Ameralloy®

SERVICE IN SPECIALTY STEELS

800 237 0113 sales@ameralloy.com www.ameralloy.com

Maintenance Alloy Steels

Stainless Steel Alloys

Abrasion / Impact Resistant Products

Tool And Die Steels

Ameralloy Steel Corporation

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Phone 847 967 0600
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Ameralloy®

Ameralloy Steel Corporation

STEEL COLOR CODES			
	DURELLOY	DURELLOY TGP	DURELLOY TUBING
DURELLOY PM	DURA-FORM	AMERA-BRAZE	AMERA-BRAZE 500
AMERALLOY	AMERALLOY AR	AMERICAN-50	DURA-LUGG
AMERA-MANG	AMERALLOY OIL	AMERALLOY-60	AMERALLOY AIR
AMERALLOY-D	AMERA-GRAF	AMERALLOY-5	AMERALLOY-6
AMERALLOY-7	AMERALLOY-13	AMERALLOY-20	AMERALLOY W1 & W2
AMERALLOY-FH	AMERALLOY HIGH SPEED-2	AMERA-MOLD	DURA-KROME
DOUBLE-C	AMERA-PLEX	AMERA-PLEX MINE PLATE	

Ameralloy®

MAINTENANCE ALLOY STEELS

- Durelloy™ Heat Treated Alloy
- Durelloy TGP™
- Durelloy™ Threaded Bar
- Dura-Form™ Brake Die
- Durelloy™ Tubing
- Durelloy™ Key Stock
- Durelloy PM™

Durelloy™

HEAT TREATED ALLOY

Color Code: RED

Durelloy is a well balanced, fine grained electric furnace alloy steel, delivered standard in the heat treated hardness of Rockwell C 28–32. Durelloy is produced for applications requiring high tensile strength, resistance to wear, shock, and fatigue. Each heat lot must pass rigid quality control procedures which assure consistent physical and chemical standards.

In the pre-heat treated condition, Durelloyis excellent for applications requiring high torque and torsional strains. The combined alloy blend of chrome, molybdenum,and manganese produces excellent physical properties, depth of heat treatment, resistance to many forms of corrosion, excellent toughness, and good ductility.

Durelloy Replaces Both Carbon And Alloy Grade Standard Steels

Carbon Grades
C10xx*
C11xx
C12xx

Chrome-Moly Grades
41xx*

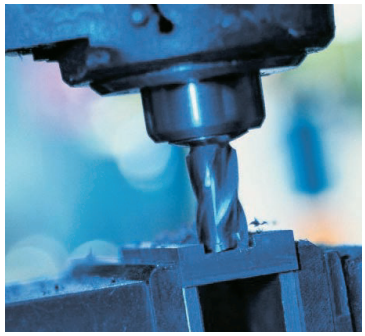
Nickel-Moly Grades
46xx
48xx

Nickel-Chrome Grades
31xx
33xx

Chrome-Nickel-Moly Grades
43xx*
47xx
81xx
86xx
87xx
88xx
93xx
98xx

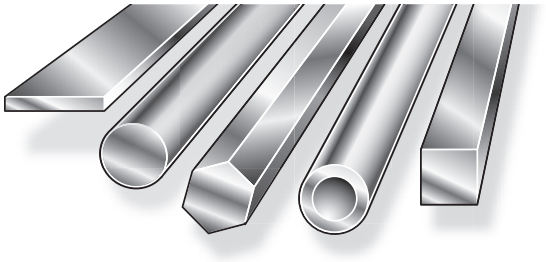
** xx indicates amount of Carbon content.*

Alloy steel marketed under various trade names are included, but are too extensive for listing. Contact your Ameralloy representative or Central Sales Office at 847-967-0600 for assistance in clarification and comparison.



Durelloy™

HEAT TREATED ALLOY



Applications

- Arbors
- Armature shafts
- Axles
- Bolts & studs
- Boring bars
- Bushings
- Cement mill shafts
- Chain links & pins
- Conveyer shafts
- Conveyer rollers
- Crane axles
- Crank shafts
- Drill bit bodies
- Drive shafts & gears
- Feed screws
- Flame hardened parts
- Gears
- Gear shafts
- Hammer shafts
- Hoist shafts
- Hooks
- Hubs
- Impeller shafts
- Journals
- Lead screws
- Line shafts
- Mining equipment
- Motor shafts
- Mandrels
- Nuts
- Pinions
- Pins
- Piston & push rods
- Power shovel shafts
- Pump shafts & rods
- Shafts
- Spindles
- Sprockets
- Studs
- Textile equipment
- Tie rods
- Tool holders
- Tracks
- Track pins
- U-Bolts

Features And Advantages

- Pre-hardened, heat treated, stress relieved
- Machine straightened to minimize distortion and run-out
- Fine grain microstructure
- Free machining (75% machinability rating)
- Work hardening capabilities
- Fatigue resistant
- High shear strength, abrasion resistant
- Precision controlled analysis
- Excellent temperature tensile properties up to 1100°F

Specials, Heat Treat & Machining

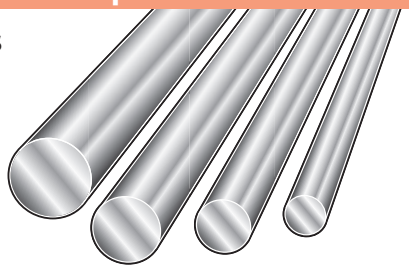
- **Durelloy pre-machined flats** Thickness 1/2"–2", width 2" to 24", length 72". Blanchard ground top and bottom TOL plus .020–.030
- **Durelloy special heat-treat**
- **Durelloy annealed** Every Durelloy size is available in the annealed condition, and can be further heat treated
- **Durelloy forgings** Custom forging to your specifications
- **Custom machining and grinding**

Durelloy™ HEAT TREATED ALLOY

shapes & sizes

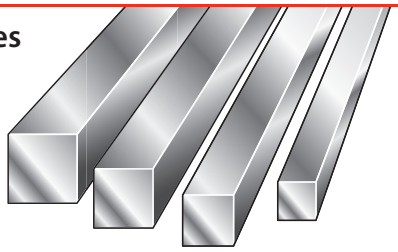
Available Shapes And Sizes

Rounds



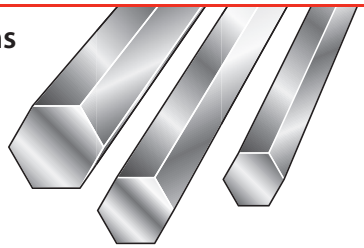
Flats

Squares



Plates

Hexagons



Specials

- Rings
- Blocks
- Gear blanks
- Step-downs

Durelloy Sizes Available For Immediate Shipment

Rounds

1/2	3-1/8	7-1/4
5/8	3-1/4	7-1/2
3/4	3-3/8	7-3/4
7/8	3-1/2	8
1	3-5/8	8-1/4
1-1/8	3-3/4	8-1/2
1-1/4	4	8-3/4
1-3/8	4-1/8	9
1-1/2	4-1/4	9-1/2
1-5/8	4-3/8	10
1-3/4	4-1/2	10-1/2
1-7/8	4-3/4	11
2	5	11-1/4
2-1/8	5-1/4	11-1/2
2-1/4	5-1/2	12
2-3/8	5-3/4	14
2-1/2	6	15-1/2
2-5/8	6-1/4	16
2-3/4	6-1/2	18
2-7/8	6-3/4	20
3	7	24

Squares

1-1/4
1-1/2
1-3/4
2
2-1/4
2-1/2
2-3/4
3
3-1/2
4
4-1/2
5
5-1/2
6
8

Hexagons

3/8
1/2
5/8
3/4
7/8
1
1-1/8
1-1/4
1-3/8
1-1/2
1-5/8
1-3/4
2
2-1/8
2-1/4
2-3/8
2-1/2
2-3/4
3
3-1/4
3-1/2

Flats

1/2 x 2	1-1/8 x 2-1/2	x 3-1/2
x 3	x 4-1/2	2 x 4
x 4	1-1/4 x 2	x 4-1/2
5/8 x 3	x 2-1/2	x 5
x 2-1/2	x 3	x 6
x 3	x 3-1/2	x 8
x 4	x 4	2-1/2 x 3
x 4-1/2	x 4-1/2	x 3-1/2
3/4 x 1	x 5	x 4
x 2	x 6	x 4-1/2
x 3	x 8	x 5
x 4	1-1/2 x 2	x 6
1 x 1-1/2	x 2-1/2	x 8
x 2	x 3	3 x 4
x 2-1/2	x 3-1/2	x 5
x 3	x 4	x 6
x 3-1/2	x 4-1/2	x 8
x 4	x 5	3-1/2 x 8
x 4-1/2	x 6	4 x 5
x 5	x 8	x 6
x 6	2 x 2-1/2	x 8
	x 3	

Plates

3/8 x 96 x 120
1/2 x 96 x 120
3/4 x 96 x 120
1 x 96 x 120
1-1/4 x 96 x 120
1-1/2 x 96 x 120
2 x 96 x 120
2-1/2 x 96 x 120
3 x 96 x 120
3-1/2 x 96 x 144
4 x 96 x 144
5 x 96 x 144
6 x 96 x 144
8 x 96 x 144

Lengths: 18′-20′ or custom cut to size.

Mechanical Properties As stocked in the heat treated (hardened) condition

Tensile Strength PSI	Yield Point PSI	Elongated In 2" %	Reduction Of Area %	Brinell Hardness BHN	Charpy V-Notch FT-LB
155/172,000	140/155,000	21.0/18.0	62/54	312/330	60/25

Properties are typical over a wide range of cross-sectional dimensions. Refer to following charts.

Tempering, Tensile, Yield Data

Section Size Inches	Tempering Temperature °F/°C	Tensile Strength PSI	Yield Point PSI	Elongated In 2" %	Reduction Of Area %	Surface Hardness BHN	Charpy V-Notch FT-LB	Mid-Radius Hardness BHN
1	AQ	—	—	—	—	698	—	698
	800/427	246,500	234,000	12.5	48.5	480	13	480
	1000/538	198,250	189,500	18.5	58.0	412	22	412
	1200/649	166,500	154,750	20.5	60.8	302	54	302
2	AQ	—	—	—	—	660	—	660
	800/427	238,750	226,000	14.5	52.5	469	15	469
	1000/538	202,000	190,750	18.6	59.0	412	22	412
	1200/649	164,000	155,500	21.2	61.5	340	56	340
4	AQ	—	—	—	—	586	—	586
	800/427	222,000	208,500	16.0	54.0	442	20	440
	1000/538	196,750	184,500	19.0	60.5	410	25	402
	1200/649	162,250	154,000	21.5	64.0	336	58	332
6	AQ	—	—	—	—	498	—	488
	800/427	205,500	190,250	16.8	55.0	408	24	398
	1000/538	192,000	178,000	19.8	61.8	398	27	390
	1200/649	160,000	149,500	21.8	64.6	330	62	326
8	AQ	—	—	—	—	412	—	396
	800/427	198,750	183,500	18.2	56.2	396	24	390
	1000/538	190,500	172,500	20.5	62.5	388	28	380
	1200/649	154,500	146,250	22.0	65.5	322	68	316

Durelloy bar samples oil-quenched from 1550°F (843°C).

Normalized Air cooled from 1550°F – 1650°F (843°C – 899°C)

Section Size Inches	Tensile Strength PSI	Yield Point %	Elongated In 2" %	Reduction Of Area %	Brinell Hardness BHN	Charpy V-Notch FT-LB
1	214,500	176,000	15.3	53.7	402	13
2	208,750	172,500	15.7	54.2	394	14
4	198,000	165,750	16.5	55.1	376	16
6	184,500	151,250	17.2	56.0	358	18
8	168,000	138,500	17.8	56.4	332	20

Annealed Slow cooled from 1600°F (871°C)

1	116,250	84,500	28.5	68.2	210	81

Critical Points

Heating At 50° Per Hour		Cooling At 50° Per Hour		
AC[1]	AC[3]	AR[3]	AR[1]	Ms
1360°F	1495°F	1350°F	1220°F	525°F
738°C	813°C	732°C	660°C	274°C

Forging

Heat thoroughly to 2250°F (1232°C) Max. Reheat as often as necessary to finish forging operation, but do not work below 1550°F (816°C). May be air-cooled *(normalized)* or oil-quenched after forging. For maximum properties, tempering is recommended prior to cooling below 150°F (66°C). Refer to *Metallurgical Data* for resultant properties.

Annealing

Heat to 1500°–1600°F (816°–871°C). Hold for 1 hour per inch of greatest thickness. Slow cool to 500°F (260°C). Air cool. Refer to *Metallurgical Data* for resultant properties.

Normalizing

Heat to 1550°–1650°F (843°–899°C). Soak thoroughly. Air cool. Refer to *Metallurgical Data* for resultant properties.

Hardening

- **Heating** Heat slowly and uniformly to 1550°–1650°F (843°–899°C). Hold for 1 hour per inch of greatest thickness. Soak thoroughly.
- **Quenching** Oil-quenching preferred. Agitate quenching medium as section size increases to accelerate process and provide more uniform cooling.
- **Tempering** All steels possess residual stresses and brittleness after normalizing or hardening by quenching, regardless of quenching medium. When possible, tempering is necessary to relieve these stresses and impart the required combination of strength and ductility (toughness). Tempering consists of heating to a temperature below the lower critical (AC1–1360°F), and holding for 1 hour per inch of greatest thickness. Follow tempering by cooling in still air.

Begin tempering before quenched section cools below 150°F.

Durelloy can be tempered in the range of 300°–1300°F (149°–704°C), depending on the application and final properties desired (wear vs. toughness ratio). The lower the tempering temperature, the higher the resultant hardness and resistance to wear. The higher the tempering temperature, the lower the resultant hardness and the greater the strength/toughness combination.

Hardness properties of .505" diameter test specimens,oil-quenched from 1550°F (843°C) and tempered as shown:

Tempering Temperature		Hardness
°F	°C	BHN
300	149	612
500	260	548
700	371	498
900	482	439
1100	593	365
1300	704	289

Refer to *Metallurgical Data* for resultant properties. Optimum properties depend on adequate facilities and processing. Duralloy-HT, from Ameralloy stock, should be used when possible.

surface hardening

Surface (Case) Hardening

• **Flame hardening** In some applications, it is desirable that surfaces subjected to extreme wear be harder than other surfaces of the same piece. The surfaces to be further hardened are heated with an oxyacetylene flame torch to a temperature of 1500°–1700°F (red/orange color), then rapidly quenched.

The exact quenching medium is determined by the percentage of heated surface. Small surfaces of larger pieces can simply be air-quenched because of rapid cooling due to the conduction of heat away from the small heated surface into the larger adjacent surfaces. Pieces with a larger percentage of surfaces to be hardened should be quenched by spraying with water. Residual heat after quenching will relieve hardening stresses.

This flame hardening process can yield hardenesses 0f 578–698 BHN with a hardness depth of up to 1/4".

• **Carburizing** Carburizing is the process of adding additional carbon to surface of steel by heating the metal to a temperature below its melting point in contact with carbonaceous solids *(pack-carburizing),* liquids *(liquid-carburizing),* or gases *(gas-carburizing).* High surface hardnesses are obtained while the core retains strength, ductility, and toughness.

Localized carburizing may also be accomplished by applying a protective coating which the carbon will not penetrate. Commercial pastes are widely available.

Durelloy carburizing case depths (inches), when carburized and quenched immediately in agitated oil and tempered at 300°–400°F. Resultant surface hardness of 615/700 BHN:

Hours	1550°F (843°C)	1650°F (899°C)	1750°F (954°C)	1850°F (1010°C)
2	.024	.034	.046	.062
4	.033	.047	.064	.089
6	.040	.058	.079	.109
8	.046	.067	.090	.123
10	.051	.072	.101	.137
12	.057	.079	.111	.151
16	.065	.089	.126	.172
20	.072	.101	.141	.192
24	.079	.111	.155	.208

Carburized at 1750°F for 8 hours. Quenched in agitated oil. Tempered at 300°F

Carburized at 1750°F for 8 hours. Quenched in agitated oil. Tempered at 400°F

Durelloy™
HEAT TREATED ALLOY

field welding data

Durelloy HR (hot roll) and Durelloy TGP heat treated alloy steel can be welded using standard welding methods.

No special electrode needed. Standard low-hydrogen rods recommended for maximum strengths. Most popular AWS designations are E7016, 7018, 10016 and (10018–preferred).

- Because of the carbon and other alloy elements, pre-heating to approximately (800 degrees) is recommended. Keep at pre-heated temperature during welding to prevent under-bed cracking.

- Welding rods should be clean and dry. Insure welding surface is clean. Hold inter-pass temperature at (800 degrees). Use minimum recommended arc voltage and amperage and reduce amperage slightly for secondary and finishing passes.

- Use the smallest-diameter electrode, rod or wire that will do the job.

- Travel slowly and straight.

- Use several small stringer beads rather than deposits. A weave bead of (2½) times the rod diameter can be used. Brush slag and dirt from the beads frequently.

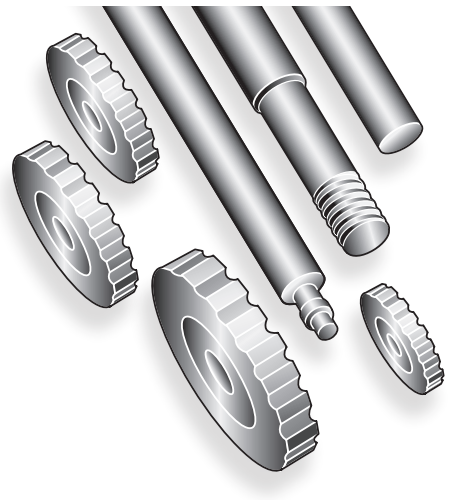
- When welding cracks, cracks should be U-ed not V-ed; sharp angles tend to induce cracking. Take care to grind away any and all existing cracks.

- To relieve welding stresses, a post-heat of approximately (400 degrees) should be maintained for (2) hours.

Durelloy-TGP™

HEAT TREATED ALLOY

Color Code:
ENDS RED



Durelloy-TGP is produced from Durelloy hot roll heat treat 28-32 Rc bars, then precision turned, ground, and flawlessly polished to exacting sizes. Durelloy-TGP eliminates costly machining to size at your plant, which helps reduce downtime. Durelloy-TGP allows you to produce long, straight keyways without bowing problems.

Features And Advantages

- Precision tuned, ground and polished
- Not cold drawn, free from drawing stresses
- Straightness guaranteed prior to shipment
- Good weldability
- Free machining
- Ultra fine grain microstructure
- Wear resistant
- Eliminates premature fatigue/failure due to hardness and high luster
- Stress relieved

Applications

- Arbors
- Gear shafts
- Journals
- Line shafts
- Lead screws
- Drive shafts
- Motor shafts
- Crank shafts
- Armature shafts
- Cement mill shafts
- Textile equipment
- Mining equipment
- Generator shafts
- Pinions
- Piston rods
- Push rods
- Spindles
- Feed screws
- Tie rods

Standard Tolerances

- Standard finish of 8 micro-inches
- 1/4" to 4" diameter: +.000" to -.002" tolerance
- Over 4" diameter: +.000" to -.003" tolerance
- Closer tolerance of +/- .0005" available

All shipments of Durelloy-TGP are specially oiled, then wrapped or tubed and delivered in perfect condition. All bars are inspected prior to shipping for straightness and tolerances.

Durelloy-TGP Rounds 1/8" Diameter Rounds in 1/16" Increments

1/8	3/4	1-5/16	1-7/8	2-7/16	3	4	5-15/16
3/16	13/16	1-3/8	1-15/16	2-1/2	3-1/8	4-1/4	6
1/4	7/8	1-7/16	2	2-9/16	3-3/16	4-7/16	6-1/2
5/16	15/16	1-1/2	2-1/16	2-5/8	3-1/4	4-1/2	7
3/8	1	1-9/16	2-1/8	2-11/16	3-3/8	4-3/4	8
1/2	1-1/16	1-5/8	2-3/16	2-3/4	3-7/16	4-15/16	
9/16	1-1/8	1-11/16	2-1/4	2-13/16	3-1/2	5	
5/8	1-3/16	1-3/4	2-5/16	2-7/8	3-3/4	5-7/16	
11/16	1-1/4	1-13/16	2-3/8	2-15/16	3-15/16	5-1/2	

Lengths: 20' R/L. Larger sizes and metric sizes in stock.

Durelloy™
THREADED BAR

Color Code:
RED

Durelloy Threaded Bar is a precision rolled thread onto a heat treated alloy conforming to ASTM A 193-B-7 specifications. Durelloy Threaded Bar is delivered in a Brinell hardness of 280–300 for greater thread strength and wear resistance. The rolled threads guarantee strength and perfect fit for shock-resistant applications subject to high pressure, high temperatures, and repetitive tortional stresses.

Applications

- Studs
- Anchor bolts
- High compression bolts
- Adjustment bolts
- Pressure vessels
- Stud pullers
- Machine anchors
- Positioning rods

Features And Advantages

- Immediate usage, no machining required
- High tensile strength
- Precision rolled threads
- Heat treated to assure long, useful life
- All bars stocked in 12-foot lengths
- Conforms to ASTM specifications
- Eliminates multiple stocking

Types

- Unified Course
- SAE National Fine
- Unified 8 Thread
- Metric
- Acme
- Left Hand
- ASTM A320 L7

Typical Mechanical Properties

	Durelloy B-7	Durelloy B-16	Dura-Krome Stainless
Tensile strength psi minimum	150,000	166,000	100,000
Yield point psi minimum	132,000	150,000	40,000
Elongation in 2"	17%	18%	55%
Reduction of area	50%	55%	60%
Rockwell C hardness	28/30	26/34	20

Available Sizes For Immediate Shipment

Stock Sizes / Class 2 Fit (B–7)

Dia.	USS (Std.) Th/In.	SAE (Fine) Th/In.	8 Thd.	Dia.	USS (Std.) Th/In.	SAE (Fine) Th/In.	8 Thd.
1/4	20	28		1-1/4	7	12	8
5/16	18	24		1-3/8	6	12	8
3/8	16	24		1-1/2	6	12	8
7/16	14	20		1-5/8	5-1/2	12	8
1/2	13	20		1-3/4	5	12	8
9/16	12	18		1-7/8	5	12	8
5/8	11	18		2	4-1/2	12	8
3/4	10	16		2-1/4	4-1/2		8
7/8	9	14		2-1/2	4		8
1	8	14	8	2-3/4	4		8
1-1/8	7	12	8	3	4		8

Stock Sizes / Class 2 Fit (B–16)

Dia.	USS (Std.) Th/In.	SAE (Fine) Th/In.	Dia.	USS (Std.) Th/In.	SAE (Fine) Th/In.	8 Thd.
1/4	20	28	1	8	14	8
5/16	18	24	1-1/8	7	12	8
3/8	16	24	1-1/4	7	12	8
7/16	14	20	1-3/8	6	12	8
1/2	13	20	1-1/2	6	12	8
5/8	11	18				
3/4	10	16				
7/8	9	14				

Lengths: 12′ R/L. Over 3" thru 7" by special order.

Dura-Form™

BRAKE DIE

Color Code:
BLACK

Dura-Form is a heat treated tooling alloy which is oil-quenched and tempered to develop a full balance of mechanical properties. Dura-Form heat treated alloy has every requisite for excellent brake die service, high wear resistance, adequate toughness, high resistance to impact, and good machinability. Dura-Form is stress relieved before the final gag straightening process to ensure a minimum of residual stresses, and to eliminate warping and bowing.

Typical Analysis

- Carbon .48/.51
- Manganese .87/1.05
- Chromium 1.00/1.25
- Vanadium .20/.30
- Silicon .24/.35
- Molybdenum .25/.35

Heat Treatment

- **Forging** 1900°–2100°F, cool slowly
- **Annealing** 1400°–1450°F, Brinell 185–195
- **Normalizing** 1600°–1650°F
- **Hardening** 1500°–1600°F, oil-quench
- **Tempering** 300°– 1300°F, average hardness after heat treatment Brinell 241–601

Applications

- Bead-forming dies
- Bending dies
- Corrugating dies
- Double-decker dies
- Flanging dies
- Multi vee dies
- Offset dies
- Seaming dies

Features And Advantages

- Heat treated–ready to use
- Free machining
- Machine straightened
- High compressive strength
- Controlled analysis
- Hardened to Brinell 248–293
- High carbon content insures greater resistance to wear
- Machines to a smooth finish without grinding

Typical Mechanical Properties

Draw	300°F	500°F	800°F	1200°F	1300°F
Tensile	340,000	295,000	231,000	141,500	120,000
Yield psi	327,000	256,000	214,000	129,000	112,000
Elongation	9%	12%	11%	21%	24%
Red. area	24%	31%	33%	56%	60%
BHN	601	560	462	275	248
Rockwell C	58	56	47	28	25

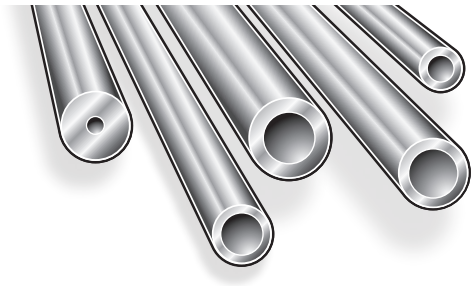
Dura-Form Shapes And Sizes Available For Immediate Shipment

Squares		Flats						
1/2	3	**1/2**	**3/4**	x 3-1/2	x 4	x 4	x 4-1/2	**3**
5/8	3-1/2	x 2	x 1	x 4	x 4-1/2	x 4-1/2	x 5	x 4
1-1/8	4	x 3	x 2	x 4-1/2	x 5	x 5	x 6	x 5
1-1/4	4-1/2	x 4	x 3	x 5	x 6	x 6	x 8	x 6
1-1/2	5	**5/8**	x 4	x 6	x 8	x 8	**2-1/2**	**4**
1-3/4	5-1/2	x 2	**1**	**1-1/4**	**1-1/2**	**2**	x 3	x 5
2	6	x 2-1/2	x 1-1/2	x 2	x 2	x 2-1/2	x 3-1/2	x 6
2-1/4	8	x 4	x 2	x 2-1/2	x 2-1/2	x 3	x 4	x 8
2-1/2	10	x 4-1/2	x 2-1/2	x 3	x 3	x 3-1/2	x 5	
2-3/4			x 3	x 3-1/2	x 3-1/2	x 4	x 6	

Lengths: 20′ R/L. Available for immediate shipment.

Durelloy™
TUBING

Color Code:
RED



Durelloy Tubing is a fine grained alloy delivered with perfect concentricity and excellent machinability. When oil-quenched, Durelloy Tubing provides a tough core and excellent case hardness. Also available: Durelloy-FM and Durelloy-CD Tubing.

