



GENERAL INFORMATION

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AEROSPACE MATERIALS SPECIFICATIONS (Commonly Requested by Airframe & Missile Mfgs.)

AMS-2300	Magnetic Inspection Procedure Premium Aircraft Quality (Vac. Melt.)
AMS-2301	Aircraft Quality Magnetic Inspection Procedure
AMS-2303	Aircraft Quality Magnetic Corrosion Resistance Steel Inspection Procedure
AMS-2304	Special Aircraft-Quality Steel Cleanliness Magnetic Particle Inspection Procedure
AMS-4117	Type 6061 T-651 C.F.
AMS-4120	Type 2024 T-4 / T-351 C.F.
AMS-4122	Type 7075 T-6 /T-73 (Chems Only) C.F.
AMS-4123	Type 7075 T-651 C.F.
AMS-4124	Type 7075 T-7351 (Chems Only) C.F.
AMS-4154	Type 7075 T-6 EXT.
AMS-4152	Type 2024 T-3 EXT.
AMS-4150	Type 6061 T-6 EXT.
AMS-4165	Type 2024 T-3511 EXT.
AMS-4167	Type 7075 T-73511 EXT.
AMS-4169	Type 7075 T-6511 EXT.
AMS-4173	Type 6061 T-6511 EXT.
AMS-4339	Type 2024 T-851 C.F.
AMS-4640	NI-AL-BRZ (C63000)
AMS-4674	"405" Nickel Alloy
AMS-4675	"400" Nickel Alloy (Chems Only)
AMS-4676	K-500 (Chems Only)
AMS-5062	C-1018 (Chems Only)
AMS-5069	C-1018 (Chems Only)
AMS-5610	416 Condition A (Type 2)
AMS-5612	410 Condition A
AMS-5613	410 Condition A
AMS-5616	418 (Greek Ascology) Condition A
AMS-5617	³ Custom 455 (12-9-2) Gr. 1 & 2
AMS-5618	440 C Vac. Melt.
AMS-5620	420-F Condition A (Type 2)
AMS-5621	420 Condition A
AMS-5627	430 Condition A
AMS-5628	431 Condition A
AMS-5629	PH 13-8 MO Solution Treated
AMS-5630	440-C Condition A
AMS-5631	440-A Condition A
AMS-5632	440-F Se (Type 2)
AMS-5637	302 High Tensile (Condition B) (Chems Only)
AMS-5639	304 Condition A
AMS-5640	303 Condition A Type 1 & 2
AMS-5641	303 Selenium Condition A
AMS-5643	17-4 PH "Double" H-1150 (Chems Only)
AMS-5643	17-4 PH "H-1150" (Chems Only)
AMS-5643	17-4 PH Solution Treated
AMS-5644	17-7 PH Solution Treated
AMS-5645	321 Condition A
AMS-5646	347 Condition A
AMS-5647	304 L Condition A
AMS-5648	316 Condition A
AMS-5650	309 Condition A
AMS-5651	310 Condition A
AMS-5653	316 L Condition A
AMS-5655	422 "Cap. of"
AMS-5656	¹ Nitronic 40 (21-6-9)
AMS-5659	15-5 PH "H-1025" (Type 1)
AMS-5659	15-5 PH Solution Treated Type 1 & 2
AMS-5662	718 Nickel Alloy
AMS-5663	718 Nickel Alloy "Cap. of"
AMS-5665	"600" Nickel Alloy (Chems Only)
AMS-5666	"625" Nickel Alloy
AMS-5667	X-750 Nickel Alloy
AMS-5708	² Waspaloy H.Q.
AMS-5709	² Waspaloy "Cap. of"
AMS-5716	330 Condition A
AMS-5726	A-286 (Cap. 210 KSI) Cold Reduced

AEROSPACE MATERIAL SPECIFICATIONS (Continued)

AMS-5731	A-286 Solution Treated (1800° 1 Hour)
AMS-5732	A-286 Solution Treated (1800°) and Aged
AMS 5734	A-286 Solution Treated (1650° 2 hours) (Chems Only)
AMS-5735	Superseded by AMS-5732
AMS-5736	Superseded by AMS-5731
AMS-5737	A-286 Solution Treated (1650°) and Aged
AMS-5738	303 Selenium High Yield (Condition B)
AMS-5743	AM-355
AMS-5744	AM-355 "Cap. of "
AMS-5750	Fry Alloy C
AMS-5754	Fry Alloy X
AMS-5759	L-605 (sic. Haynes 25)
AMS-5764	¹ Nitronic 50 (XM-19) (22-13-5)
AMS-5842	⁴ MP-159
AMS-5843	⁴ MP-159 "Cap. of"
AMS-5844	⁴ MP-35N
AMS-5845	⁴ MP-35N "Cap. of"
AMS-5848	¹ Nitronic 60
AMS-5853	A-286 (Cap. 160 KSI) Cold Reduced (Chems Only)
AMS-5962	718 Cold Reduced
AMS-6257	300M (Vacuum Melt.) (Exc. Hardness)
AMS-6260	E-9310
AMS-6265	E-9310 (Vacuum Melt.)
AMS-6267	E-9310 (Vacuum Melt.)
AMS-6322	E-8740
AMS-6346	E-4130 HT
AMS-6348	E-4130
AMS-6349	E-4140 Norm
AMS-6370	E-4130
AMS-6382	E-4140 Ann
AMS-6409	E-4340 N & T
AMS-6411	E-4330 Modified (Vacuum Melt.)
AMS-6414	E-4340 (Vacuum Melt.)
AMS-6415	E-4340
AMS-6416	"300M" (obsolete-use AMS-6419)
AMS-6417	E-4340 Modified (Vacuum Melt.)
AMS-6418	Hy-Tuf Gr. A & B
AMS-6419	300M (Vacuum Melt.)
AMS-6427	E-4330 Modified
AMS-6431	D6AC (Vacuum Melt.)
AMS-6440	E-52100
AMS-6444	E-52100 (Vacuum Melt.)
AMS-6448	E-6150
AMS-6470	E-135 Modified (Nitriding) (Exc. Hardness)
AMS-6471	E-135 Modified (Nitriding) (Vacuum Melt.)
AMS-6472	E-135 Modified (Nitriding Comp A)
AMS-6484	E-4340/E-4340 (Vacuum Melt.)
AMS-6485	H-11
AMS-6487	H-11 (Vacuum Melt.)
AMS-6488	H-11 (Vacuum Melt.)
AMS-6514	Maraging (Grade 300)
AMS-6526	9-4-30 Exc. Condition
AMS-6532	Aermet 100
AMS-7718	4750 (Exc. Hardness)
AMS-7727	³ Kovar

MILITARY SPECS (Commonly Requested for Military Hardware)

MIL-I-23011	CL 1 ³ (Kovar)
MIL-N (Nickel)	
MIL-N-6710	"600" Nickel Alloy "Exc. Max Tens"
MIL-N-14411	Comp 3 (4750) "Cap. of"
MIL-S (Steel)	
MIL-S-5000	E-4340

¹ Trademark Armco

² Trademark Carpenter Technology

³ Trademark United Technology

⁴ Trademark SPS Technology

MILITARY SPECIFICATIONS (Continued)

MIL-S-5626	E-4140
MIL-S-6049	E-8740
MIL-S-6709	E-135 Modified Comp. A (Nitriding)
MIL-S-6758	E-4130
MIL-S-7108	E-Hy Tuf
MIL-S-7393	E-9310
MIL-S-7420	E-52100
MIL-S-7493	E-4620
MIL-S-7720	303, 302, 316 (See top of page 154)
MIL-S-83030	Comp. 3 E-9310 (Vacuum Melt.)
MIL-S-8503	E-6150
MIL-S-8699	E-4330
MIL-S-8844	Class 1 E-4340 (Vacuum Melt.)
MIL-S-8844	Class 3 E-4340 Modified "300M" (Vacuum Melt.)
MIL-S-8949	D6AC (Exc. Sonic)
MIL-S-16598	INVAR 36 "FM" (Chemistry Only)
MIL-S-18732	431
MIL-S-46850	Maraging Grade 300 Type 4 Exc. Para 3.5.3
MIL-S-83135	E-4340 Modified (Vacuum Melt.)
MIL-S-83311	Nickel 455
MIL-W	(Steel Wire)
MIL-W-52263	(Same as ASTM-A-581)

FEDERAL SPECS

(U.S. Government Method of Cataloging Metals)

QQN-281	Class A Nickel "400" Alloy Class B Nickel "405" Alloy
QQN-286	Form 1 Nickel "K500" Alloy "Annealed" Form 2 Nickel "K500" Alloy "Aged" (Same as ASTM-A-322-A-331)
QQS-624	(Same as QQS-634 & QQS-637)
QQS-633	(1010 Thru 1050)
QQS-634	(1109 Thru 1215)
QQS-637	See top of page 154
QQS-763	Superceded by ASTM-A-582
QQS-764	

BOILER CODE SPECIFICATIONS

(Commonly Requested by Bolt, Pump, Fitting and Valve Mfg's)

ASTM-A-	(American Society for Testing and Materials)
ASTM-A-108	Carbon Steel Bars Cold Finished C-1018 Thru C-1215 (Chems Only)
ASTM-A-193	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service GR-B8 (304) GR-B8 CL 2 (304 Strain Hardened High Tensile) GR-B8C (347) GR-B8M (316) GR-B8M CL 2 (316 Strain Hardened High Tensile) GR-B8T (321) GR-B8R ¹ (Nitronic 50), GR-B8S ¹ (Nitronic 60)
ASTM-A-194	Nitronic 60
ASTM-A-276	Stainless and Heat Resisting Steel Bars and Shapes 302 309 316-L 403 304 310 317 410 304 "B" 316 321 420 304 L 316 "B" 347 430 ("B"= High Tensile) 431 ¹ Nitronic 60 440-A ¹ Nitronic 50 (XM-19, 22-13-5) 440-C ¹ Nitronic 40 (21-6-9) 446
ASTM-A-320	Alloy Steel Bolting Materials for Low Temperature Service GR-B8(304) GRB8C(347) GR-B8T(321) GR-B8M(316)

BOILER CODE SPECIFICATIONS (Continued)

ASTM-A-320	GR-B8F(303-303 Se) GR-B8F CL 2 (303 S "B")
ASTM-A-322	Hot Rolled Alloy Steel Bars
ASTM-A-331	Cold Finished Alloy Steel Bars (Same as A-322)
ASTM-A-453	Bolting Materials, High Temperature, (A286 Grade 660 CL A & B)
ASTM-A-484	General Requirements for Stainless (Except Wire)
ASTM-A-479	Stainless and Heat Resisting Steel Bars and Shapes for use in Boilers and other Pressure Vessels 302 304-L 316 317 403 304 310-S 316-L 321 430 ¹ Nitronic 50 (XM-19, 22-13-5) 347 410 ¹ Nitronic 60 (UNS 21800)
ASTM-A-564	Hot Rolled and Cold Finished Aged Hardening Stainless and Heat Resisting Steel Bars and Shapes (Cap. of) Type 630-17-4 PH Type XM-12-15-5 PH Type 631-17-7 PH Type XM-13-PH 13-8 Type 634-AM-355
ASTM-A-565	422 (Grade 616)
ASTM-A-582	Free Machining Stainless and Heat Resisting Steel Bars Hot Rolled or Cold Finished 303 S (Cond. A), 416 (Cond. A & T) 303 SE (Cond. A), 420-F, 430-F, 440-FSe
ASTM-A-638	Precipitation Hardening Iron Base Super Alloy Bars, Forgings and Forging Stock for High Temperature Service GR-660 (A-286) Age Hard-Type 1 & 2
ASTM-B-16	Alloy 360 (Chems Only)
ASTM-B-160	"200" Nickel Alloy
ASTM-B-164	"400" Nickel Alloy
ASTM-B-166	"600" Nickel Alloy (Chems Only)
ASTM-B-446	"625" Nickel Alloy (Grade 1)
ASTM-B-473	Fry Alloy 20
ASTM-B-574	Fry Alloy C
ASTM-B-637	718 Nickel Alloy
ASTM-F-15	³ Kovar

A.S.M.E. (American Society of Mechanical Engineers)
 ASME-SA-182 Same as ASTM-A-182
 ASME-SA-240 Same as ASTM-A-240
 ASME-SA-479 Same as ASTM-A-479
 ASME-SB-574 Fry Alloy C (C-276)
 ASME-SB-637 718 Sol. Tr.

"COMPANY" SPECS:

AIRESEARCH:

EMS-537	416 H.T. (125 KSI Min.)
EMS-642	H-11 V.M. (Exc. Fatigue Test)
EMS-55443	AM-355 (Ariz. Div.)
EMS-56280	9310 V.M.
EMS-96242	E-4330 Mod. V.M. (Tor. Div.) (Exc. Sonic)
HT-5042	9310 Air Melt. / V.M. (Cap. of)

¹ Trademark Armco

² Trademark Carpenter Technology

³ Trademark United Technology

⁴ Trademark SPS Technology

"COMPANY" SPECS

(Continued)

BELL:

BPS 299-947-032 E-9310 V.M. (Exc. Hardness)
 BPS-299-947-036 E-135 Modified (Nitriding) V.M.
 BPS 299-947-055 E-4340 V.M.

BENDIX:

CE-0896 E-4340 Mod V.M. "300"
 CE-0906 E-4330 Mod V.M.
 BEMS-25003 440-C Vac. Melt. (L.A. DIV.)

BOEING:

BMS-7-26 E-4340 Mod Vac. Melt. N & T
 "300M" Class 1
 BMS-7-27 E-4330 Mod N & T Hi Transverse
 BMS-7-28 E-4340 V.M., E-4340 N & T
 BMS-7-122 E-4330 Mod V.M.
 BMS-7-182 HP 9-4-30 (Type II)

GENERAL DYNAMICS:

FMS-1011 D6-AC V.M. (Exc. Sonic)
 FMS-1012 4330 V.M. (Exc. Sonic)

GENERAL ELECTRIC

B50A951A1 Stainless 422 (Cap of)
 B50TF15 718 Sol Tr (AMS 5662)
 718 Cold Reduced, (Chems Only)
 B50T69A 718 Sol Tr (AMS-5662)
 B50YP44B1 X-750
 C50TF13 718 Cold Reduced
 (Chems Only)
 718 Sol Tr (AMS-5662)
 (Chems Only)

GRUMMAN AIRCRAFT:

GM-1010 E-4330 Mod V.M. (Exc. Sonic)
 GM-1012 E-4340 Mod V.M. "300M"
 GM-1013 E-D6AC V.M. (Exc. Sonic)

HUGHES AIRCRAFT:

HMS-6-1404 Type 2 Class 1 (V.M.)
 Maraging 300
 HMS-6-1105 PH 13-8 MO
 HMS-6-1093 Type 455 (Exc. Para 3.2.1.1)

KAYNAR:

MS-301 A-286 (AMS-5731), 1-1/4" Rd Max

LOCKHEED

LC05-1190 (CA. CO) (4340 Mod) "300M" V.M.
 LCM05-2190 D6AC (V.M.) (Exc. Para 4.8.1)
 STM05-500 (Georgia) D6AC (V.M.)
 STM05-602 (Georgia) PH 13-8 MO

MC DONNELL DOUGLAS:

DMS-1555 Grade A E-4340 Vac. Melt.
 Grade B E-4340 N & T
 DMS-1565 431 Stainless Steel, (Exc. Sonic)
 DMS-1841 Grade A Hy-Tuf Vac. Melt.
 Grade B Hy-Tuf
 DMS-1935 300 M V.M. (4340 Mod)
 DMS-2050 304-L Cond A
 DMS-2100 PH 13-8 MO
 DMS-2209 718 Cold Reduced,
 (Chems Only)
 MMS-2102 (St. Louis) HP-9-4-30, (Exc. Fracture & Sonic
 Test)

"COMPANY" SPECS

(Continued)

ROCKWELL:

ABO 170-014 4750
 (Autonetics)
 LBO-160-164 18-9-5 Maraging (300 Grade)
 (L.A. Div.)
 MBO-160-003 17-4 PH (Cap. of)
 (Downey Div.)
 MBO-160-006 18-9-5 Maraging
 (Downey Div.) (300 Grade), (Exc. Sonic)
 MBO-160-034 304-L Vac. Melt
 (Downey Div.) (Exc. Sonic)
 MBO-160-037 304-L Vac. Melt
 (Downey Div.) (Exc. Grain Size)
 MBO-160-151 Invar 36 "FM", (Chems Only)
 RBO-170-153 718 Sol TR, (AMS-5662)
 (Rocketdyne) (Cap. of)
 STO-160LB0013 PH 13-8 MO
 (Corporate)
 STO-160-LB0012 9-4-30 Vac Melt
 (Corporate)

STANDARD PRESSED STEEL:

SPS-M-118 A-286 Cold Reduced (Cap. of 160 KSI)
 SPS-M-175 ²Waspaloy Cold Reduced, (Exc.
 Hardness)
 SPS-M-250 A-286 (Cap. 200 KSI) Cold Reduced
 SPS-M-275 718 Sol TR (AMS-5662) (Chems Only)
 SPS-M-637 718 Cold Reduced
 SPS-M-646 ⁴MP 35N

VOI SHAN:

VS-71001 ²Waspaloy Cold Reduced, (Exc.
 Hardness)

DEPT OF DEFENSE:

DOD-F-24669/7 Stainless 422

WESTINGHOUSE:

10705BU Stainless 422 (Cap of)

HI-SHEAR:

HS#115 Stainless 431 (Chems Only)
 HS#140 Type 3 A-286 (AMS-5731), (Chems Only)
 HS#156 718 Sol Tr/Cold Reduced,
 (Chems Only)

VALLEY TODECO:

VMS-110 718 Cold Reduced, (Chems Only)
 VMS-112 ²Waspaloy Cold Reduced, (Exc.
 Hardness)

AIR INDUSTRIES:

AIC-MS-110 718 Cold Reduced (Chems Only)

EUROPEAN STANDARD:




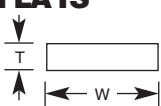
EN-2404 718 Vac. Melt. Under 4"
 EN-2303 A286 (AMS 5737) Under 4"

¹ Trademark Armco
² Trademark Carpenter Technology

³ Trademark United Technology
⁴ Trademark SPS Technology

MIL-S-7720 Amend. #1 Supersedes AN-S-771		QQ-S-763B Supersedes QQ-S-00763A Rev. 1 and MIL-S-854 (in part)				
Conditions						
PHYSICAL CONDITION	SURFACE CONDITION	COMPOSITION	Class	Type	Class	Type
(A) Annealed	(a) Hot Finished	302	(1)	302	(8) CB	347
(B) Cold Finished	(b) Pickled	303 S	(7)	303	(3)	410
(C) As Rolled	(c) Cold Drawn	303 Se	(1)	303 Se	(6)	416
	(d) Cold Rolled	316	(9)	304	(5)	420
	(e) Turned			304L	(4)	430
	(f) Centerless Ground			310		430F
			(8) Ti	316	(10)	431
				316L		440C
				321		

