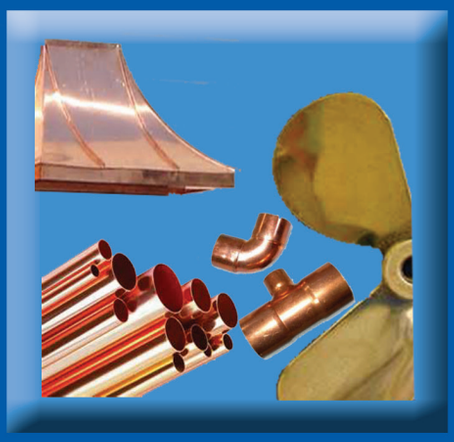
COPPER

Copper Alloys, Brass and Bronze

WELDING AND BRAZING RODS AND WIRES



WA. ALLOY CO.

NAVAL BRONZE ALLOY NO. 470
UNS/CDA C47000

AWS A5.8 Class RBCuZn-A
† ASME SFA5.8 RBCuZn-A QQ-R-571C,
† MIL-R-19631B Type RCuZn-A
MIL-B-7883 QQ-B-650

DESCRIPTION AND APPLICATIONS

Washington Alloy Naval Bronze is a 1 % tin filler metal used for brazing or oxyacetylene welding of steel, cast iron, malleable iron, copper, bronze and nickel alloys. The addition of tin improves strength and corrosion resistance in the weld deposit. A borax-boric acid flux is generally required. Joint clearances should be 0.002" to 0.005" wide. Preheating may be desirable for some applications. A neutral or slightly oxidizing flame should be used.

NICKEL BRONZE ALLOY NO. 680
UNS/CDA C68000

† ASME SFA5.8 RBCuZn-B,
† QQ-R-571C, MIL-R-19631B
† Type RCuZn-B

DESCRIPTION AND APPLICATIONS

Washington Alloy Nickel Bronze (also referred to as Manganese Bronze) is similar to Naval Bronze, however iron, manganese and nickel have been added to the analysis. The iron and manganese increases the hardness and strength of the weld deposit while nickel ensures uniform distribution of iron in the deposit. Nickel Bronze is primarily used to braze or oxyacetylene weld steel, cast iron, brass and bronze. Also used for building-up wearing surfaces and bearings. Flux required. Use a boric acid or borax commercial flux. A neutral or slightly oxidizing flame should be used. Preheating may be required for some applications.

LOW FUMING BRONZE ALLOY NO. 681
UNS/CDA C68100

AWS A5.8 Class RBCuZn-C
† ASME SFA5.8 RBCuZn-C,
† QQ-R-571C, MIL-R-19631B
Type RCuZn-C

DESCRIPTION AND APPLICATIONS

Washington Alloy Low Fuming Bronze is a general-purpose oxyacetylene brazing rod used for steel, copper alloys, cast iron, nickel alloys and stainless steel. A balanced chemical analysis of copper and zinc as well as alloying elements of tin, iron, manganese and silicon produce weld deposits with excellent mechanical properties. High strength, ductile and sound weld deposits are easily attained simply by applying a neutral or slightly oxidizing flame. The high silicon content of Washington Alloy Low Fuming Bronze keeps fumes to a minimum. Preheating is required for some applications and bronze brazing flux is required for the bare rods.

* Order as bare or flux-coated.

NICKEL SILVER ALLOY NO. 773
UNS/CDA C77300

AWS A5.8 Class RBCuZn-D
† ASME SFA5.8 RBCuZn-D,
† QQ-R-571C, MIL-R-19631B
Type RCuZn-D QQ-B-650 (BCuZn-D)

DESCRIPTION AND APPLICATIONS

Washington Alloy Nickel Silver filler metal contains 10% nickel and is used primarily for brazing or oxyacetylene welding of steel or cast iron. The weld deposits of Washington Alloy Nickel Silver have very high tensile strength, good ductibility and excellent corrosion resistance. The weld deposits are machinable and work harden when put into service. For this reason Nickel Silver is commonly used for building-up or overlaying worn parts such as gear teeth, bearings and valve seats. It is also used in the matrix of tungsten carbide rods where it acts as a "binder'' for the tungsten carbide particles. Excellent for tubular structures. A boric acid or borax flux is required. Preheating may be desired for some applications. A neutral or slightly oxidizing flame is recommended.

