.00-13.00	.08	2.00	.03	Cb +Ta 10XC Min.
	316 Pump Shaft (S31600)	5648	A-276 A-479	—	763	Pump shaft quality bar is manufactured with special surface finish, close diameter tolerance, controlled mechanical properties and precision straightness.	16.00-18.00	10.00-14.00	.08	2.00	.03	Mo 2.00-3.00
	UNS (S20910) (XM-19)	5764	A-193 Grade B8R A-276 Grade XM-19 A-479 Grade XM-19	—	—	NITRONIC 50® bars offer an excellent combination of high strength and corrosion resistance. This austentic stainless steel has corrosion resistance better than Type 316 and 317, plus almost twice the yield strength of those grades.	20.50-23.50	11.50-13.50	.06	4.00-6.00	.03	N .20-.40 Mo 1.5-3.0 Cb .10-.30 V .10-.30
	NITRONIC 50® [15] High Strength (S20910)	5764 (Chem Only)	A-193 Grade B8R (Chem Only) A-276 Grade XM-19 A-479 Grade XM-19	—	—	NITRONIC 50® bars in the HS condition feature extremely high tensile and yield strength properties. These high mechanical properties are accomplished through cold working at the producing mill.	20.50-23.50	11.50-13.50	.06	4.00-6.00	.03	N .20-.40 Mo 1.5-3.0 Cb .10-.30 V .10-.30
	UNS (S21800)	5848	A-193 Grade B8S A-276 A-479	—	—	NITRONIC 60® is an economical galling and wear resistant stainless steel. Better corrosion resistance than Type 304 and superior pitting resistance to Type 316 plus twice the yield strength of Type 304.	16.00-18.00	8.00-9.00	.10	7.00-9.00	.03	Si 3.50-4.50 N .08-.18

Stainless Steel Bars

TYPICAL MECH. PROPERTIES					SIZE RANGE—INCHES						TYPE
Tensile 10^3 P.S.I.	Yield 10^3 P.S.I. .2% Offset	Elongation % 2 in.	Reduction in Area %	Hardness Brinell	Rounds	Hexagons	Squares	Flats	Angles	AISI TYPE Unified Numbering System (UNS)	
90	35	50	55	160	5/64–10	3/16–3	3/16–2	—	—	303 (S30300)	AUSTENTIC
85	35	60	70	170	3/32–20	3/8–3	1/4–2	T 1/8–1 W 1/2–6	T 1/8–3/8 W 3/4–4	304[5] (S30403)	
75	30	60	70	160	3/16–20	—	—	—	—	304-L (S30403)	
80	35	55	65	170	1/8–20	7/16–2-1/2	3/16–1-1/2	T 3/16–1 W 1–4	T 1/8–3/8 W 1–3	316[5] (S31600)	
75	30	55	65	160	3/16–20	—	—	T 3/16–1 W 1–4	T 1/8–3/8 W 1–4	316-L[5] (S31603)	
85	35	55	65	150	1/4–6	—	—	—	—	321 (S32100)	
90	30	50	65	170	1/8–5-1/2	—	—	—	—	347 (S34700)	
75	30	30	40	149	3/4–3-7/16	—	—	—	—	316 Pump Shaft (S31600)	
100	55	35	55	—	3/4–6	—	—	—	—	UNS (S20910) (XM-19)	
135	105	20	50	—	1-1/4–2	—	—	—	—	NITRONIC 50® [15] High Strength (S20910)	
95	50	35	55	—	1-1/4–4	—	—	—	—	UNS (S21800)	

(15) NITRONIC 50®, NITRONIC 60® are registered trademarks of AK Steel.

(16) SANMAC® is a registered trademark of SANDVIK Steel.

(17) Some Chemical and Mechanical properties may differ contact your sales representative for clarification.