WEIGHT FORMULAS

LBS. PER LINEAL FOOT		CONVERSION FACTORS	
		Multiply Steel Weight by	Density Lbs./In. ³
ROUNDS  Steel: $2.6729 \times D^2$ Aluminum: $.924 \times D^2$ D = Size, Inches	Aluminum		
	2011	.3604	.102
	2024	.3533	.100
	6061	.3462	.098
SQUARES  Steel: $3.4032 \times D^2$ Aluminum: $1.18 \times D^2$ D = Size, Inches	6262	.3452	.098
	7075	.3568	.101
	Stainless		
	300 Series	1.030	.292
HEXAGONS  Steel: $2.9473 \times D^2$ Aluminum: $1.02 \times D^2$ D = Size, Inches	400 Series	1.010	.286
	Nickel		
	200	1.132	.321
	400	1.125	.318
FLATS  Steel: $3.4032 \times T \times W$ Aluminum: $1.20 \times T \times W$ W = Width, Inches T = Thickness, Inches	R-405	1.121	.318
	K-500	1.075	.305
	600	1.072	.306
	625	1.075	.305
	800H	1.012	.287
	800HT	1.012	.287
	825	1.037	.294
	330	1.012	.287
	20	1.030	.292
	C-276	1.132	.321
	Brass		
		1.084	.307



FRACTIONAL INCHES

CONVERTED TO DECIMAL INCHES

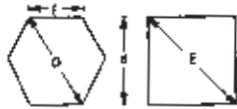
Fraction of Inch	Decimal of Inch	Fraction of Inch	Decimal of Inch
1/64 . . . . .	.015625	33/64 . . . . .	.515625
1/32 . . . . .	.03125	17/32 . . . . .	.53125
3/64 . . . . .	.046875	35/64 . . . . .	.546875
1/16 . . . . .	.0625	9/16 . . . . .	.5625
5/64 . . . . .	.078125	37/64 . . . . .	.578125
3/32 . . . . .	.09375	19/32 . . . . .	.59375
7/64 . . . . .	.109375	39/64 . . . . .	.609375
1/8 . . . . .	.125	5/8 . . . . .	.625
9/64 . . . . .	.140625	41/64 . . . . .	.640625
5/32 . . . . .	.15625	21/32 . . . . .	.65625
11/64 . . . . .	.171875	43/64 . . . . .	.671875
3/16 . . . . .	.1875	11/16 . . . . .	.6875
13/64 . . . . .	.203125	45/64 . . . . .	.703125
7/32 . . . . .	.21875	23/32 . . . . .	.71875
15/64 . . . . .	.234375	47/64 . . . . .	.734375
1/4 . . . . .	.250	3/4 . . . . .	.750
17/64 . . . . .	.265625	49/64 . . . . .	.765625
9/32 . . . . .	.28125	25/32 . . . . .	.78125
19/64 . . . . .	.296875	51/64 . . . . .	.796875
5/16 . . . . .	.3125	13/16 . . . . .	.8125
21/64 . . . . .	.328125	53/64 . . . . .	.828125
11/32 . . . . .	.34375	27/32 . . . . .	.84375
23/64 . . . . .	.359375	55/64 . . . . .	.859375
3/8 . . . . .	.375	7/8 . . . . .	.875
25/64 . . . . .	.390625	57/64 . . . . .	.890625
13/32 . . . . .	.40625	29/32 . . . . .	.90625
27/64 . . . . .	.421875	59/64 . . . . .	.921875
7/16 . . . . .	.4375	15/16 . . . . .	.9375
29/64 . . . . .	.453125	61/64 . . . . .	.953125
15/32 . . . . .	.46875	31/32 . . . . .	.96875
31/64 . . . . .	.484375	63/64 . . . . .	.984375
1/2 . . . . .	.500	1	1.000

HARDNESS CONVERSION TABLE

(Approximate)

Brinell Hardness	Rockwell B Scale	Rockwell C Scale	Approximate Tensile Lbs., p.s.i.	Brinell Hardness	Rockwell B Scale	Approximate Tensile Lbs., p.s.i.
653	—	62	324,000	217	96	103,000
627	—	60	311,000	212	96	103,000
601	—	59	306,000	207	95	101,000
578	—	57	290,000	202	94	98,000
555	—	56	284,000	197	93	96,000
534	—	54	270,000	192	92	93,000
514	—	53	263,000	187	91	91,000
495	—	51	250,000	183	90	89,000
477	—	50	243,000	179	89	87,000
461	—	49	236,000	174	88	85,000
444	—	47	223,000	170	87	83,000
429	—	47	217,000	166	86	81,000
415	—	45	211,000	163	85	80,000
401	—	42	194,000	159	84	78,000
388	—	41	188,000	156	83	77,000
375	—	40	182,000	153	82	76,000
363	—	38	171,000	149	81	75,000
352	—	37	166,000	146	80	74,000
331	—	36	162,000	143	79	73,000
321	—	34	153,000	140	78	71,000
311	—	33	148,000	137	77	70,000
302	—	32	144,000	134	76	69,000
293	—	31	140,000	131	74	67,000
285	—	30	136,000	128	73	66,000
277	—	29	132,000	126	72	65,000
269	—	28	129,000	124	71	63,000
262	—	27	126,000	121	70	62,000
255	—	25	120,000	118	69	61,000
248	—	24	117,000	116	68	60,000
241	100	23	115,000	114	67	59,000
235	99	22	112,000	112	66	58,000
229	98	21	110,000	109	65	57,000
223	97	20	108,000	107	64	55,000

**DISTANCES ACROSS CORNERS
 OF HEXAGONS AND SQUARES**



$D = 1.1547d$
 $E = 1.4142d$
 $F = 0.5773d$

**RECTANGLE INSCRIBED
 IN A CIRCLE (DIAGONAL)**

$\sqrt{W^2 + T^2}$

W = WIDTH T = THICKNESS
 (Square Root of Sum of Squares)

d	D	E	F
1/16	0.0721	0.0884	0.0361
1/8	0.1443	0.1767	0.0721
5/32	0.1804	0.2210	0.0902
3/16	0.2164	0.2651	0.1082
7/32	0.2526	0.3094	0.1263
1/4	0.2886	0.3535	0.1443
9/32	0.3247	0.3977	0.1623
5/16	0.3608	0.4419	0.1803
11/32	0.3968	0.4861	0.1983
3/8	0.4329	0.5303	0.2164
13/32	0.4690	0.5745	0.2344
7/16	0.5051	0.6187	0.2524
15/32	0.5412	0.6629	0.2705
1/2	0.5773	0.7071	0.2885
17/32	0.6133	0.7513	0.3065
9/16	0.6494	0.7955	0.3246
19/32	0.6855	0.8397	0.3426
5/8	0.7216	0.8839	0.3606
21/32	0.7576	0.9281	0.3787
11/16	0.7937	0.9723	0.3967
23/32	0.8298	1.0165	0.4147
3/4	0.8659	1.0606	0.4328
25/32	0.9020	1.1048	0.4508
13/16	0.9380	1.1490	0.4688
27/32	0.9741	1.1932	0.4869
7/8	1.0102	1.2374	0.5049
29/32	1.0463	1.2816	0.5229
15/16	1.0824	1.3258	0.5410
31/32	1.1184	1.3700	0.5590
1	1.1547	1.4142	0.5770
1-1/32	1.1907	1.4584	0.5950
1-1/16	1.2268	1.5026	0.6131
1-3/32	1.2629	1.5468	0.6311
1-1/8	1.2990	1.5910	0.6491
1-5/32	1.3351	1.6452	0.6672
1-3/16	1.3712	1.6793	0.6852
1-7/32	1.4073	1.7235	0.7032
1-1/4	1.4434	1.7677	0.7213
1-9/32	1.4794	1.8119	0.7393
1-5/16	1.5155	1.8561	0.7573
1-11/32	1.5516	1.9003	0.7754
1-3/8	1.5877	1.9445	0.7934
1-13/32	1.6238	1.9887	0.8114
1-7/16	1.6598	2.0329	0.8295
1-15/32	1.6959	2.0771	0.8475
1-1/2	1.7320	2.1213	0.8655
1-17/32	1.7681	2.1655	0.8836
1-9/16	1.8042	2.2097	0.9016
1-19/32	1.8403	2.2539	0.9196
1-5/8	1.8764	2.2981	0.9377
1-21/32	1.9124	2.3423	0.9557
1-11/16	1.9485	2.3865	0.9742
1-23/32	1.9846	2.4306	0.9918
1-3/4	2.0207	2.4708	1.0098

d	D	E	F
1-25/32	2.0568	2.5190	1.0278
1-13/16	2.0929	2.5632	1.0459
1-27/32	2.1289	2.6074	1.0639
1-7/8	2.1650	2.6516	1.0819
1-29/32	2.2011	2.6958	1.1000
1-15/16	2.2372	2.7400	1.1180
1-31/32	2.2733	2.7842	1.1360
2	2.3094	2.8284	1.1540
2-1/32	2.3453	2.8726	1.1720
2-1/16	2.3815	2.9168	1.1901
2-3/32	2.4176	2.9610	1.2081
2-1/8	2.4537	3.0052	1.2261
2-5/32	2.4898	3.0404	1.2442
2-3/16	2.5259	3.0936	1.2622
2-1/4	2.5981	3.1820	1.2983
2-5/16	2.670	3.2703	1.3343
2-3/8	2.7424	3.3587	1.3704
2-7/16	2.8145	3.4471	1.4065
2-1/2	2.8867	3.5355	1.4425
2-9/16	2.9583	3.6239	1.4786
2-5/8	3.0311	3.7123	1.5147
2-11/16	3.1032	3.8007	1.5507
2-3/4	3.1754	3.8891	1.5868
2-13/16	3.2476	3.9794	1.6229
2-7/8	3.3197	4.0658	1.6589
2-15/16	3.3919	4.1542	1.6950
3	3.4641	4.2426	1.7310
3-1/16	3.5362	4.3310	1.7671
3-1/8	3.6084	4.4194	1.8032
3-3/16	3.6806	4.5078	1.8392
3-1/4	3.7627	4.5962	1.8753
3-5/16	3.8249	4.6846	1.9114
3-3/8	3.8971	4.7729	1.9474
3-7/16	3.9692	4.8613	1.9835
3-1/2	4.0414	4.9497	2.0196
3-9/16	4.1136	5.0381	2.0556
3-5/8	4.1857	5.1265	2.0917
3-11/16	4.2579	5.2149	2.1277
3-3/4	4.3301	5.3033	2.1638
3-13/16	4.4023	5.3917	2.1999
3-7/8	4.4744	5.4801	2.2359
3-15/16	4.5466	5.5684	2.2720
4	4.6188	5.6568	2.3080
4-1/8	4.7631	5.8336	2.3801
4-1/4	4.9074	6.0104	2.4523
4-3/8	5.0518	6.1872	2.5244
4-1/2	5.1961	6.3639	2.5965
4-3/4	5.485	6.717	2.7400
5	5.774	7.071	2.8900
5-1/4	6.062	7.425	3.0300
5-1/2	6.351	7.778	3.1800
5-3/4	6.640	8.132	3.3200
6	6.928	8.485	3.4600

NOTE — These are theoretical distances for sharp corners only.

UNIFIED NUMBERING SYSTEM INDEX

UNS	A92011	2011	UNS	R10359	⁴ MP 159
UNS	A92024	2024	UNS	R30035	⁴ MP 35N
UNS	A96061	6061	UNS	R30605	L-605
UNS	A96262	6262	UNS	S13800	13-8 PH
UNS	A97075	7075	UNS	S15500	15-5 PH
UNS	C36000	Alloy 360	UNS	S17400	17-4 PH
UNS	C62400	AL-BRZ	UNS	S17700	17-7 PH
UNS	C63000	NI-AL-BRZ	UNS	S45500	³ Custom 455
UNS	G10180	1018	UNS	S20910	¹ Nitronic 50
UNS	G41300	4130	UNS	S21800	¹ Nitronic 60
UNS	G41400	4140	UNS	S21904	¹ Nitronic 40
UNS	G43400	4340	UNS	S30200	302
UNS	G46200	4620	UNS	S30300	303 Su
UNS	G52986	52100	UNS	S30323	303 Sel
UNS	G61500	6150	UNS	S30400	304
UNS	G87400	8740	UNS	S30403	304-L
UNS	G93106	9310	UNS	S30908	309-S
UNS	K23080	4330 Mod.	UNS	S31008	310-S
UNS	K24065	Nitriding	UNS	S31600	316
UNS	K24728	D6AC	UNS	S31603	316-L
UNS	K32550	Hy-Tuf	UNS	S31700	317
UNS	K91283	9-4-30	UNS	S31703	317-L
UNS	K92580	Aermet 100	UNS	S32100	321
UNS	K93120	Maraging "300"	UNS	S32109	321 H
UNS	K93602	Invar 36 "FM"	UNS	S34700	347
UNS	K94610	³ Kovar	UNS	S34709	347 H
UNS	K95000	4750	UNS	S35500	AM-355
UNS	N02200	Nickel "200"	UNS	S40300	403
UNS	N04400	Nickel "400"	UNS	S41000	410
UNS	N04405	Nickel "405"	UNS	S41600	416
UNS	N05500	Nickel "K-500"	UNS	S41800	418 (Greek Ascology)
UNS	N06002	Fry Alloy "X"	UNS	S42000	420
UNS	N06600	Nickel "600"	UNS	S42020	420-F
UNS	N06625	Nickel "625"	UNS	S42200	422
UNS	N07001	² Waspaloy	UNS	S43000	430
UNS	N07718	718	UNS	S43020	430-F
UNS	N07750	X-750	UNS	S43100	431
UNS	N08020	Fry Alloy 20	UNS	S44002	440-A
UNS	N08330	330	UNS	S44004	440-C
UNS	N08800	Nickel "800"	UNS	S44023	440-F Sel
UNS	N08810	Nickel "800-H"	UNS	S44600	446
UNS	N08811	Nickel "800-HT"	UNS	S66286	A-286
UNS	N08825	Nickel "825"	UNS	T20811	H-11
UNS	N10276	Fry Alloy C			

¹ Trademark Armco
² Trademark Carpenter Technology

³ Trademark United Technology
⁴ Trademark SPS Technology

STAINLESS

PH-13-8 MO Vac. Melt.	Silver & Dk. Blue
15-5 PH Vac. Melt.	Dk. Blue & Copper
15-5 E.S.R.	Light Blue & Copper
15-5 PH "H1025"	Orange & Copper
17-4 PH	Silver & Red
17-4 PH "H1150"	Light Green & Gold
17-4 PH "Double" H-1150	Black & Gold
17-4 PH Prec. Grd.	Silver & Copper
17-7 PH	Gold & Red
³ Custom 455	Lt. Blue & Green
302	Pink & White
302 "Cold Drawn Flats"	Light Blue & Red
302 Cond. "B"	Red & Brown
302 Prec. Grd.	Gold & Pink
303 Sul	Red
303 Sul "Cold Drawn Flats"	Light Blue & White
303 Sul Cond. "B."	Red & Yellow
303 Sul Prec. Grd.	Gold
303 Sel	Purple
303 Sel Cond. "B."	Brown
303 Sel Prec. Grd.	Tan
304	Pink & White
304 "Cold Drawn Flats"	Light Blue & Red
304/304-L Cond. "B"	Red & Brown
304/304-L Prec. Grd.	Gold & Pink
304 L	Pink & Brown
304 L "Cold Drawn Flats"	Light Blue & Red
302/304/304-L Plate-Bar	Pink & Green
304 L Vac. Melt.	Red & Pink
309	Black & White
310	Purple & Black
316	Pink & Black
316/316-L Cond. "B"	Gray & Yellow
316 L	Pink & Dark Blue
316/316-L Prec. Grd.	Pink & Silver
316/316-L Vac. Melt.	Pink & Orange
317/317 L	Dk. Blue & Dk. Green
321	Black
330	Tan & Brown
347	White
AM-355	Purple & White
403/410	Green & Black
416	Green
416 "Cold Drawn Flats"	Black & Tan
416 Prec. Grd.	Yellow
416 HT RC 26/32	Green & Red
418 (Greek Ascology)	Red & Purple
420	Gray & Black
420 F	Light Green
422	Gray & Pink
430	Blue & White
430 F	Red & Black
431	Green & Yellow
440 A	Dk. Blue & Tan
440 C	Dark Blue
440 C Prec. Grd.	Light Blue
440 C Vac. Melt.	Dk. Blue & Aqua
440 F Se	Light Blue & Purple
446	Light Green & Orange
¹ Nitronic 40	Brown & Orange
¹ Nitronic 50	Purple & Brown
¹ Nitronic 60	Gray & Brown
Fry Alloy 20	Yellow & Orange

SUPER ALLOYS

A-286 Age Hard. AMS 5737	Green & White
A-286 Age Hard. AMS 5732	Purple & Gold
A-286 Sol Treated AMS 5731	Yellow & Black
A-286 (Cap. 160 KSI)	Light Blue & Gold
Cold Reduced	
A-286 (Cap. 210 KSI)	
Cold Reduced	Black & Light Blue
L-605	Orange & White
Nickel "200"	Silver & Yellow
Nickel "400"	Red & Orange
Nickel "405"	Light Blue & Yellow
Nickel "K-500" ANN	Gray & Orange
Nickel "K-500" ANN & AGED	Green & Tan
Nickel "600"	Green & Pink
Nickel "625"	Purple & Silver
718 Vac. Melt. AMS 5662	Orange & Blue
718 Vac. Melt. (Cap. 220 KSI)	
Cold Reduced	Yellow & Pink
X-750	Brown & White
Nickel "800/800-H/800-HT"	Gold & Silver
Nickel "825"	Dk. Blue & Lt. Blue
Maraging "300"	Brown & Green
² Waspaloy	Purple & Yellow
⁴ MP 35N	Silver
⁴ MP 159	Gold & Orange
Fry Alloy X	Red & White
Fry Alloy C	Purple & Pink
³ Aermet 100	Lt. Green & Silver

ELECTRICAL STEELS

INVAR 36 "FM"	Pink
³ Kovar	Chartreuse
4750	Orange

AIRCRAFT ALLOYS

E-4130 Norm	Pink
E-4130 H.T.	Red
E-4140	Gray
E-4330 Mod. Vac. Melt.	Orange & Purple
E-4340	Yellow
E-4340 Vac. Melt.	Yellow & White
E-4340 Mod. Vac. Melt. ("300M")	Yellow & Dk. Blue
E-4620 Vac. Melt.	Black & Brown
E-6150 Vac. Melt.	Green & Purple
E-8740	Red & Yellow
E-9310 N&T	Red & White
E-9310 N&T Vac. Melt.	Brown & Yellow
E-52100 Vac. Melt.	Red & Tan
D6AC Vac. Melt.	Tan
H-11 Vac. Melt.	Red & Blue
Hy-Tuf	Orange & White
Hy-Tuf Vac. Melt.	Tan & Purple
Nitriding	Blue & Brown
Nitriding Vac. Melt.	Gray & White
9-4-30 Vac. Melt.	Gold & White