Applications

- Sleeves
- Slitters
- Spacers
- Ring gauges
- Punches
- Rings
- Bushings
- Bearings
- Collets
- Knives
- Wearing rolls
- Cams
- Ring dies
- Trimmers
- Rollers

Features And Advantages

- Fully annealed
- Fine grain structure
- Free machining
- Excellent weldability
- Tough core with case hardness

Typical Analysis

- Carbon .18/.25
- Manganese .50/.70
- Chromium .85/1.10
- Silicon .20/.35
- Molybdenum .25/.32

Heat Treatment

- **Case hardening** Direct quenching only
- **Carburizing** 1725°–1750°F
- **Oil-quench** Case: Rockwell C 58–62
- **Tempering** 300°– 330°F, case: Rc 58–62
- Above heat treatment produces course case
- Core hardness will be approx. Rc 20–35

Durelloy Tubing Sizes Available For Immediate Shipment

Tube Ident.	Outer Dia.	Wall Thickness	Inner Dia.	Tube Ident.	Outer Dia.	Wall Thickness	Inner Dia.	Tube Ident.	Outer Dia.	Wall Thickness	Inner Dia.	Tube Ident.	Outer Dia.	Wall Thickness	Inner Dia.
101	1	3/32	13/16	131	1-1/2	7/32	1-1/16	161	2	5/32	1-11/16	191	2-1/2	9/64	2-7/32
102	1	7/64	25/32	132	1-1/2	1/4	1	162	2	11/64	1-21/32	192	2-1/2	5/32	2-3/16
103	1	1/8	3/4	133	1-5/8	3/32	1-7/16	163	2	3/16	1-5/8	193	2-1/2	3/16	2-1/8
104	1	9/64	23/32	134	1-5/8	7/64	1-13/32	164	2	7/32	1-9/16	194	2-1/2	7/32	2-1/16
105	1	5/32	11/16	135	1-5/8	1/8	1-3/8	165	2	1/4	1-1/2	195	2-1/2	1/4	2
106	1	3/16	5/8	136	1-5/8	5/32	1-5/16	166	2	9/32	1-7/16	196	2-1/2	9/32	1-15/16
107	1-1/8	3/32	15/16	137	1-5/8	3/16	1-1/4	167	2	5/16	1-3/8	197	2-1/2	5/16	1-7/8
108	1-1/8	7/64	29/32	138	1-5/8	7/32	1-3/16	168	2	3/8	1-1/4	198	2-1/2	3/8	1-3/4
109	1-1/8	1/8	7/8	139	1-5/8	1/4	1-1/8	169	2-1/4	3/32	2-1/16	199	2-5/8	3/32	2-7/16
110	1-1/8	5/32	13/16	140	1-3/4	3/32	1-9/16	170	2-1/4	7/64	2-1/32	200	2-5/8	1/8	2-3/8
111	1-1/8	3/16	3/4	141	1-3/4	7/64	1-17/32	171	2-1/4	1/8	2	201	2-5/8	5/32	2-5/16
112	1-1/4	3/32	1-1/16	142	1-3/4	1/8	1-1/2	172	2-1/4	5/32	1-15/16	202	2-5/8	3/16	2-1/4
113	1-1/4	7/64	1-1/32	143	1-3/4	9/64	1-15/32	173	2-1/4	3/16	1-7/8	203	2-5/8	7/32	2-3/16
114	1-1/4	1/8	1	144	1-3/4	5/32	1-7/16	174	2-1/4	7/32	1-13/16	204	2-5/8	1/4	2-1/8
115	1-1/4	9/64	31/32	145	1-3/4	3/16	1-3/8	175	2-1/4	1/4	1-3/4	205	2-5/8	5/16	2
116	1-1/4	5/32	15/16	146	1-3/4	7/32	1-5/16	176	2-1/4	9/32	1-11/16	206	2-3/4	3/32	2-9/16
117	1-1/4	3/16	7/8	147	1-3/4	1/4	1-1/4	177	2-1/4	5/16	1-5/8	207	2-3/4	7/64	2-17/32
118	1-1/4	7/32	13/16	148	1-3/4	9/32	1-3/16	178	2-1/4	3/8	1-1/2	208	2-3/4	1/8	2-1/2
119	1-3/8	3/32	1-3/16	149	1-7/8	3/32	1-11/16	179	2-3/8	3/32	2-3/16	209	2-3/4	5/32	2-7/16
120	1-3/8	1/8	1-1/8	150	1-7/8	7/64	1-21/32	180	2-3/8	7/64	2-5/32	210	2-3/4	3/16	2-3/8
121	1-3/8	5/32	1-1/16	151	1-7/8	1/8	1-5/8	181	2-3/8	1/8	2-1/8	211	2-3/4	7/32	2-5/16
122	1-3/8	3/16	1	152	1-7/8	9/64	1-19/32	182	2-3/8	9/64	2-3/32	212	2-3/4	1/4	2-1/4
123	1-3/8	7/32	15/16	153	1-7/8	5/32	1-9/16	183	2-3/8	5/32	2-1/16	213	2-3/4	9/32	2-3/16
124	1-3/8	1/4	7/8	154	1-7/8	3/16	1-1/2	184	2-3/8	3/16	2	214	2-3/4	5/16	2-1/8
125	1-1/2	3/32	1-5/16	155	1-7/8	7/32	1-7/16	185	2-3/8	7/32	1-15/16	215	2-3/4	3/8	2
126	1-1/2	7/64	1-9/32	156	1-7/8	1/4	1-3/8	186	2-3/8	1/4	1-7/8	216	2-3/4	7/16	1-7/8
127	1-1/2	1/8	1-1/4	157	1-7/8	9/32	1-5/16	187	2-3/8	5/16	1-3/4	217	2-7/8	3/32	2-11/16
128	1-1/2	9/64	1-7/32	158	2	3/32	1-13/16	188	2-1/2	3/32	2-5/16	218	2-7/8	1/8	2-5/8
129	1-1/2	5/32	1-3/16	159	2	7/64	1-25/32	189	2-1/2	7/64	2-9/32	219	2-7/8	9/64	2-19/32
130	1-1/2	3/16	1-1/8	160	2	1/8	1-3/4	190	2-1/2	1/8	2-1/4	220	2-7/8	5/32	2-9/16

(continued)

Durelloy™
TUBING

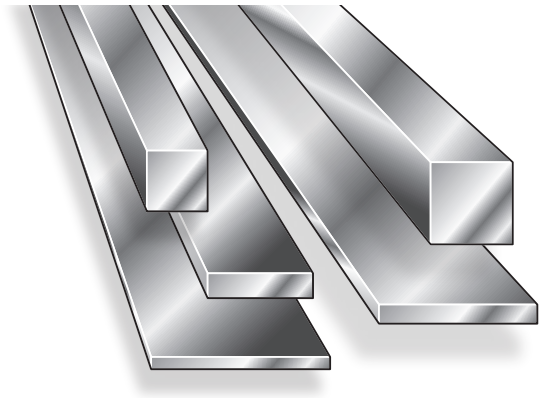
Durelloy Tubing Sizes Available For Immediate Shipment *(continued)*

Tube Ident.	Outer Dia.	Wall Thickness	Inner Dia.
221	2-7/8	3/16	2-1/2
222	2-7/8	7/32	2-7/16
223	2-7/8	1/4	2-3/8
224	2-7/8	9/32	2-5/16
225	2-7/8	5/16	2-1/4
226	2-7/8	3/8	2-1/8
227	3	3/32	2-13/16
228	3	7/64	2-25/32
229	3	1/8	2-3/4
230	3	5/32	2-11/16
231	3	3/16	2-5/8
232	3	7/32	2-9/16
233	3	1/4	2-1/2
234	3	9/32	2-7/16
235	3	5/16	2-3/8
236	3	3/8	2-1/4
237	3	7/16	2-1/8
238	3	1/2	2
239	3-1/4	3/32	3-1/16
240	3-1/4	7/64	3-1/32
241	3-1/4	1/2	3
242	3-1/4	9/64	2-31/32
243	3-1/4	5/32	2-15/16
244	3-1/4	3/16	2-7/8
245	3-1/4	7/32	2-13/16
246	3-1/4	1/4	2-3/4
247	3-1/4	9/32	2-11/16
248	3-1/4	5/16	2-5/8
249	3-1/4	3/8	2-1/2
250	3-1/4	7/16	2-3/8
251	3-1/4	1/2	2-1/4
252	3-1/2	3/32	3-5/16
253	3-1/2	7/64	3-9/32
254	3-1/2	1/8	3-1/4
255	3-1/2	9/64	3-7/32
256	3-1/2	5/32	3-3/16
257	3-1/2	3/16	3-1/8
258	3-1/2	7/32	3-1/16
259	3-1/2	1/4	3
260	3-1/2	9/32	2-15/16
261	3-1/2	5/16	2-7/8
262	3-1/2	3/8	2-3/4
263	3-1/2	7/16	2-5/8
264	3-1/2	1/2	2-1/2
265	3-5/8	3/32	3-7/16
266	3-5/8	1/8	3-1/2
267	3-5/8	5/32	3-5/16
268	3-5/8	3/16	3-1/4
269	3-5/8	7/32	3-3/16
270	3-5/8	1/4	3-1/8
271	3-5/8	3/8	2-7/8
272	3-5/8	7/16	2-3/4
273	3-3/4	3/32	3-9/16
274	3-3/4	1/8	3-1/2
275	3-3/4	5/32	3-7/16
276	3-3/4	3/16	3-3/8
277	3-3/4	7/32	3-5/16
278	3-3/4	1/4	3-1/4
279	3-3/4	5/16	3-1/8
280	3-3/4	3/8	3
281	3-3/4	7/16	2-7/8
282	3-3/4	1/2	2-3/4
283	3-7/8	3/32	3-11/16
284	3-7/8	1/8	3-5/8
285	3-7/8	5/32	3-9/16
286	3-7/8	3/16	3-1/2
287	3-7/8	1/4	3-3/8
288	3-7/8	5/16	3-1/4
289	3-7/8	3/8	3-1/8
290	4	3/32	3-13/16
291	4	7/64	3-25/32
292	4	1/8	3-3/4
293	4	9/64	3-23/32
294	4	5/32	3-11/16
295	4	3/16	3-5/8
296	4	1/4	3-1/2
297	4	9/32	3-7/16
298	4	5/16	3-3/8
299	4	3/8	3-1/4
300	4	7/16	3-1/8
301	4	1/2	3
302	4	5/8	2-3/4
303	4-1/4	3/32	4-1/16
304	4-1/4	7/64	4-1/32
305	4-1/4	1/8	4
306	4-1/4	5/32	3-15/16
307	4-1/4	3/16	3-7/8
308	4-1/4	7/32	3-13/16
309	4-1/4	1/4	3-3/4
310	4-1/4	5/16	3-5/8
311	4-1/4	3/8	3-1/2
312	4-1/4	7/16	3-3/8
313	4-1/4	1/2	3-1/4
314	4-1/4	9/16	3-1/8
315	4-1/4	5/8	3
316	4-1/2	3/32	4-5/16
317	4-1/2	1/8	4-1/4
318	4-1/2	5/32	4-3/16
319	4-1/2	3/16	4-1/8
320	4-1/2	7/32	4-1/16
321	4-1/2	1/4	4
322	4-1/2	5/16	3-7/8
323	4-1/2	3/8	3-3/4
324	4-1/2	7/16	3-5/8
325	4-1/2	1/2	3-1/2
326	4-1/2	5/8	3-1/4
327	4-1/2	3/4	3
328	4-3/4	3/32	4-9/16
329	4-3/4	1/8	4-1/2
330	4-3/4	5/32	4-7/16
331	4-3/4	3/16	4-3/8
332	4-3/4	1/4	4-1/4
333	4-3/4	5/16	4-1/8
334	4-3/4	3/8	4
335	4-3/4	7/16	3-7/8
336	4-3/4	1/2	3-3/4
337	5	3/32	4-13/16
338	5	1/8	4-3/4
339	5	5/32	4-11/16
340	5	3/16	4-5/8
341	5	7/32	4-9/16
342	5	1/4	4-1/2
343	5	5/16	4-3/8
344	5	3/8	4-1/4
345	5	7/16	4-1/8
346	5	1/2	4
347	5	5/8	3-3/4
348	5	3/4	3-1/2
349	5-1/4	3/32	5-1/16
350	5-1/4	1/8	5
351	5-1/4	5/32	4-15/16
352	5-1/4	3/16	4-7/8
353	5-1/4	1/4	4-3/4
354	5-1/4	5/16	4-5/8
355	5-1/4	3/8	4-1/2
356	5-1/4	7/16	4-3/8
357	5-1/4	1/2	4-1/4
358	5-1/4	5/8	4
359	5-1/2	3/32	5-5/16
360	5-1/2	1/8	5-1/4
361	5-1/2	5/32	5-3/16
362	5-1/2	3/16	5-1/8
363	5-1/2	1/4	5
364	5-1/2	5/16	4-7/8
365	5-1/2	3/8	4-3/4
366	5-1/2	7/16	4-5/8
367	5-1/2	1/2	4-1/2
368	5-1/2	9/16	4-3/8
369	5-1/2	5/8	4-1/4
370	5-1/2	3/4	4
371	5-3/4	3/32	5-9/16
372	5-3/4	1/8	5-1/2
373	5-3/4	3/16	5-3/8
374	5-3/4	1/4	5-1/4
375	5-3/4	5/16	5-1/8
376	5-3/4	3/8	5
377	5-3/4	7/16	4-7/8
378	5-3/4	1/2	4-3/4
379	6	3/32	5-13/16
380	6	1/8	5-3/4
381	6	5/32	5-11/16
382	6	3/16	5-5/8
383	6	1/4	5-1/2
384	6	5/16	5-3/8
385	6	3/8	5-1/4
386	6	7/16	5-1/8
387	6	1/2	5
388	6	9/16	4-7/8
389	6	5/8	4-3/4
390	6	3/4	4-1/2
391	6-1/4	3/32	6-1/16
392	6-1/4	1/8	6
393	6-1/4	3/16	5-7/8
394	6-1/4	1/4	5-3/4
395	6-1/4	5/16	5-5/8
396	6-1/4	3/8	5-1/2
397	6-1/4	1/2	5-1/4
398	6-1/4	5/8	5
399	6-1/2	3/32	6-5/16
400	6-1/2	1/8	6-1/4
401	6-1/2	1/4	6
402	6-1/2	5/16	5-7/8
403	6-1/2	3/8	5-3/4
404	6-1/2	1/2	5-1/2
405	6-1/2	5/8	5-1/4
406	6-1/2	3/4	5
407	6-3/4	3/32	6-9/16
408	6-3/4	1/8	6-1/2
409	6-3/4	3/16	6-3/8
410	6-3/4	1/4	6-1/4
411	6-3/4	5/16	6-1/8
412	6-3/4	3/8	6
413	6-3/4	7/16	5-7/8
414	6-3/4	1/2	5-3/4
415	6-3/4	3/4	5-1/4
416	7	3/32	6-13/16
417	7	1/8	6-3/4
418	7	3/16	6-5/8
419	7	1/4	6-1/2
420	7	5/16	6-3/8
421	7	3/8	6-1/4
422	7	1/2	6
423	7	5/8	5-3/4
424	7	3/4	5-1/2
425	7-1/4	1/8	7
426	7-1/4	3/16	6-7/8
427	7-1/4	1/4	6-3/4
428	7-1/4	5/16	6-5/8
429	7-1/4	3/8	6-1/2
430	7-1/4	1/2	6-1/4
431	7-1/2	3/32	7-5/16
432	7-1/2	1/8	7-1/4
433	7-1/2	3/16	7-1/8
434	7-1/2	1/4	7
435	7-1/2	5/16	6-7/8
436	7-1/2	3/8	6-3/4
437	7-1/2	1/2	6-1/2
438	7-1/2	3/4	6
439	7-3/4	1/8	7-1/2
440	7-3/4	3/16	7-3/8
441	7-3/4	1/4	7-1/4
442	7-3/4	5/16	7-1/8
443	7-3/4	3/8	7
444	7-3/4	1/2	6-3/4
445	7-3/4	3/4	6-1/4
446	8	3/32	7-13/16
447	8	1/8	7-3/4
448	8	3/16	7-5/8
449	8	1/4	7-1/2
450	8	3/8	7-1/4
451	8	1/2	7
452	8	9/16	6-7/8
453	8	5/8	6-3/4
454	8	3/4	6-1/2
455	8-1/4	1/8	8
456	8-1/4	1/4	7-3/4
457	8-1/4	3/8	7-1/2
458	8-1/4	1/2	7-1/4
459	8-1/2	1/8	7-1/4
460	8-1/2	3/16	8-1/8
461	8-1/2	1/4	8
462	8-1/2	3/8	7-3/4
463	8-1/2	1/2	7-1/2
464	8-1/2	5/8	7-1/4
465	8-1/2	3/4	7
466	9	1/8	8-3/4
467	9	3/16	8-5/8
468	9	1/4	8-1/2
469	9	3/8	8-1/4
470	9	7/16	8-1/8
471	9	1/2	8
472	9	5/8	7-3/4
473	9	3/4	7-1/2
474	9-1/2	1/8	9-1/4
475	9-1/2	3/16	9-1/8
476	9-1/2	1/4	9
477	9-1/2	3/8	8-3/4
478	9-1/2	1/2	8-1/2
479	9-1/2	9/16	8-3/8
480	9-1/2	3/4	8
481	10	1/8	9-1/4
482	10	3/16	9-5/8
483	10	1/4	9-1/2
484	10	3/8	9-1/4
485	10	1/2	9
486	10	5/8	8-7/8
487	10	3/4	8-1/2
488	10-1/2	1/8	10-1/4
489	10-1/2	3/16	10-1/8
490	10-1/2	1/4	10
491	10-1/2	3/8	9-3/4
492	10-1/2	1/2	9-1/2
493	10-1/2	3/4	9
494	11	3/16	10-5/8
495	11	1/4	10-1/2
496	11	3/8	10-1/4
497	11	1/2	10
498	11-3/4	3/16	11-3/8
499	11-3/4	1/4	11-1/4
500	11-3/4	3/8	11
501	11-3/4	1/2	10-3/4
502	11-3/4	9/16	10-5/8
503	11-3/4	5/8	10-1/2
504	11-3/4	11/16	10-3/8
505	11-3/4	3/4	10-1/4
506	11-3/4	1	9-3/4
507	12	1/8	11-3/4
508	12	3/16	11-5/8
509	12	1/4	11-1/2
510	12	3/8	11-1/4
511	12	1/2	11
512	12	5/8	10-3/4
513	12	3/4	10-1/2
514	12-3/4	1/8	12-1/2
515	12-3/4	3/16	12-3/8
516	12-3/4	1/4	12-1/4
517	12-3/4	1/2	11-3/4
518	12-3/4	9/16	11-5/8
519	12-3/4	3/4	11-1/4

Durelloy™

KEY STOCK

Color Code:
ENDS RED



Durelloy Key Stock bars are sharp-cornered with parallel sides, for applications such as keys, tool shanks gauges and wear strips. For areas requiring close tolerance and high tensile strength. All bars are cold drawn.

Features And Advantages

- Closer tolerance +.001–.000
- Square corner
- High shear strength

Mechanical Properties

- **Hardness** Rockwell C 24–28
- **Tensile strength** 115,000–135,000
- **Shear strength** 70,000–80,000

Durelloy Key Stock Sizes Available For Immediate Shipment

Squares

1/8	3/4	1-1/2
3/16	13/16	1-5/8
1/4	7/8	1-3/4
5/16	15/16	2
3/8	1	
7/16	1-1/16	
1/2	1-1/8	
9/16	1-3/16	
5/8	1-1/4	
11/16	1-3/8	

Flats

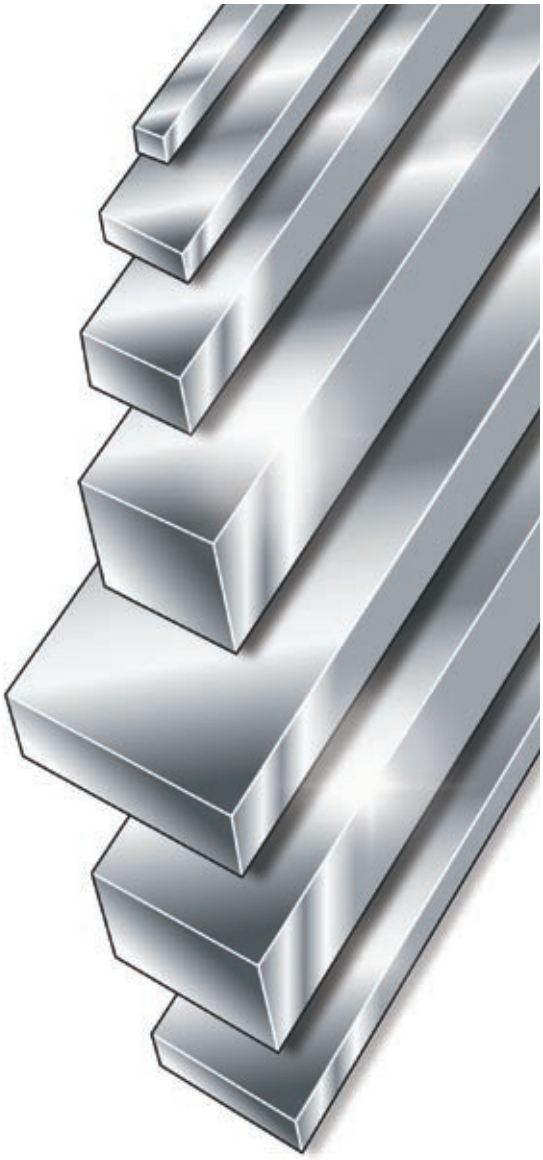
1/8	x 7/16	**1/2**	**1**	**1-1/2**
x 3/16	x 1/2	x 5/8	x 1-1/4	x 1-3/4
x 1/4	**1/4**	x 3/4	x 1-1/2	x 2
x 5/16	x 1/2	x 1	x 1-3/4	x 2-1/2
x 3/8	x 3/4	x 1-1/4	x 2	**1-3/4**
x 7/16	**3/8**	x 1-1/2	x 2-1/4	x 2
x 1/2	x 1/2	x 2	**1-1/4**	
x 5/8	x 5/8	**5/8**	x 1-1/2	
x 3/4	x 3/4	x 3/4	x 1-3/4	
x 3/8	x 1	x 1	x 2	

Lengths: 12′ minimum. Special sizes not shown in stock can be ground to order. Metric sizes available.

Durelloy-PM™

HEAT TREATED ALLOY

Color Code:
ENDS RED



Durelloy pre-machined is a fine grained, stress relieved, electric furnace alloy. It is heat treated to Rockwell C 28–32, Blanchard ground top and bottom +.020/.030 – .000, width +1/8" – .000.

A machinability rating of 80% means Durelloy-PM is ready for use in most tooling applications with no further heat treating. Durelloy-PM can be flame-hardened to 578/698 BHN for applications in which a higher hardness is required at wear points.

Applications

- Base plates
- Backup plates
- Bolsters
- Fixtures
- Guides
- Holder blocks
- Peenable dies
- Punch pads
- Strippers
- Jigs
- Molds

Available Sizes

- **Thickness** 1/2"–5" custom grinds to 20"
- **Widths** 2"–24" custom grinds to 96"
- **Lengths** 60"–72" custom grinds to 120" and 144"
- **Custom sizes** Available upon request

Ameralloy®

STAINLESS STEEL ALLOYS

Dura-Krome™ Stainless Steel

• Plate • Flats • Squares • Sheets

Dura-Krome Tubing

Dura-Krome Threaded Bar

Machining & Fabrication

Dura-Krome™

STAINLESS STEEL

Color Code:
YELLOW &
WHITE

Dura-Krome stainless steel alloy is designed to meet the requirements for tough applications. Dura-Krome resists corrosion, delivers strength, and provides machineability in a non-hardenable fatigue resisting alloy compatable with the 300 stainless series (302, 304, 316, and 321).

Typical Analysis

- Carbon .02/.05
- Silicon .40/1.25
- Chromium 19.00/25.00
- Nickel 25.00/35.00

Features And Advantages

- Free machining
- Fatigue resistant
- Non-galling
- Corrosion resistant
- non-magnetic
- High tensile strength

Dura-Krome Rounds

- Available from 1/8" through 8"
- Cold drawn finish
- Centerless ground finish
- Precision ground and polished finish (+.000/.002")

Dura-Krome™
STAINLESS STEEL

Dura-Krome Plates, Squares, Flats, Sheets

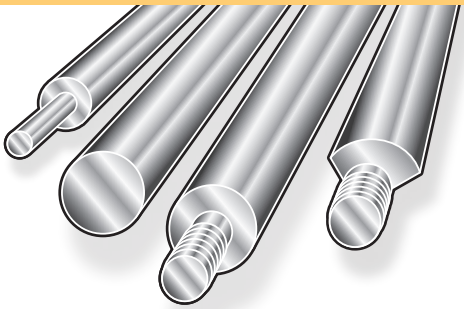
- Available thickness from 1/8" through 2"
- Over one inch special order to your specifications
- Stock sizes or plasma cut to shape

Dura-Krome Tubing

- Welded and seamless available–consult Ameralloy plant for stock sizes

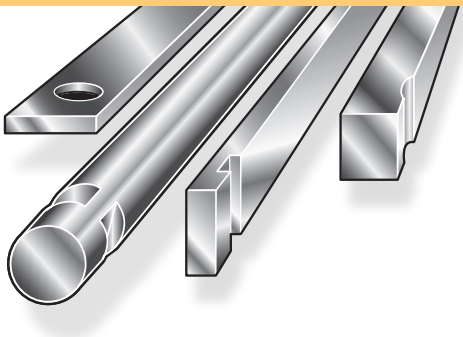
Dura-Krome Threaded Bar

- 1/4" through 2" standard, fine, and 8 pitch
- Class 2 fit



Machining And Fabrication

- Forming, rolling, punching, and perforating
- Specialty forgings and machining to your specifications



Dura-Krome™
STAINLESS STEEL

specifications




Applications

- Acetic acid
- Acetylene
- Alcohol
- Aluminum acetate
- Aluminum sulfate
- Ammonia
- Aniline
- Barium carbonate
- Barium chloride
- Barium sulphate
- Benzene
- Boric acid
- Butyl acetate
- Calcium chloride
- Calcium hydroxide
- Carbonic acid
- Carbon tetrachloride
- Cellulose
- Chlorine gas
- Chromic acid
- Copper acetate
- Copper nitrate
- Creosote
- Ethyl alcohol
- Ethyl chloride
- Ethyl alcohol
- Ferric chloride
- Ferric nitrate
- Ferrous sulfate
- Flourine
- Formaldehyde
- Fuel oil
- Gasoline
- Glycerin
- Hops
- Hydrogen peroxide
- Iodine
- Lactic acid
- Magnesium sulfate
- Mercuric chloride
- Methanol
- Naptha
- Nitric acid
- Pieric acid
- Potassium chlorate
- Potassium hydroxide
- Salt brine
- Soap
- Steam
- Sugar
- Sulphur
- Sulphuric acid
- Tannic acid
- Tar
- Trichlorethylene
- Uric acid
- Vinegar
- Water

Mechanical Properties Comparison

	Dura-Krome	302	304	316
Tensile strength psi minimum	115,000	89,000	85,000	90,000
Yield point psi minimum	51,000	39,000	35,000	40,000
Elongation in 2"	50%	55%	55%	50%
Reduction of area	55%	70%	70%	65%
Rockwell C hardness	20	Annealed	Annealed	Annealed

Dura-Krome Shapes And Sizes Available For Immediate Shipment

Rounds

1/8	3/4	1-1/2	3	5-1/2
3/16	13/16	1-5/8	3-1/4	6
1/4	7/8	1-3/4	3-1/2	6-1/2
5/16	15/16	1-7/8	3-3/4	7
3/8	1	2	3-15/16	7-1/2
7/16	1-1/8	2-3/16	4	8
1/2	1-3/16	2-1/4	4-1/4	
9/16	1-1/4	2-3/8	4-1/2	
5/8	1-3/8	2-1/2	4-3/4	
11/16	1-7/16	2-3/4	5	

Plate

1/8 x 60 x 120	1/2 x 72 x 120
3/16 x 48 x 120	5/8 x 48 x 120
3/16 x 72 x 120	5/8 x 72 x 120
1/4 x 48 x 120	3/4 x 48 x 120
1/4 x 78 x 120	3/4 x 72 x 120
5/16 x 48 x 120	1 x 48 x 120
5/16 x 72 x 120	1 x 72 x 120
3/8 x 48 x 120	
3/8 x 72 x 120	
1/2 x 48 x 120	

Lengths: 12'–14'.