* Order as bare or flux-coated.

SILICONE BRONZE ALLOY NO. 656
UNS/CDA C65600

AWS A5.7 ERCuSi-A
† ASME SFA5.7 ASME
† QQ-R-571C, MIL-R-19631B
Type RCuSi-A MIL-E-23765/3
(MIL-CuSi)

DESCRIPTION AND APPLICATIONS

Washington Alloy Silicon Bronze is a copper based filler metal containing 3% silicon and small amounts of manganese, tin and zinc. Primarily used for MIG, TIG and oxyacetylene welding of copper, copper-silicon and copper-zinc base metals to themselves and to steel. Excellent for plain~or galvanized steel sheet metal as well as other coated steels. Washington Alloy Silicon Bronze is also used for surfacing areas subjected to corrosion.

The oxyacetylene gas flame should be slightly oxidizing. Keep the weld puddle small in order to promote fast solidification and minimize cracking. A high boric acid flux should be used both before and during welding. Preheating is NOT recommended.

DEOX COPPER ALLOY NO. 189
UNS/CDA 18980

AWS A5.7 Class ERCu
† ASME SFA5.7
† QQ-R-571C, MIL-R-19631B Type MIL-RCu-2 MIL-C-19654 (MIL-RCu-2)

DESCRIPTION AND APPLICATIONS

Washington Alloy DEOX Copper is a 98% copper filler metal used for MIG, TIG and oxyacetylene welding of copper and copper-alloyed base metals. DEOX Copper contains small amounts of phosphorus and silicon which act as the deoxidizing agents to promote sound weld joints. Washington Alloy DEOX Copper is easy flowing and produces weld deposits that are porosity free, electrically conductive and the color will match that of copper. Excellent for joining copper to mild steel, for overlaying steel and for the fabrication of copper pipes, tanks and copper fittings.
The oxyacetylene gas flame must be neutral or slightly oxidizing. Tip size must be one to two sizes larger than the base plate. Preheating should be done only if the part is thick. A boric acid or borax flux is recommended.

PHOS BRONZE A ALLOY NO. 518
UNS/CDA C51800

† AWS A5.7 Class ERCuSn-A
† ASME SFA5.7 ERCuSn-A
† QQ-R-571C, MIL-R-1963B Type RCuSn-A

DESCRIPTION AND APPLICATIONS

Washington Alloy Phos-Bronze A filler metal is used for MIG and TIG welding of tin-bronze base metals such as 509 to 519 series, for brass and for overlay welding of steel. Phos-Bronze A contains approximately 5% tin and up to 0.35% phosphorus. The tin content increases the wear resistance of the weld deposit while the phosphorus acts as a deoxidizer.
Preheating is recommended.

PHOS BRONZE C ALLOY NO. 521
UNS/CDA C52100

AWS A5.7 CLASS ERCuSn-C
† ASME SFA5.7 ERCuSn-C,
† MIL-E-23765/3 (MIL-CuSn-C)

DESCRIPTION AND APPLICATIONS

Washington Alloy Phos-Bronze C filler metal is used quite extensively for surfacing applications. The higher tin (Sn) content (7.0 - 9.0%) gives "PBC" weld deposits greater hardness and higher tensile/yield strength than Phos-Bronze A. "PBC" is commonly used for base metals of similar composition, for joining brass alloys and for joining cast iron to carbon steel. Preheating is recommended.