Quik Guide to

TYPE	AISI GRADE Unified Numbering System (UNS)	SPECIFICATION[3] AMS	ASTM	ASME	QQS	CHARACTERISTIC AND TYPICAL APPLICATION[3]	COMPOSITION %[2] Chromium	Nickel	Carbon	Manganese	Sulfur	Others[4]
MARTENSITIC	**410** (S41000)	2303 5612 5613	A-276 A-314 A-479 A-193	SA-479 SA-193	763	General purpose heat treatable type. Machine parts; pump shafts; bolts; bushings; coal chutes; cutlery; fishing tackle; hardware; jet engine parts; mining machinery; rifle barrels; screws; valves.	11.5-13.50	—	.15	1.00	.03	—
	410 Quench & Dbl Temp.		A-484 API 6A NACE MR-01-91			Quenched and doubles tempered form of 410 for parts used in hydrogen sulfide.	11.5-13.50	—	.15	1.00	.03	—
	416[6] (S41600) Available in CMQ® [17]	5610	A-484 A-582	—	764	Free-machinery modification of type 410; for heavier cuts. Aircraft fittings; bolts; nuts; fire extinguisher inserts; rivets; screws.	12.00-14.00	—	.15	1.25	.15 Min.	—
	416HT (S41600)	5610	A-484 A-582	—	764	Pre-hardened 416 for finished machine parts Rc26-32.	12.00-14.00	—	.15	1.25	.15 Min.	—
	440C (S44004)	5630	A-276	—	763	Yields highest hardnesses of hardenable stainless steels. Balls; bearings; races; nozzles; balls and seats for oil well pumps; valve parts.	16.00-18.00	.75	.95-1.20	1.00	.03	Mo .40–.65 Cu. 50
	440C BQ[7] (S44004)	5630 5880	A-276 A-756	—	763	Martensitic stainless with high strength, corrosion resistance and hardness obtained by low temperature heat treatment. Gear; cams; cutlery; shafting; aircraft parts.	16.00-18.00	.75	.95-1.20	1.00	.03	Mo .40–.65 Cu. 50
	416 Pump Shaft (S41600)	5610	A-582	—	—	Pump shaft quality bar is manufactured with special surface finish, close diameter tolerance, controlled mechanical properties and precision straightness.	12.00-14.00	—	.15	1.25	.15 Min.	—
	420 Modified	—	A-370 E-23 E-112 A484	—	—	420 modified is an API 6A approved 13% chromium martensitic stainless steel intended for use in structural and pressure containing oil tool parts used in CO2 environments.	12.50-14.00	.20	.18-.22	1.00	.005	—
DUPLEX	**2205** (S31803)	—	A-182 A-276	SA-182	—	2205 is a duplex (austentic-ferritic) stainless steel possessing high strength and good resistance to stress corrosion used for heat exchangers, oil and gas industry equipment.	21.00-23.00	4.50-6.50	.03	2.00	.02	—
PRECIPITATION HARDENING	**13Cr-8Ni**[7] (S13800)	5629 2300	A-564 (Grade XM-13)	—	—	High strength, ductility and toughness both longitudinally and transversely. Excellent general corrosion resistance as well as high degree of resistance to stress corrosion cracking. Aircraft structural components, landing gear parts, shafts, valves, fittings, fasteners and petrochemical applications.	12.25-13.25	7.5-8.5	.05	.20	.008	P .010 Al .90-1.35 Mo 2.00–2.50
	15Cr-5Ni[7] (S15500)	2300 5659	A-564 (Grade XM-12)		—	Martensitic stainless with high strength, corrosion resistance and hardness obtained by low temperature heat treatment. Gear; cams; cutlery; shafting; aircraft parts.	14.00-15.5	3.50-5.50	.07	1.00	.03	Cu 2.50-4.50 Cb+Ta .15–.45
	17Cr-4Ni[7] (S17400) Cond. A Available in CMQ® [17]	2303 5643	A-564 (Type 630)	SA-564 (Type 630)	—	Similar to 15Cr–5Ni, but with slightly higher chromium content. Gears; springs; cutlery; fasteners; aircraft and turbine parts.	15.00-17.5	3.00-5.00	.07	1.00	.03	Cu 3.0-5.0 Cb+Ta .15–.45
	17Cr-4Ni H1150 (S17400)	5643 2303	A-564 (Type 630)	SA-564 (Type 630)	—	Age-hardened 17Cr–5Ni H1150 offers superior machinability when compared to condition A 17Cr–4Ni. Buying this product in the age-hardened condition also saves the time and additional expense of sending parts out for heat treatment.	15.00-17.50	3.00-5.00	.07	1.00	.03	Cu 3.0-5.0 Cb+Ta .15–.45
	17Cr-4Ni Double-Aged H1150 (S17400)	5643[8]	A-564 (Type 630) API 6A NACE MR-01-91	SA-564 (Type 630)	—	It is solution annealed and then double age-hardened. Use in oil field valves, pump shafts, paper mill equipment gears.	15.00-17.50	3.00-5.00	.07	1.00	.03	Cu 3.0-5.0 Cb+Ta .15–.45

(1) Castle's stainless is ordered to these specifications, however there are some restrictions by size, shape, and availability. Give us your specifications to properly service your needs.

(2) All values are maximum except as noted.