Ameralloy®

ABRASION / IMPACT RESISTANT ALLOYS
CHROMIUM CARBIDE OVERLAY• UHMW PLASTIC

Amera-Braze® 420

Amera-Braze 520

Ameralloy Plate And Strip

Ameralloy AR

American-50™

Amera-Mang™

Dura-Lugg™

Amera-Plex™ Polyethylene

Amera-Thane™ Polyurethane

Amera-Plex Mine Plate

Double-C® Chromium Carbide Overlay

Amera-Braze® 420

ULTRA HIGH IMPACT ALLOY

Color Code:
ORANGE

Amera-Braze 420 by Ameralloy is a heat treated, ultra-high impact and abrasion resistant alloy steel plate and strip. With a combination of excellent toughness and high hardness, Amera-Braze 420 has the capability to resist shock, impact, abrasion, stress, and vibration.

Because of its high strength formulation, a reduction of dead weight is achieved by using Amera-Braze in half the thickness of the original chute, liner, or wear area.

Features And Advantages

- Ultra-high wear resistance
- Heat treated, quenched, and tempered to a high Brinell hardness
- Excellent weldability
- Depth hardened
- Fine grain structure
- High tensile strength
- Corrosion resistance six times greater than mild steel
- Can be formed, rolled, and drilled
- Abrasion, impact, and wear properties retained at weld joints

Typical Mechanical Properties

Tensile strength psi	198,000
Yield point psi	165,000
Elongation in 2"	16%
Reduction of area	52%
Brinell hardness	390–420
Rockwell C hardness	39–46

Welding

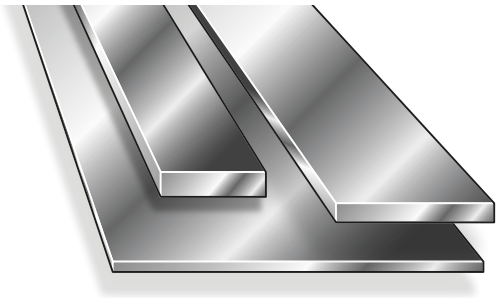
Use low hydrogen high tensile electrodes: AWS specification E100XX, E110XX, or E120XX electrodes.

- Carbon .18/.28
- Manganese 1.15/1.50
- Silicon .20/.35
- Molybdenum .08/.28
- Aluminum .03 max.
- Chromium .40/1.00
- Nickel .25 max.
- Boron .0005 min.
- Phosphorus .025 max.
- Sulfur .040 max.

Typical Analysis May Vary By Heat Lot

Amera-Braze® 420

ULTRA HIGH IMPACT ALLOY



Applications

- Agricultural tynes
- Agitator paddles
- Arms for lift trucks
- Backup plates
- Baffle plates
- Bucket lips
- Bulldozer blades
- Car plates
- Chain links
- Chain slide runners
- Chutes:
  Coal
  Coke
  Glass
  Grain
  Gravel
  Limestone
  Ore
  Refuse
  Rock
  Sand
  Slag
  Slate
- Classifier screens
- Coke bins
- Conveyor buckets
- Crusher hammers
- Clam shell bucket lips
- Concrete mixer liners
- Concrete pipe liners
- Deck plates
- Doors
- Dredge pump liners
- Drag line buckets
- Dipper sticks
- Dump truck beds
- Eye bars
- Fan blades/housings
- Flotation plates
- Flume liners
- Funnels
- Furnace liners
- Grader blades
- Hoppers
- Launder plates
- Loaders
- Log-washer paddles
- Muller bottoms
- Mixers
- Oscillator Liners
- Ore car bodies/liners
- Ore pocket liners
- Pressure plates
- Scrap baler liners
- Scraper blades
- Shakeout liners
- Shot-blast liners
- Skip cars and liners
- Sluice plates
- Spiral castings
- Transfer car liners
- Truck box liners
- Vibrators
- Wear bars
- Wear plates
- Wearing strips
- Wheelabrator end plates

Available Sizes

Amera-Braze 420 Plates
Thickness: 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4" 1-1/2" 1-3/4" 2" 2-1/2" 3"
Thicknesses over 3" upon request
Widths: 48" 60" 72" 84" 96" or burned to your specifications
Lengths: 96" 120" 144" 240" 288" or burned to your specifications

Amera-Braze 420 Wear Strips
Thickness: 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4" 1-1/2" 1-3/4" 2"
Thicknesses over 2" burned to your specifications
Widths: Burned to your specifications
Lengths: Maximum of 24'

Fabrication & Machining
Forming, rolling, punching, and perforating to your specifications

Amera-Braze® 520

ABRASION RESISTANT ALLOY

Color Code:
ORANGE
& BLACK

Amera-Braze 520 is a heat treated, abrasion resistant alloy steel plate and strip. With a combination of excellent toughness and high hardness, a reduction of dead weight can be achieved by using Amera-Braze 520 in half the thickness of the original chute, liner, or wear area.

Features And Advantages

- Ultra-high wear resistance
- Heat treated, quenched, and tempered to a high Brinell hardness
- Good weldability
- Depth hardened
- Fine grain structure
- High tensile strength
- Corrosion resistance six times greater than mild steel
- Reduces dead weight

Typical Mechanical Properties

Tensile strength psi	245,000
Yield point psi	230,000
Elongation in 2"	9%
Reduction of area	40%
Brinell hardness	480–520

Welding

Use low hydrogen high tensile electrodes: AWS specification E100XX, E110XX, or E120XX electrodes.

- Preheat to 300°–500°F on plates over 1/2" in thickness.

Consult Ameralloy plant for welding and fabrication information.
Special forming and fabrication procedures required.

Amera-Braze® 520

ABRASION RESISTANT ALLOY

Applications

- Backup plates
- Baffle plates
- Bucket lips
- Car plates
- Chain links
- Chain slide runners
- Chutes:
  Coal
  Coke
  Glass
  Grain
  Gravel
  Limestone
  Ore
  Refuse
  Rock
  Sand
  Slag
  Slate
- Classifier screens
- Coke bins
- Conveyor buckets
- Clam shell bucket lips
- Concrete pipe liners
- Deck plates
- Doors
- Dredge pump liners
- Drag line buckets
- Dipper sticks
- Dump truck beds
- Eye bars
- Fan blades & housings
- Flotation plates
- Flume liners
- Furnace liners
- Hoppers
- Launder plates
- Loaders
- Log-washer paddles
- Muller bottoms
- Mixers
- Oscillator Liners
- Ore car bodies & liners
- Ore pocket liners
- Pressure plates
- Scrap baler liners
- Shakeout liners
- Skip cars and liners
- Sluice plates
- Transfer car liners
- Truck box liners
- Vibrators
- Wear bars
- Wear plates
- Wearing strips
- Wheelabrator end plates

Available Sizes

Amera-Braze 520 Plates
Thickness: 1/4″ 3/8″ 1/2″ 5/8″ 3/4″ 1″ 1-1/4″ 1-1/2″ 1-3/4″ 2″ 2-1/2″ 3″
Thicknesses over 3″ upon request
Widths: 48″ 60″ 72″ 84″ 96″ or burned to your specifications
Lengths: 96″ 120″ 144″ 240″ 288″ or burned to your specifications

Amera-Braze 520 Wear Strips
Thickness: 1/4″ 3/8″ 1/2″ 5/8″ 3/4″ 1″ 1-1/4″ 1-1/2″ 1-3/4″ 2″
Thicknesses over 2″ burned to your specifications
Widths: Burned to your specifications
Lengths: Maximum of 24′

Ameralloy®

PLATE AND STRIP

Color Code:
GREEN

Ameralloy Plate And Strip is a medium manganese, heat treated, quenched and tempered alloy. Our balanced alloy content gives Ameralloy Plate And Strip excellent weldability and good resistance to atmospheric corrosion, when compared to original equipment and mild steel.

Features And Advantages

- Work hardening
- Reduction in dead weight
- Can be drilled with standard high speed tooling
- Excellent weldability
- Moderate cold forming
- Maximum resistance to impact and abrasion
- High tensile strength

Typical Mechanical Properties

Tensile strength psi	190,000
Yield point psi	156,000
Elongation in 2"	14%
Reduction of area	52%
Brinell hardness	400
Rockwell C hardness	42

Welding

Use low hydrogen high tensile electrodes: AWS specification E100XX, E110XX, or E120XX electrodes.

- Carbon .10/.20
- Manganese 1.70 max.
- Silicon .10/.70
- Molybdenum .70 max.
- Chromium 1.00 max.
- Boron .001/.005
- Phosphorus .020 max.
- Sulfur .010 max.

Typical Analysis May Vary By Heat Lot

Ameralloy®
PLATE AND STRIP

Applications

- Agricultural discs
- Agricultural shoes
- Agitator paddles
- Anchors
- Baffle plates
- Bucket lips
- Bulldozer blades
- Car axles
- Car plates
- Cute liners
- Coke chutes
- Concrete mixer liners
- Concrete pipe liners
- Bucket lips
- Conveyor buckets
- Crusher hammers
- Dipper sticks
- Drag buckets
- Dredge pipes
- Dredge pump liners
- Dump truck beds
- Dust collectors
- Fan blades/housings
- Flotation plates
- Foundry shakeout machines
- Funnels
- Furnace liners
- Grader blades
- Grain chutes
- Grain mill hammers
- Gravel chutes
- Hoppers
- Launder plates
- Lawnmower cutter bars
- Limestone chutes
- Lift forks
- Liners
- Loaders
- Mixers
- Muller bottoms
- Ore chutes
- Ore spouts
- Ore washers
- Pangborn parts
- Picking tables
- Rock chutes
- Sand chutes
- Scrap baler liners
- Scraper blades
- Shear handles
- Shakeout liners
- Shaker plates
- Shot blast liners
- Shovel booms
- Shovels
- Skip liners
- Slag chutes
- Slate chutes
- Sluice ways
- Spouts
- Stabilizing bars
- Trailer bodies
- Truck box liners
- Vibrators
- Wheelabrator parts
- Wrenches
- Wear plates

Available Sizes

Ameralloy Plates
Thickness: 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4" 1-1/2" 1-3/4" 2" 2-1/2" 3"
Thicknesses over 3" upon request
Widths: 48" 60" 72" 84" 96" or burned to your specifications
Lengths: 96" 120" 144" 240" 288" or burned to your specifications

Ameralloy Wear Strips
Thickness: 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4" 1-1/2" 1-3/4" 2"
Thicknesses over 2" burned to your specifications
Widths: Burned to your specifications
Lengths: Maximum of 24'

Fabrication & Machining
Forming, rolling, punching, and perforating to your specifications

Ameralloy® AR

MACHINABLE ALLOY

Color Code:
ORANGE
& BLACK

For applications where extensive forming is required. Ameralloy AR also provides good weldability, good machineability, while maintaining its abrasion and impact resistance.

Features And Advantages

- Easy to form–press brake 80° to 90° angles
- Machineability 75% compared to B-1112
- Impact resistant
- Wear resistant
- Medium hardness
- Shearing and punching in thicknesses up to 3/8"

Typical Mechanical Properties

Tensile strength psi	140,000
Yield point psi	130,000
Elongation in 2"	16%
Reduction of area	45%
Brinell hardness	250–310
Rockwell C hardness	30–32

Welding

- Preheating not required in thicknesses up to 1/2" .

Available Sizes

Ameralloy AR Plates
Thickness: 3/16" 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4" 1-1/2" 1-3/4" 2" 2-1/2" 3"
Thicknesses over 3" upon request
Widths: 48" 60" 72" 84" 96" or burned to your specifications
Lengths: 96" 120" 144" 240" 288" or burned to your specifications

American-50™

PLATE AND STRIP

Color Code:
LIGHT BLUE

A medium range abrasion resistant plate for economy-minded applications, where the cost of initial materials and the reduction of downtime are important factors. Excellent weldability and workability make American-50 well suited to applications requiring quality materials at a significantly reduced cost.

Features And Advantages

- Excellent weldability
- Economical alternative to high cost AR plate
- Can be rolled and formed with ease
- Can be drilled and flame-cut with ease
- Abrasion resistant

Typical Mechanical Properties

Tensile strength psi	130,000
Yield point psi	90,000
Elongation in 2"	16%
Brinell hardness	220–260

Welding

- Use 7016 or 8016 electrodes

Applications

- Asphalt plug mill liners
- Bucket lips
- Chute liners
- Clam shell bucket lips
- Concrete mixer liners
- Concrete pipe liners
- Conveyor buckets
- Conveyor flights
- Cylinders
- Dredge pipes
- Dust collector pipe sections
- Fan housings
- Flume liners
- Funnels
- Hoppers
- Ore trays
- Pan liners
- Plug mill mixer liners
- Screens
- Skip tub liners
- Skirt plates
- Spades
- Spouts
- Troughs
- Vibrating conveyors

Available Sizes

American-50 Plates
Thickness: 1/8" through 8"
Widths: 48" 60" 72" 84" 96" or burned to your specifications
Lengths: 96" 120" 144" 240" 288" or burned to your specifications

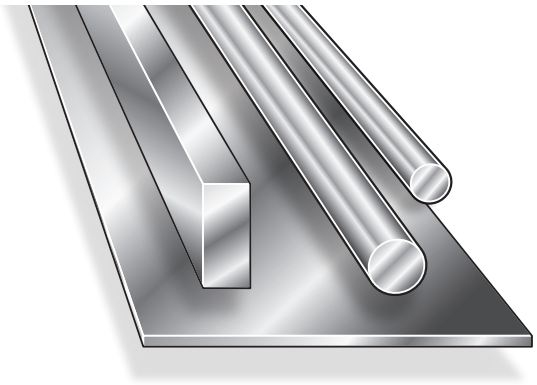
American-50 Wear Strips
Thickness: 1/8" 3/16" 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4" 1-1/2" 1-3/4" 2" 2-1/2"
Thicknesses over 2-1/2" burned to your specifications
Widths: Burned to your specifications
Lengths: Maximum of 24'

Fabrication & Machining
Forming, rolling, punching, and perforating to your specifications

Amera-Mang™

PLATE AND STRIP

Color Code:
LIGHT PINK



Amera-Mang is a balanced chemistry, high manganese (11–14%) work hardening alloy. Amera-Mang is specially formulated for high impact, extreme abrasion applications such as drag lines, dipper buckets, rock crushers, and shot and blast cleaning equipment.

Features And Advantages

- Non-magnetic
- High impact resistance
- Work hardening
- Self polishing
- Easy to torch cut and weld

Typical Mechanical Properties

Tensile strength psi	140–170,000
Yield point psi	120–135,000
Elongation in 2″	11–19%
Reduction of area	20–24%
Brinell hardness	230–255
Work hardens to	550–650 BHN

Available Sizes

Amera-Mang Plates
Thickness: 3/16″ 1/4″ 3/8″ 1/2″ 3/4″ 1″ 1-1/4″ 1-1/2″ 2″
Widths: 48″ 60″ 72″
Lengths: 120″ 144″ 240″

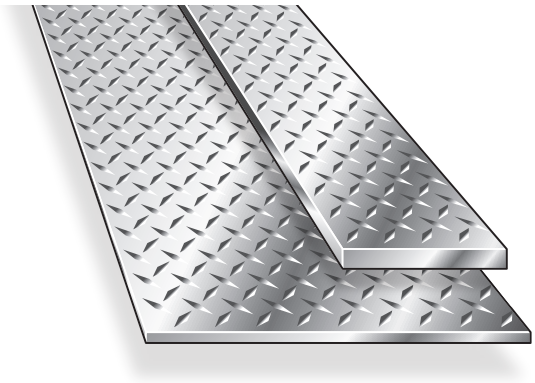
Amera-Mang Rounds
Diameter: 3/8″ through 7″
Standard Lengths: 20′ R/L

Amera-Mang Strips
Cut to your specified length and thickness

Dura-Lugg™

FOUR-WAY PLATE

Color Code:
ORANGE



Dura-Lugg Four-Way Plate is a balanced alloy of manganese-chromium-vanadium combined in an extremely tough heat treated condition with high Brinell hardness. Dura-Lugg is suited for applications where lugs assist in deflecting abrasive particles off of fan blades, resulting in the elimination of straight-line wear and wash-out problems.

Dura-Lugg offers excellent corrosion resistance properties considerably higher than structural carbon steels. It is also frequently specified to reduce the high cost of hard-facing or hard-surfacing.

Applications

- Fan blades
- Pulverizing equipment
- Ore handling equipment
- Pulverizing floats
- Coal handling equipment
- Ash handling equipment
- Rotor blades

Typical Mechanical Properties

Tensile strength psi	190,000
Base plate hardness	350–360 BHN
Lug hardness	390–410 BHN

Available Sizes

Dura-Lugg Plates
Thickness: 1/4" 3/8" 1/2"
Widths: 48" 72"
Lengths: 120" 144"

Fabrication & Machining
Forming, rolling, drilling, countersinking to your specifications

Amera-Plex™

ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE

Color Code:
WHITE OR
GREEN

Amera-Plex reduces maintenance problems with increased cost savings wherever excessive wear problems occur due to sliding action. Amera-Plex provides a cling-free surface, eliminating material buildup and corrosive action.

Features And Characteristics

High abrasion resistance
- Outwears AR steel 3 to 4 times longer
- Outwears stainless steel 6 times longer
- Outwears carbon steel 8 to 10 times longer
- Outwears Nylon, Teflon, Delrin, Nylatron

Resists fatigue
- No cracking when subjected to high mechanical stress or temperature variations
- Zero moisture absorption

Chemically inert
- Resists all acids, alkalies, and corrosive conditions

Lightweight, easily fabricated
- 1/8 the weight of steel
- Use standard wood or metal working tools to saw, turn, plane, drill, pierce, or mill

High notch impact strength
- Retains excellent impact strength despite sub-zero temperatures or repeated impact of blunt medium
- Work hardens with repeated abuse

Superslippery
- Material will not stick, freeze, cake, or cause bridging
- Self-lubricating
- Low coefficient of friction
- Materials able to move faster in chutes

Electrical/Noise insulator
- Eliminates static charge buildup
- Reduces decibel level compared to steel

FDA And USDA Approved

- Odor-free
- Taste-free
- Noncorrosive
- Food industry approved for abrasion and chemical applications

Available Sizes

Amera-Plex Sheets
Thickness: 1/8" thru 5"
Width/Length: 48" x 96" or 48" x 120"

Amera-Plex Rods
Diameter: 1/2" thru 6" (in 1/4" increments)
Length: 10'

Amera-Plex Bars
Thickness: 1/4" x 4"
Width: 1/2" x 24"

Tubing and profiles available

Amera-Thane™

IMPACT RESISTANT POLYURETHANE

Color Code: BLUE

Amera-Thane is our own outstanding formulation of thermo-set polyester polyurethane. It is uniquely molded to produce a superior impact resistant plate with the smoothest surface possible and a low coefficient of friction. Amera-Thane is certified as complying with FDA Article 121.2522, and can be used as the contact surface for grain and other dry bulk foods.

Amera-Thane is poured to order, and is also available with 16GA expanded steel backing for rigidity and installation.

Typical Mechanical Properties

Property	Units	Test Method	Results
Shore A hardness		ASTM D-2240-64T	87 ± 1
Split tear strength	psi	Fed. spec. 601-M-4221 mod.	315+
Tensile strength	psi	ASTM D-412-62T	7200+
Ultimate elongation	%	ASTM D-412-62T	570–580
Break set	%	ASTM D-412-62T	10
100% modulus	psi	ASTM D-412-62T	725
200% modulus	psi	ASTM D-412-62T	1100
300% modulus	psi	ASTM D-412-62T	1500
Compression set	%	ASTM D-395-61 (B)	35
Compression deflection	psi	ASTM D-575-46	80
2% deflection			170
5% deflection			310
10% deflection			440
15% deflection			590
20% deflection			740
50% deflection			2150
ASTM No. 1 oil (125°C, 70 hrs.)	% tensile retention	ASTM D-741-63T	43
ASTM No. 3 Oil (125°C, 70 hrs.)	% tensile retention	ASTM D-741-63T	50
Humidity aging (70°C, 100% R.H.)	% tensile retention/2 wks.	ASTM D-1349-62	60
Humidity aging (121°C, 15 psi)	% tensile retention/24 hrs.	ASTM D-1349-62	25
Heat aging (125°C, 150°C)	% tensile retention/72 hrs.	ASTM D-1564-65	83, 28
Glass transition, Clashberg	°C	ASTM D-1043-61T	-35
Solenoid impact	°C	ASTM D-746-57T	-35
TMA penetrometer, melt transition (74 lb, 1800 min^{1}, 0.2" amp)	°C Minutes to failure	 ASTM D-623-62	+173 12
Zwick flex life	Cycles to failure	ASTM D-813-59	105
Taber abrasion (H-18, 1 kg, 10^3 cycles)	mg loss	ASTM D-1044-56	8.5
NBS abrasion index	% rubber standard	ASTM D-1630	250
Outdoor aging	% tensile retention/1 yr.	ASTM D-412-62T	60

Applications

- Belt skirting
- Cutting pads
- Conveyor scrapers
- Duct work elbow
- Gaskets
- Guides
- Impact pads
- Impact skirts
- Idler wheels
- Slides
- Spout linings
- Strippers
- Sorter blocks
- Truck bed liners
- Wear pads
- Wiper blades

Available Sizes

Amera-Thane Sheets Poured to order – 48" x 120" max. length/width

Amera-Thane Bars Molded to order

Amera-Plex™ Mine Plate

ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE

Color code: MAROON

Amera-Plex is one of Ameralloy's new breed of extremely long chain polymeric-type materials. Amera-Plex Mine Plate provides a cling-free surface, eliminating material buildup and corrosive action. Far superior to conventional plastics, and with so many unique advantages, it has become the specification of choice for a growing number of diverse applications.

Amera-Plex Mine Plate was developed to replace and outperform less durable plastics, metals, and other conventional materials. Its uniqueness stems from its unusual properties. Amera-Plex has characteristics similar to those of both plastic and metal, and several unique properties that are found only in Amera-Plex Mine Plate.

The Ameralloy sales and engineering staff offer assistance with complicated or unusual applications. To get started, send us your blueprints and specifications.

Features And Advantages

- High abrasion resistance
- Outwears AR, stainless, and carbon steels
- Outwears Nylon, Teflon, Delrin, and Nylatron
- Chemically inert–resists all acids, alkalies, and corrosive conditions
- Lightweight, easily fabricated
- High notch impact strength
- Superslippery–low coefficient of friction
- Eliminates static buildup and reduces noise level compared to steel.

Typical Mechanical Properties

Property	Env.	Test Method	Unit	Results
Specific gravity		ASTM D-792	g/cm^3	0.950
Yield strength	@73°F	ASTM D-638	psi	3300
Ultimate tensile strength	@73°F	ASTM D-638	psi	6250
Break elongation	@73°F	ASTM D-638	%	326
Rockwell C hardness		ASTM D-785	—	64–70
Environmental stress cracking	$@F_{50}$	ASTM D-1693 Mod	hours	7000
Water absorption		ASTM D-570	—	nil

Amera-Plex™ Mine Plate

ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE

Applications

- Bumper blocks
- Bucket conveyor housing
- Bushings
- Cable guides
- Cam rollers & guides
- Chain guides
- Chutes:
  Coal
  Coke
  Glass
  Grain
  Gravel
  Limestone
  Ore
  Refuse
  Rock
  Sand
  Slag
  Slate
- Conveyor belt rollers
- Conveyor belt wipers & guides
- Conveyor slats
- Conveyor tracks
- Couplings & fittings
- Cutting boards
- Flat chain wear plates
- Gears
- Guide plates, rails, rollers
- Hopper linings
- Noise abatement–plastic + metal gears
- Sandblasting shields
- Screen wire guides
- Screen wire strips
- Vacuum pump valve cones
- Washer linings
- Wet side spur gears

Coefficient Of Friction

Amera-Plex Mine Plate has a lower coefficient of friction than glass. With its self-lubricating characteristics, it is an ideal material for bearings, bushings, valves, wear strips, or any application involving sliding contact.

Comparison of coefficient of friction on various materials:

Materials	Static	Test Method
Mild steel vs. mild steel	0.30–0.40	
TIVAR-100 vs. TIVAR-100	0.20–0.30	
Mild steel vs. Amera-Plex	0.15–0.20	
Amera-Plex vs. Amera-Plex Mine Plate	0.10–0.13	ASTM D-1894

Comparison of dynamic coefficient of friction on polished steel:

	Dry	Water	Oil
Amera-Plex Mine Plate	0.10–0.22	0.05–0.10	0.05–0.08
Nylon 6/6	0.15–0.40	0.14–0.19	0.02–0.11
Nylon 6	0.15–0.40	0.14–0.19	0.02–0.11
Teflon®	0.04–0.25	0.04–0.08	0.04–0.05
Delrin®	0.15–0.35	0.10–0.20	0.05–0.10
Nylatron GS®	0.12–0.20	0.10–0.12	0.08–0.10

Abrasive Resistance

Materials listed below were rotated 24 hours @ 1750 rpm in a 50/50 sand/water slurry. The weight loss for each material is relative to carbon steel = 100. The lower the value, the better the abrasive resistance.