ALUMINUM BRONZE A-1 ALLOY NO. 610
UNS/CDA C61000

AWS A5.7 Class ERCuAl-A1
† ASME SFA5.7 ERCuAl-A1 QQ-C-450

DESCRIPTION AND APPLICATIONS

Washington Alloy Aluminum Bronze A 1 is an iron-free aluminum bronze filler metal used for MIG and TIG overlay welding of bearing and wear resistant surfaces exposed to corrosive environments such as salt or brackish water and commonly used acids.
Aluminum Bronze A-1 is not recommended for joining. Commonly used in steel and pulp mills to overlay tube sheets, valve seats and refineries.

ALUMINUM BRONZE A-2 ALLOY NO. 618
UNS/CDA C61800

AWS A5.7 Class ERCuAl-A2
† ASME SFA5.7 ERCuAl-A2,
† QQ-R-571C, MIL-R-19631B Type MIL-RCuAl-A2 MIL-W-6712 Mil-E-237653/3 (MIL-CuAl-A2)

DESCRIPTION AND APPLICATIONS

Washington Alloy Aluminum Bronze A-2 is an iron-bearing MIG and TIG filler metal used for joining aluminum bronze of similar composition, silicon and manganese bronze, high strength copper-zinc alloys, some copper-nickel alloys, ferrous metals and dissimilar metals. Dissimilar metal combinations would include aluminum bronze to steel and copper to steel. Washington Alloy Aluminum Bronze A-2 is excellent for building-up or overlaying metal for wear and corrosion resistant surfaces. Weld deposits exhibit high mechanical properties, tensile strength, yield strength and hardness. Most common applications would include marine maintenance and repair welding of ship propellers; pump housings, rigging jacks, piston heads, bearings and many overlay or surfacing applications.

ALUMINUM BRONZE A-3 ALLOY NO. 624
UNS/CDA C62400

AWS A5.7 Class ERCuAl-A3

DESCRIPTION AND APPLICATIONS

Washington Alloy Aluminum Bronze A-3 contains a higher Iron (Fe) content than Aluminum Bronze A-2. The higher Iron content gives "A-3" greater strength when joining aluminum bronze castings of similar composition. "A-3" is often used for piston overlay and bearing surface applications which require higher strength, while maintaining good ductility.

NICKEL-ALUMINUM BRONZE ALLOY
UNS/CDA C63280

AWS A5.7 Class ERCuNiAl
† ASME SFA5.7 ERCuNiAl
† MIL-E-23765/3

DESCRIPTION AND APPLICATIONS

Washington Alloy Nickel-Aluminum Bronze filler metal is used for MIG and TIG welding of cast and wrought nickel-aluminum bronze parts such as ship propellers, where high resistance to corrosion, erosion and cavitation in salt or brackish water is required. Nickel-Aluminum Bronze is a very popular filler metal in offshore technology for such items as sea-water desalting, shipbuilding and repair. Also used in the power plant and chemical industry for pumps and tube systems.

MANGANESE-NICKEL-ALUMINUM ALLOY
UNS/CDA C63380

AWS A5.7 CLASS ERCuMnNiAl
† ASME SFA5.7 ERCuMnNiAl
† MIL-E-23765/3

DESCRIPTION AND APPLICATIONS

Washington Alloy Manganese-Nickel-Aluminum Bronze filler metal is designed for MIG and TIG welding or surfacing of cast or wrought base metals of similar analysis. Especially suited for welding ship propellers where resistance to corrosion, erosion and cavitation is required. Manganese-Nickel-Aluminum Bronze is also used for joining or surfacing copper alloys of unalloyed and low alloy steel as well as grey cast iron. Good toughness and hardness.

WASHINGTON ALLOY 67
UNS/CDA C71581

AWS A5.7 Class ERCuNi
† MIL-E-21562 Type MIL-RN67, MIL EN67
† ASME SFA5.7, Class ERCuNi
† QQ-R-571C Mil-R-19631B
Type MIL-RCuNi Mil-I-23413 (MIL-67)

DESCRIPTION AND APPLICATIONS

Washington Alloy 67 is a copper-nickel filler metal used for MIG, TIG, oxyacetylene and submerged arc welding of wrought or cast 70/30, 80/20 and 90/10 copper-nickel to themselves or to each other. Excellent for joining copper-nickel alloys to nickel-copper Alloy 400, R-405, K-500 or high nickel alloy 200. Note: Washington Alloy 67 can be used for overlaying on steel, however a barrier layer of Washington Alloy 61 should be used for the first pass when MIG welding. Washington Alloy 60 should be used for the first pass when submerged arc welding.