(3) This column is provided for your convenience. A.M. Castle & Co. cannot and does not make recommendations of type or grade of material for end use. Proper selection of material for proposed end use is our customer's responsibility.

(4) Abbreviations:

Cb–Columbium
Cu–Copper
Mo–Molybdenum
N–Nitrogen
S–Sulfur
Ta–Tantalum
Ti–Titanium
WQ–Water Quench
AC–Air Cool
O–Oil Quench
L–Longitudinal
T–Transverse

Stainless Steel Bars

TYPICAL MECH. PROPERTIES					SIZE RANGE—INCHES						TYPE
Tensile 10^3 P.S.I.	Yield 10^3 P.S.I. .2% Offset	Elongation % 2 in.	Reduction in Area %	Hardness Brinell	Rounds	Hexagons	Squares	Flats	Angles	AISI TYPE Unified Numbering System (UNS)	
75	40	35	70	155	1/2–7-1/2	—	—	—	—	**410** (S41000)	AUSTENTIC
100	80	17	35	241 Max.	2–15	—	—	—	—	**410** Quench & Dbl Temp.	
75	40	30	60	155	3/32–6-1/2	3/8–2	3/16–2	—	—	**416**(6) (S41600)	
—	—	—	—	—	1/4–7	—	—	—	—	**416HT** (S41600)	
110	65	14	25	230	1/4–8	—	—	—	—	**440C** (S44004)	
—	—	—	—	—	1/2–6	—	—	—	—	**440C BQ**(7) (S44004)	
100	85	20	46	262	5/8–3-7/16	—	—	—	—	**416 Pump Shaft** (S41600)	
100	80	20	40	241	3-1/4–9	—	—	—	—	**420 Modified**	
90	65	25	—	290	1–10	—	—	—	—	**2205** (S31803)	DUPLEX
160	120	17	65	300	1/2–4	—	—	—	—	**13Cr-8Ni**(7) (S13800)	PRECIPITATION HARDENING
160	145	15	—	332	1/4–8	—	—	—	—	**15Cr-5Ni**(7) (S15500)	
—	—	—	—	332	3/16–20	—	—	—	T 3/8–3 W 1–4	**17Cr-4Ni**(7) (S17400)	
160	145	15	—	311	1/2–8	—	—	—	—	**17Cr-4Ni** H1150 (S17400)	
130	105	16	50	310	1/2–9	—	—	—	—	**17Cr-4Ni** Double-Aged H1150 (S17400)	

(5) Edge conditioned flats chemical and mechanical properties to apply.
(6) Also stocked as pump shafting.
Tensile strength 90/120,000 P.S.I.
Yield Strength 70,000 P.S.I. min.
Hardness—Approximately Brinell 207/245
(7) Mechanical properties are typical for solution treated condition. (Cond. A)
(8) Chemistry only.
(9) This section of 300 Series marked WQ (AC) are usually air cooled to minimize distortion, heavier section water quenched.
(10) Charpy V Notch.
(11) Solution treating temperature.
(12) Available 17Cr–4Ni Single Aged H1150.
(13) Properties are longitudinal and transverse direction except where indicated.
(14) Properties are taken longitudinal, transverse properties on 15Cr–5Ni are similar for tensile and yield strength.

Precipitation Hardening Grades

Unique alloys which offer corrosion resistance that approaches Type 304. The general corrosion resistance is greatest in the fully hardened condition. The alloys can obtain a wide range of mechanical properties with low temperature precipitation hardening (aging).

Typical Mechanical Properties

	13Cr-8Ni[13]							15Cr-5Ni						
	RH950	**H950**	**H1000**	**H1050**	**H1100**	**H1150**	**H1150M**	**H900**	**H1025**	**H1075**	**H1100**	**H1150**	**DBL H1150**	**H1150M**
Tensile x 10^3 P.S.I.	235	225	215	190	160	145	130	200	170	165	150	145	130	125
Yield x 10^3 P.S.I. 2% Offset	215	210	205	180	150	105	85	185	165	150	135	125	105	85
Elongation % in 2"	12	12	13	15	18	20	22	14	15	16	17	19	20	22
Reduction in Area %	[4] L-45 [4] T-35	[4] L-50 [4] T-40	[4] L-55 [4] T-50	55	60	63	70	50	56	58	58	60	64	68
Impact Value Charpy V Notch Ft.–lb.	20	30	40	60	100	110	120	20	35	40	45	50	—	100
Hardness Brinell	453	443	422	400	336	310	273	420	352	341	332	311	—	277