¹ Trademark Armco
² Trademark Carpenter Technology

³ Trademark United Technology
⁴ Trademark SPS Technology

COLD FINISHED CARBON

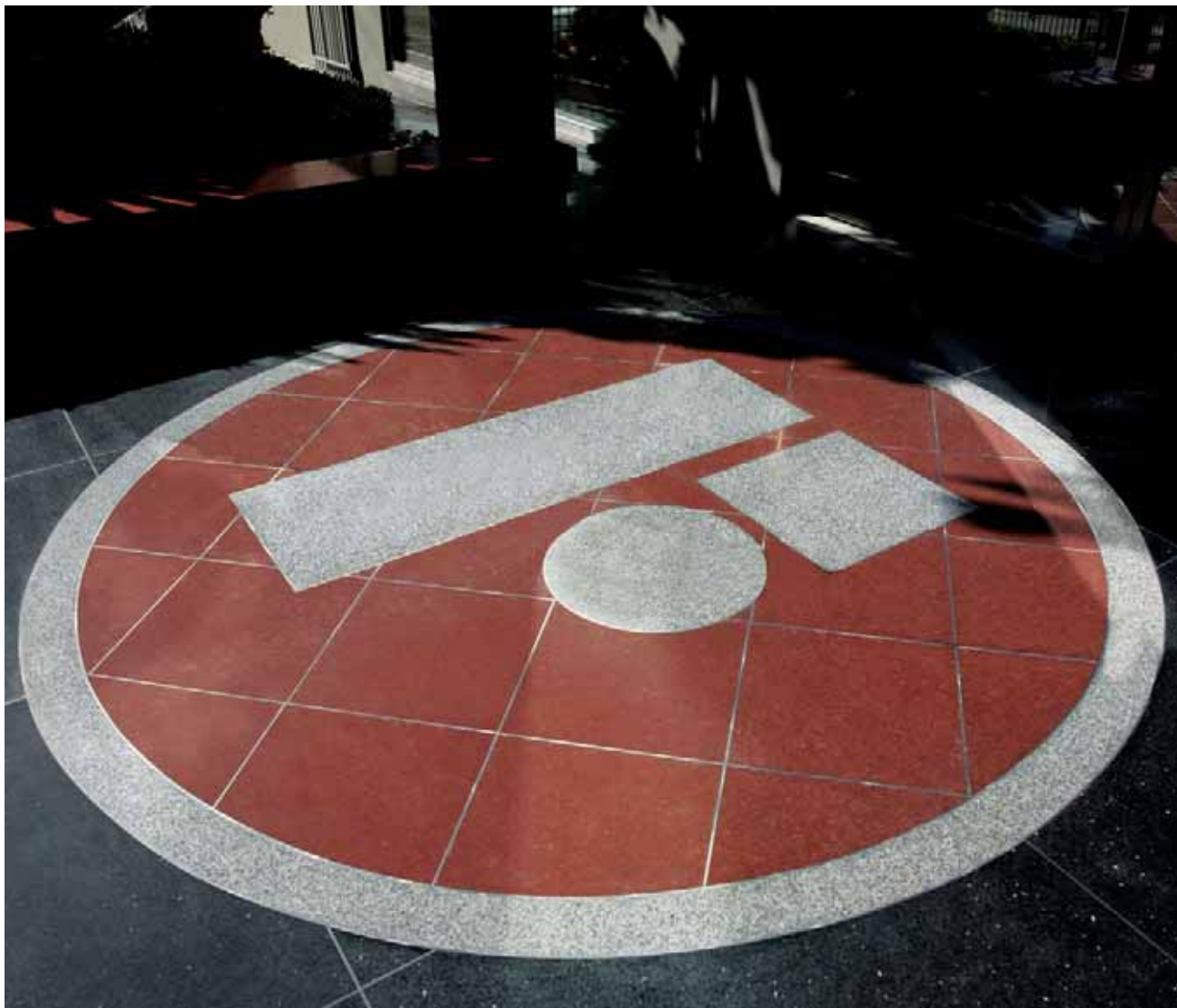
C-1018	Black
C-12L14	White
Ledloy-A	White

BRASS/BRONZE

C-Alloy 360	Red & Copper
Ni-Al-Brz	Bronze & Green

ALUMINUM

CF 2011 T-3	Brown
CF 2024 T-4	Red
CF 2024 T-351	Red
CF2024 T-351	Red With Black Stripe
CF 2024 T-851	Pink
EXT 2024 T-3	Red With White Stripe
EXT 2024 T-3511	Red With White Stripe
CF 6061 T-6	Dk Blue
CF 6061 T-651	Dk Blue
EXT 6061 T-6	Dk Blue With White Stripe
EXT 6061 T-6511	Dk Blue With White Stripe
CF 6262 T-9	Orange
EXT 6262 T-6511	Orange With White Stripe
CF 7075 T-6	Black
CF 7075 T-651	Black
CF 7075 T-651	White With Black Stripe
CF 7075 T-73	Black With Yellow Stripe
CF 7075 T-7351	Black With Yellow Stripe
EXT 7075 T-6	Black With White Stripe
EXT 7075 T-6511	Black With White Stripe
EXT 7075 T-73511	Yellow With Black Stripe



As a Stock list, this book contains descriptions, sizes, and weights of items of steel, brass, bronze and aluminum normally carried in stock for immediate delivery.

As a Reference book, the information herein has been compiled from authoritative sources such as: metal producers, trade associations, technical societies, and is believed to reflect accurately standard practices. It should be recognized, however, that practices and producing equipment vary among mills. Constant technological changes are also taking place. The result is that properties and characteristics of the material itself can vary. Such variations should be realized and evaluated accordingly.

Material specifications are constantly being revised by issued agencies. The issuance of revisions represent upgrading of the material . It is the basic policy of producers, as well as suppliers, to work to the latest revisions. Data herein should be used as a guide with the realization that changes may occur at any time.

Procedure for purchase orders and general conditions of sale.

Confirmation of orders

When orders are received by telephone, every effort is made to ship exactly as requested, the same day the order is placed, providing material is in stock. However, when material is processed and/or shipped prior to the receipt of a written confirming order, we cannot assume responsibility for any deviation from instructions or specifications contained on such confirming order. In order to avoid duplication of shipment, the written purchase order should clearly indicate if it is merely "confirming" a previously given telephone order.

Quotations

Fry Steel prides itself in quoting prices promptly, either by telephone, facsimile or mailed written requests. Prices are subject to change without notice and delivery promises are subject to delays which are beyond our control. Quotations of availability are subject to prior sale.

Warranties and Claims

In general Fry Steel warrants that the materials shipped to a customer meet the specifications designated by the customer at the time of order. The materials ordered from Fry Steel should be inspected upon arrival for conformance with the specifications ordered including grade, size, and quantity. If materials shipped to a customer do not conform to such specifications, we will replace the non-conforming material or refund the purchase price to the original customer provided a claim is submitted within a reasonable time. Fry Steel will also honor claims for defective material, if submitted within a reasonable time after shipment, provided the material has not been improperly used or processed, and subject to our inspection.

Since steel, brass/bronze and aluminum are basic materials whose uses and applications are limited almost solely by the inventiveness and ingenuity of the user, FRY STEEL DOES NOT WARRANT THE SUITABILITY OF ANY OF OUR PRODUCTS FOR ANY PARTICULAR APPLICATION OR PURPOSE, OR MAKE ANY OTHER WARRANTIES EXPRESSED OR IMPLIED.

Return shipments

Return shipments must be authorized by Fry Steel in advance. Material which has been cut or otherwise processed by the buyer or to his order is not returnable.

Deliveries

Any delivery schedule indicated is based on our present estimate of the time required to ship after receipt of your order. Any item which is indicated to be shipped from a producing mill, is based upon current production schedules from the producing mill. In the event of any delay in our performance due in whole or in part to any cause beyond our reasonable control, we shall have such additional time for our performance as may be reasonably necessary under the circumstances. Acceptance by you of any goods shall constitute a waiver by you of any claim for damages on account of any delay in delivery of such goods.

Suspension of Performance

If in our judgment, reasonable doubt exists as to your financial responsibility, or if you are past due in payment of any amount owing to us, we reserve the right, without liability and without prejudice to any other remedies, to suspend performance, decline to ship, to stop any material in transit, until we receive payment of all amounts owing to us, or adequate assurance of such payment whether or not due.

Shipments

Unless otherwise expressly stated, shipment may be by carrier or other means selected by Fry Steel.

Tolerances and variations

All goods shall be subject to tolerances and variations consistent with usual trade practices regarding dimensions, straightness, section, composition and mechanical properties and normal variations in surface and internal conditions and quality and shall also be subject to deviations from tolerances and variations consistent with practical testing and inspection methods.

The data contained in the Stock List has been compiled and developed from many sources. Although every effort has been made to cross-check this information, Fry Steel Company is not responsible for its accuracy. This data is not to be used for design or specification purposes. ALL DATA SHOULD BE VERIFIED.



ABOUT FRY STEEL COMPANY

An Equal Opportunity Employer

Fry Steel was founded in 1946.

Our Warehouse is 180,000 total square feet.

ISO 9001/AS9120

Our Sales Staff is available from 6:30AM - 6PM M-Th & 6:30AM - 5PM Fri PST

53 Saws
33 Cranes
32 Trucks
28 Scales
142 Different Grades of Material
9,000 Different size Items
(2) 1,200 AMP Emergency Generators

FRY STEEL COMPANY POLICIES

To become and remain the finest long bar product distributor in North America.

To ensure that the materials our customers order will be of the desired quality and delivered in an expeditious manner.

To procure material from producers we feel to be of the highest quality in the industry.

To promote organizational effectiveness and provide an open participative work environment with an opportunity for personal growth for all employees.

To cross train employees wherever possible.

AGE HARDENING – The term as applied to soft, or low carbon steels, relates to a wide variety of commercially important, slow gradual changes that take place in properties of steels after the final treatment. These changes, which bring about a condition of increased hardness elastic limit, and tensile strength with a consequent loss in ductility, occur during the period in which the steel is at normal temperatures

AGING – Spontaneous changes in the physical properties (for example, increase in tensile strength and hardness) of some metals, which occurs on standing at atmospheric temperatures after final cold working or after a final heat treatment. Frequently synonymous with the term “Age-Hardening.”

AIR COOLING – Cooling of the heated metal, intermediate in rapidity between slow furnace cooling and quenching, in which the metal is permitted to stand in the open air.

AIR HARDENING STEEL – A steel containing sufficient carbon and other alloying elements to harden fully during cooling in air or other gaseous mediums from a temperature above its transformation range. The term should be restricted to steels that are capable of being hardened by cooling in air in fairly large sections, about 2 in. or more in diameter.

AISI STEELS – Steels of the American Iron and Steel Institute. Common and alloy steels have been numbered in a system essentially the same as the SAE. The AISI system is more elaborate than the SAE in that all numbers are preceded by letters: “A” represents basic open-hearth alloy steel, “B” acid Bessemer carbon steel, “C” basic open-hearth carbon steels, “CB” either acid Bessemer or basic open-hearth carbon steel, “E” electric furnace alloy steel.

ALLOY STEEL – A carbon steel to which is added a definite amount of one or more elements other than carbon, in order to impart special properties to the steel so that it can be used for specific purposes.

ANGULARITY – The conformity to, or deviation from, specified angular dimensions in the cross section of a shape.

ANNEALING – Heat the material to a specific temperature then control the rate at which the material cools (while in the furnace). This gives a uniform hardness and the best machining properties to the material. The purpose of such a heat treatment may be: to remove stresses; to induce softness; to alter ductility; toughness; electrical magnetic, or other physical properties; to refine the crystalline structure; to remove gases; to produce a definite micro-

structure. In annealing, the temperature of the operation and the rate of cooling depend upon the material being treated and the purpose of the treatment.

A.S.T.M. – Abbreviation for American Society for Testing Material. An organization for issuing standard specifications on materials, including metals and alloys.

AS ROLLED – The condition the material is in when it comes off the sizing rollers. Cooling as it's being processed. As rolled is more prone to hard spots and higher as shipped hardness.

ATOMIC SYMBOLS –

Aluminum	= Al	Nitrogen	= N
Boron	= B	Oxygen	= O
Carbon	= C	Phosphorus	= P
Chromium	= Cr	Selenium	= Se
Cobalt	= Co	Silicon	= Si
Columbium	= Cb	Sulfur	= S
Copper	= Cu	Tantalum	= Ta
Hydrogen	= H	Tin	= Sn
Iron	= Fe	Titanium	= Ti
Lead	= Pb	Tungsten	= W
Manganese	= Mn	Vanadium	= V
Molybdenum	= Mo	Yttrium	= Yt
Nickel	= Ni		

AUSTENITE – Phase in certain steels, characterized as a solid solution, usually of carbon or iron carbide, in the gamma form of iron. Such steels are known as “austenitic.” Austenite is stable only above 1333 F. In a plain carbon steel, but the presence of certain alloying elements, such as nickel and manganese, stabilizes the austenitic form, even at normal temperature.

AUSTENITIC STEEL – Steel which, because of the presence of alloying elements, such as nickel, manganese, chromium, etc., shows stability of Austenite at normal temperatures. (Example 200 & 300 series). Austenitic types are non-magnetic as annealed, and depending on the composition, may become slightly magnetic when cold worked. They are readily welded and may be work hardened to high levels, although, not as high as can be obtained by heat treating the hardenable types of the 400 series. The austenitic types provide the best corrosion resistance of all the stainless steels.

BILLET – An ingot or bloom that has been reduced through rolling or hammering to an approximate square ranging from 1-1/2 to 6 inches square, or to an approximate rectangular cross section of an equivalent area. Billets are classified as semifinished products for rerolling or forging.

BLISTER – A raised spot on the surface of the metal caused by expansion of gas in a subsurface zone during thermal treatment.

BLOWHOLE – A cavity produced during the solidification of metal by evolved gas, which, in failing to escape, is held in pockets.

BRASSES – Copper base alloys in which zinc is the principal added element. Brass is higher and stronger than either of its alloying elements copper or zinc; it is malleable and ductile; develops high tensile strength with cold-working and is not heat treatable for purposes of hardness development.

BRINELL HARDNESS – A common standard method of measuring the hardness of certain metals. The smooth surface of the metal is subject to indentation by a hardened steel ball under pressure or load. The diameter of, the resultant indentation, in the metal surface, is measured by a special microscope and the Brinell hardness value read from a chart or calculated by formula.

BROKEN SURFACE – Surface fracturing, generally most pronounced at sharp corners and minute cracks on the surface of a drawn product normal to the direction of drawing.

BRONZE – Primarily an alloy of copper and tin, but the name is now applied to other alloys not containing tin; e.g. aluminum bronze, manganese bronze, and beryllium bronze.

BURR – A thin ridge or roughness left by cutting operation such as in sawing, metal slitting, shearing, or blanking. Burrs are common on almost every cut piece of steel.

CAMBER – Curvature of a straight plane. Not to be confused with a bow. Standard steel industry tolerance for camber is 1/8" in 5 feet.

CARBON STEEL – A steel in which carbon is the only alloying element added to the iron to control its properties; also known as *ordinary steel*, or *straight carbon steel*; or *plain carbon steel*.

CARBURIZING – Adding carbon to the surface of iron-base alloys by absorption through heating the metal at a temperature below its melting point in contact with carbonaceous solids, liquids or gases. The oldest method of case hardening.

CASE HARDENING – A heat treatment or combination of heat treatments by which the surface layer of steel is made harder than the interior. The processes of carburizing, nitriding, and cyaniding accomplish this result by changing the composition of the case.

CASTING – The metal shape that is obtained as a result of pouring metal into a mold or cavity and allowing it to harden so that it will assume and retain the size and shape of the mold/cavity when cold.

CHARPY TEST – A notched-bar or impact test in which a notched specimen, fixed at both ends, is struck behind the notch by a striker carried on a pendulum. This test is used to determine how many pounds of pressure will cause the part to break, or how many pounds the part can withstand.

CHATTER – An uneven surface on drawn products usually formed by vibration of the metal during drawing.

CHROMIUM – Element No. 24 of the periodic system; atomic weight 52.01. It is of bright silvery color, relatively hard. It is strongly resistant to atmospheric and other oxidation. It is of great value in the manufacture of Stainless Steel as an iron-base alloy. Chromium plating has also become a large outlet for the metal. Its principal functions as an alloy is steel making; (1) increase resistance to corrosion and oxidation; (2) increases hardenability; (3) adds some strength at high temperatures; (4) resists abrasion and wear (with high carbon).

CHROMIUM-NICKEL STEEL – Steel usually made by the electric furnace process in which chromium and nickel participate as alloying elements. The stainless steel of 18% chromium and 8% nickel are the better known of the chromium-nickel types.

COILS – Coiled flat sheet or strip metal – usually in one continuous piece or length.

COLD DRAWING – Permanent deformation of metal below its recrystallization temperature, by drawing the bar through one or more dies.

COLD FINISH – The term "Cold Finish" is an umbrella definition for any material that has had some sort of surface treatment. Ex: Cold Drawn is cold finish surface. Centerless Ground & Smooth Turned Rough Turned - these are all "Cold Finish" Ex: S# 49050 HR T 4" RD 4340 is considered a cold finished product because the surface has been turned.

COLD REDUCTION – Reduction of metal size, usually by rolling or drawing particularly thickness while the metal is maintained at room temperature or below the recrystallization temperature of the metal.

COLD ROLLED FINISH – Finish obtained by cold rolling plain pickled sheet or strip with a lubricant resulting in a relatively smooth appearance.

COLD ROLLING – Rolling metal at a temperature below the softening point of the metal; to create strain hardening (work-hardening). Same as cold reduction, except that the working method is limited to rolling. Cold rolling changes the mechanical properties of strip and produces certain useful combinations of hardness, strength, stiffness, ductility and other characteristics known as tempers.

COLD WORKING – Plastic deformation of a metal at a temperature low enough to insure strain (work) hardening. In the 300 series (that cannot be heat treated to increase the hardness) it can go through this cold working process, at time of manufacturing, to increase the physical properties.

CONCENTRICITY – Center to the end of the circle. All round bars have three tolerances to consider; size, straightness and out of round. The 'out of round' tolerance could effect the concentricity of a bar. Fry Steel's stock list advises "it is not advisable to try to *finish* on size from the size purchased."

CONSTITUENT – A necessary part or element; component.

CONSUMET – Carpenters trade name for "consumable electrode vacuum melt."

CONTINUOUS FURNACE – Furnace, in which the material being heated moves steadily through the furnace.

CORROSION – Gradual chemical or electrochemical attack on a metal by atmosphere, moisture or other agents.

CREEP – Slow permanent deformation in a metallic specimen produced by a relatively small steady force, below the elastic limit, acting for a long period of time.

CRITICAL RANGE – A temperature range in which an internal change takes place within a metal. Also termed transformation range.

CRUCIBLE – A ceramic pot or receptacle made of graphite and clay, or clay or other refractory material, and used in the melting of metal. The term is sometimes applied to pots made of cast iron, cast steel, or wrought steel.

DEBURRING – A method whereby the raw slit edge of metal is removed by rolling or filing.

DECARBURIZATION – Removal of carbon from the outer surface of iron or steel, usually by heating in an oxidizing or reducing atmosphere. Water vapor, oxygen and carbon dioxide are strong decarburizers.