Sand slurry test:

Amera-Plex™ Mine Plate	5	Polyacetal	110
Amera-Plex	15	TFE/glass fiber	113
Nylon	31	Normal MW polyethylene	125
High MW polyethylene	44	Phosphor bronze	193
TFE	72	Yellow brass	409
Stainless steel	84	Phenolic laminate	571
Polypropylene	87	Hickory wood	967
Polycarbonate	96	Carbon steel	100

Available Sizes

Amera-Plex Mine Plate
Thickness: 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1-1/4"
Widths: 48"
Lengths: 120"

Fabrication & Machining
Forming, rolling, punching, perforating

Also Available: Ceramic filled, rubber backed, tubing, profiles

Amera-Plex™ Mine Plate

ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE

Installation Instructions

• **Handling** Amera-Plex lightweight sheets (¼" thick x 4' x 10') weigh approximately 53 lbs. One or two workers can handle the sheet with ease. Amera-Plex can be cut and drilled with normal woodworking or metal tools.

• **Fastening** It is important that the material be firmly fastened to the substrate. The linear expansion of Amera-Plex (.0013" per inch/per 1°F) creates a force that moves the sheet. Proper spacing of fasteners according to sheet thickness will overcome this force and hold the sheet flat against the substrate. Improper fastening will result in surface ripples and gaps where sections are joined. Surface ripples will show excessive wear.

It is recommended that Amera-Plex be held in place with mechanical fasteners. Correct spacing of fasteners can be determined by the thickness of the sheet:

Sheet Thickness	Recommended Fastener Spacing (on centers)
1/4	6" to 8"
3/8"	8" to 10"
1/2, 5/8, 3/4	12" to 15"
1" and over	15" to 20"

For all thicknesses, fasteners should be no closer than 2" from the edges of the sheet. Tighten fasteners to hold the material securely against the substrate. Correct fastener strength and spacing will minimize warpage of Amera-Plex due to linear thermal expansion. Adjoining panels should be butted together as tightly as possible.

To allow for linear expansion and contraction, the diameter of the bolt should be 1/8" smaller than the diameter of the drilled hole. The bolt head should have a washer to prevent pull-out.

• **Stainless steel flathead bolts** These fasteners are easy to install and remove when replacing liners, and can hold sheets of Amera-Plex from 3/8" to 1" thick. Stainless steel is preferred for its higher abrasion and corrosion resistance compared to mild or carbon steel bolts. Flathead shape permits bolt to be flush with the surface.

• **Drive rivets** Blind fastening to metal and less dense materials like wood. Drive rivets are preferred in some cases to reduce installation time. Correct rivet size is determined by the combined thickness of the liner and the substrate. Place rivets in pre-drilled holds and sink with a hammer. The rivet head will flare out and provide a secure installation. Fast, effective, ideal for hard-to-reach areas.

Note: All fastening heads should be at least flush with the lining's surface. Protruding or exposed bolts will wear faster than Amera-Plex, which could result in loss of holding strength. Protrusion above the surface also causes upward deflection in the smooth flow of bulk material.

Fabrication & Machining

• **Fabrication** Amera-Plex can be fabricated using conventional wood and metal working equipment. Machining characteristics of Amera-Plex are very similar to yellow brass. Frictional heat is recommend when cutting or milling deep holes and slots. Amera-Plex can be drilled easily for inserting bolts or self-tapping screws. Installing chute and hopper liners does not require special training or equipment. One sheet of Amera-Plex weighs only 78 lbs., as compared to the same size sheet of AR weighing 480 lbs.

• **Milling** Milled shapes can be created using two high speed flute milling cutters. Sufficient clearance angle on cutting tooth is important to allow for chip clearance. Spindle speed and feed rate are determined by depth of cut and the amount of material to be removed.

• **Sawing** Use band saw with skip tooth blade or circular saw with carbide tipped blade.

• **Turning, boring** Conventional metal lathe recommended for machining Amera-Plex. Use high spindle speed and feed. Round-nosed boring and turning tools with increased top angle–up to 16°–provide excellent finishes.

• **Drilling** Use conventional twist drill. Drilling of deep holes is improved by using the use of low helix drills to improve chip removal.

• **Planing** Use conventional wood planer with high speed steel planer blade. High speed wood routers can also be used for high volume production of profile shapes.

• **Coolants** The use of mist or flood coolants is recommended when drilling or milling deep holes or slots. When machining Amera-Plex, it is important not to generate excessive heat.

Forming

• Although Amera-Plex is comparatively more rigid than urethane, with the use of heat it can be permanently bent to almost any configuration to fit corners and angles.

• **Hot forming** Amera-Plex can be custom-formed on site using a propane or blow torch. Keeping flame 3"–4" above the surface, heat material broadly over the surface to be formed. When the material becomes pliable, apply to contoured surface and allow to cool. After shape is set upon cooling, use normal fastening procedures as described. Amera-Plex will retain all of its original properties upon cooling.

For more complex forming, Amera-Plex blanks can be heated in an electric oven at 325°–350°F for varying lengths of time according to the thickness of the material. When it has plastified, apply material to a forming fixture built to form the desired shape. Clamp Amera-Plex to the form and cool.

Amera-Plex can be immersed in a preheated glycerine bath set at a controlled temperature of 302°F (150°C). Heating time varies according to sheet thickness:

Sheet Thickness	Heating Time @ 150°C
8mm (.3150")	15 minutes
15mm (.600")	25 minutes

In all cases, the sheet must be properly plastified. The material will assume a translucent glass-like condition when it reaches the proper temperature. Remove immediately from the bath. Form while hot, or place into a form or mold and allow to conform to the desired shape. If necessary, Amera-Plex may be pressed into shape after it is placed into the form or mold.

Cooling is performed at room temperature. Because of its heat dissipation characteristics, cooling time takes somewhat longer than the heating cycle. Once the sheet reaches 158°F (70°C), introduction of tap water at approximately. 68°F (20°C) helps speed cooling. Tap water serves the dual purpose of removing the remaining glycerin from the surface.

• **Cold forming–rectangular** Amera-Plex may be cold formed through the use of breakpress, roll, hand forming, or by using bolts to draw and form in place. Due to the spring back effect of Amera-Plex, formed angles must be over bent by 75–100%. Cold forming is used for sheets less than 3/8" thick.

• **Cold forming–circular** **Recommended minimum forming diameters for Amera-Plex sheets:**

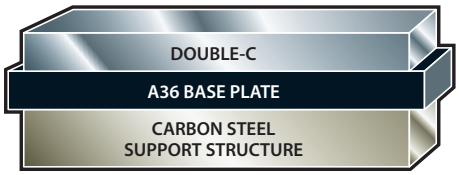
Sheet Thickness	Minimum Diameter
1/8"	8"
3/16"	10"
1/4"	12"
3/8"	24"

Double-C®

CHROMIUM CARBIDE OVERLAY

Color Code:
BLUE

Double-C Chromium Carbide Overlay is the perfect solution to premature equipment and part wear in extremely abrasive conditions with low to moderate impact. Double-C was engineered utilizing an innovative new cladding process to create the most wear-resistant surface available.



Double-C's low carbon steel base allows for weldments, bolts, and stud attachments. The alloy overlays provide a surface with superior wear resistance. Double-C reduces your maintenance costs and virtually eliminates unnecessary downtime.

Double-C has proven durability and value through punishing use in the mining industry, coke, cement, and asphalt plants, power utilities, and pulp & paper mills.

Typical Analysis

- Carbon 4.8
- Silicon .50
- Chromium 26.8
- Manganese 2.06

Available Sizes

Standard Thickness	Cladding Overlay	A-36 Base Plate
3/8″	1/8″	1/4″
1/2″	1/4″	1/4″
5/8″	1/4″	3/8″
3/4″	3/8″	3/8″
7/8″	3/8″	1/2″
1″	1/2″	1/2″

All standard plate sizes, custom sizes, and strip sizes upon request.

Double-C®
CHROMIUM CARBIDE OVERLAY

fabrication

General Characteristics

Double-C is a fusion-clad chromium carbide composite overlay that has been permanently bonded to a carbon steel base. Double-C carries a hardness rating of Rockwell C 60–62. Characterized by a high chromium and high carbon content, this material is more resistant to wear, corrosion, and heat.

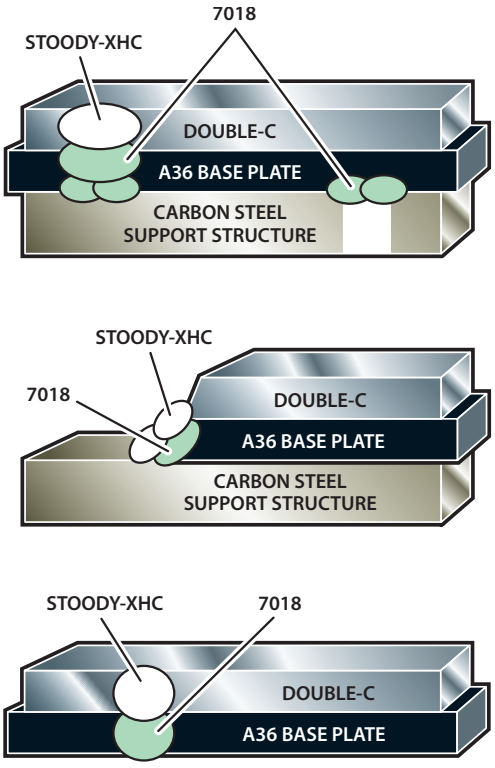
- **Base plate** ASTM A36 is used to enhance Double-C weldability and ductility.
- **Appearance** Double-C overlay is applied in 1" to 1-1/4" beads on the base metal, giving the product a ribbed appearance. The cladding process produces natural stress relief cracks, providing maximum wear life in heavily abrasive applications by relieving stresses in the plate. The stress relief cracks are limited to the overlay and do not extend to the base plate. Double overlay is recommended for severe wear applications.
- **Heat resistance** Double-C is effective up to 1250°F with an abrasion ratio of 20:1 over heat resistant steels. Repeated heating and cooling does not affect its wear-resistant properties.
- **Impact resistance** The mild steel base metal absorbs shock, providing moderate resistance to impact-type wear. The impact resistance of Double-C improves with the thickness of the base metal.

Fabrication Instructions

Using proper fabrication methods, the mild steel base and arc-welded overlay bends readily. Double-C can be specially rolled and formed to your specifications at our plant.

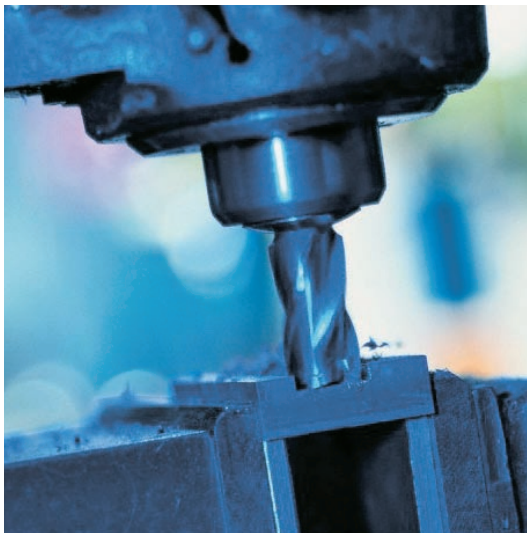
- **Cutting** Use plasma burning equipment, air arc, or abrasive saws when cutting, piercing, or beveling Double-C. Best results are obtained when cutting from the low carbon steel side.
- **Welding** When welding Double-C into position, it is recommended that the weld extend thicker than the mild steel base plate. The life of the weld joint can be enhanced by running a bead of hard surface along the welded area. These precautions will prevent wearing of the mild steel base plate as well as overlay chipping.

Plug Welding



Ameralloy®

TOOL AND DIE STEELS

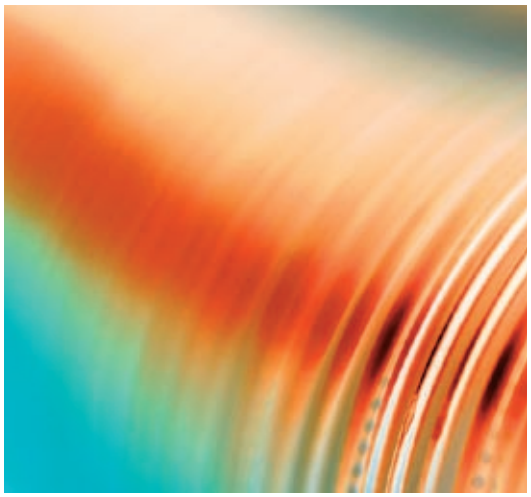


- Ameralloy® Oil
- Ameralloy® Air
- Ameralloy®-60
- Ameralloy® D-2
- Amera-Graf™
- Ameralloy® W1 & W2
- Ameralloy® Drill Rods
- Ameralloy® Precision Flat Ground
- Ameralloy®-5
- Ameralloy®-7
- Ameralloy®-13
- Ameralloy®-20
- Amera-Mold™
- Ameralloy®-6
- Ameralloy®-FH
- Ameralloy® High Speed-2
- Ameralloy-T™
- Durelloy-PM™

Ameralloy® Oil

OIL HARDENING STEEL AISI 0-1

Color Code: YELLOW



Ameralloy Oil is an electric furnace, fully deoxidized tool steel and is produced under conditions of strictest tool steel practice. Ameralloy Oil is one of the best general purpose oil hardening tool and die steels. It machines with relative ease to a high finish. With reasonable care, Ameralloy Oil can be hardened safely with very little dimensional change. It has a good combination of abrasion resistance and toughness for a wide variety of tool and die applications.

Typical Analysis

- Carbon .90
- Manganese 1.20
- Chromium .65
- Vanadium .30
- Tungsten .55
- Silicon .30
- Molybdenum .15

Heat Treatment

- **Forging** 1850°–1950°F, stop at 1500°F, cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1450°F, furnace-cool. Brinell 202 max.
- **Hardening** 1475°F, oil-quench to 150°F
- **Tempering** 300°– 450°F, average hardness after heat treatment Rockwell C 61–63

Features And Advantages

- Good machinability
- Spheroidize annealed prior to shipment
- Safe hardening
- Maximum surface hardness
- Keen cutting edges
- Low distortion in heat treatment
- High core strength
- Controlled analysis
- Good toughness and wear resistance

Applications

- Cold forming
- Blanking
- Bending dies
- Broaches
- Knurling tools
- Gages

Ameralloy® Oil

OIL HARDENING STEEL AISI O-1

Characteristics

• **Machinability** Annealed to Brinell 202 max., Ameralloy Oil machines easily and approaches the machinability of straight-carbon water hardening tool steel. Where a 1% carbon steel is rated at 100, Ameralloy Oil has a rating of 90.

• **Dimensional stability** When quenched from proper hardening temperature, this grade normally expands .0015 in./in. plus. In many instances, slight scaling occurs during heat treatment which tends to counteract the expansion. Like all tool steels, hardening of Ameralloy Oil to insure minimum size change necessitates careful study of the die or tool and the furnace used for heat treatment.

• **Critical points** Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400°F/hour:

Heating – Ac range 1390° to 1450°F
Cooling – Ar range 1280° to 1260°F

• **Decarburization** Ameralloy Oil is not inherently subject to excessive decarburization or to a soft skin on the surface. Good furnace practice as to atmosphere, time, and temperature will result in excellent properties.

General Instructions

• **Forging** Heat slowly to 1850°–1950°F and do not forge below 1500°F. If a preheater is available, hold at 1200°F until uniformly heated before heating to the forging temperature. After forging, bury in an insulation medium for slow cooling.

• **Annealing** The recommended practice is to use controlled-atmosphere furnaces. When not available, pack-anneal in an inert material. For a quick annealing cycle to develop fair machining properties, heat slowly to 1375°–1425°F, and cool slowly in the furnace. To develop the lowest hardness and best spheroidization for optimum machinability, heat slowly to 1400°F and furnace cool at 20°F per hour to 900°F. The piece may then be removed from the furnace and cooled in air. Hardness after this cycle will be Brinell 202 max.

• **Hardening** If pack-hardening cannot be used or is not essential, a slight oxidizing atmosphere should be used in heating to the hardening temperature of 1450°–1475°F for minimum decarburization and distortion. On large parts, pack-harden and preheat at approximately 1200°F with a thorough soaking before raising to the quenching temperature of 1475°–1500°F. Hold at the quenching temperature for 1/2 hour per inch of greatest cross section. Follow by quenching in oil to 150°F and temper immediately.

Ameralloy-tested hardness and fracture grain ratings for various oil-quenching temperatures:

Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1400°	9	60
1425°	9	62
1450°	9½	63
1475°	9½	65
1500°	9½	65
1525°	9¼	65
1550°	9¼	65

• **Tempering** Employ varying temperatures from 300°–450°F depending on size and properties required. Tempering at 350°F is satisfactory for general purpose use. Temperatures above 450°F are rarely used on Ameralloy Oil. The hardness levels produced by tempering above 450°F can also be produced in shock-resisting grades. Where greater toughness is required, Ameralloy recommends using a shock-resisting steel.

Small tools should be held at the tempering temperature for at least 1 hour, and larger tools for 2 hours per inch of greatest thickness. If a second temper is used, it should be 25° lower than the first.

Resulting Rockwell hardness for various tempering temperatures. Obtained from 1" round samples oil-quenched from 1475°F and tempered for 2 hours.

Tempering Temperature (°F)	Rockwell C
None	65
300°	63
350°	62.5
400°	62
450°	61
500°	60
600°	57
700°	53
800°	50
900°	47
1000°	44
1100°	39
1200°	31
1300°	22

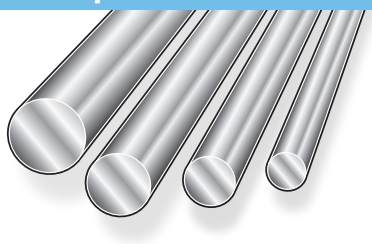
Above results on 1" diameter specimens may be used as a guide in tempering tools to desired hardness. Tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

Ameralloy® Oil

OIL HARDENING STEEL AISI O-1

Available Shapes And Sizes

Rounds



Flats

Squares

ROUNDS: Lengths precut to any size desired, or 10'–12' R/L lengths. FLATS & SQUARES: Standard 8'–10' R/L lengths. Wider widths and non-standards available upon request. Prompt forging service available.

Rounds Decarb Free Or Hot Rolled Annealed

1/4	1	2	4	8
9/32	1-1/16	2-1/8	4-1/4	8-1/4
5/16	1-1/8	2-1/4	4-1/2	8-1/2
3/8	1-3/16	2-3/8	4-3/4	8-3/4
7/16	1-1/4	2-1/2	5-1/4	9
1/2	1-5/16	2-9/16	5-1/2	9-1/2
9/16	1-3/8	2-5/8	5-3/4	10
5/8	1-1/2	2-3/4	6	10-1/2
11/16	1-5/8	2-7/8	6-1/4	11
3/4	1-3/4	3	6-1/2	12
13/16	1-7/8	3-1/8	6-3/4	
7/8		3-1/4	7	
15/16		3-1/2	7-1/4	
		3-5/8	7-1/2	
		3-3/4		

Flats & Squares Decarb-Free Plus .015/.035

1/2	5/8	3/4	7/8	1
x 1/2	x 5/8	x 3/4	x 7/8	x 1
x 3/4	x 3/4	x 7/8	x 1	x 1-1/4
x 7/8	x 7/8	x 1	x 1-1/8	x 1-1/2
x 1	x 1	x 1-1/8	x 1-1/4	x 1-3/4
x 1-1/8	x 1-1/8	x 1-1/4	x 1-1/2	x 2
x 1-1/4	x 1-1/4	x 1-3/8	x 1-3/4	x 2-1/4
x 1-3/8	x 1-1/2	x 1-1/2	x 2	x 2-1/2
x 1-1/2	x 1-3/4	x 1-3/4	x 2-1/4	x 2-3/4
x 1-3/4	x 1-7/8	x 2	x 2-1/2	x 3
x 1-7/8	x 2	x 2-1/4	x 2-3/4	x 3-1/2
x 2	x 2-1/4	x 2-1/2	x 3	x 4
x 2-1/4	x 2-1/2	x 2-3/4	x 3-1/2	x 4-1/2
x 2-1/2	x 2-3/4	x 3	x 4	x 5
x 2-3/4	x 3	x 3-1/2	x 4-1/2	x 5-1/2
x 3	x 3-1/4	x 4	x 5	x 6
x 3-1/4	x 3-1/2	x 4-1/2	x 6	x 7
x 3-1/2	x 4	x 5	x 7	x 8
x 3-3/4	x 4-1/2	x 6	x 8	x 10
x 4	x 5	x 8	x 10	x 12
x 4-1/2	x 6	x 10	x 12	
x 5	x 8	x 12		
x 6	x 10			
x 8	x 12			
x 10				
x 12				

1-1/8	1-1/4	1-3/8	1-1/2	1-3/4
x 1-1/8	x 1-1/4	x 1-3/8	x 1-1/2	x 1-3/4
x 1-1/4	x 1-1/2	x 1-1/2	x 1-3/4	x 2
x 1-1/2	x 1-3/4	x 1-3/4	x 2	x 2-1/4
x 1-3/4	x 2	x 2	x 2-1/4	x 2-1/2
x 2	x 2-1/4	x 2-1/4	x 2-1/2	x 2-3/4
x 2-1/4	x 2-1/2	x 2-1/2	x 2-3/4	x 3
x 2-1/2	x 2-3/4	x 2-3/4	x 3	x 3-1/2
x 2-3/4	x 3	x 3	x 3-1/2	x 4
x 3	x 3-1/2	x 3-1/2	x 4	x 4-1/2
x 3-1/2	x 4	x 4	x 4-1/2	x 5
x 4	x 4-1/2	x 4-1/2	x 5	x 6
x 4-1/2	x 5	x 5	x 6	x 7
x 5	x 5-1/2	x 6	x 7	x 8
x 6	x 6	x 8	x 8	x 10
x 8	x 7	x 10	x 9	x 12
x 10	x 8	x 12	x 10	
x 12	x 10		x 12	
	x 12			

2	2-1/4	2-1/2	3	3-1/2
x 2	x 2-1/4	x 2-1/2	x 3	x 3-1/2
x 2-1/4	x 2-1/2	x 2-3/4	x 3-1/2	x 4
x 2-1/2	x 3	x 3	x 4	x 4-1/2
x 2-3/4	x 3-1/2	x 3-1/2	x 4-1/2	x 5
x 3	x 4	x 4	x 5	x 6
x 3-1/2	x 4-1/2	x 4-1/2	x 6	x 8
x 4	x 5	x 5	x 8	x 10
x 4-1/2	x 6	x 6	x 10	x 12
x 5		x 7	x 12	
x 5-1/2		x 8		
x 6		x 10		
x 7		x 12		
x 8				
x 10				
x 12				

4	4-1/2	5	6
x 4	x 4-1/2	x 5	x 6
x 4-1/2	x 5	x 6	x 8
x 5	x 6	x 8	x 10
x 6	x 8	x 10	x 12
x 8	x 10	x 12	
x 10	x 12		
x 12			

Ameralloy® Air

AIR HARDENING STEEL AISI A-2

Color Code:
BLUE

Ameralloy Air is an air-hardening tool steel possessing excellent non-deforming properties. Its wear resistance is midway between the high carbon/high chromium Ameralloy D, and the manganese oil hardening steel, Ameralloy Oil.

While Ameralloy Air may be hardened by quenching in either air or oil, air-quenching is recommended to virtually eliminate the risk of breakage. Ameralloy Air is particularly adapted to applications that demand toughness and high abrasion resistance.

Typical Analysis

- Carbon 1.00
- Chromium 5.75
- Vanadium .25
- Molybdenum 1.15
- Silicon .20
- Manganese .60

Heat Treatment

- **Forging** 1700°–1950°F, stop at 1750°F, cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1650°F, furnace-cool. Brinell 212 max.
- **Preheating** 1200°F prior to hardening
- **Hardening** 1775°F, air-quench to 150°F
- **Tempering** 350°– 400°F, resulting hardness Rockwell C 60–61

Features And Advantages

- Low distortion in heat treatment
- High abrasion resistance and hardness
- Good hardenability

Applications

- Cold forming
- Blanking
- Bending dies
- Forming rolls
- Broaches
- Knurling tools
- Gages

Ameralloy® Air

AIR HARDENING STEEL AISI A-2

Characteristics

- **Machinability** If properly annealed to Brinell 212, Ameralloy Air has a machinability of 65, as compared with a 1% carbon tool steel rated at 100.
- **Dimensional stability** When air-quenched from the proper hardening temperature, this grade generally expands .001 in./in. of cross section.
- **Critical points** Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400°F/hour:

Heating – Ac range 1475° to 1540°F

Cooling – Ar range 1310° to 670°F

General Instructions

- **Forging** Before forging Ameralloy Air, preheat at 1250°F and soak thoroughly. Then raise temperature to 2000°–2050°F, and hold until the steel is uniformly heated. Forging should be discontinued at 1700°F. Reheat as often as necessary to complete the forging operation. Immediately after forging, bury in an insulating medium to avoid cooling cracks.
- **Annealing** Ameralloy Air should always be annealed after forging. To prevent decarburization, use a controlled atmosphere furnace or pack in a sealed container using inert material. To anneal for lowest hardness, heat slowly to 1650°F and hold at this temperature for approximately two hours per inch of greatest cross section. Cool at a rate of 20°F per hour to 1150°F and reheat to 1350°F. Hold three hours per inch of greatest cross section. Furnace-cool at 20°F per hour to 1100°F, then furnace-cool to 900°F, then air-cool. Resulting hardness from this treatment will be Brinell 212 max.
- **Hardening** To prevent decarburization, pack in inert material, or the treatment can be carried out in a salt bath or controlled atmosphere furnace. Preheat to 1200°F and hold at this temperature until thoroughly soaked. Heat to 1750°–1800°F, and hold for one hour per inch of greatest cross section. Remove from the furnace and cool in air. Although Ameralloy is primarily an air hardening grade, flash oil-quenching is occasionally used on large sections. However, tools must be removed from the oil when they reach 1000°F, then air-cooled to 150°F. Temper immediately to minimize the possibility of cracking.

Ameralloy-tested fracture grain size and Rockwell C hardness of specimens 1" square x 4" long, quenched in air and oil after holding one hour at 1600°–1900°F:

Still Air Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1600°	7	48
1650°	9½	54
1700°	9¾	59.5
1750°	9¾	64
1800°	10	64
1850°	9½	63
1900°	9¼	62
Oil Quenching Temperature (°F)	**Fracture Grain Size**	**Rockwell C**
1600°	9¾	54
1650°	9¾	55
1700°	9¾	62
1750°	9¾	65
1800°	9¾	64
1850°	9.625	63.5
1900°	9¾	62

- **Tempering** After cooling in the quench to approximately 150°F, temper immediately. For most applications, Ameralloy Air should be tempered at 350 °–400°F at a minimum holding time of 2 hours per inch of greatest cross section.