COPPER BASED MIG & TIG ALLOYS

AVAILABLE SIZES AND PACKAGING

Package Form	(in.)	.023	030	.035	.045	1/16	3/32	1/8	5/32	3/16	1/4	3/8	**MASTER CARTON**
	(mm)	(0.6)	(0.8)	(0.9)	(1.2)	(1.6)	(2.4)	(3.2)	(4.0)	(4.8)	(6.4)	(9.5)	
2# Spools	(4")	x	x	x	x	x							20 Spools
10# Spools	(8")	x	x	x	x	x							4 Spools
30# Spools	(12")	x	x	x	x	x	x	x					1 Spool
60# Coils					x	x	x	x	x	x			1 Coil
* 36" Cut Lengths		x	x	x	x	x	x	x	x	x	x	x	50 lbs **

*Note: Flux-coated 1/16 (1.6mm) is only available in 18" lengths.
** 10 lb. tubes in a 50 lb. master carton is available upon request..
*** Flag-tagging is also available upon request.

WARNING! Protect yourself and other. Read and understand this information. BRAZING AND SIOLDERING ALLOYS AND FLUXES MY PRODUCE FUMES AND GASES DANGEROUS TO YOUR HEALTH. FLUXES MAY CONTAIN FLOURIDES. FLUXES MAY BURN EYES AND SKIN ON CONTACT AND CAN BE FATAL IF SWALLOWED! Before use, read, understand and follow manufacturer's instructions. Material Safety Data Sheets (MSDS) and your employer's safety practices. *Keep head out of fumes. Use enough ventilation and exhaust to keep fumes and gases away from your breathing zone and the general area. *Avoid flux contact with eyes and skin. *Do not take flux internally. *Keep out of reach of children and those unfamiliar with, or unwilling to use safe handling practices. *See American National Standars Z49.1 Safety in Welding and Cutting published by the American Welding Society (AWS), 550 NW LeJeune Rd, PO Box 351040, Miani, FL 33135: OSHA Safety and HEalth Standards 29 CFR 1910, available fromthe US Government Printing Office, Superintendent of Document, PO Box 37194 Pittsburg, PA 15250-7954. MSDS sheets are available from US ALLOY CO Charlotte, NC 28216. on our website at www.weldingwire.com, from your enployer or by contacting your supplier.

COPPER BASED FLUX COATED ELECTRODES

RAINIER 3A
UNS/CDA W60521

AWS A5.6 Class ECuSn-C
DC Reverse Polarity (Electrode+)
All-Position Phosphor (Tin) Bronze Electrode for Copper, Steel, Cast Iron and Galvanized Iron

APPLICATIONS

Rainier 3A is a multipurpose flux-coated electrode used for joining steel and cast iron parts to copper, brass and bronze. Excellent for overlays on shafts, pumps, impellers and propeller blades. Used for building-up bearing journals and frictional wear surfaces on heavier sections. Other uses include ornamental iron, galvanized iron and as a substitute for torch alloys on larger sections.

FEATURES

Rainier 3 A is specially formulated to be used in any position with a minimum of spatter. Weld deposits are ductile, strong and machinable. Rainier 3A deposits offer good corrosion resistance to salt water and chemicals. Provides a good color match on bronze and will work harden.