Reheating with adhering scale is also strongly decarburizing in action.

DEGASSING PROCESS – (in steel making) Removing gases from the molten metal by means of a vacuum process in combination with mechanical action.

DRAWING – The process of pulling material through a die to reduce the size, change the cross sectional shape, or to harden the material.

DRAWING BACK – Reheating after hardening to a temperature below critical for the purpose of changing the hardness of the steel (see Tempering).

DRAWN-IN-SCRATCHES – Scratches which occur during the fabricating process and are subsequently drawn over. They are characterized by a drawing over the scratch which makes it relatively smooth to the touch.

DRILL ROD – A term given to an annealed and polished high carbon tool steel rod usually round and centerless ground. The sizes range in round stock from .013 to 1-1/2" diameter. Commercial qualities embrace water and oil hardening grades. A less popular but nevertheless standard grade is non-deforming quality. Drill Rods are used principally by machinists and tool and die makers for punches, drills, taps, dowel pins, screw machine parts, small tools, etc.

DROP FORGING – The process of shaping metal parts by forging between two dies, one fixed to the hammer and the other to the anvil of a steam or mechanical hammer. It is used for mass production of such parts as connecting rods, crankshafts, and similar articles.

DUCTILITY – The property of metals that enables them to be mechanically deformed when cold, without fracture. In steel, ductility is usually measured by elongation and reduction of area is determined in a tensile test.

E T D – Elevated Temperature Drawn. Our Stressproof is this type of material. The bars are cold worked and stress relieved as they are drawn through the dies to size them. We achieve a tensile around 130,000 on our stressproof.

ELECTRIC FURNACE STEEL – Steel made in any furnace where heat is generated electrically, almost always by arc. Because of relatively high cost, only tool steels and other high-value steels are made by the electric furnace process.

ELECTROSLAG REMELT – This process produces high purity metals. The electrode to be refined is remelted by passing a current through it into a molten slag, which is resistively heated and which in turn melts the electrode. Molten metal forms on the end of the electrode and fall through the slag, forming an ingot in a water cooled crucible. The process continues until the electrode is consumed and the newly formed ingot is complete. The slag essentially cleans and purifies the metal up when it passes through it. Nitrides will not pass through the sludge with low temps and times. Materials produced by the ESR technique exhibit better property levels and, more significantly, less scatter in these properties. In addition the hot workability of superalloys which were not previously forgeable can be processed in that manner after ESR.

ELONGATION – Increase in length which occurs before a metal is fractured, when subjected to stress. This is usually expressed as a percentage of the original length and is a measure of the ductility of the metal.

EXTRUSION – Shaping metal into a chosen continuous form by forcing it through a die of appropriate shape.

FATIGUE – The phenomenon leading to fracture under repeated or fluctuating stress. Fatigue fractures are progressive beginning as minute cracks and grow under the action of fluctuating stress.

FERROALLOY – An alloy of iron with a sufficient amount of some element or elements such as manganese, chromium, or vanadium for use as a means in adding these elements into molten steel.

FERROUS – Related to iron. Ferrous alloys are iron base alloys.

FINE GRAIN STEEL – Steels which resist grain growth over a considerable temperature range, when held at temperature for a reasonable length of time as is customary in heat treatment of steel.

FRACTURE TEST – A test for carbon in which a specimen of metal is drawn off, cooled rapidly in water, and broken with a sledge hammer. The appearance of the metal exposed in the fracture permits a fairly accurate estimate of carbon content or the presence of internal defects.

FREQUENCY & SEVERITY – Ratings for inclusions and stringers, as allowed per each individual grade specification. How many inclusions per square inch = frequency. What is the length of the inclusions per

square inch = severity. The ideal F/S rating would be "0/0". Each grade of steel has its own F/S.

Examples: 1018 & 4130 can have up to 1" length severity
Type 15-5 5/64" length severity
Type 13-8 3/64" length severity

FULL ANNEALING – Heating iron-base alloys above the critical temperature range, holding the alloy above that range for a proper period of time and then slowly cooling it to below the range either in the furnace or in some thermal insulating material.

GAS CARBURIZING – A method of carburizing carried out in an atmosphere of carburizing gases, including carbon monoxide and hydrocarbons as butane, ethane, methane, and propane.

GRAIN – Individual crystals in metals. A solid polyhedral (or many sided crystal) consisting of groups of atoms bound together in a regular geometric pattern. In mill practice grains are usually studied only as they appear in one plane (1) (Direction of,) Refers to grain fiber following the direction of rolling and parallel to edges of strip or sheets; (2) To bend across the grain is to bend at right angles to the direction of rolling; (3) To bend with the grain is to bend parallel to the directions of rolling. In steel, the ductility in the direction of rolling is almost twice that at right angles to the direction of rolling.

GRAIN BOUNDARY – Bounding surface between crystals. When alloys yield new phases (as in cooling) grain boundaries are the preferred location for the appearance of the new phase. Certain deteriorations such as season cracking and caustic embrittlement, occur almost exclusively at grain boundaries.

GRAIN GROWTH – An increase in the average grain size resulting from some crystals absorbing adjacent ones when the metal is raised to a temperature above that necessary for recrystallization and kept at that temperature for a sufficient length of time.

GRAIN SIZE – Average diameter of grains in the metal under consideration, or alternatively, the number of grains per unit area. Since increase in grain size is paralleled by lower ductility and impact resistance the question of general grain size is of great significance. The addition of certain metals affects grain size, for example vanadium and aluminum tend to give steel a fine grain. The ASTM has set up a grain size standard for steels, and the McQuaid-Ehn Test had been developed as a method of measurement.

H-STEELS – Steels made under specifications that include hardenability tolerance.

HARDENABILITY – The ability of metal, usually steel, to harden in depth as distinguished from the term “hardness.” The depth to which steel can be hardened to martensite under stated conditions of cooling.

HARDNESS – Degree to which metal will resist cutting, abrasion, penetration, bending and stretching. The indicated hardness of metals will differ somewhat with the specific apparatus and technique of measuring. For details concerning the various types of apparatus used in measuring hardness, see Brinell Hardness and Rockwell Hardness. Tensile Strength also is an indication of hardness.

HEAT OF STEEL – The product of a single melting operation in a furnace, starting with the charging of raw materials and ending with the tapping of molten metal and consequently identical in its characteristics.

HEAT TREAT STAIN – Discoloration of the metal surface caused by oxidation during thermal treatment.

HEAT TREATMENT – Altering the properties of a metal by subjecting it to a sequence of temperature changes, time of retention at specific temperatures and rate of cooling therefrom being as important as the temperature itself. Heat treatment usually markedly affects strength, hardness, ductility, malleability, and similar properties of both metals and their alloys.

HIGH-SPEED TOOL STEEL – A hard steel used to make tools that can cut while red hot and running at high speeds. It permits fast working and deep cuts while hot.

HIGH TENSILE – Using external pressure to increase the hardness (physical properties). Drawing material through a die will create a high tensile bar. Cold working is a term used in conjunction with high tensile. In the stainless grade, this is also referred to as “Condition B.”

HOT WORKING – Work carried out at a temperature at or above the recrystallization temperature of the metal in question. During hot working, the grains are constantly being deformed and broken up, but new ones are constantly forming to take their place. Plastic deformation of metal at a temperature sufficiently high not to create strain hardening. The lower limit of temperature for this process is the recrystallization temperature.

HYPERM 49 – Carpenters trade name for 4750.

IMPACT TEST – Test designed to determine the resistance of metals to breakage by impact, usually by concentrating the applied stress to a notched specimen. Results usually are expressed in terms of energy absorbed or number of blows (of a given intensity) required to break the specimen. Izod impact or Charpy impact are the common methods of studying impact resistance.

INCLUSIONS – Particles of impurities (usually oxides, sulfides, silicates, etc.) that are held mechanically or are formed during the solidification or by subsequent reaction within the solid metal.

INDENTATION HARDNESS – The resistance of a material to indentation. This is the usual type of hardness test, in which a pointed or rounded indenter is pressed into a surface under a substantially static load.

INDUCTION HARDENING – A surface hardening process based upon the heating effect produced in a piece of steel by placing it in a high-frequency electric field generated in a suitable shaped water-cooled coil of copper wire or tubing.

INGOT – Metal casting of uniform sizes and shapes for subsequent rolling, forging, or processing.

INGOT IRON – An open-hearth product low in carbon, manganese, and impurities.

INTERNAL STRESS – A residual stress that may exist between different parts of metal products as a result of the differential effects of heating, cooling, working operations, or of constitutional changes in the solid metal. It may be relieved by heating to a low temperature without affecting the mechanical properties.

IZOD TEST – A notched-bar or impact test in which a notched specimen held in a vise is struck on the end by a striker carried on a pendulum; the energy absorbed in fracture is obtained from the height to which the pendulum rises.

JOMINY TEST – A standardized procedure by which the hardenability of a steel is determined.

KILLED STEEL – The terms “killed” indicated that molten steel is held in a ladle, furnace, or crucible (and usually treated with aluminum, silicon, or manganese) until no more gas is evolved and the metal is perfectly quiet, when the molten metal is poured into the ingot mold. A properly killed steel is more uniform as to analysis and is comparatively free from aging. In general all steels above 0.25% carbon are killed, also all forging grades, structural steels from 0.15% to 0.25% carbon and some special steels in the low carbon range.

KINK – Small creases or indentations caused by localized bending during handling, etc.

LADLE – A vessel lined with refractory material; used for conveying molten metal from the furnace to the mold or from one furnace to another.

LADLE ANALYSIS – A term applied to the chemical analysis representative of a heat of steel as reported by the producer. It is determined by analyzing a test ingot sample obtained during pouring the steel from a ladle.

LAMINATIONS – Internal cracks aligned parallel to the worked surface of the metal.

LAP – A continuous longitudinal defect caused by metal folding back on its own surface. A surface defect appearing as a seam, caused by folding over hot metal, fins or sharp corners and then rolling or forging them into the surface, but not welding them.

LONGITUDINAL DIRECTIONS – The principal direction of flow in a worked metal. Usually the length of the bar. Grain direction also runs the length of the bar.

LOW CARBON STEELS – Contain from 0.10% to 0.30% carbon and less than 0.60% manganese (The product of Basic Oxygen, Bessemer, Open Hearth or Electric Processes).

MACHINABILITY – A property of metals that permits them to be cut, turned, broached, or otherwise formed by machine tools. The relative ease of machining a metal. The machinability rating is usually reported in “Surface feet per minute.”

MACHINE FINISH ALLOWANCE – The allowance made for machining the finished part.

MACROETCH TEST – Consists of immersing a carefully prepared section of the steel in hot acid and of examining the etched surface to evaluate the soundness and homogeneity of the product being tested.

MACROGRAPH – A photographic reproduction of any object that has not been magnified more than ten times.

MACROSCOPIC – Visible either with the naked eye or under low magnification (as great as about ten diameters.)

MACROSTRUCTURE – The structure of metal as revealed by macroscopic examination of the etched surface of a polished specimen at a magnification (as great as about ten diameters.)

MAG QUALITY – Material that has had stock removal performed to insure that the material is free from any seams or non-metallic inclusions located on or immediately below the surface. This test is used on all Type 400 & PH Grades. 200 & 300 steels cannot be tested. This is normally performed on material that is magnetic.

MAGNAFLUX TEST – A magnetic test used to detect defects on or near the surface of metals.

MAGNETIC-PARTICLE INSPECTION – A nondestructive method of inspection for determining the existence and extent of possible defects in ferromagnetic materials. Finely divided magnetic particles, applied to the magnetized part, are attracted to and outline the patterns of any magnetic-leakage fields created by discontinuities.

MAGNETIC PERMEABILITY – The ratio of the magnetic induction of a substance to the magnetizing field to which it is subjected.

MALLEABILITY – The property that determines the ease of deforming a metal when the metal is subjected to rolling or hammering. The more malleable metals can be hammered or rolled into thin sheet more easily than others.

MARTENSITE – A distinctive needlelike structure existing in steel as a transition stage in the transformation of austenite. It is the hardest constituent of steel of eutectoid composition. It is produced by rapid cooling from quenching temperature and is the chief constituent of hardened carbon tool steels. Martensite is magnetic.

MARTENSITIC STEEL – Steel which has martensite as its chief constituent after cooling in air. The hardenable stainless types are all martensitic steels. An example of martensitic steel is the 400 series.

MECHANICAL PROPERTIES – Properties of a metal determining its behavior under stress. Those properties of a material that reveal elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain; for example, the modulus of elasticity, tensile strength and fatigue limit. These properties have often been designated as “physical properties” but the term “mechanical properties” is much to be preferred. The mechanical properties of steel are dependent on its microstructure.

METALLURGIST – A technically trained person who has specialized in that science which deals with the separation of metals from the earthy materials with which they are combined.

METALLURGY – The art and science of extracting metals from their ores and other metal-bearing product and adapting these metals for human utilization.

MICROSCOPIC – Visible under a magnification of about 10 diameters or more.

MICROSTRUCTURE – The structure and internal condition of metal as revealed in polished and usually etched metal samples when examined under a microscope.

MILL EDGE – The edge of strip, sheet or plate in the as rolled state. Unsheared.

MOLD – A form of cavity into which molten metal is poured to produce a desired shape.

NITRIDING – Process of surface hardening certain types of steel by heating in ammonia gas at about 935-1000 F., the increase in hardness being the result of surface nitride formation. Certain alloying constituents, principal among them being aluminum greatly facilitate the hardening reaction. In general, the depth of the case is less than with carburizing.

NITRIDING STEEL – Steel which is particularly suited for the nitriding process, that is, it will form a very hard and adherent surface upon proper nitriding (heating in a partially dissociated atmosphere of ammonia gas). Composition usually .20-.40 carbon .90-1.50 chromium, .15-1.00 molybdenum, and .85-1.20% aluminum.

NON-FERROUS METALS – Metals or alloys that are free of iron or comparatively so.

NONFILLS – Nonfilling of roll cavity causing incomplete section or deviation from expected contour.

NON-METALLIC INCLUSIONS – Impurities (commonly oxides), sulphides, silicates or similar substances held in metals mechanically during solidification or formed by reactions in the solid state.

NORMALIZED – Material (alloy) that is cooled in “open air,” not a controlled cooling process. This procedure is quicker and cheaper than annealing, because you don’t tie up a furnace. Material that is normalized may not have a uniform hardness. Characteristics would be “hard spots” and a higher as shipped hardness than an annealed bar. Is performed to refine the crystal structure and eliminate internal stress.

NORMALIZED & TEMPERED – This is an abbreviation for the correct heading Normalized and Sub Critical Annealed. This means: if a customer calls

and asks for “Annealed” you can expand their statement by telling them that this material is a subcritical annealed material, so it can be considered an annealed product. The first operation is the normalizing, which gives the material a certain grain structure and then sub critically annealed, which further enhances the grain structure and puts it in an excellent position to be heat treated (aka: hardened). Norm & Temp (Subcritical annealed) is a process where the mill controls the maximum as shipped hardness. You will hear “normalized & tempered to RC 33 max.” RC 33 is the maximum hardness the mill aims for, for the material (alloy) to still be considered annealed.

OFF GAGE – Dimension outside the specified tolerances.

OIL HARDENING – A process of hardening a ferrous alloy of suitable composition by heating within or above the transformation range and quenching in oil.

OIL-HARDENING STEEL – Steel adaptable to hardening by heat treatment and quenching in oil.

OIL STAIN – Stains produced by the incomplete burning of lubricants on the surface of a product. Drawing subsequent to staining will change color from darker browns to lighter browns down to white.

OPEN-HEARTH PROCESS – Process of making steel by heating in a refractory-lined, shallow-bath, rectangular furnace in which both hearth and charge are subjected to direct action of the fuel flame. The fuel may be produced gas, natural gas, coke oven gas, powdered coal or oil.

ORANGE PEEL – A surface roughening encountered in forming products from material which has a coarse grain size.

OVERAGING – Aging under conditions of time and temperature greater than those required to obtain maximum strength.

OXIDATION – The addition of oxygen to a compound. Exposure to atmosphere sometimes results in oxidation of the exposed surface, hence a staining or discoloration. This effect is increased with temperature increase.

OXIDE – Compound of oxygen with another element.

PASSIVATION – The changing of the chemically active surface of a metal to a much less reactive state.

PENETRANT INSPECTION – A method of non-destructive testing for determining the existence and extent of discontinuities that are open to the surface in the part being inspected. The indications are made visible through the use of a dye or fluorescent chemical in the liquid employed as the inspection medium.

PHYSICAL PROPERTIES – Those properties familiarly discussed in physics, exclusive of those described under mechanical properties; for example, density, electrical conductivity, coefficient of thermal expansion. This term often has been used to describe mechanical properties, but this usage is not recommended.

PICKLING – The process of chemically removing oxides and scale from the surface of a metal by immersion in a diluted acid bath so as to obtain a chemically clean surface preparatory to cold rolling or wire drawing.

PIPE – (Defect) A shrinkage cavity formed in metal (especially ingots) during solidification of the last portion of liquid metal. Contraction of the metal causes this cavity or pipe. Contraction cavity, essentially cone-like in shape, which occurs in the approximated center, at the top and reaching down into a casting; caused by shrinkage of cast metal.

POLISHING – A mechanical finishing operation for the purpose of applying a gloss or luster to the surface of a product.

POROSITY – State of being porous. The more stringers and inclusions involved, the higher the porosity.

PRECIPITATION HARDENING – The phenomenon which results in an increase in hardness with the passage of time at room or elevated temperature. The increase is produced by a change in structure associated with precipitation of a constituent from solid solution along the grain boundaries.

PRECIPITATION HEAT TREATMENT – (Nonferrous metal) Any of the various aging treatments conducted at elevated temperatures to improve certain of the mechanical properties through precipitation from solid solutions.

PROCESS ANNEALING – Same as subcritical annealing.

PYROMET 680 – Carpenter's trade name for Hastelloy X (Fry Alloy X).

PYROMETER – An instrument, of any various types, used for measuring and determining elevated temperature.

QUENCHING – Rapid cooling of steel from above the critical range by immersion in liquids or gases, or by contact with metal, in order to harden it.

QUENCH CRACKS – Surface cracks in metal which occur on quenching, due to improper heat-treating practices.

QUENCH HARDENING – (Steel) A process of hardening a ferrous alloy of suitable composition by heating within or above the transformation range and cooling at a rate sufficient to increase the hardness substantially. The process usually involved the formation of martensite.

R C S – Round Corner Square.

R M S – A rating used on the finish of a ground bar. Normally called out as a "micro". The smaller the number, the finer the grain.

RECRYSTALLIZATION – Formation of new crystals or grains from deformed metal, accomplished by suitable heat treatment.

REDUCTION OF AREA – (1) Commonly, the difference, expressed as a percentage of original area, between the original cross-sectional area of a tensile test specimen and the minimum cross-sectional area measured after complete separation. (2) The difference, expressed as a percentage of original area, between original cross-sectional area and that after straining the specimen.