Rockwell C hardness of specimens 1" square when air-quenched from 1775°F or oil-quenched from 1750°F. Tempered at various temperatures:

Tempering Temperature (°F)	Rockwell C 1775°F Air-Quench	Rockwell C 1750°F Oil-Quench
None	64	65
300°F	62	62.5
400°F	60	61
500°F	56	57.5
600°F	56	56
700°F	56	56
800°F	56	56
900°F	56	56
1000°F	56	55
1100°F	50	50
1200°F	43	45
1300°F	34	34

Above results on 1" diameter specimens may be used as a guide in tempering tools to desired hardness. Tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

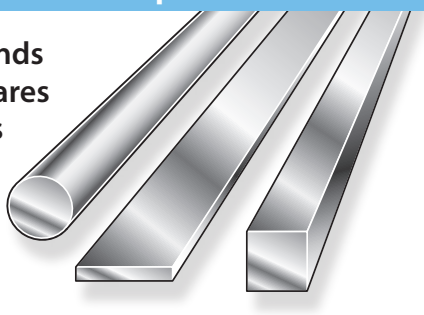
Effect Of Mass

Effectiveness of heat treatment on sections of increasing mass. Sample lengths of at least double the cross section were hardened as shown below. Rockwell C hardness obtained for 1" disc cut from the midsection of sample length:

Size	Treatment	Hardness – (Rc) Surface	Center
1"sq.	Preheat 1200°F, austenitize 1775°F, air-cool to 150°F Temper at 400°F	64 61	64 61
4"sq.	Preheat 1200°F austenitize 1775°F Air-cool to 150°F Temper at 400°F	63 59	60 59
5"sq.	Preheat 1200°F, austenitize 1775°F, oil to 1000°F Air-cool to 150°F Double temper at 400°F	63 59	60 59
6"sq.	Preheat 1200°F, austenitize 1775°F, oil to 1000°F Air-cool to 150°F Double temper at 400°F	62 59	59 57
8"sq.	Preheat 1200°F, austenitize 1775°F, oil to 150°F Double temper at 400°F	62 61	61 59

Available Shapes And Sizes

Rounds
Squares
Flats



ROUNDS: Lengths precut to any size desired, or 8'–10' R/L lengths. FLATS & SQUARES: Standard 10'–12' R/L lengths.

Rounds Decarb Free Or Hot Rolled Annealed

1/4	1	2	4	7
5/16	1-1/16	2-1/8	4-1/4	7-1/2
3/8	1-1/8	2-1/4	4-1/2	8
7/16	1-1/4	2-3/8	4-3/4	8-1/2
1/2	1-3/8	2-1/2	5	9
9/16	1-1/2	2-5/8	5-1/4	10
5/8	1-5/8	2-3/4	5-1/2	11
11/16	1-3/4	2-7/8	5-3/4	12
3/4	1-7/8	3	6	
13/16		3-1/8	6-1/4	
7/8		3-1/4	6-1/2	
15/16		3-1/2		
		3-3/4		

Flats & Squares Decarb-Free Plus .015/.035

1/2	5/8	3/4	7/8	1
x 1/2	x 5/8	x 3/4	x 7/8	x 1
x 3/4	x 3/4	x 7/8	x 1	x 1-1/4
x 7/8	x 7/8	x 1	x 1-1/8	x 1-1/2
x 1	x 1	x 1-1/8	x 1-1/4	x 1-3/4
x 1-1/8	x 1-1/8	x 1-1/4	x 1-1/2	x 2
x 1-1/4	x 1-1/4	x 1-3/8	x 1-3/4	x 2-1/4
x 1-3/8	x 1-3/8	x 1-1/2	x 2	x 2-1/2
x 1-1/2	x 1-1/2	x 1-3/4	x 2-1/4	x 2-3/4
x 1-3/4	x 1-3/4	x 1-7/8	x 2-1/2	x 3
x 1-7/8	x 2	x 2	x 2-3/4	x 3-1/2
x 2	x 2-1/4	x 2-1/4	x 3	x 4
x 2-1/4	x 2-1/2	x 2-1/2	x 3-1/2	x 4-1/2
x 2-1/2	x 2-3/4	x 2-3/4	x 4	x 5
x 2-3/4	x 3	x 3	x 4-1/2	x 6
x 3	x 3-1/2	x 3-1/2	x 5	x 7
x 3-1/2	x 4	x 4	x 6	x 8
x 4	x 4-1/2	x 4-1/2	x 7	x 10
x 4-1/2	x 5	x 5	x 8	x 12
x 5	x 6	x 6	x 10	
x 6	x 8	x 8	x 12	
x 8	x 10	x 10		
x 10	x 12	x 12		
x 12				

1-1/8	1-1/4	1-3/8	1-1/2	1-3/4
x 1-1/8	x 1-1/4	x 1-3/8	x 1-1/2	x 1-3/4
x 1-1/4	x 1-1/2	x 1-3/4	x 1-3/4	x 2
x 1-1/2	x 1-3/4	x 2	x 2	x 2-1/4
x 1-3/4	x 2	x 2-1/4	x 2-1/4	x 2-1/2
x 2	x 2-1/4	x 2-1/2	x 2-1/2	x 2-3/4
x 2-1/4	x 2-1/2	x 3	x 2-3/4	x 3
x 2-1/2	x 2-3/4	x 3-1/2	x 3	x 3-1/2
x 2-3/4	x 3	x 4	x 3-1/2	x 4
x 3	x 3-1/2	x 4-1/2	x 4	x 4-1/2
x 3-1/2	x 4	x 5	x 4-1/2	x 5
x 4	x 4-1/2	x 6	x 5	x 6
x 4-1/2	x 5	x 8	x 6	x 7
x 5	x 6	x 10	x 7	x 8
x 6	x 7	x 12	x 8	x 10
x 8	x 8		x 10	x 12
x 10	x 10		x 12	
x 12	x 12		x 18-1/4	
	x 18-1/4			

2	2-1/4	2-1/2	3	3-1/2
x 2	x 2-1/4	x 2-1/2	x 3	x 3-1/2
x 2-1/4	x 2-1/2	x 2-3/4	x 3-1/2	x 4
x 2-1/2	x 3	x 3	x 4	x 4-1/2
x 2-3/4	x 3-1/2	x 3-1/2	x 4-1/2	x 5
x 3	x 4	x 4	x 5	x 6
x 3-1/2	x 4-1/2	x 4-1/2	x 6	x 8
x 4	x 5	x 5	x 8	x 10
x 4-1/2	x 6	x 6	x 10	
x 5		x 8		
x 5-1/2		x 10		
x 6		x 12		
x 8				
x 10				
x 12				

4	4-1/2	5	6
x 4	x 4-1/2	x 5	x 6
x 4-1/2	x 5	x 6	x 8
x 5	x 6	x 8	x 10
x 6	x 8	x 10	x 12
x 8	x 10	x 12	
x 10	x 12		
x 12			

Ameralloy®-60

AIR HARDENING STEEL AISI A-6

Color Code:
BLUE WITH
WHITE STRIPE

Ameralloy-60 is an air hardening, cold work die steel that shows less distortion during heat treatment than water or oil hardening steels, and most high alloy air hardening die steels. A 6-inch cube of Ameralloy-60 will harden to Rockwell C 60 in still air. A major advantage is its low hardening temperature range of 1500°–1600°F, usually available only with oil hardening steels.

The minimum distortion characteristics of Ameralloy-60 make it perfectly suited for dies and punches in blanking and forming operations, or for tools where close size tolerance is critical.

Typical Analysis

- Carbon .70
- Manganese 2.10
- Silicon .30
- Chromium 1.00
- Molybdenum 1.35
- Sulfur .09

Heat Treatment

- **Forging** Ameralloy-60 should be heated slowly to the forging temperature of 2000°–2025°F. Do not hot work below 1600°F. Cool slowly in the furnace or bury in Sil-o-cel, fine dry ashes, lime, expanded mica, or other insulating material.

- **Annealing** Ameralloy-60 may be annealed in either a controlled atmosphere furnace or packed in spent pitched coke, spent cast iron chips, lime, fine dry ashes, sand, or ground mica with approximately 10% burned charcoal added. Heat to 1325°–1375°F and hold approximately 4 hours for each inch of thickness. Cool very slowly at a rate of 20°F per hour to approximately 1000°F. Annealed hardness range is normally Brinell 235 to 245

- **Hardening** The hardening temperature range for Ameralloy-60 is 1500°–1600°F. Tools with simple shapes may be heated to the hardening temperature directly from room temperature. A preheat of 1200°–1250°F should be used for tools with intricate shapes. A slightly oxidizing furnace atmosphere should be used for hardening. Cool in still air or in an air blast.

- **Tempering** To obtain high hardness with minimum distortion, Ameralloy-60 should be tempered at temperatures between 300°–400°F. Tempering time varies with the size of the piece being hardened, but even the smallest tools should be tempered for a minimum of 1 hour. Refer to the hardening and tempering table to determine approximate hardness obtained from various tempering temperatures.

Ameralloy®-60

AIR HARDENING STEEL AISI A-6

Hardened from 1500°F

Tempering Temperature (°F)	Energy-Absorbed Hardness (Ft-Lb)	Rockwell C
As Quenched	78	59
300°	81	58.5
350°	56	58
400°	52	57
450°	45.5	57
500°	63.5	56
600°	52	54
800°	99.5	49.5
1000°	Beyond Machine Capacity	45

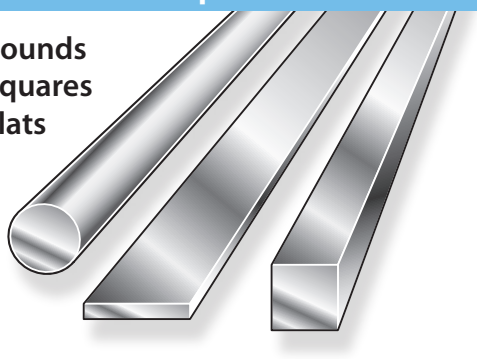
Hardened from 1600°F

Tempering Temperature (°F)	Energy-Absorbed Hardness (Ft-Lb)	Rockwell C
As Quenched	51	63
300°	66	61
350°	106	60
400°	81	59
450°	80.5	58
500°	38	57
600°	100	55
800°	83.5	51
1000°	Beyond Machine Capacity	48

Typical results. Actual data may vary. Not to be construed as maximum or minimum values for final design specification.

Available Shapes And Sizes

Rounds
Squares
Flats



ROUNDS: Lengths precut to any size desired, or 10'–12' R/L lengths. FLATS & SQUARES: Standard 8'–10' R/L lengths or cut pieces. Wider widths and non-standards available upon request. Prompt forging service available.

Rounds Decarb Free Or Hot Rolled Annealed

Hot Rolled Annealed			Pre-Machined	
1/2	1	2	4	7
5/8	1-1/8	2-1/4	4-1/2	7-1/2
3/4	1-1/4	2-1/2	5	8
7/8	1-3/8	2-3/4	5-1/2	9
	1-1/2	3	6	10
	1-5/8	3-1/4	6-1/2	
	1-3/4	3-1/2		
	1-7/8	3-3/4		
		6		
		6-1/2		

Flats & Squares Decarb-Free Plus .015/.035

1/2	5/8	3/4	7/8	1
x 1/2	x 5/8	x 3/4	x 7/8	x 1
x 1	x 1	x 1	x 1	x 1-1/4
x 1-1/2	x 1-1/2	x 1-1/2	x 1-1/8	x 1-1/2
x 2	x 2	x 2	x 1-1/4	x 1-3/4
x 2-1/2	x 2-1/2	x 2-1/2	x 1-1/2	x 2
x 3	x 3	x 3	x 1-3/4	x 2-1/4
x 4	x 4	x 4	x 2	x 2-1/2
x 5	x 5	x 5	x 2-1/2	x 2-3/4
x 6	x 6	x 6	x 3	x 3
x 8	x 8	x 8	x 3-1/2	x 3-1/2
x 10	x 10	x 10	x 4	x 4
x 12	x 12	x 12	x 5	x 4-1/2
			x 6	x 5
			x 8	x 6
			x 10	x 8
			x 12	x 10
				x 12

1-1/8	1-1/4	1-3/8	1-1/2	1-3/4
x 1-1/8	x 1-1/4	x 1-3/8	x 1-1/2	x 1-3/4
x 1-1/4	x 1-1/2	x 1-1/2	x 1-3/4	x 2
x 1-1/2	x 1-3/4	x 1-3/4	x 2	x 2-1/4
x 1-3/4	x 2	x 2	x 2-1/4	x 2-1/2
x 2	x 2-1/4	x 2-1/4	x 2-1/2	x 2-3/4
x 2-1/4	x 2-1/2	x 2-1/2	x 2-3/4	x 3
x 2-1/2	x 2-3/4	x 2-3/4	x 3	x 3-1/2
x 2-3/4	x 3	x 3	x 3-1/2	x 4
x 3	x 3-1/2	x 3-1/2	x 4	x 4-1/2
x 3-1/2	x 4	x 4	x 4-1/2	x 5
x 4	x 4-1/2	x 5	x 5	x 6
x 5	x 5	x 6	x 6	x 8
x 6	x 6	x 8	x 8	x 10
x 8	x 8	x 10	x 10	x 12
x 10	x 10	x 12	x 12	
x 12	x 12			
	x 18-1/4			

2	2-1/2	3	4	5–6
x 2	x 2-1/2	x 3	x 4	5 x 5
x 2-1/4	x 2-3/4	x 3-1/2	x 4-1/2	5 x 6
x 2-1/2	x 3	x 4	x 5	5 x 8
x 2-3/4	x 3-1/2	x 4-1/2	x 6	5 x 10
x 3	x 4	x 5	x 8	6 x 6
x 3-1/2	x 4-1/2	x 6	x 10	6 x 8
x 4	x 5	x 8	x 12	6 x 10
x 4-1/2	x 6	x 10		
x 5	x 8	x 12		
x 6	x 10			
x 8	x 12			
x 10				
x 12				

Ameralloy® D-2

AIR HARDENING STEEL

AISI D-2

Color Code: GREEN

Ameralloy D-2 is a premium quality, high carbon/high chrome air hardening steel for use in high volume production applications. It is recommended for dies with production quotas in the hundreds, thousands, or millions of pieces at minimum cost. Ameralloy D-2 resists edge chipping, sometimes experienced with other types of die steel. This decreases both the number and depth of grinds necessary to maintain the die.

Ameralloy D-2 hardens with a minimum amount of distortion and is perfectly suited for dies where close size tolerance is critical. Ameralloy D-2 is easier to machine than other high carbon/high chrome die steels.

Typical Analysis

- Carbon 1.55
- Silicon .35
- Chromium 12.50
- Vanadium 1.00
- Molybdenum 1.00
- Manganese .55

Applications

- Ring gauges
- Swaging dies
- Plug gauges
- Coining dies
- Shear knives
- Blanking dies
- Trimming dies
- Slitting dies
- Forming dies
- Drawing dies
- Lamination dies
- Thread rolling dies
- Forming rolls
- Lathe centers
- Seaming rolls
- Punches

Features And Advantages

- Maximum die life
- Maximum resistance to edge wear and chipping
- Minimum dimensional change during hardening
- Air hardening/deep hardening
- Hugh compressions strength
- Non-scaling properties with fair resistance to corrosion
- Good machinability for a high alloy steel

Heat Treatment

- **Forging** 1950°–2050°F, stop at 1700°F, cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1650°F, furnace-cool. Brinell 217 max.
- **Preheating** 1200°–1250°F, prior to hardening
- **Hardening** 1850°F, air-quench to 150°F
- **Tempering** 900°F, minimum (see Tempering under General Instructions)

Characteristics

- **Machinability** Ameralloy D-2 has a machinability rating of 65, as compared with a rating of 100 for a 1% carbon steel tool.
- **Dimensional stability** Tests on this grade normally show a slight amount of contraction after hardening with a piece in the as-quenched condition or tempered below 900°F. Tempering at approximately 925°F usually eliminates the contraction and virtually brings the part back to its original size. Ameralloy D-2 has the minimum distortion in heat treatment as compared with other tool steels.
- **Critical points** Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400°F/hour:

Heating – Ac range 1520° to 1600°F
Cooling – Ar range 1390° to 1300°F

- **Decarburization** To prevent decarburization, pack in an inert material or heat for hardening in a salt bath or controlled-atmosphere atmosphere furnace, or a vacuum furnace.
- **Grinding** Ameralloy D-2 is somewhat sensitive to grinding stresses resulting from improper practice. Oversize allowance for machining should be held to a minimum to avoid excessive grinding for finishing. The superior abrasion resistance of this grade makes it necessary to use a soft wheel with the coarsest grit commensurate with the finish required. Use a generous amount of coolant to cover the work at all times. Light cut must be made to avoid danger of cracking. For specific grinding operations, consult your grinding wheel representative for aid in selecting the proper grain and grade of wheel.

General Instructions

- **Forging** Due to a combination of high carbon/high chromium, take special care when hot working. Heat slowly and uniformly to 10 approximately 1250°F, and hold temperature sufficiently long to thoroughly soak the piece. For forging, heat to 1950°–2050°F. Discontinue forging at 1700°F and reheat. When forging is complete, cool slowly, preferably burying in dry insulating material.
- **Annealing** To prevent decarburization, use a controlled-atmosphere furnace or pack in inert material in a sealed container. Heat slowly to approximately 1600°–1650°F and hold at temperature for 1½ hours per inch of greatest thickness. Cool slowly at 20° per hour to 900°F, then allow steel to cool down with the furnace. Resulting hardness will be Brinell 217 max.
- **Hardening** When heating, protect the steel by packing or wrapping in inert material. When available, use a well-regulated salt bath, a controlled-atmosphere furnace, or a vacuum furnace. Preheat to 1200°F and hold at this temperature until thoroughly soaked. Heat to 1850°F and hold at this temperature 1 hour per inch of greatest cross section. The piece may then be removed and cooled in still air to 150°F and tempered immediately. Oil-quenching is required on pieces 6" and larger.

Ameralloy-tested hardness and fracture grain ratings for various air-quenching temperatures:

Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1700°	8¾	62
1750°	9¼	64
1800°	9¼	65
1850°	9½	65
1900°	9¼	63

- **Tempering** Double tempering is preferable with the second temper 50°F lower than the first. The tool type and service requirements determine the temperature. For most applications, the tempering range is 900°–960°F. Use a minimum holding time of 2 hours for each inch of greatest cross section. To minimize cracking, temper immediately after hardening, and heat slowly to desired tempering temperature.

In the as-quenched condition, Ameralloy-D2 normally shows a slight amount of contraction in size. Tempering at 900°F or slightly higher usually neutralizes the original shrinkage produced in the quench, and brings the part virtually back to its original size. If the first temper does not completely neutralize the shrinkage, then a second or even a third temper may be used, with each temper raised 10°F over the previous. This produces a hardness in the range of Rockwell C 58 to 60.

After the shrinkage of the part has been neutralized, it is advisable to give the part a final temper to temper any newly formed martensite. This final temper should be done at 25°–50°F below the previous temper.

Rockwell hardness from various heats of steel, air-quenched from 1850°F and tempered a minimum or 2 hours per inch of cross section.

Tempering Temperature (°F)	Rockwell C
None	64
400°	60
500°	58
600°	58
700°	58
800°	57
900°*	58/60
960°	
1000°	56
1100°	48
1200°	40

See Tempering

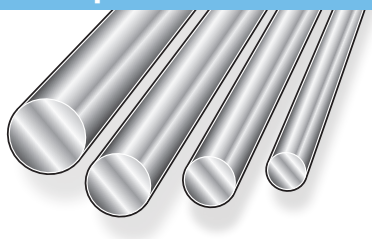
Above results may be used as a guide in tempering tools to desired hardness, however, tempering below 900°F is not recommended. Tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

Ameralloy® D-2

AIR HARDENING STEEL AISI D-2

Available Shapes And Sizes

Rounds



Flats

Squares

ROUNDS: Lengths precut to any size desired, or 10'–12' R/L lengths. FLATS & SQUARES: Standard 8'–10' R/L lengths. Wider widths and non-standards available upon request. Prompt forging service available.

Rounds Decarb Free Or Hot Rolled Annealed

1/4	1	2	4	8
5/16	1-1/8	2-1/8	4-1/4	8-1/2
3/8	1-1/4	2-1/4	4-1/2	9
7/16	1-3/8	2-3/8	4-3/4	9-1/2
1/2	1-1/2	2-1/2	5	10
9/16	1-5/8	2-5/8	5-1/4	10-1/2
5/8	1-3/4	2-3/4	5-1/2	11
11/16	1-7/8	2-7/8	5-3/4	11-1/2
3/4		3	6	12
13/16		3-1/8	6-1/4	12-1/2
7/8		3-1/4	6-1/2	13
15/16		3-1/2	7	14
		3-3/4	7-1/2	16

Flats & Squares Decarb-Free Plus .015/.035

1/2	5/8	3/4	7/8	1
x 1/2	x 5/8	x 3/4	x 1	x 1
x 3/4	x 3/4	x 7/8	x 1-1/8	x 1-1/4
x 7/8	x 7/8	x 1	x 1-1/4	x 1-1/2
x 1	x 1	x 1-1/4	x 1-1/2	x 1-3/4
x 1-1/8	x 1-1/8	x 1-3/8	x 1-3/4	x 2
x 1-1/4	x 1-1/4	x 1-1/2	x 2	x 2-1/4
x 1-1/2	x 1-1/2	x 1-3/4	x 2-1/2	x 2-1/2
x 1-3/4	x 1-3/4	x 2	x 2-3/4	x 2-3/4
x 1-7/8	x 2	x 2-1/4	x 3	x 3
x 2	x 2-1/4	x 2-1/2	x 3-1/2	x 3-1/2
x 2-1/4	x 2-1/2	x 2-3/4	x 4	x 4
x 2-1/2	x 2-3/4	x 3	x 4-1/2	x 4-1/2
x 2-3/4	x 3	x 3-1/2	x 5	x 5
x 3	x 3-1/2	x 3-3/4	x 5-1/2	x 6
x 3-1/4	x 3-3/4	x 4	x 6	x 7
x 3-1/2	x 4	x 4-1/2	x 8	x 8
x 3-3/4	x 4-1/2	x 5	x 10	x 10
x 4	x 5	x 6	x 12	x 12
x 4-1/2	x 6	x 8		
x 5	x 8	x 10		
x 6	x 10	x 12		
x 8	x 12			
x 10				
x 12				

1-1/8	1-1/4	1-3/8	1-1/2	1-3/4
x 1-1/8	x 1-1/4	x 1-3/8	x 1-1/2	x 1-3/4
x 1-1/4	x 1-1/2	x 1-3/4	x 1-3/4	x 2
x 1-1/2	x 1-3/4	x 2	x 2	x 2-1/4
x 1-3/4	x 2	x 2-1/2	x 2-1/4	x 2-1/2
x 2	x 2-1/4	x 2-3/4	x 2-1/2	x 2-3/4
x 2-1/4	x 2-1/2	x 3	x 2-3/4	x 3
x 2-1/2	x 2-3/4	x 3-1/2	x 3	x 3-1/2
x 2-3/4	x 3	x 4	x 3-1/2	x 4
x 3	x 3-1/2	x 4-1/2	x 4	x 4-1/2
x 3-1/2	x 4	x 5	x 4-1/2	x 5
x 4	x 4-1/2	x 6	x 5	x 6
x 4-1/2	x 5	x 8	x 6	x 8
x 5	x 6	x 10	x 7	x 10
x 6	x 7		x 8	x 12
x 8	x 8		x 10	
x 10	x 10		x 12	
x 12	x 12			

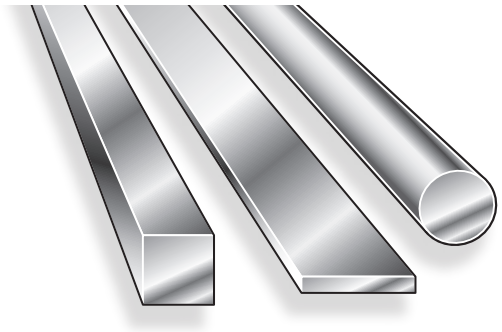
2	2-1/4	2-1/2	3	3-1/2
x 2	x 2-1/4	x 2-1/2	x 3	x 3-1/2
x 2-1/4	x 2-1/2	x 2-3/4	x 3-1/2	x 4
x 2-1/2	x 3	x 3	x 4	x 4-1/2
x 2-3/4	x 3-1/2	x 3-1/2	x 4-1/2	x 5
x 3	x 4	x 4	x 5	x 6
x 3-1/2	x 6	x 4-1/2	x 6	x 8
x 4	x 8	x 5	x 8	x 10
x 4-1/2	x 10	x 6	x 10	x 12
x 5	x 12	x 8	x 12	
x 5-1/2		x 10		
x 6		x 12		
x 8				
x 10				
x 12				

4	4-1/2	5	6
x 4	x 4-1/2	x 5	x 6
x 4-1/2	x 5	x 6	x 8
x 5	x 6	x 8	x 10
x 6	x 8	x 10	x 12
x 8	x 10	x 12	
x 10	x 12		
x 12			

Amera-Graf™

OIL HARDENING STEEL AISI 0-6

Color code:
TAN



Amera-Graf is a medium alloy 1.45 carbon oil-hardening tool steel. In its annealed condition, about one-third of the carbon is present as graphitic carbon. The remainder is present as combined carbon in the form of carbides. In this condition, Amera-Graf is the most readily machinable of the oil hardening tool grades.

Typical Analysis

- Carbon 1.45
- Silicon 1.25
- Manganese 1.0
- Molybdenum .25

Features And Advantages

- Excellent machinability
- Good wear resistance

Applications

Forming, shaping, and drawing dies. Suitable for a great variety of cold-work dies calling for physical properties, wear resistance, and edge holding similar to standard oil hardening tool steels like Type 01. Non-galling, self-lubricating characteristics of Amera-Graf make it well suited for dies subject to galling and seizing.

Heat Treatment

- **Forging** 2000°F max., stop at 1700°F, cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1425°–1450°F, furnace-cool to 1000°F, hold 1 hour per inch of greatest cross section. Air cool. Brinell 212 max.
- **Preheating** 1250°F prior to hardening
- **Hardening** 1450°–1500°F, oil-quench to 150°F
- **Tempering** 300°– 400°F, resulting hardness Rockwell C 61–62

Characteristics

- **Machinability** When properly annealed to Brinell 212 max., Amera-Graf has a machinability rating of 125 – as compared with a 1% carbon tool steel rated at 100.
- **Dimensional stability** When oil-quenched from proper hardening temperature, this grade normally expands .0015 in./in. plus.
- **Critical Points** Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400°F/hour:

Heating – Ac range 1400° to 1420°F
Cooling – Ar range 1340° to 1280°F

- **Decarburization** Decarburizes more rapidly than other tool steels when heated for forging, annealing, or hardening. This is due to the high silicon and molybdenum content. Care should be taken when heating Amera-Graf to protect it from decarburization. Preheating can be very helpful, as it shortens exposure to high temperature. Use controlled-atmosphere annealing furnace if available. If not available, pack-anneal with inert material in a sealed container.