SPECIFICATIONS

Tensile strength (psi) ..... Up to 65,000
Elongation in 2" (%) 45-50
Brinell Hardness 85-100
Machinability ..... Excellent

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
(Amps)	60-115	100-150	125-200	190-250

PROCEDURES

Clean the weld area. Bevel edges to a 45° vee. Thin sections generally do not require preheating. However heavier sections of cast iron and steel should be preheated to 200°F (93°C), phosphor (tin) bronze to 400°F (205°C) and other copper alloys to 700°F (371°C). Maintain the preheat temperature during welding and between passes. Use DC reverse polarity (electrode+). Holding the electrode 90° to the workpiece, maintain a medium arc length and weave slightly. For thicker deposits shorten the arc length and make stringer beads. Allow the part to cool slowly before removing the slag with a chipping hammer and wire brush.

NOTE: RAINIER 7A, WHICH MEETS AWS A5.6 CLASS ECUSN-A IS AVAILABLE UPON REQUEST.

RAINIER 4A
UNS/CDA W60189

AWS A5.6 Class ECu
DC Reverse Polarity (Electrode+)
High Purity Copper Electrode for Joining Copper and Overlaying Steel

APPLICATIONS

Rainier 4-A is a copper-cored flux-coated electrode used to surface, build-up, and fabricate electrolytic tough pitch and oxygen-free copper. Excellent for applications that require high corrosion resistance. Commonly used to overlay steel or to join heavier sections of copper to steel.

FEATURES

Rainier 4A produces high purity copper weld deposits. Corrosion resistance and electrical conductivity is excellent. Perfect color match to copper.

SPECIFICATIONS

Tensile strength (psi) ..... Up to 35,000
Elongation (%) ..... Approx. 35
Brinell Hardness ..... Rockwell F 20-40
Machinability ..... Excellent

AVAILABLE SIZES AND AMPERAGE

(in.)	1/8	5/32
(mm)	3.2	4.0
(Amps)	100-150	125-200

PROCEDURES

Clean joint area of all dirt, grease, and oxides. Bevel heavy sections. Porosity free welds on heavy sections can be achieved by preheating and maintaining the preheat temperature during the entire welding operation. Silicon Bronze should not be preheated above 150°F. Pure copper requires a 900°F to 1000°F preheat, while all other copper base alloys require a 500°F to 700°F preheat. Thin sections of steel do not require preheating, however if the base metal is warmed a lower amperage can be used. Using DC reverse polarity (electrode+) and the largest diameter electrode as possible, maintain a short arc length. Stress and distortion can be avoided by peening each deposit between passes. Allow the part to cool slowly before removing slag with a chipping hammer and wire brush.

RAINIER 5A
UNS/CDA W60614

AWS A5.6 Class ECuAl-A2
DC Reverse Polarity (Electrode+)
Flat Horizontal Positions, Versatile Copper Base Electrode for Joining and Overlaying Copper,, Brass, Bronze and Dissimilar Metals.

APPLICATIONS

Rainier 5A is a flux-coated electrode designed for overlays exposed to frictional wear or corrosives such as salt water, alkalies and some acids. Ideal for aluminum bronze, manganese bronze, silicon bronze, bronze to steel and cast iron. Also used on malleable iron, galvanized iron, stainless steel and as a build-up on bearing surfaces. Some common applications are: brake drums, hydraulic pistons, tractor gear housings, paper mill rolls, impellers, motor bases, pickling hooks, ship propellers, mixer arms, yokes, press rams, valve seats, bushings, foundry flasks and bearings.

FEATURES

Rainier 5A produces strong, dense, ductile and crack free weld deposits in so many ferrous and nonferrous combinations of dissimilar metals. Weld deposits are extremely tough and will work harden under compressive loads. Overall - an excellent choice.

SPECIFICATIONS

Tensile strength (psi) ..... Up to 100,000
Yield Strength (psi) ..... Up to 63,000
Elongation in 2" (%) 24-27
Brinell hardness 130-150
Machinability ..... Excellent

AVAILABLE SIZES AND AMPERAGE

(in.)	1/8	5/32	3/16
(mm)	3.2	4.0	4.8
(Amps)	90-120	115-150	140-210

PROCEDURES

Clean the weld area. Bevel heavy sections. Preheat copper base alloy and heavy sections of steel or cast iron at 250°F to 400°F, depending on the thickness of the part. Use DC reverse polarity (electrode+). Holding the electrode 10°-15° off perpendicular, maintain a short arc length and apply thin layers using stringer beads or the weaving technique. Allow the part to cool slowly. Use a chipping hammer and brush to remove slag between passes.