REPHOSPHORIZING – (Steel) A ladle-chemical treatment consisting of the addition of phosphorus as a work hardening agent when temper rolling black plate or sheet steel resulting in greater hardness and stiffness and with a corresponding loss in ductility.

RESIDUAL STRESS – Macroscopic stresses that are set up within a metal as the result of nonuniform plastic deformation. This deformation may be caused by cold working or by drastic gradients or temperature from quenching or welding.

RESIDUALS – "Incidental" elements not named in specification. These inclusions are usually due to contaminated scrap.



ROCKWELL HARDNESS (TEST) – A standard method for measuring the hardness of metals by indenting them with a hard steel ball or a diamond cone under a specified load, measuring the depth of penetration, and subtracting the latter from an arbitrary constant. Rockwell hardness numbers are based on the difference between the depths of penetration at major and minor load; the greater this difference, the less the hardness number. This residual penetration is automatically registered on a dial when the major load is removed from the penetrator. Various dial readings combined with different major loads, give “scales” designated letters varying from “A” to “H”; “B” and “C” scales are most commonly in use.

RODS – Wire rods are semifinished hot-rolled rounds of great lengths, usually coiled, and used principally for drawing to wire.

ROLLING – A term applied to the operation of shaping and reducing metal in thickness by passing it between rolls which compress, shape and lengthen it following the roll pattern.

ROLLING MILLS – Mills in which a preheated steel ingot is passed between heavy chilled cast sheet rolls.

ROLLED-IN-METAL – An extraneous chip or sliver of metal rolled into the surface of the rod or bar.

ROLLED-IN-SCRATCHES – Scratches which occur during the fabricating process and are subsequently rolled over. They are characterized by a rolling-over of the scratch which makes it relatively smooth to the touch.

ROUGH MACHINING – Machining without regard to finish, usually to be followed by a subsequent operation.

RUBMARK – A minor form of scratching consisting of areas made up of a large number of very fine scratches or abrasions.

SAE – Abbreviation for Society of Automotive Engineers. This organization has specified common and alloy steels and copper base alloys in accordance with a numerical index system allowing approximation of the composition of the metal. The last two digits always indicate the carbon content, usually within 0.05%.

SCRATCH – A mark on the surface of the product produced by scratching. Such marks are generally rough to the touch.

SEAM – (A defect) On the surface of metal a crack that has been closed but not welded; usually pro-

duced by some defect either in casting or in working such as blowholes that have become oxidized or folds and laps that have been formed during working.

SEGREGATION – Nonuniform distribution of impurities, inclusions, and alloying constituents in metals.

SEMIFINISHED STEEL – Blooms, billets, slabs, sheet bars, rods, and other product.

SHEAR STRENGTH – The stress required to produce fracture in the plane of cross section, the conditions of loading being such that the directions of force and of resistance are parallel and opposite although their paths are offset a specified minimum amount.

SHIM – A thin flat hard metal strip produced to close tolerances; used primarily for tool, die and machine alignment purposes.

SINTERING – Converting powder into a continuous mass by heating to a temperature considerable below fusion, usually after preliminary compacting by pressure.

SLAB – An ingot reduced, generally by rolling, to a thickness better suited to the operation that follows. A slab, as distinguished from a bloom, has width at least twice its thickness and a minimum thickness of 1-1/2 inches. It is re-rolled to plates and to sheet bar. Slabs are classified as semifinished products.

SLAG – A nonmetallic covering on molten metal as the result of the combining of impurities contained in the original charge, some ash from the fuel, and any silica and clay eroded from the refractory lining. Except in bottom-pour ladles it is skimmed off prior to pouring the metal.

SLIVER – Slender fragments or splinters which are an integral part of the material but which are incompletely attached to the metal.

SOAKING PIT – An underground furnace in which a stripped ingot is heated or soaked in heat until it is uniformly heated throughout to its rolling temperature.

SOLUTION HEAT TREATMENT – A process in which an alloy is heated to a suitable temperature, is held at this temperature long enough to allow a certain constituent to enter into solid solution and is then cooled rapidly to hold the constituent in solution. The metal is left in a supersaturated, unstable state and may subsequently exhibit age hardening.

SPARK TEST – Classification of steels according to their chemical analysis by visual examination of the sparks thrown off when the steels are held against a high-speed grinding wheel.

SPECTROGRAPH – An optical instrument for determining the presence or concentration of minor metallic constituents in a material indicating the presence an intensity of specific wave lengths of radiation when the material is thermally or electrically excited.

SPHEROIDIZING – Any process of prolonged heating and slow cooling of steel which will convert the carbide content into rounded or spheroid form.

SPRING STEEL – Steel, normally of the high-carbon or alloy type, used in the manufacture of springs, lending itself to appropriate heat treatment; usually made in the open hearth or electric furnace.

STABILIZING TREATMENT – A thermal treatment designed to precipitate material from solid solution, in order to improve the workability, to decrease the tendency of certain alloys to age harden at room temperature, or to obtain dimensional stability and service at slightly elevated temperatures.

STAINLESS STEEL – Corrosion resistant steel of a wide variety, but always containing a high percentage of chromium. These are highly resistant to corrosion attacked by organic acids, weak mineral acids, atmospheric oxidation, etc.

STAMPING – A term used to refer to various press forming operation in coining, embossing, blanking, and pressing.

STEEL – Iron, malleable in at least one range of temperature below its melting point without special heat treatment, substantially free from slag, and containing carbon more than about 0.05% and less than about 2.00%. Other alloying elements may be present in significant quantities, but all steels contain at least small amounts of manganese and silicon, and usually as undesirable constituents, also sulfur and phosphorus.

STELLITE – A series of alloys containing cobalt, chromium, tungsten, and molybdenum in various compositions. Stellites are used for high-speed cutting tools and for protecting surfaces subjected to heavy wear.

STOCK REMOVAL – This is a designated or predetermined amount of material to be removed from the surface or surfaces of the bar stock. Fry Steel lists these amounts of stock removal in our Stock List. Refer to these charts. The idea being that, usually the larger the size, the more stock removal is

required. Hot rolled and Cold Drawn surfaces, must always have some stock removal prior to any inspection or heat treating. If the customer chooses not to do the recommended stock removal, it is at their own risk. On the other finished, CG, PG, ST and RT, the customer does not have to remove surface stock prior to heat treating or surface inspection, The exception being, if the inspection specification requires surface removal, then this must be done according to that specification. Fry's turned surface (CG PG ST RT) materials are guaranteed to be free from surface lapse, cracks and seams.

STRESS RELIEF – Heating to a suitable temperature, holding long enough to reduce residual stresses and then cooling slowly enough to minimize the development of new residual stresses. A thermal treatment in which the lock-up stresses in a bar caused by cold working are removed by heating the bar close to but below the lower limit of the critical temperature range, or to approximately 100°F below the tempering temperature.

STRESS-RUPTURE TEST – A tension test performed at constant temperature, the load being held at such a level as to cause rupture. Also known as “creep-rupture test.”

STRAIGHTNESS TOLERANCE – In the steel industry, the standard straightness tolerance is 1/8 inch per 5 feet.

STRINGERS – A form of inclusion normally caused by the banding together of elements within the material. (Example: In Grade 321 the titanium doesn't mix well and tends to clump together, thus 321 has inherent titanium stringers.)

STRAIN HARDENING – An increase in hardness and strength caused by plastic deformation at temperature lower than the recrystallization range.

SUBCRITICAL ANNEALING – Heat steel to a temperature below its critical temperature, and subsequently cooling at a rate dependent upon the carbon content; also called process annealing.



TEMPER – The state of or condition of a metal as to its hardness or toughness produced by either thermal treatment or heat treatment and quench or cold working or a combination of same in order to bring the metal to its specified consistency. Each branch of the metal producing industry has developed its own system or temper designations.

TEMPERING – A process of reheating quench-hardened or normalized steel to a temperature below the transformation range and then cooling at any rate desired. The primary purpose of tempering is to decrease the hardness and impart a degree of plasticity or toughness to the steel to alleviate the brittleness of its martensite.

TENSILE STRENGTH – Breaking strength of a material when subjected to a tensile (stretching) force. Usually measured by placing a standard test piece in the jaws of a tensile machine, gradually separating the jaws, and measuring the stretching force necessary to break the test piece. Tensile strength is commonly expressed as pound (PSI) per square inch of original cross section.

TENSILE TEST – Application of a pulling force to a specimen of material and measurement of the reactions that occur. In steel, these reactions occur in two distinct phases; the elastic phase wherein the material is not permanently deformed by the pulling force, and the plastic or yield phase wherein the material becomes either permanently deformed or ruptured.

TOLERANCE – Allowable deviation from a specified dimension.

Close Tolerance - Any Special Tolerance that is closer than Standard.

Commercial Tolerance - This term is sometimes used synonymously with “Standard Tolerance.” In such cases the term “Standard Tolerance” is preferred.

Published Tolerance - This term is sometimes used synonymously with “Standard Tolerance.” In such cases the term “Standard Tolerance” is preferred.

Special Tolerance - Any tolerance that is closer or wider than Standard.

Standard Tolerance - An established tolerance for a certain class of product. This term is preferred to “Commercial” or “Published” tolerance.

Wide Tolerance - Any Special Tolerance that is wider than Standard Tolerance.

TOOL STEEL – Any high carbon or alloy steel capable of being suitably tempered for use in the manufacture of tools.

TOUGHNESS – Property of resisting fracture or distortion. Usually measured by impact test, high impact values indicating high toughness.

TORN SURFACE – A deep longitudinal rubmark resulting from abrasion by tools.

TRAFFIC MARKS – Abrasions which result from metal or metal contact and vibration during transit. These abrasions are usually dark in appearance because of the presence of a dark powder consisting of aluminum and aluminum oxide.

TRANSVERSE – Literally, “across” usually signifying a direction or plane perpendicular to the direction of working.

TREPANNING – A type of cutting/boring/drilling procedure done down the middle of a solid bar. The end result produces a tube or pipe from what was once a solid bar. Gun makers use this procedure to make gun barrels. After the trepanning process is completed, a core formation (aka: a plug, solid cylinder, or core) comes out of the middle of the bar, instead of metal chips that are the result of drilling.

TWIST – A winding departure from flatness.

VACUUM MELTING – Melting in a vacuum to prevent contamination from air, as well as to remove gases already dissolved in the metal; the solidification may also be carried out on a vacuum or at low pressure.

VACUUM ARC REMELTING – A vacuum-arc-remelting furnace consists mainly of two parts - upper electrode housing and lower crucible assembly. The electrode can be lowered or raised without breaking the vacuum. The water-cooled crucible forms the mold. Cast or forged electrodes, melted by any suitable process, are consumably remelted by any suitable process, are consumably remelted at pressures from 1 to 50 microns. During the process, the metal transfers from the electrode to the mold as a uniform flow of superheated fine spray and collects in a molten pool. The ingot solidifies progressively from bottom to top. As a result, the center porosity and segregation normally found in static-cast ingots are minimized. Near the end of the melting, power is gradually reduced to produce a minimum of shrinkage cavity. Degassification, dissociation, and deoxidation take place to various degrees both during the transfer of metal from the electrode to the ingot and in the molten pool.

VICKERS HARDNESS – (Test) Standard method for measuring the hardness of metals, particularly those with extremely hard surfaces; the surface is subjected to a standard pressure for a standard length of time by means of pyramid-shape diamond. The diagonal of the resulting indentation is measured under a microscope and the Vickers Hardness value read from a conversion table.

VIM VAR – Double Vac Melt process (Example: Fry's Grade 13-8) Vacuum induction melt plus vacuum arc remelt.

WATER HARDENING STEELS – Low-carbon and low-alloy steels that must be quenched in water for hardening.

WATER STAINS – A superficial etching of the surface from prolonged contact with moisture in a restricted air space such as between the layers of the product. Such stains are generally white in appearance.

WELDABILITY – The ease with which simple metal parts made of similar and dissimilar metals may be joined together in order to form complicated structures.

WELDING – A process used to join metals by the application of heat. Fusion welding, which includes

gas, arc, and resistance welding, requires that the parent metals be melted. This distinguishes fusion welding from brazing. In pressure welding joining is accomplished by the use of heat and pressure without melting. The parts that are being welded are pressed together and heated simultaneously, so that recrystallization occurs across the interface.

WORK HARDENING – Hardening that takes place in a metal when work of any sort, such as bending, rolling, hammering, drawing, punching, and the like, is done at a temperature below that at which recrystallization takes place. Increase in resistance to deformation (i.e. in hardness) produced by cold working.

YIELD POINT – The load per unit at original cross section at which, in soft steel, a marked increase in deformation occurs without increase in load.

YIELD STRENGTH – The load per unit area at which a material exhibits a specified permanent deformation or a specified elongation under load.

ZYGLO – A highly fluorescent nondestructive penetrant inspection test applied to nonmagnetic materials to detect flaws.



AMS – Abbreviations for Aerospace Material Specification.

ANSI – Abbreviations for American National Standards Institute.

ASME – Abbreviations for American Society of Mechanical Engineers.

ASTM – Abbreviations for American Society for Testing and Materials.

AWS – Abbreviations for American Welding Society.

Abrasion – See “Mark, Traffic.”

Age Hardening – An aging process which results in increased strength and hardness.

Age Softening – Spontaneous decrease of strength and hardness that takes place at room temperature in certain strain hardened alloys containing magnesium.

Aging – Precipitation from solid solution resulting in a change in properties of an alloy, usually occurring slowly at room temperature (natural aging) and more rapidly at elevated temperatures (artificial aging).

Alclad – An aluminum or aluminum-alloy coating that is metallurgically bonded to either one or both surfaces of an aluminum alloy product, and that is anodic to the alloy to which it is bonded, thus electrolytically protecting the core alloy against corrosion. For Alclad products, see specific product such as “Plate,” “Sheet,” “Tube,” or “Wire.”

Alligating – See “Lamination.”

Alloy – A substance having metallic properties and composed of two or more elements of which at least one is an elemental metal.

Angularity – Conformity to, or deviation from, specified angular dimensions in the cross section of a shape or bar.

Angulation – The deliberate departure from a horizontal passline on the entry side of a rolling mill used for one-side bright rolling.

Annealing – A thermal treatment to soften metal by removal of stress resulting from cold working or by coalescing precipitates from solid solution.

Annealing, Partial – Thermal treatment (H2X temper nomenclature) given cold worked metal to reduce strength and increase ductility to controlled levels other than annealed temper.

Anodizing – Forming a coating on a metal surface produced by electrochemical treatment through anodic oxidation.

Anodizing Sheet – See “Sheet, Anodizing.”

Arbor Break – See “Buckle, Arbor.”

Arbor Mark – See “Mark, Arbor.”

Artificial Aging – See “Aging.”

Back End Condition – A condition occurring in the last metal to be extruded. It is a result of the oxidized surface of the billet feeding into the extrusion.

Backup Rolls – Nongrooved rolls which stiffen or strengthen work rolls.

Bar – A solid wrought product that is long in relation to its cross section which is square or rectangular (excluding plate and flattened wire) with sharp or rounded corners or edges, or is a regular hexagon or octagon, and in which at least one perpendicular distance between parallel faces is 0.375 inch or greater.

Bar, Cold Finished – Bar brought to final dimensions by cold work to obtain improved surface finish and dimensional tolerances.

Bar, Cold-Finished Extruded – Cold-finished bar produced from extruded bar.

Bar, Cold-Finished Rolled – Cold-finished bar produced from rolled bar.

Bar, Extruded – Bar brought to final dimensions by hot extruding.

Bar, Rolled – Bar brought to final dimensions by hot rolling.

Bar, Saw-Plate – Bar brought to final thickness by hot or cold rolling and to final width by sawing.

Base Box-General – An agreed-upon unit of area used primarily in packaging applications. One common base box for aluminum is 31,360 square inches, originally composed of 112 rectangular sheets each 14 by 20 inches.

Belled Edge – See “Edge, Belled.”

Belly – A loose center buckle extending to near the edges of a sheet.

Billet – A hot worked semifinished product suitable for subsequent working by such methods as rolling, forging, extruding, etc.

Blank – A piece of metal cut or formed to regular or irregular shape for subsequent processing such as by forming, bending or drawing. The piece of sheet stock cut out by blanking die. It will subsequently be drawn into a cup or end shell.

Bleed Out – See “Two-Tone.”

Blister – A raised area on the surface of an extruded product due to subsurface gas expansion. This can occur during extrusion or thermal treatment.

Blister, Bond – A raised spot on only one surface of the metal whose origin is between the cladding and core in clad products.

Blister, Coating – A blister in the coating of an alclad or a clad product.

Blister, Core – A raised spot (one or both sides) on rolled metal.

Block Mark – See “Scratch, Tension.”

Bloom – A semifinished hot rolled product, rectangular or square in cross section, produced on a blooming mill.

Blow Hole – A blister that has ruptured and may produce a void. See also “Blister.”

Boss – A knoblike projection on the main body of a forging or casting.

Bottom Draft – Taper or slope in the bottom of a forged depression to assist the flow of metal toward the sides of the depressed area.

Bow – Longitudinal curvature of rod, bar, profiles (shapes), and tube. Bow is measured after allowing the weight of the extrusion to minimize the deviation. Bow can be caused by a non-uniform extrusion rate across the cross section resulting in one portion of the extrusion being longer than the other or non-uniform contraction during quenching.

Bow, Lateral – Deviation from straight of a longitudinal edge.

Bow, Longitudinal – Curvature in the plane of sheet or plate in the rolling direction.

Bow, Transverse – Curvature across the rolling direction of sheet or plate.

Brazing – Joining metals by fusion of nonferrous alloys that have melting points above 425C (800F) but lower than those of the metals being joined. This may be accomplished by means of a torch (torch brazing), in a furnace (furnace brazing), or by dipping in a molten flux bath (dip or flux brazing).

Brazing Rod – A rolled, extruded, or cast round filler metal for use in joining by brazing.

Brazing Sheet – Sheet of a brazing alloy, or sheet clad with a brazing alloy on one or both sides.

Brazing Wire – Wire for use as a filler metal in joining by brazing.

Bright Sheet – See “Sheet, (1SBMF), (S1SBF) and (S2SBF).”

Bristle Mark – See “Mark, Bristle.”

Broken Die – A deviation from the desired cross section due to the absence of a certain portion of the die used to extrude the profile (shape).

Broken Edge – See “Edge, Broken.”

Broken Matte Finish – Non-uniform surface on the inside of packed rolled foil (Bright Spots).

Broken Surface – See “Crazing.”

Bruise – See “Mark, Roll Bruise.”

Buckle – A distortion of the surface of the metal.

Buckle, Arbor – Bend, crease, wrinkle, or departure from flat, occurring perpendicular to the slit edge of a

coil and which are repetitive in nature, with severity decreasing as the distance increase in the coil from the original source. Normally, it is found on the ID of a coil but can appear on the coil OD as a result of a prior winding operation.

Buckle, Center – Undulation (wavy region) in the center of the metal.

Buckle, Edge – Undulation (wavy region) along the edge(s) of the metal.

Buckle, Oil Can – See “Buckle, Trapped.”

Buckle, Quarter – Undulation (wavy region) which occur approximately at both quarter points across the width.