General Instructions

- **Forging** Preheat Amera-Graf at approx. 1300°F before uniformly heating to a forging temperature of 2000°F. Stop forging at 1700°F. Reheat if necessary. Bury in insulating material immediately after forging.

Amera-Graf™

OIL HARDENING STEEL AISI 0-6

Heat Treatment (continued)

- **Annealing** Heat Amera-Graf uniformly to a temperature range of 1425°–1450°F. Then cool slowly in the furnace to 1000°F and hold at this temperature approximately 1 hour per inch of greatest cross section. Cool in air. The resulting hardness will be Brinell 217 max.

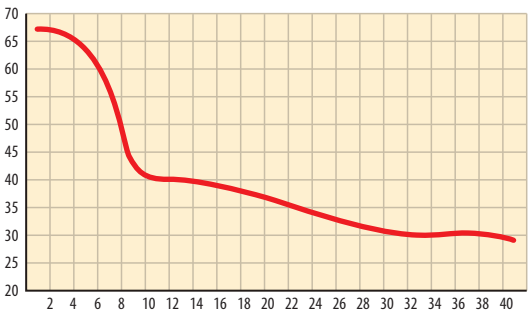
- **Hardening** Preheat Amera-Graf thoroughly at approximately 1250°F, and then heat to the hardening temperature of 1450°–1500°F. For small sections, the lower part of the hardening range should be used; larger sections require higher temperatures. All sections should be equalized at the hardening temperature for 1 hour per inch of greatest cross section before quenching in oil to 150°F. Temper immediately.

- **Tempering** For the majority of tooling work, tempering at 300°–400°F is satisfactory. This will result in a hardness of approximately Rockwell C 61/62. Heat the tools to tempering temperature and hold for approximately 2 hours per inch of greatest cross section.

Resulting Rockwell C hardness obtained from samples oil-quenched from 1475°F and tempered at various temperatures:

Tempering Temperature (°F)	Rockwell C
As Quenched	65
300°	62
400°	61
500°	60
600°	58
700°	54

Jominy Hardenability Curve



Distance from quenched end of specimen in sixteenths of an inch

Rounds Decarb Free Or Hot Rolled Annealed

1/4	1	2	4	7
3/8	1-1/8	2-1/8	4-1/4	7-1/4
1/2	1-1/4	2-1/4	4-1/2	7-1/2
5/8	1-3/8	2-3/8	4-3/4	8
3/4	1-1/2	2-1/2	5	8-1/2
7/8	1-5/8	2-5/8	5-1/4	9
	1-3/4	2-3/4	5-1/2	9-1/2
	1-13/16	3	5-3/4	10
	1-7/8	3-1/4	6	10-1/2
		3-1/2		11
		3-3/4		12

Flats & Squares Decarb-Free Plus .015/.035

1/2	5/8	3/4	7/8	1
x 1	x 1	x 3/4	x 2-3/4	x 1
x 1-1/2	x 1-1/2	x 1	x 3-1/2	x 1-1/4
x 2	x 2	x 1-1/2		x 1-1/2
x 2-1/2	x 3	x 2		x 2
x 3	x 3-1/2	x 2-1/2		x 2-1/2
x 3-1/2	x 4	x 3		x 3
x 4	x 6	x 3-1/2		x 3-1/2
x 5		x 4		x 4
x 6		x 5		x 4-1/2
		x 6		x 5
		x 8		x 6
				x 8
				x 10

1-1/8	1-1/4	1-3/8	1-1/2	1-3/4
x 1-1/2	x 1-1/4	x 2	x 1-1/2	x 1-3/4
x 2	x 1-1/2	x 2-1/2	x 2	x 2
x 2-1/2	x 1-3/4	x 3	x 2-1/2	x 2-1/2
x 3	x 2	x 4	x 3	x 3
x 3-1/2	x 2-1/4	x 5	x 3-1/2	x 3-1/2
x 5	x 2-1/2		x 4	x 4
x 6	x 3		x 4-1/2	x 5
	x 3-1/2		x 5	x 6
	x 4		x 6	
	x 4-1/2		x 7	
	x 5		x 8	
	x 6			
	x 8			

2	2-1/4	2-1/2	3	3-1/2
x 2	x 2-1/2	x 2-1/2	x 3	x 3-1/2
x 2-1/2	x 3	x 3	x 3-1/2	x 4-1/2
x 3	x 4	x 3-1/2	x 4	
x 3-1/2		x 4	x 4-1/2	
x 4		x 4-1/2	x 5	
x 4-1/2		x 5	x 6	
x 5		x 6	x 8	
x 6		x 7		
x 8				

4	5	6
x 4	x 5	x 6
x 5	x 6	x 8
x 8		x 10

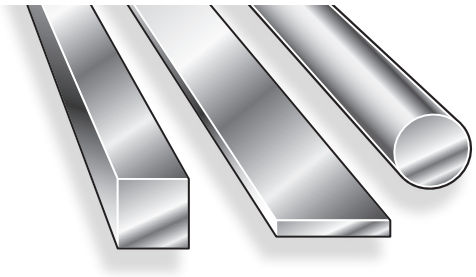
ROUNDS: Lengths precut to any size desired, or 10′–12′ R/L lengths. FLATS & SQUARES: Standard 8′–10′ R/L lengths. Wider widths and non-standards available upon request. Prompt forging service available.

Ameralloy® W1 & W2

WATER HARDENING STEEL

AISI W1–W2

Color Code: LIGHT BLUE



Ameralloy W1 is a straight carbon water hardening tool steel available in a wide range of carbon content. It is a shallow hardening steel – a case hardness of Rockwell C 66 can be attained for excellent abrasion resistance and a softer core for superior toughness.

Ameralloy W2 is a water hardening carbon tool steel containing .25 vanadium. The vanadium induces grain refinement, resists grain growth, and improves fatigue resistance. Ameralloy W2 is generally applied with .95 to 1.05 carbon.

The carbon ranges of Ameralloy W1 and W2 determine attainable hardness and dictate the analysis specified for particular applications.

Applications

- **Carbons about 1.00** Hand chisels, taps, dies, cold trimmer & header dies, forming & blanking dies, small shear blades, chuck jaws.
- **Lower carbons** Hot forming dies, blacksmith tools, hammers, crow bars, rivet sets, sheer blades
- **Higher carbons** Milling cutters, taps, drills, slotting & turning tools, engraving tools, gages

Typical Analysis

	W1	W2
Carbon	.60–1.40	.80–1.25
Manganese	.25	.25
Silicon	.20	.25
Vanadium	--	.25

Heat Treatment

	W1	W2
Annealing	1375°–1450°F	1400°–1450°F
Hardening	1400°–1500°F	1450°–1550°F
Tempering	200°–600°F	300°–600°F

Available Shapes And Sizes

Rounds

1/2
5/8
3/4
7/8
1
1-1/8
1-1/4
1-3/8
1-1/2
1-5/8
1-3/4
1-7/8
2
2-1/4
2-1/2
2-3/4
2-7/8
3
3-1/8
3-1/4
3-3/8
3-1/2
3-5/8
3-3/4
4
4-1/4
4-1/2
4-3/4
5
5-1/4
5-1/2
5-3/4
6
6-1/4
6-1/2
7
7-1/2
8
9

Squares

1/2
5/8
3/4
7/8
1
1-1/8
1-1/4
1-3/8
1-1/2
1-5/8
1-3/4
2
2-1/4
2-1/2
2-3/4
3
3-1/2
4
5

Billets

4
6
8

Flats

1/4
x 1/2
x 5/8
x 3/4
x 1
x 1-1/4
x 1-1/2
x 2
x 2-1/4
x 2-1/2
x 3
x3
3/8
x 1/2
x 5/8
x 3/4
x 1
x 1-1/4
x 1-1/2
x 2
x 2-1/2
x 3
x 4
x 6
1/2
x 5/8
x 3/4
x 1
x 1-1/4
x 1-1/2
x 1-3/4
x 2
x 2-1/4
x 2-1/2
x 3
x 3-1/2
x 4
x 5
5/8
x 3/4
x 7/8
x 1
x 1-1/4
x 1-1/2
x 1-3/4
x 2
x 2-1/4
x 2-1/2
x 3
x 3-1/2
x 4
x 5
x 6
3/4
x 1
x 1-1/4
x 1-1/2
x 1-3/4
x 2
x 2-1/4
x 2-1/2
x 3
x 3-1/2
x 4
x 6
7/8
x 1-1/4
x 1-1/2
x 2
x 2-1/2
x 3
1
x 1-1/4
x 1-1/2
x 1-3/4
x 2
1-1/2
x 1-3/4
x 2-1/4
x 2-1/2
x 3
x 4
x 5
x 6
x 8
1-1/4
x 1-1/2
x 1-3/4
x 2
x 2-1/4
x 2-1/2
x 3
x 3-1/2
x 4
x 4-1/2
x 5
x 6
x 7
x 8
1-3/4
x 2
x 2-1/4
x 2-1/2
x 3
x 7
x 8
x 9
x 10
2
x 2-1/4
x 2-1/2
x 3
x 3-1/2
x 4
x 5
x 6
x 8
2-1/4
x 3
x 2-1/2
x 3
x 3-1/2
x 4
x 5
3
x 3-1/2
x 4
x 5
x 6
4
x 10

Also available in ground two adjacent sizes.

Ameralloy® Drill Rods

Stocking All Standard Sizes And Tolerances!

Ameralloy® Oil

OIL HARDENING AISI 0-1

Ameralloy Oil is the most widely used grade of drill rod. It is a general purpose tool steel with premium hardening, wear resistance, and toughness.

Typical Analysis

GENERAL PURPOSE

- Carbon .90
- Manganese 1.20
- Silicon .30
- Tungsten .55
- Chromium .65
- Vanadium .30
- Molybdenum .15

Ameralloy®-60

AIR HARDENING AISI A-6

Ameralloy-60 has a minimum distortion characteristic which makes it particularly well suited for dies and punches in blanking and forming operations. Also recommended for gages or other tools where close size tolerance is required.

Typical Analysis

- Carbon .70
- Molybdenum 1.35
- Manganese 2.10
- Silicon .30
- Chromium 1.00
- Sulfur .09

Ameralloy®-Air

AIR HARDENING AISI A-2

Ameralloy Air is recommended over Ameralloy Oil when increased wear resistance, safe hardening, and less distortion are required.

Typical Analysis

MINIMUM DISTORTION

- Carbon 1.00
- Molybdenum 1.15
- Manganese .60
- Silicon .20
- Chromium 5.75
- Vanadium .25

Ameralloy® D-2

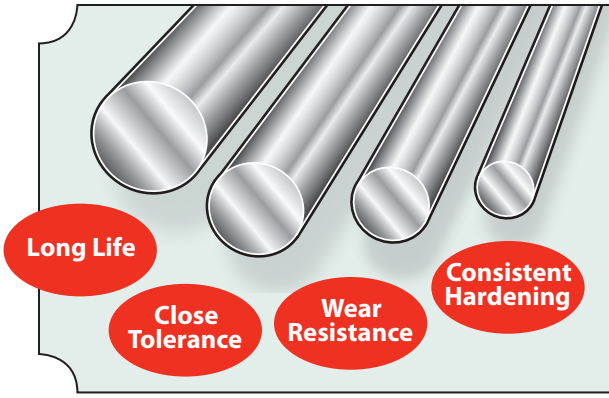
HIGH CARBON/ HIGH CHROME AISI D-2

Ameralloy D-2 is an air-hardening steel known for maximum wear resistance. It is ideal for use in tools, dies, and used in long production runs.

Typical Analysis

MAX. WEAR RESISTANCE

- Carbon 1.55
- Molybdenum 1.00
- Manganese .55
- Silicon .35
- Chromium 12.50
- Vanadium 1.00



Finish *All drill rod rounds are furnished ground and polished*

Lengths *Standard stock sizes are 36" long. Also available in 12' lengths.*

Tolerance

Size Range	Standard Tolerance
• Up to .125"	+/- .0003"
• .125" to .499"	+/- .0005"
• .500" to 2.000"	+/- .001"

Ameralloy® W1&W2

WATER HARDENING AISI W1–W2

Ameralloy W1 and W2 are water hardening grades formulated to meet the needs of the machine shop. Well suited for average work where premium grades are not required.

Typical Analysis

	W1	W2
• Carbon	.60–1.40	.80–1.25
• Manganese	.25	.25
• Silicon	.20	.25
• Vanadium	--	.25

High Speed-2

AISI M-2

Ameralloy High Speed-2 is the most widely used type of high speed tool steel. It's higher carbon content and balanced analysis produce properties applicable to all general purpose high speed uses.

Typical Analysis

- Carbon .83
- Molybdenum 5.00
- Tungsten 6.35
- Chromium 4.15
- Vanadium 1.90

Ameralloy®-7

SUPER SHOCK AISI S-7

Ameralloy-7 is our new, premium quality air hardening drill rod. It's the toughest, strongest drill rod for many applications that require maximum strength and impact.

Typical Analysis

MAXIMUM STRENGTH

- Carbon .50
- Molybdenum 1.40
- Manganese .70
- Silicon .25
- Chromium 3.25

Ameralloy®-13

HOT WORK AISI H-13

Ameralloy-13 combines good red hardness with abrasion resistance and resists heat checking. Ameralloy-13 is made from vacuum degassed tool steel ingots. This process plus carefully controlled hot work provides optimum uniformity, consistent response to heat treatment, and long service life.

Typical Analysis

EXTENDED SERVICE LIFE

- Carbon .40
- Molybdenum 1.50
- Manganese .40
- Silicon 1.10
- Chromium 5.25
- Vanadium 1.10

Ameralloy®
Precision Flat Ground
Stocking All Standard Sizes And Tolerances

Ameralloy® Oil
OIL HARDENING AISI 0-1

Ameralloy Oil is a widely used grade of precision flat grounds. It is a general purpose tool steel with premium hardening, wear resistance, and toughness.

Typical Analysis
GENERAL PURPOSE

- Carbon .90
- Manganese 1.20
- Silicon .30
- Tungsten .55
- Chromium .65
- Vanadium .30
- Molybdenum .15

Ameralloy®-60
AIR HARDENING AISI A-6

Ameralloy-60 has a minimum distortion characteristic which makes it particularly well suited for dies and punches in blanking and forming operations.

Typical Analysis

- Carbon .70
- Molybdenum .09
- Manganese 2.10
- Silicon .30
- Chromium 1.00
- Vanadium 1.35

Ameralloy®-Air
AIR HARDENING AISI A-2

Ameralloy Air is recommended over Ameralloy Oil when increased wear resistance, safe hardening, and less distortion are required.

Typical Analysis
MINIMUM DISTORTION

- Carbon 1.00
- Molybdenum 1.15
- Manganese .60
- Silicon .20
- Chromium 5.75
- Vanadium .25

Ameralloy® D-2
HIGH CARBON/ HIGH CHROME AISI D-2

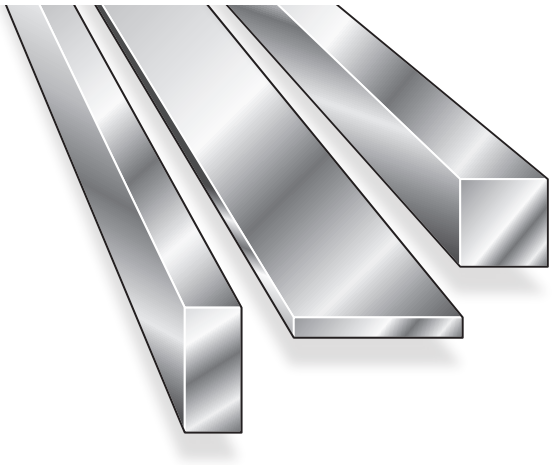
Ameralloy D-2 is an air-hardening steel known for maximum wear resistance. It is ideal for use in tools, dies, and used in long production runs.

Typical Analysis
MAX. WEAR RESISTANCE

- Carbon 1.55
- Molybdenum 1.00
- Manganese .55
- Silicon .35
- Chromium 12.50
- Vanadium 1.00

Ameralloy Flat Ground Tolerances

Thickness – regular	± .001"
Thickness – oversize	+ .010/.015"
Thickness – metric	+ .05mm/-0
Width – regular	+ .000/.005"
Width – oversize	+ .010/.015"
Width – metric	+ .2mm/-0
Squares – regular	± .001"
Squares – oversize	+ .010/.015"
Length 18"	+ .125/.250"
Length 24"	+ .1875/.375"
Length 36"	+ .250/.500"
Squareness – edge	.003" per inch
Squareness – end	.004" per inch



Ameralloy®
LOW CARBON

Typical Analysis

- Carbon .18
- Manganese .50
- Silicon .20
- Phosphorus .04
- Sulphur .04

Durelloy™ GFS
HEAT TREATED

Typical Tolerance

- Thickness +.005, -.000 Mattison ground
- Width +.005, -.000 Blanchard ground
- Length plus 1/8" saw cut
- Heat treated to 28–32 Rockwell C

Ameralloy®-7
SUPER SHOCK AISI S-7

Ameralloy-7 is our new, premium quality air hardening PFG. It's the toughest, strongest drill rod for many applications that require maximum strength and impact.

Typical Analysis

MAXIMUM STRENGTH

- Carbon .50
- Molybdenum 1.40
- Manganese .70
- Silicon .25
- Chromium 3.25

High Speed-2
AISI M-2

Ameralloy High Speed-2 is the most widely used type of high speed tool steel. It's higher carbon content and balanced analysis produce ideal properties for high speed use.

Typical Analysis

- Carbon .86
- Molybdenum 5.00
- Tungsten 6.35
- Chromium 4.15
- Vanadium 1.90

Ameralloy®-5

SHOCK RESISTANT STEEL AISI S-5

Color Code:
BROWN

Ameralloy-5 is formulated primarily for use in pneumatic and shock tools, and well suited to shock resistant parts in which a combination of great ductility and hardness is required. Carbon tool steels under Rockwell C 60 cannot compare in shock resistance to the alloyed grades. Ameralloy-5 is normally oil-quenched, particularly when machining intricate parts using Ameralloy-5. Quenching in water produces satisfactory results, but additional care should be taken if the part has drastic sectional changes or sharp corners.

Typical Analysis

- Carbon .60
- Manganese .85
- Vanadium .25
- Silicon 2.00
- Molybdenum .50

Features And Advantages

- Maximum shock resistance for hardness in the range of Rockwell C 58–60
- Good wear resistance
- Oil and water hardening

Heat Treatment

- **Forging** 1850°–1950°F, stop at 1650°F
- **Annealing** 1450°F, furnace-cool. Brinell 229 max.
- **Hardening** 1600°F, oil-quench or water-quench
- **Tempering** 400°– 650°F, average hardness after heat treatment Rockwell C 57–61

Applications

- Asphalt cutters
- Beading tools
- Caulking tools
- Moil points
- Pavement breakers
- Pneumatic chipping chisels
- Punches
- Rivet busters
- Rivet sets
- Shear blades

General Instructions

- **Forging** Heat Ameralloy-5 to 1850°–1950°F and do not forge below 1650°F. Ameralloy-5 is subject to decarburization, and therefore should not be held at the forging temperature longer than necessary. After forging, the steel should be cooled slowly in a heat-insulating material such as dry ashes, dry lime, or vermiculite.

• **Annealing** Pack-annealing in sealed containers using inert material is preferable because of the decarburization tendency of this steel. Otherwise, controlled-atmosphere furnaces may be used. Heat slowly to 1450°F, and hold for 1 hour per inch of greatest thickness. To obtain optimal machining properties, Ameralloy-5 should be cooled slowly to 1000°F. Careful annealing should result in a hardness of Brinell 229 max.

• **Hardening** Ameralloy-5 is primarily an oil hardening grade, However, satisfactory results can be achieved with water-quenching when the design is not too intricate. Hardening temperature for both oil- and water-quenching is 1600°F. Holding time at hardening heat should be just sufficient for uniformity of temperature. Holding time should not exceed 1/2 hour per inch of greatest thickness because of the danger of excessive decarburization. Temper immediately after quenching.

Ameralloy-tested hardness and fracture grain ratings for various oil- and water-quenching temperatures. Specimen size 3/4" dia. x 5".

	OIL-QUENCH		WATER-QUENCH	
Quenching Temperature (°F)	Fracture Grain Size	Rockwell C	Fracture Grain Size	Rockwell C
1450°	8	49	8	51
1500°	9½	55	9	59
1550°	9½	61	9½	64
1600°	9½	64	9½	65
1650°	9	63	9½	65

• **Tempering** Temperature should range between 400°–650°F, depending on the service desired. Normal tempering procedure for Ameralloy-5 is to hold at temperature for at least 2 hours per inch of greatest thickness.

Resulting Rockwell hardness for tempering oil- and water-quenched 3/4" dia. specimens at various temperatures

Tempering Temperature (°F)	1600°F Oil-Quench Rockwell C	1600°F Water-Quench Rockwell C
300°	63	63
400°	61	61
500°	60.5	60
600°	59	59
700°	57.5	57.5
800°	53	53.5
900°	51	51
1000°	49	48
1100°	47	45
1200°	40.5	40
1300°	33.5	33

Available Shapes And Sizes

Rounds
Squares
Flats
Octagons
Hexagons
Billets

Standard lengths 10'–12' R/L lengths. Other sizes available upon request. Prompt forging service also available

Rounds Decarb Free Or Hot Rolled Annealed

1/4	1	2	3	4
5/16	1-1/8	2-1/8	3-1/4	4-1/4
3/8	1-1/4	2-1/4	3-1/2	4-1/2
7/16	1-3/8	2-1/2	3-3/4	4-3/4
1/2	1-1/2	2-3/4		5
5/8	1-5/8			5-1/8
3/4	1-3/4			6
7/8	1-7/8			

Squares

3/8	2
1/2	2-1/2
5/8	3
3/4	4
1	
1-1/4	
1-3/8	
1-1/2	
1-3/4	

Octagons

1/4	1
3/8	1-1/8
7/16	1-1/4
1/2	
5/8	
3/4	
7/8	

Hexagons

3/8	1
1/2	1-1/8
5/8	1-1/4
3/4	1-1/2
7/8	

Billets

Round Cornered Square

4
6
8
10

Flats

3/8	x 2-1/2	x 2-1/2	x 4-1/2	**3**
x 1	x 3	x 3	x 5	x 4
x 1-1/2	x 4	x 4	x 6	x 4-1/2
x 2	x 5	x 5	**2**	x 5
x 5	**1**	x 6	x 2-1/2	x 6
1/2	x 1-1/2	**1-1/2**	x 3	x 7
x 5/8	x 2	x 2	x 4	x 8
x 1	x 2-1/2	x 2-1/2	x 4-1/2	**3-1/2**
x 1-1/2	x 3	x 3	x 5	x 4
x 2	x 3-1/2	x 3-1/2	x 6	x 5
x 2-1/2	x 4	x 4	x 8	x 6
x 3	x 4-1/2	x 4-1/2	**2-1/2**	**4**
x 6	x 5	x 5	x 3	x 4-1/2
3/4	x 6	x 5-1/2	x 4	x 5
x 1	**1-1/4**	x 6	x 4-1/2	x 6
x 1-1/2	x 1-1/2	**1-3/4**	x 5	x 7
x 2	x 2	x 4	x 6	x 8

Ameralloy®-7

IMPACT RESISTANT STEEL AISI S-7

Color Code:
TAN & ORANGE

Ameralloy-7 is remarkably versatile. It is widely used for medium run cold-work tools and dies, plastic molding dies, shear blades, medium hot-work dies, master hobs, and component parts. Ameralloy-7 is a shock steel with exceptional impact properties, unnotched Charpy over 200 ft-lbs at 400°F temper. Since it hardens in air, Ameralloy-7 is safe and stable in heat treatment.

Ameralloy-7 Modified* is available in mill run quantities.

Typical Analysis

- Carbon .50
- Manganese .70
- Chromium 3.25 (3.75)*
- Silicon .25
- Molybdenum 1.40 (1.50)*

Features And Advantages

- Good machinability
- Maximum shock resistance
- Air hardening
- Medium hot-work characteristics

Heat Treatment

- **Forging** Preheat 1200°–1300°F, forge at 2000°–2050°F, stop at 1700°F and cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1500°–1550°F, cool slowly to 1000F°, air cool. Brinell 197 max.
- **Preheating** 1200°–1300°F prior to hardening
- **Hardening** 1725°F, quench in air if cross section is 2½" or smaller. Sections 2½–6" should be oil-quenched to black (1000°F) then air-cooled to 150°F. Larger cross sections should be oil-quenched to 150°F.
- **Tempering** 400°F minimum, double temper oil-quenched masses

Applications

- Hot and cold shock applications
- Rivet sets
- Chisels
- Punches
- Moil points
- Hot headers
- Gripper dies
- Cold Forming
- Blanking
- Bending
- Engraving dies
- Machined cavities
- Plastic-molding dies
- Die-casting dies
- Shear blades
- Master hobs

Ameralloy®-7

IMPACT RESISTANT STEEL AISI S-7

Characteristics

• **Machinability** When annealed to Brinell 197 max. Ameralloy-7 is rated at 95, as compared to a rating of 100 for a 1.00% carbon tool steel.

• **Dimensional stability** When quenched in air from the proper hardening temperature, Ameralloy-7 expands no more than 0.001 in./in. of cross section.

General Instructions

• **Maintain surface chemistry** Precautions should be taken to avoid excessive decarburization or carburization when heating Ameralloy-7 for forging, annealing, and hardening.

• **Forging** Preheat Ameralloy-7 at 1200°–1300°F before raising to a forging temperature of 2000°–2050°F. Discontinue forging at 1700°F and reheat rather than forge below this temperature. Ameralloy-7 is subject to decarburization and should not be held at the forging temperature longer than necessary. Following forging, cool slowly by burying in your choice of heat-insulating material to avoid cooling cracks.

• **Annealing** Anneal in a protective atmosphere. Heat rapidly to 1500°–1550°F and hold at temperature for 1½ hours per inch of greatest thickness. To obtain best machining properties, cool slowly to 1000° then air cool. Resulting hardness will be Brinell 197 max.

• **Hardening** To maintain surface chemistry, Ameralloy-7 should be hardened in a controlled neutral environment. Note that packing in cast-iron chips could impart a light carburized case. Unless such a case is considered desirable, make provisions for grinding it after treatment.

Ameralloy-7 should be preheated at 1200°–1300°F and raised to a hardening temperature of 1725°F. Hold at temperature 1 hour per inch of greatest thickness. Thicknesses 2½" or less should be quenched in still air. Upon reaching 150°F, temper without delay.

Thicknesses of 2½–6" should be oil-quenched until black (1000°F), then cooled in air. For massive sections larger than 6", it is advisable to oil-quench until the piece reaches 150°F then temper immediately. After oil-quenched sections have cooled to room temperature, temper again to insure complete transformation.