Precipitation Hardening Treatment

Alloy	Condition	Aging Temperature °F	Time at Temperature (Hrs.)	Method of Quench
13Cr-8Ni		All Temp. ±10°F		
	RH950*	950	4	Air Cool
	H950	950	4	Air Cool
	H1000	1000	4	Air Cool
	H1050	1050	4	Air Cool
	H1100	1100	4	Air Cool
	H1150	1150	4	Air Cool
	H1150M	1400	2	Air Cool
		Plus		
		1150	4	Air Cool
15Cr-5Ni		All Temp. ±15°F		
17Cr-4Ni	H900	900	1	Air Cool
	H925	925	4	Air Cool
	H1025	1025	4	Air Cool
	H1075	1075	4	Air Cool
	H1100	1100	4	Air Cool
	H1150	1150	4	Air Cool
	DBL H1150	1150	4	Air Cool
		1150	4	Air Cool
	H1150M	1400	2	Air Cool
		1150	4	Air Cool

* Within 24 hours of solution treatment, cool to -100°F for two hours minimum, air warm and age as shown.

Stainless Bar
Minimum Recommended Stock Removal

Cold Drawn;	**Rounds - Hexagons - Squares**
Up to & Incl. 5/16"	.003 per side except 440-C
Over 5/16"	1% of Diameter per Side

Centerless Ground:
All Ground **Defect Free** within the Standard Size Tolerances
Example: 1-1/2" Rd. TOL is ±.003
Material must not have any defect under –.003

Rough Turned:
All "R.T." sizes are produced on the plus side.
Material must be defect free on size.
Example: 5" Rd. HR-RT must be defect free at 5"

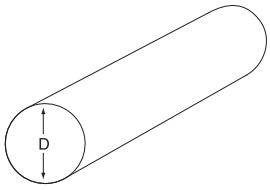
HR-A&P Flats & Squares and Cold Drawn Flats
Recommended Machining Allowances

(B) Removal From Thickness		Each Surface Specified Thickness (D) (Inches)			
(A) SPECIFIED WIDTH	1/8-1/2"	1/2-1"	1-2"	2-3"	(C) REMOVAL FROM WIDTH-EACH SURFACE
Up to 1" Incl.	.008	.010	—	—	.015
Over 1-2" Incl.	.012	.015	.031	—	.031
Over 2-3" Incl.	.015	.020	.031	.047	.047
Over 3-4" Incl.	.015	.020	.031	.047	.062
Over 4-6" Incl.	.015	.020	.031	—	.093

(A) Select the "Width" first and then read across to:
(B) Select the reading–this is the stock removal for the thickness per side
(C) Continue across on same line for the readings for width
(D) As measured form the minimum of the tolerance

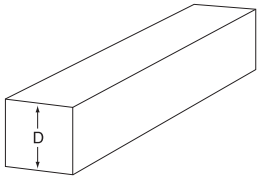
Stainless Bar
Weight Formulas

ROUNDS



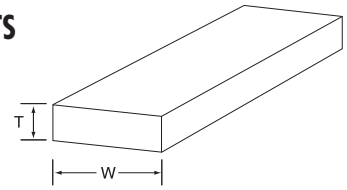
Lbs. per lineal foot = $2.67036 \times D^2$

SQUARES



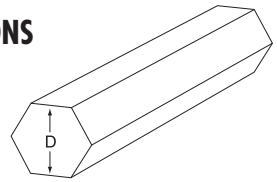
Lbs. per lineal foot = $3.4 \times D^2$

FLATS



Lbs. per lineal foot = 3.4 x T x W

HEXAGONS



Lbs. per lineal foot = $2.9446 \times D^2$

TOLERANCES-STAINLESS STEEL FLAT BARS

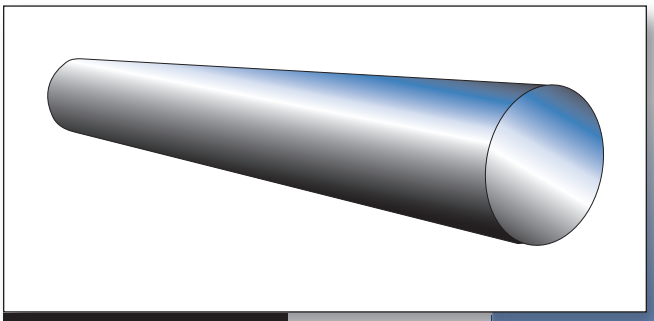
HOT ROLLED FLATS						EDGE CONDITIONED FLATS		
Thickness Variation	SPECIFIED WIDTHS					Thickness Specified	Thickness Tolerance	Width Tolerance
	To 1" Incl.	Over 1" to 2"	Over 2" to 4"	Over 4" to 6"	Over 6" to 8"			
1/8 – 1/2	± .008	± .012	± .015	± .015	± .016	*1/8"	±.010	+.030 –.000
Over 1/2 to 1 Incl.	± .010	± .015	± .020	± .020	± .025	*3/16"	+.020 –.010	+.030 –.000
Over 1 to 2 Incl.	—	± .031	± .031	± .031	± .031	*1/4"	+.020 –.010	+.030 –.000
Width Variation						3/8"	+.060 –.010	+.0625 –.000
Over	.015	.031	.062	.093	.125	1/2"	+.060 –.010	+.125 –.000
Under	.015	.031	.031	.062	.156			