RAINIER 6A
UNS/CDA W60656

AWS A5.6 Class ECuSi
AC-DC Reverse Polarity (Electrode+)
All-Position
AC/DC All Purpose Electrode for "Arc Brazing"
Cast Iron to Steel.

APPLICATIONS

Rainier 6A flux-coated electrodes are used for welding or building-up silicon bronze as well as other copper alloys. It is an excellent choice for applications involving cast iron to steel or where the part is exposed to corrosives. Rainier 6A is commonly used on bronze impellers, bronze wear plates, hydraulic piston overlays, track wheels, gears, sprockets and quite often farm implements.

FEATURES

Rainier 6A performs well in any position utilizing AC as well as DC machines. Rainier 6A weld deposits are strong, ductile and crack resistant - even when welding on dirty, oily, burned cast or malleable parts. The high silicon content of this electrode allows it to be used as a welding or brazing electrode.

SPECIFICATIONS

Tensile strength (psi) ..... Up to 60,000
Yield strength (psi) ..... Up to 42,000
Elongation in 2" (%) 52-55
Brinell Hardness 80-100
Machinability ..... Excellent

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
(Amps)	40-80	80-125	120-150	140-215

PROCEDURES

Clean the weld area. Heavier sections should be beveled and preheated up to 500°F depending on the thickness of the part. Thin sections do not require preheating. Maintain a medium arc length and deposit stringer beads in groove or overlay welding and use weave beads for rapid overlays, large areas and for welding ferrous metals. Peen the weld deposit and remove slag between passes.

WASHINGTON ALLOY 187
UNS/CDA W60715

AWS/SFA 5.6 Class ECuNi
† MIL-E-22200/4
Type Mil-CuNi (70/30)
UNS #W60715

DESCRIPTION

Washington Alloy 187 is a 70% copper-30% nickel flux-coated electrode designed for welding wrought or cast forms of 70/30, 80/20 and 90/10 copper -nickel alloys. This electrode is also used for many dissimilar applications such as joining nickel-copper Alloy 400, R-405 and K500 or high nickel alloy 200 to the copper-nickel alloys.

APPLICATIONS

The most popular use of Washington Alloy 187 would involve marine applications where it offers excellent resistance to the corrosive effects of salt water. Also used for welding the clad side of copper-nickel clad steel.

TYPICAL WELD METAL CHEMISTRY (%)

*Nl	29.0-33.0	Ti	0.50 max.
Mn	1.00-2.50	Pb	0.02 max.
Fe	0.40-0.75	P	0.020 max.
Si	0.50 max.	Other (total)	0.50 max.
Cu	Balance	*Includes Cobalt (Co)	

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi) .....50,000 min.
Yield strength (psi) .....20,000 min.
Elongation in 2" (%).....30
Brine ll Hardness.....60-80

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)

3/32 (2.4mm).....50-75 amps
1/8 (3.2mm)..... 75-110 amps
5/32 (4.0mm)..... 110-145 amps
3/16 (4.8mm)..... 145-185 amps