Buckle, Trapped – Undulation (wavy region) which is smaller sized and often circular in shape.

Buff Streak – See “Streak.”

Buffing – A mechanical finishing operation in which fine abrasives are applied to a metal surface by rotating fabric wheels for the purpose of developing a lustrous finish.

Burnish Streak – See, “Streak, Burnish.”

Burnishing – See “Two-Tone.”

Burr – A thin ridge of roughness left by a cutting operation such as slitting, trimming, shearing, blanking or sawing.

Bursting Strength – The pressure required to rupture a foil specimen when it is tested in a Mullen instrument under specified conditions. See also “Mullen Test.”

Bus Bar – A rigid electric conductor in the form of a bar.

Butt-Seam Tube – See “Tube, Open-Seam.”

Camber – See “Bow, Lateral.”

Carbon Mark – See “Mark, Carbon.”

Center – The difference in thickness between the middle and edges (average) of a sheet.

Center Buckle – See “Buckle.”

Chafing – See “Mark, Traffic.”

Chatter Mark – See “Mark, Chatter.”

Chip Mark – See “Dent, Repeating.”

Chop – Metal sheared from a vertical surface of a die forging, which is spread by the die over an adjoining horizontal surface.

Chucking Lub – A lug or boss added to a forging so that “on center” machining and forming may be performed with one setup or checking. This lug is finally machined or cut away.

Cinching – See “Scratch, Tension.”

Circle – A circular blank fabricated from plate, sheet or foil.

Clad Sheet – See “Sheet, Clad.”

Coating – Continuous film on the surface of a product.

Coating Blister – See “Blister, Coating.”

Coating Build-Up – A coating thickness greater than nominal in localized area of sheet, usually along edges, due to uneven application techniques.

Coating Drip – A non-uniform extraneous deposit of coating on the coated sheet.

Coating Oven Trash – See “Dirt.”

Coating Streak – See “Streak, Coating.”

Coating, Conversion – An inorganic pretreatment sometimes applied to metal surface to enhance coating adhesion and to retard corrosion.

Coating, High or Low – Failure of the coating to meet the agreed upon thickness limits measured in weight per unit area.

Cobble – (1) A jamming of the mill by aluminum product while being rolled. (2) A piece of aluminum which for any reason has become so bent or twisted that it must be withdrawn from the rolling operations and scrapped.

Coil Curvature – See “Coil Set.”

Coil Orientation – Clockwise Coil: With the coil core vertical (“eye to the sky”) and viewed from above, a trace of the metal edge from the ID to the OD involves clockwise movement. Counter-Clockwise (Anti-Clockwise) Coil: With the coil core vertical (“eye to the sky”) and viewed from above, a trace of the metal edge from the ID to the OD involves counter-clockwise (anti-clockwise) movement.

Coil Set – Longitudinal bow in an unwound coil in the same direction as curvature of the wound coil.

Coil Set Differential – The difference in coil set from the edge to edge of a coiled sheet sample. It is measured with the sample on a flat table, concave side up, and is the difference in elevation of the corners on one end.

Coil Set, Reversed – Longitudinal bow in an unwound coil in the direction opposite to the curvature of the wound coil.

Coiled Sheet – See “Sheet, Coiled.”

Cold Shut – (1) A Linear discontinuity in a cast surface caused when meeting streams of metal fail to merge prior to solidification. (2) A forging defect developed by metal flowing into a section from two directions, resulting in a discontinuity at the junction.

Cold Working – Plastic (i.e., permanent) deformation of metal at such temperature and rate that strain-hardening occurs.

Collapse – Out-of-round condition of coil often due to inappropriate tension during rewinding operations.

Coloring – A finishing process or combination of processes, which alters the appearance of an aluminum surface via coating, chemical and/or mechanical operations.

Concavity – Curved like the inner surface of a sphere. See also “Convexity.”

Concentricity – Conformance to a common center as, for example, the inner and outer walls of round tube.

Condensation Stain – See “Corrosion, Water Stain.”

Condenser Tube – The term “Heat-Exchanger Tube” is preferred, unless specific reference to a condenser application is intended.

Conduit – A tube used to protect electric wiring. See also “Tubing, Electrical Metallic.”

Conduit, Rigid – Conduit having dimensions of ANSI Schedule 40 pipe in standardized length with threaded ends.

Coned-out Coil – See “Telescoping.”

Contour – That portion of the outline of a transverse cross section of an extruded shape that is represented by a curved line or curved lines.

Conversion Coating-Can Ends – See “Coating, Conversion.”

Convexity – Curved like the outer surface of a sphere. See also “Concavity.”

Core – A hollow cylinder on which a coiled product may be wound that forms the inside diameter of a coil.

Core Blister – See “Blister, Core.”

Coring – See “Back End Condition.”

Corner Turn-up – A distortion, buckle or twist condition that causes the corner(s) of the sheet to deviate from a perfectly flat plane on which it rests.

Corrosion – The deterioration of a metal or chemical or electrochemical reaction with its environment.

Corrosion, Exfoliation – Corrosion that progresses approximately parallel to the metal surface, causing layers of the metal to be elevated by the formation of corrosion product.

Corrosion, Galvanic – Corrosion associated with the current of galvanic cell consisting of two dissimilar conductors in an electrolyte or two similar conductors in dissimilar electrolytes. Aluminum will corrode if it is anodic to the dissimilar metal.

Corrosion, Intergranular – Corrosion occurring preferentially at grain boundaries (also termed intercrystalline corrosion).

Corrosion, Pitting – Localized corrosion resulting in small pits or craters in a metal surface.

Corrosion, Stress Cracking – Failure by cracking resulting from selective directional attack caused by the simultaneous interaction of sustained tensile stress at an exposed surface with the chemical or electro-chemical effects of the surface environment. The term is often abbreviated SCC which correctly stands for stress corrosion cracking.

Corrosion, Water Stain – Superficial oxidation of the surface with a water film, in the absence of circulating air, held between closely adjacent metal surfaces.

Corrugating – Forming rolled metal into a series of straight parallel regular alternate grooves and ridges.

Coupon – A piece of metal from which a test specimen may be prepared.

Covering Area – Yield expressed in terms of a given number of square inches in a pound. For metric units, use square meters per kilogram.

Crazing – A macroscopic effect of numerous surface tears, transverse to the rolling direction, which can occur when the entry angle into the cold mill work rolls is large.

Crease – A sharp deviation from flat in the sheet which is transferred from processing equipment subsequent to the roll bite.

Cross Hatching – See “Crazing.”

Crown – See “Convexity.”

Curl – An undesirable condition caused by uneven rates of absorption or evaporation of moisture, uneven rates of contraction or expansion, or internal stresses in the material. Curl is most prevalent in laminated structures where the components have differing physical properties.

Deep Drawing – Forming a deeply recessed part by forcing sheet metal to undergo plastic flow between dies, usually without substantial thinning of the sheet.

Defect – A defect is anything that renders the aluminum unfit for the specific use for which it was ordered.

Dent – (1) For rolled products, a sharply defined surface impression on the metal which may be caused by a blow from another object. (2) For extrusions, a synonym for handling mark. See “Mark, Handling.”

Dent, Expansion – Localized surface deviation from flat generated by expansion of vapor during thermal treatment of cold rolled coiled sheet.

Dent, Repeating – Repeating depression caused by a particle adhering to a rotating roll over which the metal has passed.

Die Line – A longitudinal depression or protrusion formed on the surface of drawn or extruded material. Die lines are present to some degree in all extrusions and are caused by a roughening of the die bearing.

Die Number – The number assigned to a die for identification and cataloging purposes, and which usually is assigned for the same purpose to the product produced from that die.

Diffusion Streak – See “Streak, Diffusion.”

Dirt – Foreign debris from rolling or post-rolling operations imbedded in or under the coating.

Disc – A circular blank fabricated from plate, sheet or foil, from which a central concentric area has been removed.

Double Shear Notch – See “Notch, Double Shear.”

Draft – Taper on the sides of a die or mold impression to facilitate removal of forgings, castings or patterns from dies or molds.

Drag Mark – See “Rub, Tool.”

“Draw and Iron” - Can Bodies – Term which refers to a method of fabricating a can body in which a cup is drawn from flat sheet, redrawn to the final diameter and then wall ironed to reduce the wall thickness and to achieve the required height.

Drawing – (1) In forging, an operation of working metal between flat dies to reduce the cross section and increase length. (2) The process of pulling material through a die to reduce the size, change the cross section or shape, or harden the material.

Drawing Stock – A hot worked intermediate solid product of uniform cross section along its whole length, supplied in coils and of a quality suitable for drawing into wire.

Drawn Product – A product formed by pulling material through a die.

Drawn-in Scratch – See “Scratch, Drawn-in.”

Dropped Edge – See “Edge, Dropped.”

Dry Sheet – See “Lube, Low.”

Dry Surface – A foil surface substantially free from oily film, and suitable for lacquering, printing, or coating with water-dispersed adhesives.

Duct Sheet – Coiled or flat sheet in specific tempers, widths and thicknesses, suitable for duct applications.

Ductility – The property that permits permanent deformation before fracture by stress in tension.

Earing – Wavy symmetrical projections formed during cupping, deep drawing or spinning. Earing is caused by nonuniform directional properties in the aluminum and/or by improperly adjusted tooling.

Ears – Wavy symmetrical projections formed in the course of deep drawing or spinning as a result of directional properties or anisotropy in sheet. Ears occur in groups of 4 or 8 with the peaks of the projections located at 45 degrees and/or 0 and 90 degrees to the rolling direction. Degree of earing is the difference between average height at the peaks and average height at the valleys, divided by average height at the valleys, multiplied by 100 and expressed in percent.

Eccentricity – Deviation from a common center, as, for example, the inner and outer walls of a round tube. The difference between the mean wall thickness and minimum or maximum wall thickness at any one cross section. The permissible degree of eccentricity can be expressed by a plus and minus wall-thickness tolerance.

Edge, Band – See “Two-Tone.”

Edge, Belled – Excessive buildup of material on edge(s) during a rewinding operation. Typical causes include excessive edge burr, turned edge, and “dog bone” shaped cross sectional profiles.

Edge, Broken (Cracked) – Edge(s) containing crack, split, and/or tear which is caused by inability to deform without fracturing.

Edge, Buildup – See “Edge, Belled.”

Edge, Damaged – Edge of a coil that has been bent, torn or scraped by an object.

Edge, Dropped – A continuous, downward edge deflection.

Edge, Liquated – Surface condition remaining after portions of a side of an as-cast rolling ingot deforms enough during hot rolling to become top and/or bottom surface(s) of the rolled product at an edge.

Edge, Ripped – See “Buckled, Edge.”

Edge, Wavy – See “Buckle, Edge.”

Electrical Conductivity — The capacity of a material to conduct electric current. For aluminum, this capacity is expressed as a percentage of the International Annealed Copper Standard (IACS), which has a resistivity of 1/58 ohm-mm²/meter at 68 degrees F and an arbitrarily designated conductivity of unity.

Electrical Resistivity – The electrical resistance of a body of unit length and unit cross-sectional area or unit weight. The value of 1/58 ohm-mm²/meter at 68 degrees F is the resistivity equivalent to the International Annealed Copper Standard for 100 percent conductivity. This means that a wire of 100 percent conductivity, 1 meter in length and 1 square millimeter in cross-sectional area would have a resistance of 0.017241 ohms at 68 degrees F.

Elongation – The percentage increase in distance between two gauge marks that results from stressing the specimen in tension to fracture. The original gauge length is usually 2 inches for flat

specimens and round specimens whose diameter is 1/2 inch, or four times the diameter for specimens where that dimension is under 1/2 inch. Elongation values depend to some extent upon size and form of the test specimen. For example, the values obtained from sheet specimens will be lower for thin sheet than for thicker sheet.

Embossing – Raising a design in relief against a surface.

Endurance Limit – The limiting stress below which a material will withstand a specified large number of cycles of stress.

Equivalent Round – The diameter of a circle having a circumference equal to the outside perimeter of other than round tube.

Extrusion – A product formed by pushing material through a die.

Extrusion Billet – The starting stock for the extrusion operation. Extrusion billet is a solid or hollow form, commonly cylindrical and is the length charged into the extrusion press cylinder. It is usually a cast product but may be a wrought product or powder compact.

Extrusion Butt End Defect – A longitudinal discontinuity in the extreme rear portion of an extruded product, which is normally discarded.

Extrusion Ingot – A cast form that is solid or hollow, usually cylindrical, suitable for extruding. See also “Fabricating Ingot.”

Extrusion Log – The starting stock for extrusion billet. Extrusion log is usually produced in lengths from which shorter extrusion billets are cut.

Extrusion Seam – A region in extruded hollow profiles observed after creating two streams of metal and rejoining them around the mandrel of a porthole or bridge die.

Eyehole – See “Holiday.”

Fabricating Ingot – A cast form suitable for subsequent working by such methods as rolling, forging, extruding, etc. (“Rolling Ingot,” “Forging Ingot,” “Extrusion Ingot.”)

Fatigue – The tendency for a metal to break under conditions of repeated cyclic stressing considerably below the ultimate tensile strength.

Feed In – See “Back End Condition.”

Feed Line – See “Streak, Grinding.”

Fillet – A concave junction between two surfaces.

Fin – A thin projection on a forging resulting from trimming or from the metal under pressure being forced into hairline cracks in the die or around die inserts.

Fin Stock – Coiled sheet or foil in specific alloys, tempers, and thickness ranges suitable for manufacture of fins for heat-exchanger applications.

Finish – The characteristics of the surface of a product.

Fish Mouthing – See “Lamination.”

Flag – A marker inserted adjacent to the edge at a splice or lap in a roll or foil.

Flaking – A condition in coated sheet where portions of the coating become loosened due to inadequate adhesion.

Flange – See “Rib.”

Flash – A thin protrusion at the parting line of a forging which forms when metal, in excess of that required to fill the impressions, is forced between the die interfaces.

Flash Line – A line left on a forging where flash has been removed.

Flatness – (1) For rolled products, a distortion of the surface of sheet such as a bulge or a wave, usually transverse to the direction of rolling. Often described by location across width, i.e., edge buckle, quarter buckle, center, buckle, etc. (2) For extrusions, flatness (off contour) pertains to the deviation of a cross-section surface intended to be flat. Flatness can be affected by conditions such as die performance, thermal effects and stretching.

Flow Lines – (1) Lines on the surface of painted sheet, brought about by incomplete leveling of the paint. (2) The line pattern revealed by etching, which shows the direction of plastic flow on the surface or within a wrought structure.

Flow Through – A forging defect caused when metal flows past the base of a rib resulting in rupture of the grain structure.

Foil – A rolled product rectangular in cross section of thickness less than 0.006 inch. In Europe, foil is equal to and less than 0.20 mm.

Foil Stock – See “Reroll Stock.”

Foil, Annealed – Foil completely softened by thermal treatment.

Foil, Bright Two Sides – Foil having a uniform bright specular finish on both sides.

Foil, Chemically Cleaned – Foil chemically washed to remove lubricant and foreign material.

Foil, Embossed – Foil on which a pattern has been impressed by means of an engraved roll or plate.

Foil, Etched – Foil roughened chemically or electrochemically to provide an increased surface area.

Foil, Hard – Foil fully work-hardened by rolling.

Foil, Intermediate Temper – Foil intermediate in temper between Annealed Foil and Hard Foil.

Foil, Matte One Side (MIS) – Foil with a diffuse reflecting finish on one side and a bright specular finish on the other.

Foil, Mechanically Grained – Foil mechanically roughened for such applications as lithography.

Foil, Mill Finish (MF) – Foil having a non-uniform finish which may vary from coil to coil and within a coil.

Foil, Scratch Brushed – Foil abraded, usually with wire brushes, to produce a roughened surface.

Fold – A forging discontinuity caused by metal folding back on its own surface during flow in the die cavity.

Forgeability – The term used to describe the relative workability of forging material.

Forging – A metal part worked to a predetermined shape by one or more processes such as hammering, upsetting, pressing, rolling, etc.

Forging Billet – The term “Forging Stock” is preferred.

Forging Ingot – A cast form intended and suitable for subsequent working by the forging process.

Forging Plane – A reference plane or planes normal to the direction of applied force from which all draft angles are measured.

Forging Stock – A wrought or cast rod, bar or other section suitable for forging.

Forging, Blocker-Type – A forging made in a single set of impressions to the general contour of a finished part.

Forging, Cold-Coined – A forging that has been restruct cold in order to obtain closer dimensions, to sharpen corners or outlines and in non-heat-treatable alloys, to increase hardness.

Forging, Die – A forging formed to the required shape and size by working in impression dies.

Forging, Draftless – A forging with zero draft on vertical walls.

Forging, Flashless – A closed die forging made in dies constructed and operated to eliminate, in predetermined areas, the formation of flash.

Forging, Hammer – A forging produced by repeated blows in a forging hammer.

Forging, Hand – A forging worked between flat or simply shaped dies by repeated strokes or blows and manipulation of the piece.

Forging, No-Draft – See “Forging, Draftless.”

Forging, Precision – A forging produced to tolerances closer than standard.

Forging, Press – A die forging produced by pressure applied in a forging press.

Forging, Rolled Ring – A cylindrical product of relatively short height, circumferentially rolled from a hollow section.

Forging, Upset – A forging having part or all of its cross section greater than that of the stock.

Formability – The relative ease with which a metal can be shaped through plastic deformation.

Fracture Toughness – A generic term for measure of resistance to extension of a crack. The term is sometimes restricted to results of a fracture mechanics test, which is directly applicable in fracture control.

Fretting – See “Mark, Traffic.”

Friction Scratch – See “Scratch, Friction.”

Full Center – See “Buckle, Center.”

Gauge – A term previously used in referring to the thickness of a wrought product. Thickness is preferred in dimension description.

Glaze – See “Pickup, Roll.”

Gouge – A gross scratch. See “Scratch.”

Gouge, Rolled In – A more localized gross rolled-in scratch. See also “Scratch, Rolled-in.”

Grain Flow – The directional characteristics of the metal structure after working, revealed by etching a polished section.

Grain Size – A measure of crystal size usually reported in terms of average diameter in millimeters, grains per square millimeter, or grains per cubic millimeter.

Grease Streak – See “Streak, Grease.”

Hair, Slitter – Minute hair-like sliver along edge(s) due to shearing or slitting operation.

Handling Mark – See “Mark, Handling.”

Hardener – An alloy containing at least some aluminum and one or more added elements for use in making alloying additions to molten aluminum. Also referred to as “Master Alloy.”

Hardness – Resistance to plastic deformation, usually by indentation. The term may also refer to stiffness or temper, or to resistance to scratching, abrasion or cutting. Brinell Hardness: Brinell hardness of aluminum alloys is obtained by measuring the permanent impression in the material made by a ball indenter 10 millimeters in diameter after loading with a 500 kilogram-force for 15 seconds and dividing the applied load by the area of the impression. Rockwell Hardness: An indentation hardness test based on the depth of penetration of a specified penetrator into the specimen under

certain arbitrarily fixed conditions.

Heat Streak – See “Streak, Heat.”