Ameralloy-tested Rockwell hardness and fracture grain ratings for specimens 1" round by 3" long, preheated to 1300°F. Various quenching methods and temperatures listed.

STILL AIR

Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1550°	6½	43.5
1600°	7	48
1650°	8	57
1700°	9	60
1725°	8½	60
1750°	8	60
1800°	7	60
1850°	7	60

AIR-BLAST

Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1550°	6½	52.5
1600°	7	57
1650°	8½	57.5
1700°	9	58
1725°	8½	60
1750°	8	60
1800°	7½	60
1850°	7	61

OIL-QUENCH

Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1550°	8	52
1600°	8	54
1650°	9	57.5
1700°	9	61
1725°	8½	61
1750°	8	61.5
1800°	8	62
1850°	7	62

• **Carburizing** During heating for hardening to increase wear resistance, for some types of tools such as master hobs, striking dies, die stamps, and forming dies it is possible to increase wear resistance of Ameralloy-7 while retaining desirable shock resistance.

The best case depth for many applications is 0.010" or less. Hardness will be approximately Rc 60/62. A carburized case can be put on while heating for the hardening operation, by packing the tool in carburizing compound instead of inert material. A low activity carburizer such as wood charcoal is recommended to avoid the possibility of excessively deep or extremely high-carbon cases, which can produce "austenitic soft skin."

Avoid using cyanide cases due to brittleness.

Ameralloy®-7

IMPACT RESISTANT STEEL AISI S-7

General Instructions (continued)

• **Tempering** Ameralloy-7 is normally tempered 1½ to 2 hours per inch of greatest thickness. Tempering temperature varies according to intended use. For cold-work and similar applications, a temperature of 400°F is recommended. For hot-work applications, temper at 900°–1000°F. Never temper at less than 400°F.

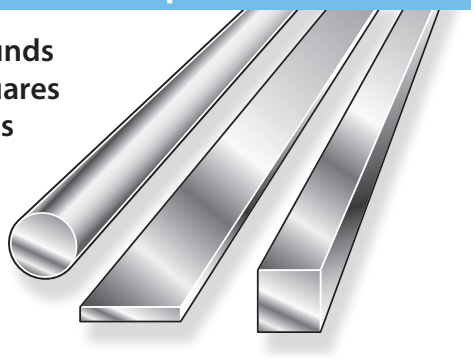
When interrupted oil-quench (to 1000°F) or full oil-quench (150°F) has been utilized in hardening, always temper immediately. After cooling down to room temperature, temper again to insure complete transformation.

Rockwell hardness for specimens 1" round by 3" long, air hardened from 1725°F and tempered at various temperatures for 2 hours.

Tempering Temperature (°F)	Rockwell C
As quenched	60
300°	59
400°	58
500°	56
600°	55
700°	54
800°	53
900°	52
1000°	51
1100°	47
1200°	38
1300°	31

Available Shapes And Sizes

Rounds
Squares
Flats



ROUNDS: Standard lengths 8'–10' R/L. FLATS & SQUARES: Standard lengths 8'–12' R/L. Specify O.D. and I.D. Ameralloy-7 Modified and special sizes available upon request. Prompt forging service available.

Rounds Hot Rolled Annealed & Pre-Machined

1/2	1-1/2	2-1/2	3-3/4	7
5/8	1-5/8	2-5/8	4	7-1/2
3/4	1-3/4	2-3/4	4-1/4	8
7/8	1-7/8	2-7/8	4-1/2	9
1	2	3	5	10
1-1/8	2-1/8	3-1/4	5-1/2	11
1-1/4	2-1/4	3-1/2	6	12
1-3/8	2-3/8	3-5/8	6-1/2	

Flats & Squares Decarb-Free Plus .015/.035

1/2	5/8	3/4	7/8	1
x 1/2	x 5/8	x 3/4	x 7/8	x 1
x 1	x 3/4	x 1	x 1	x 1-1/2
x 1-1/2	x 1	x 1-1/2	x 1-1/2	x 2
x 2	x 1-1/2	x 2	x 2	x 2-1/2
x 2-1/2	x 2	x 2-1/2	x 2-1/2	x 3
x 3	x 2-1/2	x 3	x 3	x 3-1/2
x 3-1/2	x 3	x 3-1/2	x 3-1/2	x 4
x 4	x 3-1/2	x 4	x 4	x 5
x 5	x 4	x 5	x 5	x 6
x 6	x 5	x 6	x 6	x 8
x 8	x 6	x 8	x 8	x 10
x 10	x 8	x 10	x 10	x 12
x 12	x 10	x 12	x 12	
	x 12			

1-1/4	1-1/2	1-3/4	2	2-1/2
x 1-1/4	x 1-1/2	x 1-3/4	x 2	x 2-1/2
x 1-1/2	x 2	x 2	x 2-1/2	x 3
x 2	x 2-1/2	x 2-1/2	x 3	x 3-1/2
x 3	x 3	x 3	x 3-1/2	x 4
x 4	x 3-1/2	x 4	x 4	x 4-1/2
x 5	x 4	x 5	x 5	x 5
x 6	x 5	x 6	x 6	x 6
x 8	x 6	x 8	x 8	x 8
x 10	x 8	x 10	x 10	x 10
x 12	x 10	x 12	x 12	x 12
	x 12			

3	3-1/2	4	5	6
x 3	x 3-1/2	x 4	x 5	x 6
x 3-1/2	x 4	x 5	x 6	x 8
x 4	x 5	x 6	x 7	x 10
x 4-1/2	x 6	x 8	x 8	x 12
x 5	x 8	x 10	x 10	
x 6	x 10	x 12	x 12	
x 8	x 12			
x 10				
x 12				

Ameralloy®-13

HOT WORK DIE STEEL VACUUM DEGASSED

AISI H-13

Color code:
MAROON-13

Ameralloy-13 is a chromium-molybdenum-vanadium hot work steel with high vanadium content which increases its wash resistance. In addition, the alloy content minimizes heat checking at high operating temperatures.

Ameralloy-13 is best used for long run zinc and magnesium die casting dies; also in forging, heading, and extruding applications where toughness, impact, strength and hot work steel qualities are essential.

Ameralloy-13 requires a relatively simple heat treatment and can be quenched in air with a minimum of distortion. It may also be quenched in oil with satisfactory results.

Typical Analysis

- Carbon .40
- Manganese .40
- Chromium 5.25
- Silicon 1.10
- Molybdenum 1.50
- Vanadium 1.10

Features And Advantages

- High resistance to heat checking
- Good red hardness
- Good shock resistance
- Good machinability
- Good dimensional stability
- Excellent hardenability

Heat Treatment

- **Forging** 2050°–2150°F, stop at 1650°F and cool slowly
- **Annealing** 1600°F, then furnace-cool. Brinell 207 max.
- **Preheating** 1350°F, soak before heating for hardening
- **Hardening** 1850°F, air-quench
- **Tempering** 1050°–1150°F, avg. Rockwell C 38/46, die casting dies should be hardened to Rockwell C 44/48

Applications

Die Casting
(aluminum, long run zinc, magnesium)

- Cylinder liners
- Die casting nozzles (aluminum)
- Cams (die casting machines)
- Plunger and tip
- Dies
- Cores
- Ejector pins
- Sleeves

Forging And Heading
(steel, brass, and aluminum)

- Cold heading dies, hot press dies
- Drop forging die inserts
- Forging machine dies and plungers
- Hot heading dies, hot trim dies
- Hot work rolls
- Bolt dies, rivet dies, bull dies, gripper dies, bending dies, swagging dies
- Shear blades, punches, nut piercers

Extrusion

- Extrusion dies
- Extrusion press liners
- Extrusion rams
- Rolls
- Dummy blocks, backer blocks
- Cylinders

Ameralloy®-13

HOT WORK DIE STEEL AISI H-13
VACUUM DEGASSED

Characteristics

• **Machinability** In the thoroughly annealed condition Ameralloy-13 may be machined without difficulty. Where a 1% carbon steel is rated at 100, Ameralloy-13 has a rating of 75.

• **Dimensional stability** When air-quenched from proper hardening temperature, Ameralloy-13 generally expands .001 in./in. of cross section.

• **Critical points** Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400°F/hour:

Heating – Ac range 1600° to 1665°F
Cooling – Ar range 1460° to 1350°F

• **Surface Chemistry** This grade does not decarburize as readily as other types of tool steels having higher carbon content. However, care must be taken to maintain surface chemistry during heat treatment, since either carburization or decarburization are possible and would affect the steel's resistance to heat checking.

When heat treating Ameralloy-13, maintain as near a neutral atmosphere as possible, preferably by vacuum heat treating or by wrapping the piece in stainless steel foil. If this is not possible, working surfaces should be ground after heat treatment.

General Instructions

• **Forging** Large pieces of Ameralloy-13 should be preheated slowly to 1300°–1500°F, and thoroughly soaked before heating rapidly to the forging temperature of 2050°–2150°F. The steel should be thoroughly heated before beginning the forging operation. Do not forge below 1650°F, but reheat as many times as necessary. After forging is completed, the steel should be slowly cooled by burying in a heat-insulating material such as dry ashes, lime, or vermiculite.

• **Annealing** Ameralloy-13 may be annealed by heating to 1600°F. Soak 1 hour per inch of greatest thickness, and furnace cool at 30°F per hour to 900°F. Then air cool. Proper annealing procedure includes packing in a steel container using a neutral inert material. Maximum Brinell hardness of 207.

• **Hardening** In a controlled atmosphere, preheat thoroughly to 1300°–1400°F. Then heat to 1850°F and hold for 1 hour per inch of greatest cross section. Quench in still air and temper immediately.

When maximum hardness is the primary requirement, Ameralloy-13 may be oil-quenched. But keep in mind that when oil-quenched this grade is as vulnerable to cracking as and has the same distortional characteristics as an oil hardening tool steel.

Ameralloy-tested Rockwell hardness and fracture grain ratings for specimens 1" round by 3" long, preheated to 1350°F. Various quenching methods and temperatures listed.

Quenching Temperature (°F)	Fracture Grain Size	Rockwell C
1750°	8½	46
1800°	8¾	52
1850°	9	54
1900°	9	54
1950°	9	55
2000°	8½	56

• **Tempering** For hot work applications, Ameralloy-13 is used in the hardness range of HRC 38–48. The usual hardness range for die casting dies is HRC 44–48, requiring a temper at approximately 1100°F. For improved shock resistance, the steel is often tempered at temperatures approaching 1150°F, resulting in a hardness range of HRC 40–44. The steel should be held at tempering temperature for at least 2 hours per inch of greatest cross section. All hot work steel should be tempered at a minimum of 50°F above the expected maximum operating temperature of the tool or die. Double tempering, with the second temper 25°–50°F lower than the first temper, is always advisable, particularly where heat checking is a problem.

Resulting Rockwell hardness for various tempering temperatures. Obtained from 1" round quenched from 1850°F and tempered for 2 hours.

Tempering Temperature (°F)	Rockwell C
400°	54
500°	53
600°	53
700°	53
800°	53
900°	54
1000°	52
1100°	46
1200°	36

Above results on 1" diameter specimens may be used as a guide in tempering tools to desired hardness. Tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

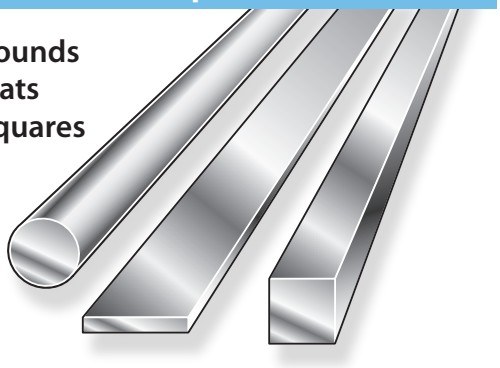
Ameralloy®-13

HOT WORK DIE STEEL
VACUUM DEGASSED

AISI H-13

Available Shapes And Sizes

Rounds
Flats
Squares



ROUNDS: Standard lengths 8'–10' R/L. FLATS & SQUARES: Standard lengths 8'–12' R/L. Specify O.D. and I.D. Modified and special sizes available upon request. Prompt forging service available.

Flats Pre-machined / Annealed

3/4	x 3	**3-1/4**	x 18	x 30
x 1-1/4	x 3-1/2	x 3-1/2	x 20	x 36
1	**2-1/2**	**3-1/2**	**5-1/2**	**10-1/4**
x 4	x 2-3/4	x 6	x 20	x 24
x 6	x 3	x 10	**6**	**11**
x 8	x 4	x 12	x 12	x 25
x16	x 5	x 14	x 14	x 28
1-1/2	x 6	x 16	x 16	**11-1/2**
x 2	x 8	**4**	x 18	x 26-1/2
x 3	x 10	x 5	x 20	**12**
x 4	x 12	x 8	x 25	x 25
x 5	x 14	x 10	x 28	x 36
x 6	x 18	x 12	**7**	x 40
x 8	**2-3/4**	x 14	x 18	**13**
x 12	x 3	x 16	x 25	x 28
x 14	x 4	x 18	**8**	**14**
2	**3**	x 20	x 16	x 28
x 3	x 3-1/2	x 25	x 20	x 28-1/2
x 4	x 4	**4-1/2**	x 25	**14-7/8**
x 5	x 6	x 14	x 28	x 19
x 6	x 7	x 16	x 30	**15**
x 8	x 8	x 18	**9**	x 28
x 10	x 10	x 24	x 12	x 30
x 12	x 12	**5**	x 25	**16**
x 16	x 14	x 10	x 36	x 24
2-1/4	x 16	x 12	**10**	
x 2-1/2	x 18	x 14	x 20	
x 2-3/4	x 20	x 16	x 25	

Rounds Hot Roll/Annealed/Decarb Free/Oversize

1/2	2	4	7	11
5/8	2-1/8	4-1/8	7-1/2	11-5/8
3/4	2-3/16	4-1/4	7-3/4	12
7/8	2-1/4	4-1/2	8	12-1/2
1	2-3/8	4-3/4	8-1/2	13
1-1/8	2-1/2	5	8-3/4	13-1/2
1-1/4	2-5/8	5-1/4	9	14–18
1-3/8	2-3/4	5-1/2	9-1/4	20
1-7/16	3	5-3/4	9-1/2	22
1-1/2	3-1/8	6	9-3/4	
1-5/8	3-1/4	6-1/4	10	
1-3/4	3-1/2	6-1/2	10-7/16	
1-7/8	3-3/4	6-3/4	10-1/2	

Centerless Ground Rounds Annealed

.250	1.506	2.1935	3-1/4	4-1/2
.3125	1.5685	2-1/4	3-1/2	4-3/4
.820	1.631	2-1/2	3.506	5
.881	1.756	2.506	3.990	5-1/2
1.006	1.881	2.756	4	5-3/4
1.256	2.010	3	4.006	6
1.3185	2.131	3.006	4-5/16	7.795

Squares Annealed

2-1/4	3	6
2-1/2	3-1/4	8
2-3/4	4	10
	5	

Billets

6	12
8	14
10	16

Ameralloy®-20

CHROME-MOLY STEEL AISI P-20

Color code:
TAN WITH
ORANGE STRIPE

Ameralloy-20 is a chrome-moly tool steel made specifically to fill the requirements for machined cavities and forces used in zinc die casting and plastic molding. Ameralloy-20 is delivered fully quenched and tempered to approximately Brinell 300. Other hardness levels may be obtained through additional heat treatment.

Typical Analysis

- Carbon .35
- Manganese .80
- Chromium 1.70
- Silicon .50
- Molybdenum .45

Features And Advantages

- Usually eliminates heat treating by customer
- Mold quantity – electric furnace melted, vacuum degassed and ultrasonically inspected
- Good machinability
- Available in a wide range of sizes
- Deep hardening
- Uniform mechanical properties

Applications

- Cavities and cores of zinc die casting dies
- Plastic molding dies
- Compression and transfer molds

Heat Treatment

For most zinc die casting and plastic molding operations, no further heat treatment is required. However, if the material is committed to reforging, if higher hardness is required, or if stress relieving is necessary after heavy machining, the following cycles are suggested:

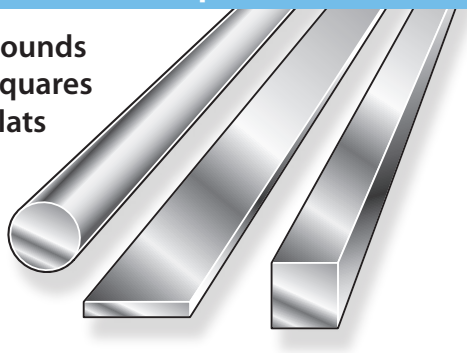
- **Stress relieving** 1000°F, air cool
- **Forging** Heat to 2000°F, stop at 1700°F and cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1450°–1500°F, furnace cool. Brinell 207 max.
- **Hardening** 1550°F, oil-quench to 150°F.
- **Tempering** Temper at 300°–400°F for Rockwell C-54/55
- **Nitriding** 1000°–1025°F for 25 hours produces 0.025" case depth
- **Carburizing** 1700°F for 8 hours produces approximately 0.05" case depth

Ameralloy®-20

CHROME-MOLY STEEL AISI P-20

Available Shapes And Sizes

Rounds
Squares
Flats



ROUNDS: Standard lengths 8'–10' R/L. FLATS & SQUARES: Standard lengths 8'–12' R/L. Specify O.D. and I.D. Modified and special sizes available upon request. Prompt forging service available.

Rounds

3/4	3-1/2	9	1
1	4	10	1-1/2
1-1/4	4-1/4	11	1-3/4
1-1/2	4-1/2	12	2
1-3/4	5	14	2-1/4
2	5-1/2	14-1/2	2-1/2
2-1/8	6	16	2-3/4
2-1/4	6-1/2	18	3
2-1/2	7	20	3-1/2
2-3/4	7-1/2	24	4
3	8		5
3-1/4	8-1/2		6

Squares

Centerless ground rounds, heat treated & rough turned.

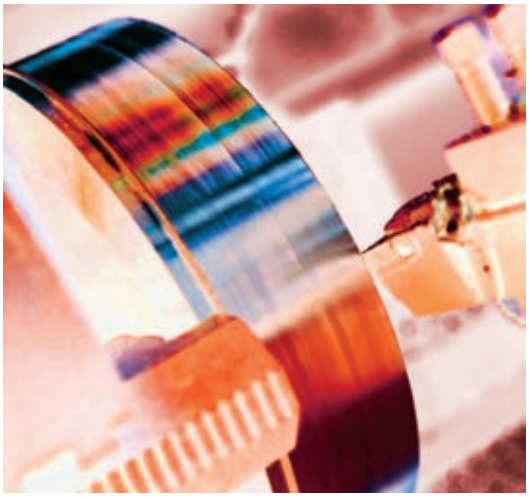
Flats Machine Oversize / Allowance to finish

1	x 16	x 12	x 10	x 14	x 34	x 20	x 40
x 2-1/4	x 18	x 14	x 12	x 16	x 36	x 25	x 48
x 6	x 20	x 16	x 14	x 18	x 38	x 26	x 60
x 8	x 36	x 25	x 16	x 20	x 40	x 30	**17**
x 12	**2-1/4**	x 27-1/2	x 18	x 22	x 45	x 32	x 48
x 18	x 12	**4**	x 20	x 25	**10**	x 34	**18**
x 36	x 14	x 6	x 22	x 26	x 12	x 36	x 23
1-1/4	**2-1/2**	x 7	x 25	x 28	x 14	x 38	x 24
x 10	x 6	x 8	x 28	x 30	x 20	x 40	x 40
x 12	x 8	x 10	x 36	x 36	x 22	x 48	x 48
x 16	x 10	x 12	**5-1/2**	x 40	x 23	x 60	x 60
1-1/2	x 12	x 14	x 16	**8**	x 25	**14**	**20**
x 3	x 14	x 16	x 40	x 10	x 26	x 23	x 22
x 6	x 16	x 18	**6**	x 12	x 28	x 25	x 24
x 7	x 20	x 20	x 9	x 16	x 30	x 30	x 34
x 8	x 36	x 24	x 12	x 18	x 32	x 32	x 40
x 10	**3**	x 25	x 14	x 20	x 36	x 34	x 48
x 12	x 5	x 27-1/2	x 16	x 22	x 38	x 36	x 60
x 14	x 6	**4-1/4**	x 18	x 25	x 40	x 38	**22**
x 16	x 6-1/2	x 5-1/4	x 20	x 28	x 48	x 40	x 24
x 18	x 8	**4-1/2**	x 22	x 30	x 60	x 48	x 48
x 20	x 10	x 8	x 25	x 32	**11**	x 60	**23**
x 36	x 12	x 10	x 26	x 34	x 25	**15**	x 48
2	x 14	x 12	x 28	x 36	x 30	x 23	**24**
x 4	x 16	x 14	x 30	x 40	x 32	x 25	x 48
x 6	x 18	x 16	x 32	**9**	x 34	x 30	
x 7	x 20	x 18	x 34	x 20	x 36	x 40	
x 8	x 25	x 28	x 36	x 22	x 40	x 48	
x 10	x 27-1/2	**5**	x 40	x 25	x 48	x 60	
x 12	**3-1/2**	x 6	**7**	x 26	x 60	**16**	
x 14	x 10	x 8	x 12	x 30	**12**	x 20	

Amera-Mold™

PRE-HARDENED STEEL

Color code:
LIGHT TAN



Amera-Mold is engineered expressly for the plastics molding industry. Amera-Mold is a pre-hardened alloy steel delivered at Rockwell C 28–32 (special hardness upon request). As a result of its fine grain structure (95% of 8), close chemistry, and quality control, Amera-Mold assures our customers of excellent machinability and high lustrous finish unequaled in the industry.

Typical Analysis

- Carbon .50
- Manganese 1.00
- Chromium 1.05
- Silicon .32
- Molybdenum .20
- Nickel .61
- Vanadium .28

Features And Advantages

- Usually eliminates the cost of heat treating by the customer
- Excellent machinability
- High lustrous (mirror-like) finish
- Deep hardening
- Good compressive strength
- Retains high strength at operating temperatures as high as 900°F

Applications

- Injection or compression molding of plastics requiring high sheen on the finished product
- Plastic film extrusion dies
- Zinc casting dies

Heat Treatment

For most plastic molding operations, no further heat treatment is required. However, if the material is committed to reforging, if higher hardness is required, or if stress relieving is necessary after heavy machining, the following cycles are suggested:

- **Stress relieving** Approximately 1000°F
- **Forging** Heat to 2100°F, stop at 1800°F and cool slowly
- **Normalizing** 1600°F, air cool
- **Annealing** 1525°F, cool 20° per hour to 1195°F, air cool, Brinell 207 max.
- **Hardening** 1525°F, oil-quench
- **Tempering** Temper at 1150°F (depending on size and desired properties)
- **Nitriding** 1000°–1025°F for 25 hours produces 0.025" case depth
- **Carburizing** 1700°–1750°F for Rockwell C 63–64 surface hardness

General Instructions

Amera-Mold is delivered fully quenched and tempered to a hardness range of Brinell 285 to 321. For most operations, no further heat treatment is required. Where heat treatment is required, refer to the following procedures.

- **Stress relieving** Stress produced by cold work operations such as hobbing, straightening, deep stamping, grinding, and heavy machining continue to add distortion during heat treatment and should be removed prior to hardening. Heat to 1000°–1100°F, holding until all parts are heated uniformly, and cooling to room temperature. If the stresses are produced after machining in the heat-treated condition, the maximum stress-relieving temperature is 100°F below the tempering temperature.

- **Forging** Heat Amera-Mold to approximately 2100°F, and hold until the piece is thoroughly heated before forging. Stop forging at 1800°F and reheat if necessary. After forging, the piece should be buried in an inert, heat-insulating material and slow cooled. Then normalize and anneal.

- **Normalizing** Heat to approximately 1600°F and hold at temperature 1 hour per inch of greatest thickness. The piece should then be cooled to room temperature in still air.

- **Annealing** Heat the piece in a protective atmosphere to 1525°F and soak 1 hour per inch of greatest thickness. Maintain atmosphere control and cool at a rate of 20°F per hour to 1195°F and then air cool. This procedure should produce a hardness of Brinell 212 maximum.

- **Hardening** Heat to a temperature of 1525°F and hold for 1 hour per inch of greatest thickness. Quench in oil to 150°F and temper immediately.

- **Tempering** Temperature will vary with the size of the piece and the application. Use the chart below to achieve desired tempering properties.

Results of tests performed on 1" round specimen. For larger sections, the mechanical properties may be somewhat lower. It may be necessary to adjust the tempering temperature to obtain the same properties as those shown:

Tempering Temperature (°F)	Yield Point (psi)	Tensile Strength (psi)	Elongation (%)	Reduction (%)	Hardness (Brinell)
400°	247,500	301,500	10.25	33.95	578
500°	249,500	283,250	10.0	37.25	555
600°	240,500	268,500	10.5	40.65	534
700°	224,250	243,000	10.25	39.6	495
800°	212,000	223.500	9.5	38.8	444
900°	201,000	214,000	11.0	44.0	429
1000°	184,500	198,000	11.5	40.1	401
1050°	170,000	182,000	14.0	48.3	375
1100°	162,000	157,000	14.5	49.5	363
1150°	160,000	174,000	15.0	49.5	363
1200°	147,000	158,000	17.0	56.2	331
1250°	130,000	142,500	18.5	58.6	292
1300°	117,000	128,000	20.0	59.1	262

Rounds

1/4	2-5/8	5-1/4	10-1/2
3/8	2-3/4	5-1/2	11
1/2	2-7/8	5-3/4	11-1/2
5/8	3	6	12
3/4	3-1/8	6-1/4	12-1/2
7/8	3-1/4	6-1/2	13-1/4
1	3-3/8	6-3/4	14-1/4
1-1/8	3-1/2	7	15-1/4
1-1/4	3-5/8	7-1/4	16-1/4
1-3/8	3-3/4	7-1/2	17-1/4
1-1/2	3-7/8	7-3/4	
1-5/8	4	8	
1-3/4	4-1/8	8-1/4	
2	4-1/4	8-3/4	
2-1/8	4-3/8	9	
2-1/4	4-1/2	9-1/4	
2-3/8	4-3/4	9-1/2	
2-1/2	5	10	

Squares

1/2	4-1/2
5/8	5
3/4	5-1/2
1	6
1-1/8	8
1-1/4	9
1-3/8	10
1-1/2	11
1-5/8	12
1-3/4	14
2	16
2-1/4	
2-1/2	
2-3/4	
3	
3-1/4	
3-1/2	
4	

Flats

3/4	x 12	x 12	x 5	x 18	x 20
x 1	**1-1/4**	**1-3/4**	x 6	3-1/2	**5**
x 1-1/2	x 4	x 6	x 7	x 4	x 10
x 2	x 5	**2**	x 8	x 5	x 12
x 3	x 6	x 3	x 10	x 6	x 14
x 4	x 7	x 4	x 12	x 8	x 18
x 5	x 8	x 5	x 14	x 10	**6**
x 6	x 10	x 6	x 16	x 12	x 10
x 8	**1-1/2**	x 7	x 18	x 14	x 12
1	x 2	x 8	**3**	**4**	x 16
x 1-1/2	x 3	x 10	x 4	x 5	x 18
x 2	x 3-1/2	x 12	x 5	x 6	x 20
x 3	x 4	x 14	x 6	x 8	**8**
x 4	x 5	x 16	x 8	x 10	x 12
x 5	x 6	x 18	x 10	x 12	x 14
x 6	x 7	**2-1/2**	x 12	x 14	x 16
x 8	x 8	x 3	x 14	x 16	x 20
x 10	x 10	x 4	x 16	x 18	

Amera-Mold sizes available for immediate shipment. Hot rolled, cold drawn, and decarb-free.