WELDING POSITIONS

Flat, horizontal, vertical, overhead

APPLICABLE JOINING PROCESSES FOR COPPER AND COPPER ALLOYS

ALLOY	UNS NO.	OXYFUEL GAS WELDING	SMAW	GMAW	GTAW	RESISTENCE WELDING	SOLID-STATE WELDING	BRAZING	SOLDERING	ELECTRON BEAM WELDING
ETP Copper	C11000-C11900	NR	NR	F	F	NR	G	E	G	NR
Oxygen-Free Copper	C102000	F	NR	G	G	NR	E	E	E	G
Deoxidized Copper	C12000-C123000	G	NR	E	E	NR	E	E	E	G
Beryllium-Copper	C17000-C17500	NR	F	G	G	F	F	G	G	F
Cadmium/Chromium Copper	C16200-C18200	NR	NR	G	G	NR	F	G	G	F
Red Brass - 85%	C23000	F	NR	G	G	F	G	E	E	_
Low Brass - 80%	C24000	F	NR	G	G	G	G	E	E	_
Cartridge Brass - 70%	C26000	F	NR	F	F	G	G	E	E	_
Leaded Brasses	C31400-C38590	NR	NR	NR	NR	NR	NR	E	G	_
Phosphor Bronzes	C50100-C52400	F	F	G	G	G	G	E	E	_
Copper-Nickel-30%	C71500	F	F	G	G	G	G	E	E	F
Copper-Nickel-10%	C70600	F	G	E	E	G	G	E	E	G
Nickel Silvers	C75200	G	NR	G	G	F	G	E	E	_
Aluminum Bronze	C61300									
	C61400	NR	G	E	E	G	G	F	NR	G
Silicon Bronzes	C65100									
	C65500	G	F	E	E	G	G	E	G	G

E=Excelent G=Good F=Fair NR=Not Recommended

Courtesy Of American Welding Society Welding Handbook 8Th Ed. Vol. 3 Part 1

CHEMICAL COMPOSITION OF COPPER BASED ALLOYS*

	Cu Copper	Zn Zinc	Fe Iron	Si Silicon	Al Aluminum	Pb Lead	Mn Manganese	P Phosphorus	Ni Nickel (+Co)	Sn Tin	Total Other Elements
Naval Bronze	57.0-61.0	BAL	—	—	0.01	0.05	—	—	—	0.25-1.00	0.50
Nickel Bronze	56.0-60.0	BAL	0.25-1.20	0.04-0.15	0.01	0.05	0.01-0.50	—	0.20-0.80	0.80-1.10	0.50
Low Fuming Bronze	56.0-60.0	BAL	0.25-1.20	0.04-0.15	0.01	0.05	0.01-0.50	—	—	0.80-1.10	0.50
Nickel Silver	46.0-50.0	BAL	—	0.04-0.25	0.01	0.05	—	0.25	9.0-11.0	—	
Silicon Bronze	BAL	1.0	.50	2.8-4.0	0.01	0.02	1.5	—	—	1.0	0.50
Deox Copper	98.0 min.	—	—	0.50	0.01	0.02	0.50	0.15	—	1.0	0.50
Phos-Bronze A	BAL	—	—	—	0.01	0.02	—	0.10-0.35	—	4.0-6.0	0.50
Phos-Bronze C	BAL	0.20	0.10	—	—	0.05	—	0.03-0.35	—	7.0-9.0	0.50
Aluminum Bronze A-1	BAL	0.20	—	0.10	6.0-8.5	0.02	0.50	—	—	—	0.50
Aluminum Bronze A-2	BAL	0.02	1.5	0.10	8.5-11.0	0.02	—	—	—	—	0.50
Aluminum Bronze A-3	BAL	0.10	2.0-4.5	0.10	10.0-11.5	0.02	—	—	—	—	0.50
Nickel Aluminum Bronze	BAL	0.10	3.0-5.0	0.10	8.5-9.5	0.02	0.60-3.50	—	4.0-5.50	—	0.50
Manganese-Nickel Aluminum Bronze	BAL	0.15	2.0-4.0	0.10	7.0-8.5	0.02	11.0-14.0	—	1.5-3.0	—	0.50
Alloy 67 Copper-Nickel	BAL	—	0.40-0.75	0.25	—	0.02	1.00	0.02	29.0-32.0	—	0.50 Ti 0.20-0.50

*Single values are maximum unless otherwise specified.