Heat Treat Lot – See “Lot, Heat Treat.”

Heat Treat Stain – A discoloration due to non-uniform oxidation of the metal surface during solution heat treatment.

Heat Treating – Heating and cooling a solid metal or alloy in such a way as to obtain desired conditions or properties. Commonly used as a shop term to denote a thermal treatment to increase strength. Heating for the sole purpose of hot working is excluded from the meaning of this definition – see “Solution Heat Treating,” Aging.”

Heat-Treatable Alloy – An alloy which may be strengthened by a suitable thermal treatment.

Herringbone – See “Streak, Herringbone.”

Hole – Void in rolled product. Typical cause is a non-metallic inclusion during rolling.

Holiday – Region where film is absent due to non-wetting of the metal surface by the coating.

Homogenizing – Is a process whereby ingots are raised to temperatures near the solidus temperature and held at that temperature for varying lengths of time. The purposes of this process are to (1) reduce microsegregation by promoting diffusion of solute atoms within the grains of aluminum and (2) improve workability.

Hook – An abrupt deviation from straightness. Hook can be caused by non-uniform metal flow during breakthrough. See also “Bow.”

Hot Line Pickup – See “Pickup, Roll.”

Hot Shortness – A condition of the metal at excessively high working temperatures characterized by low mechanical strength and a tendency for the metal to crack rather than deform.

Hot Spot – Dark grey or black surface patches appearing after anodizing. These areas are usually associated with lower hardness and coarse magnesium silicide precipitate caused by non-uniform cooling after extrusion.

Hot Tear – See “Tear, Speed.”

Hot Working – Plastic deformation of metal at such temperature and rate that strain hardening does not occur.

Impact – A part formed in a confining die from a metal slug, usually cold, by rapid single stroke application of force through a punch, causing the metal to flow around the punch and/or through an opening in the punch or die.

Inclusion – Foreign material in the metal or impressed into the surface.

Inclusion, Stringer – An impurity, metallic or non-metallic, which is trapped in the ingot and elongated subsequently in the direction of working. It may be revealed during working or finishing as a narrow streak parallel to the direction of working.

Incomplete Seam – See “Weld, Incomplete.”

Ingot – A cast form suitable for remelting or fabricating. See “Remelt Ingot,” “Fabricating Ingot,” “Extrusion Ingot,” “Forging Ingot,” “Rolling Ingot.”

Inspection Lot – See “Lot, Inspection.”

Interleaving – The insertion of paper or application of suitable strippable coatings between layers of metal to protect from damage.

Kink – (1) For rolled products, an abrupt bend or deviation from flat which is caused by localized bending during handling. (2) For extrusions, an abrupt deviation from straightness. A kink can be caused by handling.

Knife Mark – See “Mark, Knife.”

Knock-Out Mark – See “Mark, Knock-Out.”

Lacquer – Occasionally used to describe oil stain. See “Stain, Oil.”

Lamination – An internal crack or separation aligned parallel to the direction of major metal flow and, in the case of plate, sheet or foil, parallel to the rolled surfaces. In extrusions, it can be caused by contaminants that feed into the metal flow before it reaches the die opening or cracked billets. See also “Back End Condition.”

Lap – See “Fold.”

Lateral Bow – See “Bow, Lateral.”

Layout Sample – A prototype forging or a “cast” used to determine conformance to designed dimensions.

Leveling – The mechanical flattening of plate, sheet or foil.

Leveling, Roller – Leveling carried out by bending.

Leveling, Stretcher – Leveling carried out by uniaxial tension.

Leveling, Tension – Leveling continuously carried out by uniaxial stretching usually with the assistance of bending.

Leveling, Thermal – Leveling carried out at an elevated temperature under an applied load normal to the surface to be flattened.

Leveller Chatter – See “Mark, Chatter (Roll or Leveller).”

Leveller, Mark – See “Dent, Repeating.”

Leveller Streak – See “Streak, Leveller.”

Line, Flow – The line pattern which shows the direction of flow on the surface.

Line, Looper – Closely spaced symmetrical lines on the surface of metal which has undergone non-uniform deformation, usually in a drawing operation.

Line, Luders – Elongated surface marking or depressions appearing in patterns caused by localized plastic deformation that results from non-uniform yielding.

Line, Weld – See “Seam, Extrusion.”

Liner – The slab of coating metal that is placed on the core alloy and is subsequently rolled down to clad sheet as composite.

Liquated Edge – See “Edge, Liquated.”

Liquation – The bleeding of the low-melting constituents through the solidified ingot surface.

Lock – A condition in which the parting line of a forging is not all in one plane.

Log – See “Extrusion Log.”

Long Transverse Direction – For plate, sheet and forgings, the direction perpendicular to the longitudinal direction which is also at right angles to the thickness of the product. See also “Longitudinal Direction.”

Longitudinal Bow – See “Bow, Longitudinal.”

Longitudinal Direction – The direction of major metal flow in a working operation.

Looper Line – See “Line, Looper.”

Loose Wrap – See “Wrap, Loose.”

Lot, Heat Treat – Material of the same mill form, alloy, temper, section and size traceable to one heat-treat furnace load (or extrusion charge or billet in the case of press heat-treated extrusions) or, if heat treated in a continuous furnace, charged consecutively during an 8-hour period.

Lot, Inspection – (1) For non-heat treated tempers, an identifiable quantity of material of the same mill form, alloy, temper, section and size submitted for inspection at one time. (2) For heat treated tempers, an identifiable quantity of material of the same mill form, alloy, temper, section and size traceable to a heat treat lot or lots and submitted for inspection at one time. (For sheet and plate, all material of the same thickness is considered to be of the same size.)

Lube, High – Lubricant limit exceeds the maximum agreed upon limit measured in weight per unit area.

Lube, Low – Failure of the lubricant to meet the agreed upon minimum limit measured in weight per unit area.

Luders Line – See “Liner, Luders.”

Mark – Damage in the surface of the product whose name is often described by source.

Mark, Arbor – Surface damage in the vicinity of a coil ID caused by contact with a roughened, damaged or non-circular arbor.

Mark, Bearing – A depression in the extruded surface caused by a change in bearing length in the extrusion die.

Mark, Bite – A line which is generally perpendicular to the rolling direction.

Mark, Bristle – Raised surface about one inch long, crimped wire shaped and oriented in any direction.

Mark, Carbon – Gray or black surface marking caused by contact with carbon runout blocks.

Mark, Chatter (Roll or Leveller) — Numerous intermittent lines or grooves that are usually full width and perpendicular to the rolling or extrusion direction.

Mark, Drag – See “Rub, Tool.”

Mark, Edge Follower – Faint intermittent marks at the edge of a cold rolled product which are usually perpendicular to the rolling direction. This mark is caused by action of devices designed to rewind coils without weave.

Mark, Handling – (1) For rolled products, an area of broken surface that is introduced after processing. The mark usually has no relationship to the rolling direction. (2) For extrusions, damage that can be imparted to the surface during handling operations.

Mark, Heat Treat Contact – Brownish, iridescent, irregularly shaped stain with a slight abrasion located somewhere within the boundary of the stain. It is a result of metal-to-metal contact during the quenching of solution heat-treated flat sheet or plate.

Mark, Inclusion – Appearance of surface where actual inclusion or the void it left is observed. See also “Inclusion, Stringer.”

Mark, Knife – A continuous scratch (which may also be creased) near a slit edge, caused by sheet contacting the slitter knife.

Mark, Knock-Out – A small solid protrusion or circular fin on a forging or a casting, resulting from the depression of a knock-out pin under pressure or inflow of metal between the knock-out pin and the die or mold.

Mark, Leveller Chatter – See “Mark, Chatter (Roll or Leveller).”

Mark, Metal-on-Roll – See “Dent, Repeating.”

Mark, Mike – Narrow continuous line near the rolled edge caused by a contacting micrometer.

Mark, Pinch – See “Crease.”

Mark, Roll – (1) For rolled products, a small repeating raised or depressed area caused by the opposite condition on a roll. The repeat distance is a function of the offending roll diameter. (2) For extrusions, a longitudinal groove or indentation caused by pressure from contour rolls as a profile (shape) passes through them for dimensional correction.

Mark, Roll Bruise – A greatly enlarged roll, mark whose height or depth is very shallow. See also “Mark, Roll.”

Mark, Roll Skid – A full width line perpendicular to the rolling direction and repeating as a function of a work roll diameter.

Mark, Rub – A large number of very fine scratches or abrasions. A rub mark can occur by metal-to-metal contact, movement in handling and movement in transit.

Mark, Snap – A band-like pattern around the full perimeter of an extruded section and perpendicular to its length. A snap mark can occur whenever there is an abrupt change in the extrusion process. See also “Mark, Stop.”

Mark, Stop – A band-like pattern around the full perimeter of an extruded section and perpendicular to its length. A stop mark occurs whenever the extrusion process is suspended. See also “Mark, Snap.”

Mark, Stretcher Jaw – A cross hatched appearance left by jaws at the end(s) of metal that has been stretched. These marks are seen if insufficient metal has been removed after the stretching operation.

Mark, Tab – See “Buckle, Arbor.”

Mark, Tail – See “Mark, Roll Bruise.”

Mark, Take Up – See “Scratch, Tension.”

Mark, Traffic – Abrasion which results from relative movement between contacting metal surfaces during handling and transit. A dark color from the abrasively produced aluminum oxide is usually observed. A mirror image of a traffic mark is observed on the adjacent contacting surface.

Mark, Whip – A surface abrasion which is generally diagonal to the rolling direction. It is caused by a fluttering action of the metal as it enters the rolling mill.

Master Alloy – See “Hardener.”

Mean Diameter – The average of two measurements of the diameter at right angles to each other.

Mechanical Properties – Those properties of a material that are associated with elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain; for example, modulus of elasticity, tensile strength, endurance limit. These properties are often incorrectly referred to as physical properties.

Mike Mark – Narrow continuous line near the rolled edge caused by a contacting micrometer.

Minimum Residual Stress (MRS) –The term applied to products, usually flat rolled, which have been processed to minimize internal stress of the kind that causes distortion when material is disproportionately removed from one of the two surfaces through mechanical or chemical means.

Mismatch – Error in register between two halves of a forging by opposing die halves not being in perfect alignment.

Modulus of Elasticity – The ratio of stress to corresponding strain throughout the range where they are proportional. As there are three kinds of stresses, so there are three kinds of moduli of elasticity for any material – modulus in tension, in compression, and in shear.

Mottling, Pressure – Non-uniform surface appearance resulting from uneven pressure distribution between adjacent layers of the product.

Mullen Test – Measurement of bursting strength of foil in pounds per square inch. Testing machine applies increasing pressure to one square inch of the sample until it ruptures.

Natural Aging – See “Aging.”

Nick – Rolled products, see “Scratch.” Extrusions, see “Mark, Handling.”

Non-Heat-Treatable Alloy – An alloy which can be strengthened only by cold work.

Nonfill – Failure of metal to fill a forging die impression.

Notch, Double Shear – An abrupt deviation from straight on a sheared edge. This offset may occur if the flat sheet or plate product is longer than the blade for the final shearing operation.

Off Gauge – Deviation of thickness or diameter of a solid product, or wall thickness of a tubular product, from the standard or specified dimensional tolerances.

Offset – Yield strength by the “offset method” is computed from a load-strain curve obtained by means of an extensometer. A straight line is drawn parallel to the initial straight line portion of the load-strain curve and at a distance to the right corresponding to 0.2 percent offset (0.002 in. per in. of gauge length). The load reached at the point where this straight line intersects the curve divided by the original cross-sectional area (sq. in.) of the tension test specimen is the yield strength.

Oil Stain – See “Stain, Oil.”

Orange Peel - Surface roughening on formed products which occurs when large grains in the metal are present.

Oscillation – Uneven wrap in coiling and lateral travel during winding. Improper alignment of rolls over which the metal passes before rewinding and insufficient rewind tension are typical causes. See also “Telescoping.”

Out-of-Register – An embossed pattern distortion due to misalignment of the male and female embossing rolls.

Ovality – Deviation from a circular periphery, usually express as the total difference found at any one cross section between the individual maximum and minimum diameters, which usually occur at or about 90 degrees to each other. Since ovality is the difference between extreme diameters, it is not the expressed as plus of minus.

Ovalness – See “Ovality.”

Oxide Discoloration – See “Stain, Heat Treat.”

Pack Rolling – The simultaneous rolling of two or more thicknesses of foil.

Parent Coil – A coil that has been processed to final temper as a single unit. The parent coil may subsequently be cut into two or more smaller coils or into individual sheets or plates to provide the required width and length.

Parent Plate – A plate that has been processed to final temper as a single unit. The parent plate may subsequently be cut into two or more smaller plates to provide the required width and length.

Partial Annealing – See “Annealing, Partial.”

Parting Line – A condition unique to stepped extrusions where more than one cross section exists in the same extruded shape. A stepped shape uses a split die for the minor or small cross section and after its removal, another die behind it for the major configuration. Slightly raised fins can appear on that portion of the shape where the two dies meet. See also “Profile, Stepped Extruded.”

Patterned Sheet – See “Embossing.”

Physical Properties – The properties, other than mechanical properties, that pertain to the physics of a material; for example, density, electrical conductivity, heat conductivity, thermal expansion.

Pick-Off – The transfer of portions of the coating from one surface of the sheet to an adjacent surface due to poor adhesion of the coating.

Pickup – Small particles of oxide adhering to the surface of a product at irregular intervals.

Pickup, Repeating – See “Dent, Repeating.”

Pickup, Roll – Small particles of aluminum and aluminum oxide generated in the roll bite which subsequently transfer to the rolled product. It may be distributed uniformly and/or in streaks. See also “Streak, Coating.”

Pinch Mark – See “Crease.”

Pinhole – (1) Minute hole in foil. (2) A small-sized void in the coating of a sheet or foil product. A typical cause is solvent popping.

Pipe – Tube in standardized combinations of outside diameter and wall thickness, commonly designated by “Nominal Pipe Sizes” and “ANSI Schedule Numbers.”

Pipe, Drawn – Pipe brought to the final dimensions by drawing through a die.

Pipe, Extruded – Pipe formed by hot extruding.

Pipe, Seamless – Extruded or drawn pipe which does not contain any line junctures resulting from the method of manufacture.

Pipe, Structural – Pipe commonly used for structural purposes.

Piping – See “Back End Condition.”

Pit – A depression in the rolled surface which is usually not visible from opposite side.

Pitting – See “Corrosion.”

Plate – A rolled product that is rectangular in cross section and with thickness not less than 0.250 inch with sheared or sawed edges.

Plate Circle – Circle cut from plate.

Plate, Alclad – Composite plate comprised of an aluminum alloy core having on both surfaces (if on one side only, Alclad One Side Plate) a metallurgically bonded aluminum or aluminum alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

Pop, Solvent – Blister and/or void in the coating resulting from trapped solvents released during curing process.

Precipitation Hardening – See “Aging.”

Precipitation Heat Treating – See “Aging.”

Preheating – A high temperature soaking treatment to provide a desired metallurgical structure. Homogenizing is a form of preheating.

Pressure Mottling – See “Mottling, Pressure.”

Profile – A wrought product that is long in relation to its cross-sectional dimensions which is of a form other than that of sheet, plate, rod, bar, tube, wire or foil.

Profile, Class 1 Hollow Extruded – A hollow extruded profile, the void of which is round and 1 inch

or more in diameter and whose weight is equally distributed on opposite sides of two or more equally spaced axes.

Profile, Class 2 Hollow Extruded – Any hollow extruded profile other than Class 1, which does not exceed a 5-inch diameter circumscribing circle and has a single void of not less than 0.375-inch diameter or 0.110-square inch area.

Profile, Class 3 Hollow Extruded – Any hollow extruded profile other than Class 1 or Class 2.

Profile, Cold-Finished – A profile brought to final dimensions by cold-working to obtain improved surface finish and dimensional tolerances.

Profile, Cold-Finished Extruded – A profile produced by cold-finishing an extruded profile.

Profile, Cold-Finished Rolled – A profile produced by cold-finishing a rolled profile.

Profile, Drawn – A profile brought to final dimensions by drawing through a die.

Profile, Extruded – A profile produced by hot extruding.

Profile, Flute Hollow – A hollow profile having plain inside surfaces and whose outside surfaces comprise regular, longitudinal, concave corrugations with sharp cusps between corrugations.

Profile, Helical Extruded – An extruded profile twisted along its length.

Profile, Hollow – A profile any part of whose cross section completely encloses a void.

Profile, Lip Hollow – A hollow profile of generally circular cross section and nominally uniform wall thickness with one hollow or solid protuberance or lip parallel to the longitudinal axis; used principally for heat-exchange purposes.

Profile, Pinion Hollow – A hollow profile with regularly spaced, longitudinal serrations outside and round inside, used primarily for making small gears.

Profile, Rolled – A profile produced by hot rolling.

Profile, Semihollow – A profile any part of whose cross section is a partially enclosed void the area of which is substantially greater than the square of the width of the gap. The ratio of the area of the void to the square of the gap is dependent of the class of semihollow profile, the alloy and the gap width.

Profile, Solid – A profile other than hollow or semihollow.

Profile, Stepped Extruded – An extruded profile whose cross section changes abruptly in area at intervals along its length.

Profile, Streamline Hollow – A hollow profile with a cross section of tear-drop shape.

Profile, Structural – A profile in certain standard alloys, tempers, sizes, and sections, such as angles, channels, H-sections, I-beams, tees, and zees commonly used for structural purposes. For channels and I-beams, there are two standards, namely Aluminum Association Standard and American Standard.

Profile, Tapered Extruded – An extruded profile whose cross section changes continuously in area along its length or a specified portion thereof.

Quarter Buckle – See “Buckle, Quarter.”

Quenching – Controlled rapid cooling of a metal from an elevated temperature by contact with a liquid, a gas, or a solid.

RCS – Abbreviation for Rigid Container Sheet.

Razor Streak – See “Inclusion, Stringer.”

Rear End Condition – See “Back End Condition.”

Redraw Rod – This term is not recommended. The term “Drawing Stock” is preferred.

Refined Aluminum – Aluminum of very high purity (99.950 percent or higher) obtained by special metallurgical treatments.

Reflector Sheet – Sheet suitable for the manufacture of reflectors.

Reheating – Heating metal again to hot-working temperature. In general no structural changes are intended.

Reoil – Oil put on the sheet after cleaning and before coiling for shipment to prevent water stain.

Reroll Stock – A semi-finished rolled product of rectangular cross section in coiled form suitable for further rolling. Examples: “Foil Stock” and “Sheet Stock.”

Rib – An elongated projection on a shape, forging or casting to provide stiffening.

Rivet – See “Wire, Cold Heating.”

Rod – A solid wrought product that is long in relation to its circular cross section, which is not less than 0.375 inch diameter.

Rod, Alclad – Rod having on its surface a metallurgically bonded aluminum or aluminum alloy coating that is anodic to the core alloy to which it is bonded, thus electrolytically protecting the core alloy against corrosion.

Rod, Cold-Finished – Rod brought to final dimensions by cold working to obtain improved surface finish and dimensional tolerances.