Ameralloy®-6

OIL HARDENING STEEL AISI L-6

Color Code:
RED & ORANGE

Ameralloy-6 is in the general class of oil hardening alloy tool steels. Due to its lower carbon content, it has slightly better shock resistance than more highly alloyed types, and should be used in applications where some wear resistance may be sacrificed for increased toughness.

Typical Analysis

- Carbon .75
- Manganese .75
- Chromium .90
- Nickel 1.75
- Molybdenum .35

Applications

- Forming rolls
- Punches
- Blanking dies
- Forming dies
- Clutch parts
- Pawls
- Knuckle pins
- Clutch pins
- Shear blades
- Spindles

Features And Advantages

- Oil hardening
- Low distortion in heat-treatment
- Good toughness at lower hardness levels
- Good wear resistance at high hardness levels

Heat Treatment

- **Forging** 2100°–2175°F, stop at 1700°F, cool slowly
- **Normalizing** Do not normalize
- **Annealing** 1400°F, furnace-cool. Brinell 217 max.
- **Hardening** 1500°–1550°F, oil-quench
- **Tempering** 400°F, average hardness after heat treatment Rockwell C 60–61

General Instructions

- **Forging** Heat Ameralloy-6 slowly and uniformly to 2100°–2175°F, and do not forge below 1700°F. If a preheater is available, hold at 1200°F until uniformly heated before increasing temperature to the forging heat. Because of its air-hardening properties, for slow cooling bury in dry lime, silocel, or other insulating medium immediately after forging.

- **Annealing** Heat to 1400°F and hold 1 hour per inch of greatest thickness. Cool at 20°F per hour to 900°F then air-cool. A maximum hardness of Brinell 217 will be obtained following this treatment. Because of it air-hardening ability, Ameralloy-6 should not be normalized.

• **Hardening** Ameralloy-6 should be preheated at 1200°F, soaked, then raised to a hardening temperature of 1500°–1550°F and held for 1 hour per inch of greatest thickness. Oil-quench to 150°F and temper immediately. Tools made of Ameralloy-6 in sections less than 1" thickness may be air-quenched from 1500°F, providing safer hardening of intricate sections. Air-quenching also results in less distortion.

Ameralloy-tested hardness and fracture grain ratings for air-blast and oil-quenching temperatures. Specimen size 1" round x 5":

	AIR-BLAST		OIL-QUENCH	
Quenching Temperature (°F)	Fracture Grain Size	Rockwell C	Fracture Grain Size	Rockwell C
1400°	9¾	61	9¾	63
1450°	9¾	63	9¾	64
1500°	9½	63	9¾	64.5
1525°	9½	63	9¾	64.5
1550°	8¾	63	9¼	64
1600°	8½	63	8½	63
1650°	8¼	63	7½	63
1700°	8	62.5	7¼	62
1750°	8	62.5	7¼	61.5
1800°	7	62	7	61

• **Tempering** Temper Ameralloy-6 at 400°. Some hardness may be sacrificed in favor of increased toughness by using higher tempering temperatures.

Unlike many die steels, Ameralloy-6 does not become brittle when tempered in the range of 450°–800°F. Hold a minimum of 1 hour per inch of greatest thickness when tempering at 400°F. To minimize the possibility of cracking, temper immediately after hardening by heating slowly to the desired tempering temperature.

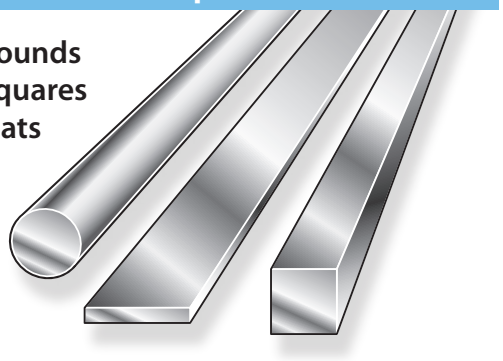
Resulting Rockwell hardness for tempering air-blast and oil-quenched specimens 7/8" round x 2-1/2" long at various temperatures:

	AIR-BLAST	OIL-QUENCH
Tempering Temperature (°F)	1500°F Rockwell C	1525°F Rockwell C
No draw	63	65
300°	59.5	62
400°	57.5	61
500°	56.5	58
600°	55	56
700°	51	53
800°	49	50
900°	47.5	48
1000°	43.5	46

Above results on 7/8" diameter specimens may be used as a guide in tempering tools to desired hardness. Tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

Available Shapes And Sizes

Rounds
Squares
Flats



Standard lengths 10'–12' R/L lengths. Larger rounds available upon request.

Rounds Hot Rolled Annealed

1/4	5/8	1	1-1/2	2-1/4
5/16	11/16	1-1/16	1-5/8	2-3/8
3/8	3/4	1-1/8	1-3/4	2-1/2
7/16	13/16	1-1/4	1-7/8	2-5/8
1/2	7/8	1-5/16	2	2-3/4
9/16	15/16	1-3/8	2-1/8	2-7/8

Rough Turned Rounds 5" And Over

3	3-3/4	5	6-1/4	7-1/2
3-1/8	4	5-1/4	6-1/2	
3-1/4	4-1/4	5-1/2	6-3/4	
3-3/8	4-1/2	5-3/4	7	
3-1/2	4-3/4	6	7-1/4	

Squares

1/2	3/4	1-1/4	1-3/4	2-1/4
5/8	1	1-1/2	2	2-1/2

Flats Hot Rolled Annealed

1/4	x 2	x 2-1/2	x 3	x 8
x 1-1/4	x 2-1/2	x 3	x 3-1/2	x 10
x 2-1/4	x 3	x 3-1/2	x 4	**2-1/4**
3/8	x 4	x 4	x 5	x 4
x 1	x 5	x 4-1/2	x 6	x 6
x 1-1/4	**3/4**	x 5	x 8	**2-1/2**
x 1-1/2	x 1	x 6	x 10	x 3
x 2	x 1-1/4	x 8	**1-3/4**	x 3-1/2
x 3	x 1-1/2	**1-1/4**	x 2	x 4
x 4	x 1-3/4	x 1-1/2	x 2-1/2	x 4-1/2
1/2	x 2	x 1-3/4	x 3	x 5
x 1	x 2-1/2	x 2	x 3-1/2	x 6
x 1-1/4	x 3	x 2-1/2	x 4	**3**
x 1-1/2	x 3-1/2	x 3	x 4-1/2	x 4
x 1-3/4	x 4	x 4	x 5	x 5
x 2	x 5	x 5	**2**	x 6
x 3	x 6	x 6	x 2-1/2	**3-1/2**
x 4	x 8	x 8	x 3	x 4
x 6	**1**	x 10	x 3-1/2	**4**
5/8	x 1-1/4	**1-1/2**	x 4	x 5
x 1	x 1-1/2	x 1-3/4	x 4-1/2	x 6
x 1-1/4	x 1-3/4	x 2	x 5	
x 1-1/2	x 2	x 2-1/2	x 6	

Ameralloy®-FH

FLAME HARDENING DIE STEELS

Color code: GRAY

Ameralloy-FH was specially developed to withstand severe wear and resist galling. The application of Ameralloy-FH will result in a more uniform section after hardening, without shrinking. Ameralloy-FH can be hardened by quenching and tempering, flame hardening, or carburizing.

Ameralloy-FH was engineered to produce a perfect hand tool with inexperienced help, or where there is a lack of adequate heat-treating facilities. Ameralloy-FH can be reworked at the forge without cracking or changing physical properties.

Typical Analysis

- Carbon .30
- Manganese .75
- Chromium 1.10
- Silicon .45
- Molybdenum .35
- Copper .50

Features And Advantages

- Minimum decarburization
- Safe–will not mushroom or chip
- Wider range of hardness
- Shock resistant
- Extremely tough
- No tempering required

Heat Treatment

- **Forging** 1900°–2150°F, stop at 1700°F
- **Annealing** 1400°F, slow furnace cool, Brinell 197
- **Hardening** 1500°–1850°F, water or oil-quench
- **Tempering** 300°–1300°F, Brinell 534–241

General Instructions

- **Annealing** If machining is to follow forging, anneal by heating to 1400°F (cherry-red), cool to 900°F, then air cool.
- **Hardening** Allow tool to cool after forging. Reheat to 1550°–1850°F (salmon-to-orange range) and quench in water.
- **Toughen striking end** In the as-forged condition, the striking end should be tapered and heated to 1325°F (cherry-red), and quenched in water. This insures elimination of mushrooming.
- **Forging** Forge at 1800°–2000°F. Discontinue operation when temperature falls below 1800°F and reheat again. After forging, the piece should be air cooled. Ameralloy-FH will have the following physical properties:

– Yield point: 96,000 lbs. psi
– Tensile strength: 152,000 lbs. psi
– Elongation in 2": 18%
– Reduction of area: 46%
– Brinell hardness: 320

Rounds

1/2	2	4-1/4
5/8	2-1/8	4-1/2
3/4	2-1/4	4-3/4
7/8	2-3/8	5
1	2-1/2	5-1/2
1-1/8	2-3/4	6
1-1/4	3	6-1/2
1-3/8	3-1/4	7
1-1/2	3-1/2	7-1/2
1-5/8	3-3/4	8
1-3/4	4	

Squares

1/2	2-1/4
5/8	2-1/2
3/4	2-3/4
7/8	3
1	3-1/2
1-1/8	4
1-1/4	
1-3/8	
1-1/2	
1-3/4	
2	

Hexagons

3/8	1-3/4
1/2	1-7/8
5/8	2
3/4	2-1/8
7/8	2-1/4
1	2-3/8
1-1/8	2-1/2
1-1/4	2-3/4
1-3/8	3
1-1/2	
1-5/8	

Flats

3/4	x 2	x 6	x 7	x 7
x 1	x 3	x 7	x 8	x 8
x 1-1/2	x 4	x 8	x 10	x 10
x 2	x 5	x 10	x 12	x 12
x 3	x 6	**1-1/2**	**1-3/4**	x 14
x 4	x 8	x 2	x 6	x 16
x 5	x 10	x 3	**2**	x 18
x 6	x 12	x 3-1/2	x 3	**2-1/2**
x 8	**1-1/4**	x 4	x 4	x 3
1	x 4	x 5	x 5	x 4
x 1-1/2	x 5	x 6	x 6	x 5

Ameralloy-FH sizes for immediate shipment. Lengths: 18-20'. Custom sizes by request.

Ameralloy® HIGH SPEED-2

HIGH CARBON STEEL

AISI M-2

Color code:
ORANGE WITH
BLACK STRIPE

Ameralloy High Speed-2 is the most widely used type of high-speed steel. It is generally used for the same applications as T-1 high speed. Ameralloy High Speed-2 has higher carbon content and balanced analysis producing properties applicable to all general-purpose high speed uses.

Typical Analysis

- Carbon .86
- Chromium 4.15
- Tungsten 6.35
- Molybdenum 5.00
- Vanadium 1.90

Applications

- Lathe tools
- Planer tools
- Drills
- Taps
- Reamers
- Broachers
- Milling cutters
- Form cutters
- Wood knives
- Gear cutters
- End mills

Features And Advantages

- Balanced abrasion and shock resistance
- Good red-hardness
- Weighs 6% less than T-1 high speed
- Can be hardened at 100° below T-1 high speed

Heat Treatment

- **Forging** 2050°–2100°F, stop at 1800°F and cool slowly
- **Annealing** 1600°F, cool slowly. Brinell 241 max.
- **Preheating** 1550°F, soak before hardening
- **Hardening** 2250° to 2275°F, oil-quench
- **Tempering** 1000°–1050°F, Rockwell C 65-66

Characteristics

- **Machinability** Like all highly alloyed steels, High Speed-2 machines with somewhat more difficulty than the lower alloyed steels. It is rated at 65 as compared to a 1% carbon tool steel, which is rated at 100.
- **Critical points** Critical points obtained by dilatometer tests when heating at a rate of 400° per hour and cooling at 30° per hour are as follows:

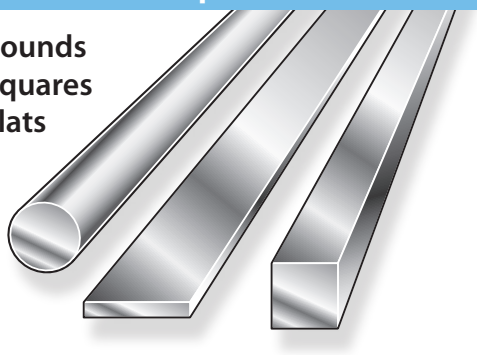
Heating – Ac range 1530° to 1610°F
Cooling – Ar range 1430° to 1380°F

Ameralloy®
High Speed-2

HIGH CARBON STEEL AISI M-2

Available Shapes And Sizes

Rounds
Squares
Flats



Standard lengths 10′–12′ or cut to specified length.
Modified and special sizes available upon request.
Prompt forging service available.

Rounds Decarb Free

1/16	5/8	1.515	2-17/64	3-11/16
5/64	21/32	1-9/16	2-5/16	3-3/4
3/32	11/16	1-19/32	2-3/8	3-13/16
7/64	3/4	1.610	2-7/16	3-7/8
1/8	5/32	1-5/8	2-1/2	3-15/16
9/64	13/16	1.650	2-17/32	4
5/32	7/8	1-11/16	2.515	4-1/32
11/64	15/16	1.700	2-9/16	4-1/16
3/16	31/32	1-3/4	2.610	4-1/8
13/64	1	1.765	2-5/8	4-1/4
7/32	1.015	1-49/64	2-11/16	4-3/8
15/64	1.055	1-25/32	2-3/4	4-1/2
1/4	1-1/16	1-13/16	2-13/16	4-5/8
17/64	1-1/8	1.860	2-7/8	4-3/4
9/32	1.160	1-7/8	2-15/16	4-25/32
5/16	1-3/16	1.890	3	4-7/8
21/64	1.192	1-15/16	3.015	5
11/32	1-7/32	1-31/32	3-1/16	5-1/4
3/8	1-1/4	2	3-1/8	5-1/2
25/64	1.275	2.015	3-1/4	5-3/4
13/32	1-5/16	2-1/64	3-5/16	6
7/16	1.360	2-1/32	3-3/8	6-1/4
15/32	1-3/8	2-1/16	3-7/16	6-1/2
1/2	1-7/16	2-1/8	3-1/2	7
17/32	1.450	2-3/16	3-9/16	7-1/2
9/16	1-1/2	2-1/4	3-5/8	8

Flats & Squares Decarb-Free Plus .015/.030

1/4	1/2	5/8	3/4	7/8
x 1/4	x 1/2	x 5/8	x 3/4	x 1-1/2
x 1	x 3/4	x 1-1/4	x 1	x 1-3/4
x 1-1/2	x 1	x 1-1/2	x 1-1/2	x 2
3/8	x 1-1/2	x 2	x 2	x 3
x 3/8	x 2	x 2-1/4	x 2-1/2	x 4
x 1	x 2-1/2		x 3	x 5
x 1-1/4	x 3		x 4	x 6
x 1-1/2	x 4		x 5	x 8
x 2	x 6		x 6	x 10
x 3	x 8		x 8	x 12
	x 10		x 10	
	x 12		x 12	

1	1-1/4	1-1/2	1-3/4	2
x 1	x 1-1/4	x 1-1/2	x 1-3/4	x 2
x 1-1/4	x 1-1/2	x 2	x 2	x 2-1/2
x 1-1/2	x 2	x 2-1/2	x 2-1/2	x 3
x 2	x 2-1/2	x 3	x 3	x 3-1/2
x 2-1/2	x 3	x 4	x 4	x 4
x 3	x 4	x 6	x 5	x 5
x 4	x 5	x 8	x 6	x 6
x 5	x 6	x 10	x 8	x 8
x 6	x 8	x 12	x 10	x 10
x 8	x 10		x 12	x 12
x 10	x 12			
x 12				

2-1/2	3
x 2-12	x 3
x 3	x 4
x 4	x 6
x 6	x 8
x 8	x 10
x 10	x 12
x 12	

Ameralloy®-T

TUNGSTEN BASE STEEL AISI T-1

Ameralloy-T is the best known tungsten base type of high speed steel. Ameralloy-T is used for general purpose cutting operations.

Typical Analysis

- Carbon .75
- Chromium 4.00
- Tungsten 18.00
- Vanadium 1.10

Features And Advantages

- Balanced combination of abrasion and shock resistance for cutting tools
- High red-hardness
- Least decarburization of the standard high speed steels.

Heat Treatment

- **Forging** 2050°–2150°F, stop at 1800°F
- **Annealing** 1650°F, furnace-cool, Brinell 241 max.
- **Preheating** 1600°F, prior to hardening
- **Hardening** 2350° oil-quench
- **Tempering** 1000°–1050°F, Rockwell C 65

Applications

- Lathe tools
- Planer tools
- Boring mill tools
- Slotter tools
- Shaper tools
- Tool bits
- Flat and twist drills
- Hobs
- Milling cutters
- Chasers
- Taps
- Reamers
- File-cutting chisels
- Gear cutters
- Form cutters
- End mills
- Broaches
- Threaders
- Punches
- Piercers
- Crowning tools

Ameralloy®-T

TUNGSTEN BASE STEEL AISI T-1

Characteristics

• **Machinability** Like all highly alloyed steels, Ameralloy-T machines with somewhat more difficulty than steels containing lower alloy content. Ameralloy-T has a machinability of 60, as compared with a 1% carbon tool steel rated at 100.

• **Critical points** Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400°F/hour:

Heating – Ac range 1540° to 1630°F
Cooling – Ar range 1550° to 735°F

• **Decarburization** Ameralloy-T is not as highly susceptible to decarburization as the molybdenum base high speed steels. However, reasonably good heat treating equipment is required, otherwise the tools must be ground to remove decarburization after hardening.

General Instructions

• **Forging** Preheat Ameralloy-T and soak at approximately 1300°F before transferring to the high temperature furnace. Heat slowly to the forging range of 2050°–2150°F. Discontinue forging as soon as the piece has cooled to about 1800°F, and reheat before resuming forging. Pieces should be cooled slowly after the forging operation is completed.

• **Annealing** Ameralloy-T should always be annealed after forging. To prevent decarburization, use a controlled atmosphere furnace or pack in a sealed container using inert material. Heat slowly to 1650°F and hold at this temperature for approximately 1 hour per inch of greatest thickness. Cool at a rate of 25°F per hour to 900°F. Resulting hardness after proper annealing is Brinell 241 max.

• **Hardening** Preheat Ameralloy-T slowly to 1600°F and hold at this temperature until thoroughly soaked. Then heat to the quenching temperature of 2350°F. Tools should be heated to the quenching temperature rapidly and not held at this temperature any longer than necessary for proper solution of carbides. If held too long, grain growth with accompanying brittleness may result. Total heating time in the furnace or bath varies from a few minutes to 10–15 minutes, depending on the size of the tool. Temper as soon as the tool has reached a quenching temperature of 150° to 200°F.

Ameralloy-tested fracture grain size & Rockwell C hardness of Ameralloy-T specimens 1" round x 5" long, quenched in oil and quenched in still air:

Quenching Temperature (°F)	OIL-QUENCHED		AIR-QUENCHED	
	Fracture Rating	Rockwell C	Fracture Rating	Rockwell C
1900°	8½	59	8½	56
2000°	8¾	61	9	61
2100°	9	63	9¼	63
2200°	9¼	65	9¼	64
2300°	9¼	65	9¼	64
2350°	9½	66	9¼	64
2400°	8¾	66	8¾	64

• **Tempering** The best combination of cutting ability, strength, hardness, shock resistance, and toughness for all types of tools is developed by tempering in the secondary hardness range. For Ameralloy-T that range is approximately 1000°–1050°F. Tools are tempered by heating to 1025°–1050°F, at a minimum holding time of 2 hours per inch of greatest cross section. Then cool to room temperature. It is customary to use a double-tempering operation carried out with a secondary heating at 25°–50°F below the primary tempering temperature. Shock resisting and hot work parts are usually tempered within a range of 1100°–1200°F.

Ameralloy®-T

TUNGSTEN BASE STEEL AISI T-1

Rockwell C hardness of specimens 1" round x 2-1/2" long, hardened in oil vs. still air at temperatures ranging from 2100°–2400°F. The specimens were then tempered for 2 hours at temperatures ranging from 300°–1400°F:

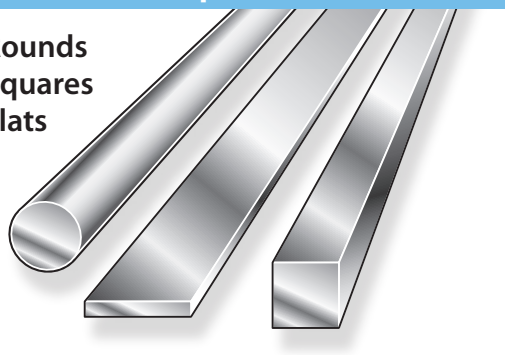
OIL-QUENCH	Quenching Temperature (°F)				
	2100°	2200°	2300°	2350°	2400°
Tempering Temperature (°F)	Rockwell C				
As quenched	63	65	65	66	66
300°	63	65	65	65	65
400°	62	63	64	64	64
500°	60	61	62	62	63
600°	60	61	61	61	62
700°	59	60	61	61	61
800°	59	60	61	61	61
900°	60	61	62	63	63
1000°	61	62	64	65	65
1050°	61	62	64	65	65
1100°	61	62	64	64	64
1200°	53	55	57	57	58
1300°	44	45	47	47	47
1400°	33	36	36	37	37

AIR-QUENCH	Quenching Temperature (°F)				
	2100°	2200°	2300°	2350°	2400°
Tempering Temperature (°F)	Rockwell C				
As quenched	63	64	64	64	64
300°	63	64	64	64	64
400°	62	63	64	64	64
500°	59	60	61	63	63
600°	59	61	61	62	62
700°	59	61	62	62	62
800°	59	61	61	62	62
900°	59	61	62	62	62
1000°	59	62	63	63	63
1050°	59	60	62	63	63
1100°	57	60	61	62	62
1200°	52	55	55	55	56
1300°	43	45	43	43	43
1400°	26	28	31	31	31

Above results on 1" diameter specimens may be used as a guide in tempering tools to desired hardness. Tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

Available Shapes And Sizes

Rounds
Squares
Flats



Standard lengths 10'–12' or cut to specified length. Modified and special sizes available upon request. Prompt forging service available.

Rounds Decarb-Free

3/4	1-1/2	2-1/2
7/8	1-5/8	2-3/4
1	1-3/4	3
1-1/8	2	3-1/4
1-1/4	2-1/8	4-1/4
1-3/8	2-1/4	

Squares Hot Rolled Finish–Tolerance Standard

1-1/4	1-1/2	2

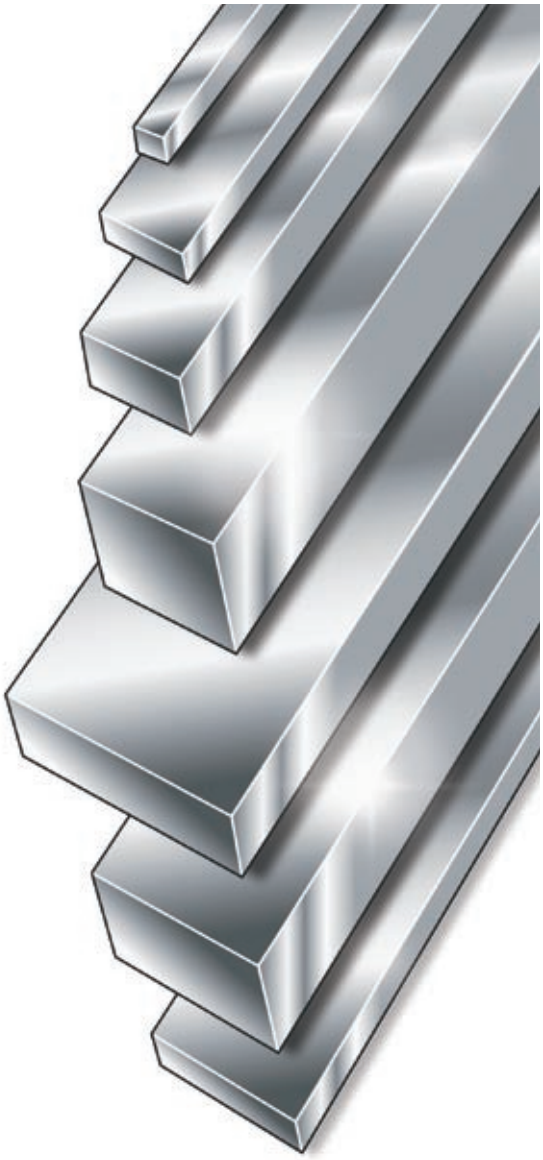
Flats Hot Rolled Finish–Tolerance Standard

3/8 x 1-1/4	**3/4**	**1-1/2**
1/2 x 2-1/2	x 1-1/4	x 2
5/8 x 1-1/4	x 1-1/2	x 2-1/2
11/16 x 1-5/16	**1**	
	x 1-1/4	
	x 1-1/2	
	x 1-3/4	
	x 2	
	x 3	

Durelloy-PM™

HEAT TREATED ALLOY

Color Code:
ENDS RED



Durelloy pre-machined is a fine grained, stress relieved, electric furnace alloy. It is heat treated to Rockwell C 28–32, Blanchard ground top and bottom +.020/.030 – .000, width +1/8" – .000.

A machinability rating of 80% means Durelloy-PM is ready for use in most tooling applications with no further heat treating. Durelloy-PM can be flame-hardened to 578/698 BHN for applications in which a higher hardness is required at wear points.

Applications

- Base plates
- Backup plates
- Bolsters
- Fixtures
- Guides
- Holder blocks
- Peenable dies
- Punch pads
- Strippers
- Jigs
- Molds

Available Sizes

- **Thickness** 1/2"–5" custom grinds to 20"
- **Widths** 2"–24" custom grinds to 96"
- **Lengths** 60"–72" custom grinds to 120" and 144"
- **Custom sizes** Available upon request