Tolerances–Stainless Steel Bars

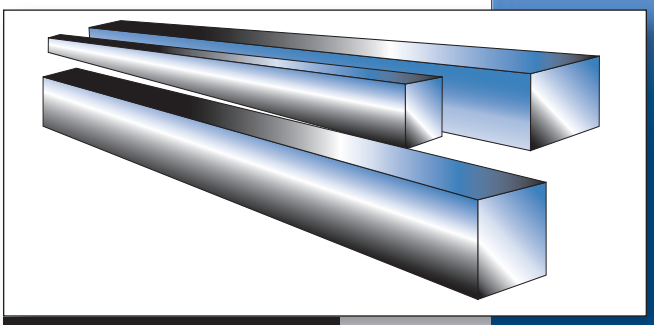
ROUNDS–COLD FINISHED	
Under 5/16	±.001
5/16 to Under 1/2	±.0015
1/2 to Under 1	±.002
1 to Under 1-1/2	±.0025
1-1/2 to 4 Incl.	±.003
Over 4 to 4-1/2 Incl.	±.005
Over 4-1/2 to 6 Incl.	±.008

ROUNDS–HOT ROLLED & ROUGH TURNED		
		Out of Rd.
Over 2 to 2-1/2	+1/32 –0	0.23
Over 2-1/2 to 3-1/2	+3/64 –0	.035
Over 3-1/2 to 4-1/2	+1/16 –0	.046
Over 4-1/2 to 5-1/2	+5/64 –0	.058
Over5-1/2 to 6-1/2	+1/8 –0	.070
Over 6-1/2 to 8	+5/32 –0	.085
Over 8 to 12	+3/16 –0	.093
Over 12 to 15	+7/32 –0	.109
Over 15 to 20	+1/4 –0	.125

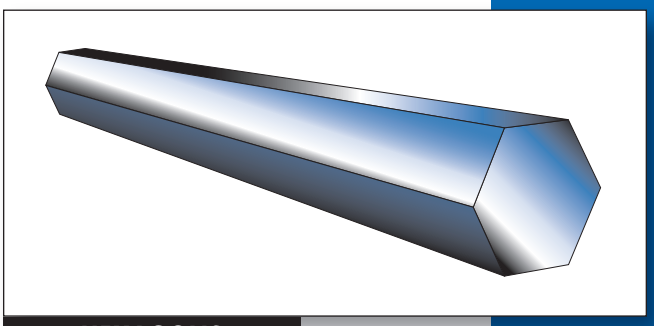
SQUARE AND HEXAGON–COLD FINISHED	
Under 5/16	±.000–.002
5/16 to Under 1/2	±.000–.003
1/2 to 1 Incl.	±.000–.004
Over 1 to 2 Incl.	±.000–.006
Over 2 to 3 Incl.	±.000–.008
Over 3	±.000–.011



ROUNDS



SQUARES



HEXAGONS

PUMP SHAFT QUALITY		
	Diameter Over	Tolerance Under
3/4 to Under 1	+.000	–.002
1 to Under 1-1/2	+.000	–.0025
1-1/2 to 4 Incl.	+.000	–.003
Over 4 to 4-1/2	+.000	–.005
Over 4-1/2 to 5 Incl.	+.000	–.008

STRAIGHTNESS TOLERANCE

Hot Finished
1/8 Inch in Any 5 Ft.,
But May Not Exceed
$1/8 \times \frac{\text{No. of Feet in Length}}{5}$

Cold Finished
1/16 Inch in Any Ft.,
But May Not Exceed
$1/16 \times \frac{\text{No. of Feet in Length}}{5}$

PUMP SHAFTING

.005 TIR n 3 ft. Plus .0015 TIR for Each Ft. Over 3 Ft.

*Straightness is a Perishable Tolerance and Will be Maintained Only on Product of a Full Stock Box.

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