Rod, Cold-Finished Extruded – Rod produced by cold working extruded rod.

Rod, Cold-Finished Rolled – Rod produced by cold working rolled rod.

Rod, Cold-Heating – Rod of a quality suitable for use in the manufacture of cold-headed products such as rivets and bolts.

Rod, Extruded – Rod produced by hot extruding.

Rod, Rivet – See “Rod, Cold Heating.”

Rod, Rolled – Rod produced by hot rolling.

Roll Chatter – See “Mark, Chatter (Roll or Leveller.)”

Roll Coating – See “Streak, Coating.”

Roll Grind – The uniform ground finish on the work rolls which is imparted to the sheet or plate during rolling.

Roll Mark – See “Mark, Roll.”

Roll Pickup – See “Pickup, Roll.”

Rolled Ring – See “Forging, Rolled Ring.”

Rolled-in Scratch – See “Scratch, Rolled-in.”

Rolled-in Metal – An extraneous chip or particle of metal rolled into the surface of the product.

Rolled-over Edge – See “Edge, Liquated.”

Rolling Ingot – A cast form suitable for rolling. See “Fabricating Ingot.”

Rolling Slab – A rectangular semifinished product, produced by hot rolling fabricating ingot and suitable for further rolling.

Roofing Sheet – Coiled or flat sheet in specific tempers, widths, and thicknesses suitable for the manufacture of corrugated or V-crimp roofing.

Roping – A rope-like appearance in the rolling direction after the metal has undergone severe deformation.

Roundness – This term is not recommended. The term “Ovality” is preferred.

Rub Mark – See “Mark, Rub.”

Rub, Tool – A surface area showing a scratch or abrasion resulting from contact of the hot extrusion with the press equipment or tooling or, in the case of multi-hole dies, with other sections as they exit the press.

Sample – A part, portion, or piece taken for purposes of inspection or test as representative of the whole.

Saw-Plate Bar – See “Bar, Saw-Plate.”

Scalping – Mechanical removal of the surface layer from a fabricating ingot or semi-finished wrought product so that surface imperfections will not be worked into the finished product.

Scratch – (1) For rolled products, a sharp indentation in the surface usually caused by a machine or during handling. (2) For extrusions, a synonym for handling mark. See “Mark, Handling.”

Scratch, Drawn-in – A scratch occurring during the fabricating process and subsequently drawn over, making it relatively smooth to the touch.

Scratch, Friction – A scratch caused by relative motion between two contacting surfaces.

Scratch, Handling – A more severe form of rub mark. See “Mark, Rub.”

Scratch, Machine – An indentation which is straight, is in the rolling direction and is caused by contact with a sharp projection on equipment.

Scratch, Oscillation – Minor indentations at an angle to the rolling direction that result from coil oscillation during unwinding or rewinding.

Scratch, Oven – A scratch which is caused by moving contact of coating against a non-moving object in an oven.

Scratch, Rolled-in – A scratch which is subsequently rolled. It will then appear as a greyish white ladder (distinct transverse lines within the longitudinal indentation).

Scratch, Slippage – See “Scratch, Tension.”

Scratch, Tension – A short longitudinal indentation parallel to the rolling direction.

Seam Defect – An unbonded fold or lap on the surface of the metal, which appears as a crack, usually the result of a defect in working that has not bonded shut.

Seam, Extrusion – The junction line of metal that has passed through a hollow die, separated and rejoined at the exit point. Seams are present in all extruded hollows produced from the direct extrusion process and in many cases are not visible. See “Weld, Incomplete.”

Seamless – A hollow product which does not contain any line junctures resulting from method of manufacture.

Section Number – The number assigned to an extruded or drawn profile (shape) for identification and cataloging purposes, usually the same number assigned for the same purpose to the die from which the profile (shape) is made.

Serpentine Weave – See “Snaking.”

Shape – This terms is no longer recommended. The terms “Profile” is preferred. See “Profile.”

Shear Strength – The maximum stress that a material is capable of sustaining in shear. In practice, shear strength is considered to be the maximum average stress computed by dividing the ultimate load in the plane of shear by the original area subject

to shear. Shear strength is usually determined by inserting a cylindrical specimen through round holes in three hardened steel blocks, the center of which is pulled (or pushed) between the other two so as to shear the specimen on two planes. The maximum load divided by the combined cross-sectional area of the two planes is the shear strength.

Sheet – A rolled product that is rectangular in cross section with thickness less than 0.250 inch but not less than 0.006 inch and with slit, sheared or sawed edges.

Sheet Stock – See “Reroll Stock.”

Sheet, Alclad – Composite sheet comprised of an aluminum alloy core having on both surfaces (if one side only, Alclad One Side Sheet) a metallurgically bonded aluminum or aluminum alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

Sheet, Anodizing – Sheet with metallurgical characteristics and surface quality suitable for the development of protective and decorative films by anodic oxidation processes.

Sheet, Clad – Composite sheet having on both surfaces (if on one side only, Clad One Side Sheet) a metallurgically bonded metal coating, the composition of which may or may not be the same as that of the core.

Sheet, Coiled – Sheet in coils with slit edges.

Sheet Coiled Circles – Circles cut from coiled sheet.

Sheet, Coiled Cut to Length – Sheet cut to specified length from coils and which has a lesser degree of flatness than flat sheet.

Sheet, Flat – Sheet with sheared, slit or sawed edges, which has been flattened or leveled.

Sheet, Flat Circles – Circles cut from flat sheet.

Sheet, Mill Finish (MF) – Sheet having a non-uniform finish that may vary from sheet to sheet and within a sheet, and may not be entirely free from stains or oil.

Sheet, One Side Bright Mill Finish (1SBMF) – Sheet having a moderate degree of brightness on one side and a mill finish on the other.

Sheet, Painted – Sheet, one or both sides of which has a factory-applied paint coating of controlled thickness.

Sheet, Standard One Side Bright Finish (S1SBF) – Sheet having a uniform bright finish on one side and a mill finish on the other.

Sheet, Standard Two Sides Bright Finish (S2SBF) – Sheet having a uniform bright finish on both sides.

Short Transverse Direction – For plate, sheet and forgings, the direction through the thickness perpendicular to both longitudinal and long transverse directions.

Shrinkage – Contraction that occurs when metal cools from the hot-working temperature.

Side Crack – See “Edge, Broken (Cracked).”

Side Set – A difference in thickness between the two edges of plate, sheet or foil.

Skip – an area of uncoated sheet which is frequently caused by equipment malfunction.

Slippage Scratch – See “Scratch, Tension.”

Slitter Hair – See “Hair, Slitter.”

Sliver – Thin fragment of aluminum which is part of the material but only partially attached. Surface damage or residual liquation which is subsequently rolled are typical causes.

Slug – A metal blank for forging or impacting.

Smudge – A dark film of debris, sometimes covering large areas, deposited on the sheet during rolling.

Smut – See “Smudge.”

Snaking – A series of reversing lateral bows in coil products. This condition is caused by a weaving action during an unwinding or rewinding operation.

Solution Heat Treating – Heating an alloy at a suitable temperature for sufficient time to allow soluble constituents to enter into solid solution where they are retained in a supersaturated state after quenching.

Specimen – That portion of a sample taken for evaluation of some specific characteristic or property.

Speed Crack – See “Tear, Speed.”

Speed Tear – See “Tear, Speed.”

Splice – The end joint uniting two webs.

Spot, Lube – A non-uniform extraneous deposit of lube on the coated sheet.

Squareness – Characteristics of having adjacent sides or planes meeting at 90 degrees.

Stabilizing – A low temperature thermal treatment designed to prevent age-softening in certain strain hardened alloys containing magnesium.

Stain, Heat Treat – A discoloration due to non-uniform oxidation of the metal surface during heat treatment.

Stain, Oil – Surface discoloration which may vary from dark brown to white and is produced during thermal treatment by incomplete evaporation and/or oxidation of lubricants on the surface.

Stain, Saw Lubricant – A yellow to brown area of surface discoloration at the ends of the extruded length. It is the residue of certain types of saw lubricants if they are not removed from the metal prior to the thermal treatment.

Stain, Water – See “Corrosion, Water Stain.”

Starvation – Non-uniform coating application which results in absence of coating in certain areas.

Sticking – Adherence of foil surfaces sufficient to interfere with the normal ease of unwinding.

Straightness – The absence of divergence from a right (straight) line in the direction of measurement.

Strain – A measure of the change in size or shape of a body under stress, referred to its original size or shape. Tensile or compressive strain is the change, due to force, per unity of length in an original linear dimension in the direction of the force. It is usually measured as the change (in inches) per inch of length.

Strain Hardening – Modification of a metal structure by cold working resulting in an increase in strength and hardness with loss of ductility.

Streak (Stripe) – A superficial band or elongated mark which produces a non-uniform surface appearance. A streak is often described by source.

Streak, Bearing – A longitudinal discoloration that can occur where there are large changes in wall thickness as a result of uneven cooling. These streaks usually appear lighter than the surrounding metal.

Streak, Bright – A bright superficial band or elongated mark which produces a non-uniform surface appearance.

Streak, Buff – A dull continuous streak caused by smudge buildup on a buff used at shearing or other operations.

Streak, Burnish – A bright region on the sheet caused by excessive roll surface wear.

Streak, Coating – A banded condition caused by non-uniform adherence of roll coating to a work roll. It can be created during hot and/or cold rolling. If generated in the hot rolling process, it is also called “Hot Mill Pickup.”

Streak, Cold – See “Streak, Heat.”

Streak, Diffusion – Surface discoloration which may vary from gray to brown and found only on Alclad products.

Streak, Dirt – Surface discoloration which may vary from gray to black, is parallel to the direction of rolling, and contains rolled in foreign debris. It is usually extraneous material from an overhead location that drops onto the rolling surface and is shallow enough to be removed by etching or buffing.

Streak, Grease – A narrow discontinuous streak caused by rolling over an area containing grossly excessive lubricant drippage.

Streak, Grinding – A streak with a helical pattern appearance transferred to a rolled product from a work roll.

Streak, Heat – Milky colored band(s) parallel to the rolling direction which vary in both width and exact location along the length.

Streak, Herringbone – Elongated alternately bright and dull chevron markings.

Streak, Leveller – A streak on the sheet surface in the rolling direction caused by transfer from the leveller rolls.

Streak, Mill Buff – See “Streak, Roll.”

Streak, Pickup – See “Streak, Coating.”

Streak, Roll – A non-uniform surface appearance parallel to the rolling direction.

Streak, Structural – A non-uniform appearance on an etched or anodized surface caused by heterogeneities (variabilities) remaining in the metal from the casting, thermal processes or hot working stages of fabrication.

Stress – Force per unit of area. Stress is normally calculated on the basis of the original cross-sectional dimensions. The three kinds of stresses are tensile, compressive, and shear.

Stress Corrosion Cracking – See “Corrosion, Stress Cracking.”

Stress Relieving – The reduction of the effects of internal residual stresses by thermal or mechanical means.

Stretcher Strain – See “Line, Luders.”

Striation – Longitudinal non-uniform coating thickness caused by uneven application of the liquid coating.

Strip – This term is not recommended. The term “Sheet” is preferred.

Structural Streak – See “Streak, Structural.”

Suck-in – A defect caused when one face of a forging is sucked into a projection on the opposite side.

Surface Tear – Minute surface cracks on rolled products which can be caused by insufficient ingot scalping.

Tail Mark – “See Mark, Roll Bruise.”

Tear, Speed – A series of surface cracks perpendicular to the extruding direction. Speed tearing normally occurs in corner radii or extremities of a section and is caused by localized high temperature.

Telescoping – Lateral stacking, primarily in one direction, of warps in a coil so that the edges of the coil are conical rather than flat. Improper alignment of roll over which the metal passes before rewinding is

a typical cause. See also “Oscillation.”

Temper – The condition produced by either mechanical or thermal treatment, or both, and characterized by a certain structure and mechanical properties.

Tensile Strength – In tensile testing, the ratio of maximum load to original cross-sectional area. Also called “Ultimate Strength.”

Tension Scratch – See “Scratch, Tension.”

Tolerance – Allowable deviation from a nominal or specified dimension.

Tool – A term usually referring to the dies, mandrels, etc., used in the production of extruded or drawn shapes or tube.

Tooling Pad – See “Chucking Lug.”

Tooling Plate – A cast or rolled product of rectangular cross section of thickness 0.250 inch or greater, and with edges either as-cast, sheared or sawed, with internal stress levels controlled to achieve maximum stability for machining purposes in tool and jig applications.

Torn Surface – A deep longitudinal rub mark resulting from abrasion by extrusion or drawing tools.

Traffic Mark – Abrasion which results from relative movement between contacting metal surfaces during handling and transit. A dark color from the abrasively produced aluminum oxide is usually observed. A mirror image of a traffic mark is observed on the adjacent contacting surface.

Transverse Bow – See “Bow, Transverse.”

Transverse Direction – A direction perpendicular to the direction of working.

Tread Plate – Sheet or plate having a raised figured pattern on one surface to provide improved traction.

Trim Inclusion – Edge trimming accidentally wound into a roll of foil.

Tube – A hollow wrought product that is long in relation to its cross section, which is symmetrical and is round, a regular hexagon or octagon, elliptical, or square or rectangular with sharp or rounded corners, and that has uniform wall thickness except as affected by corner radii.

Tube, Arc-Welded – Tube made from sheet or plate butt welded by either gas-tungsten or gas-metal arc-welding method, with or without the use of filler metal.

Tube Bloom – This term is not recommended. The term “Tube Stock” is preferred.

Tube Stock – A semifinished tube suitable for the production of drawn tube.

Tube, Alclad – Composite tube composed of an aluminum alloy core having on either the inside or outside surface a metallurgically bonded aluminum or aluminum alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

Tube, Brazed – A tube produced by forming and seam-brazing sheet.

Tube, Butt-Welded – A welded tube, the seam of which is formed by positioning one edge of the sheet against the other for welding.

Tube, Drawn – A tube brought to final dimensions by cold drawing through a die. (Note: This product may be produced from either seamless or non-seamless extruded stock or from welded stock.)

Tube, Embossed – A tube the outside surface of which has been roll-embossed with a design in relief regularly repeated in a longitudinal direction.

Tube, Extruded – A tube formed by hot extruding. (Note: This product may be either seamless or non-seamless.)

Tube, Finned – Tube which has integral fins or projections protruding from its outside surface.

Tube, Fluted – A tube of nominally uniform wall thickness having regular, longitudinal, concave corrugations with sharp cusps between corrugations.

Tube, Heat-Exchanger – A tube for use in apparatus in which fluid inside the tube will be heated or cooled by fluid outside the tube. The term usually is not applied to coiled tube or to tubes for use in refrigerators or radiators.

Tube, Helical-Welded – A welded tube produced by winding the sheet to form a closed helix and joining the edges of the seam by welding.

Tube, Lap-Welded – A welded tube the seam of which is formed by longitudinally lapping the edges of the sheet for welding.

Tube, Lock-Seam – A tube produced by forming and mechanically lock-seaming sheet.

Tube, Open-Seam – A shape normally produced from sheet of nominally uniform wall thickness and approximately tubular form but having a longitudinal unjoined seam or gap of width not greater than 25 percent of the outside diameter or greatest over-all dimension. Also referred to as “Butt-Seam Tube.”

Tube, Redraw – This term is not recommended. The term “Tube Stock” is preferred.

Tube, Seamless – A tube that does not contain any line junctures (metallurgical welds) resulting from the method of manufacture. (Note: This product may be produced by die and mandrel or by hot piercer processes.)

Tube, Sized – A tube that, after extrusion, has been cold drawn a slight amount to minimize ovality.

Tube, Stepped Drawn – A drawn tube whose cross section changes abruptly in area at intervals along its length.

Tube, Structural – Tube commonly used for structural purposes.

Tube, Welded – A tube produced by forming and seam-welding sheet longitudinally.

Tubing – This term is not recommended. The term “tube” is preferred.

Tubing-Electrical Metallic – A tube having certain standardized length and combinations of outside diameter and wall thickness thinner than that of “Rigid Conduit,” commonly designated by nominal electrical trade sizes, for use with compression-type fittings as a protection for electric wiring.

Tubular Conductor – A tubular product suitable for use as an electric conductor.

Twist – (1) For rolled products, a winding departure from flatness. (2) For extrusions, a winding departure from straightness.

Two-Tone – A sharp color demarcation in the appearance of the metal due to a difference in the work roll coating.

Ultimate Tensile Strength – See “Tensile Strength.”

Vent Mark – A small protrusion on a forging resulting from the entrance of metal into a die vent hole.

Water Stain – See “Corrosion, Water Stain.”

Wavy Edge – See “Buckle, Edge.”

Weave – See “Oscillation.”

Web – (1) A single thickness of foil as it leaves the rolling mill. (2) A connecting element between ribs, flanges, or bosses on shapes and forgings.

Weld Line – See “Seam, Extrusion.”

Weld, Incomplete – The junction line of metal that has passed through a die forming a hollow profile (shape), separated and not completely rejoined. Flare testing is a method of evaluating weld integrity.

Welding – Joining two or more pieces of aluminum by applying heat or pressure, or both, with or without filler metal to produce a localized union through fusion or recrystallization across the interface. (In cold welding, it is a solid state welding process in which pressure is used at room temperature to produce coalescence of metals with substantial deformation at the weld.)

Welding Rod – A rolled, extruded, or cast round filler metal for use in joining by welding.

Welding Wire – Wire for use as filler metal in joining by welding.

Wettability Test – The degree to which a metal surface may be wet to determine the absence of or the amount of residual rolling or added lubricants or deposits on the surface.

Whip Marks – See “Mark, Whip.”

Whisker – See “Hair, Slitter.”

Wire – A solid wrought product that is long in relation to its cross section, which is square or rectangular with sharp or rounded corners or edges, or is round, hexagonal, or octagonal, and whose diameter or greatest perpendicular distance between parallel faces is less than 0.375 inch.

Wire, Alclad – A composite wire product comprised of an aluminum-alloy wire having on its surface a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the alloy to which it is bonded, thus electrolytically protecting the core alloy against corrosion.

Wire, Cold-Heading – Wire of quality suitable for use in the manufacture of cold-headed products such as rivets and bolts.

Wire, Drawn – Wire brought to final dimensions by drawing through a die.

Wire, Extruded – Wire produced by hot extruding.

Wire, Flattened – Wire having two parallel flat surfaces and rounded edges produced by roll-flattening round wire.

Wire, Flattened and Slit – Flattened wire that has been slit to obtain square edges.

Wire, Rivet – See “Wire, Cold-Heading.”

Work Hardening – See “Strain Hardening.”

Workability – The relative ease with which various alloys may be formed by rolling, extruding, forging, etc.

Wrap, Loose – A condition in a coil due to insufficient tension which creates a small void between adjacent wraps.

Wrinkle – See “Crease.”

Wrought Product – A product that has been subjected to mechanical working by such processes as rolling, extruding, forging, etc.

Yield Strength – The stress at which a material exhibits a specified permanent set. The offset used for aluminum and its alloys is 0.2 percent of gauge length. For aluminum alloys the yield strengths in tension and compression are approximately equal.