COMMON NAME	AWS SPEC. AWS CLASS	APPROX. MELTING TEMPERATURE °F (°C)	AVERAGE AS-WELDED BRINELL HARDNESS	TENSILE STRENGTH MIN PSI (MPA)
Naval Bronze	A5.8 RBCuZn-A	1650 (899)	70-90	50,000 (345)
Nickel Bronze (Manganese Bronze)	A5.8 RBCuZn-B	1620 (882)	80-110	56,000 (386)
Low Fuming Bronze (LFB or LFBFC)	A5.8 RBCuZn-C	1630 (888)	80-110	56,000 (386)
Nickel Silver	A5.8 RBCuZn-D	1715 (935)	90-110	60,000 (414)
Silicon Bronze	A5.7 ERCuSi-A	1866 (1019)	80-100	50,000 (345)
Deox Copper	A5.7 ERCu	1967 (1075)	Rockwell F25	25000 (172)
Phos-Bronze A	A5.7 ERCuSn-A	1922 (1050)	70-85	35,000 (240)
Phos-Bronze C	A5.7 ERCuSn-C	1880 (1026)	68-83	40,000 (280)
Aluminum Bronze A-1	A5.7 ERCuAl-A1	1898 (1036)	80-110	55,000 (380)
Aluminum Bronze A-2	A5.7 ERCuAl-A2	1904 (1040)	130-150	60,000 (414)
Aluminum Bronze A-3	A5.7 ERCuAl-A3	1925 (1051)	140-180	65,000 (450)
Nickel Aluminum Bronze	A5.7 ERCuNiAl	1930 (1054)	160-200	72,000 (480)
Manganese-Nickel Aluminum Bronze	A5.7 ERCuMnNiAl	1805 (985)	160-200	75,000 (515)
Alloy 67 Copper-Nickel	A5.7 ERCuNi	2260 (1238)	60-80	50,000 (345)

SUGGESTED FILLER METAL SELECTIONS FOR COPPER-BASED ALLOYS

	Copper	Phosphor Bronze	Silicon Bronze	Yellow (Naval) Brass	Manganese Bronze	Navy G	Red Brass	Copper Nickel	Nickel Al Bronze	Low Alloy Steel	Low Carbon Steel	Medium Carbon Steel	High Carbon Steel	Cast Iron
Copper	Deox (1000º)	PHB, Deox (1000º)	PHB, Deox (1000º)	SB, PHB, Deox (1000º)	PHB, Deox (1000º)	PHB, Deox (1000º)	PHB, Deox (1000º)	AlB-A2, Deox (1000º)	AlB-A2, Deox CuNiAl (1000º)	AlB-A2, (1000º)	AlB-A2, (1000º)	AlB-A2, (1000º)	AlB-A2, (1000º)	AlB-A2, (1000º)
Phosphor Bronze		PHB. Deox (400º)	PHB. SB (150º)	PHB (600º)	AlB-A2, PHB (400º)	PHB (400º)	PHB (500º)	PHB, AlB-A2 (400º)	PHB (400º)	PHB, AlB-A2 (400º)	PHB, AlB-A2 (400º)	PHB, AlB-A2 (400º)	PHB, AlB-A2 (500º)	PHB, AlB-A2 (400º)
Silicon Bronze			SB (150º)	AlB-A2, SB (150º)	AlB-A2, SB (150º)	AlB-A2, SB (150º)	AlB-A2, SB (150º)	AlB-A2 (150º)	AlB-A2 (150º)	AlB-A2 (400º)	AlB-A2 (150º)	AlB-A2 (150º)	AlB-A2 (400º)	AlB-A2, SB (300º)
Yellow (Naval) Brass				AlB-A2 (600º)	AlB-A2, PHB (600º)	PHB (500º)	PHB (600º)	AlB-A2 (150º)	AlB-A2, CuNiAl (500º)	AlB-A2 (600º)	AlB-A2 (500º)	AlB-A2 (500º)	AlB-A2 (500º)	AlB-A2 (600º)
Manganese Bronze					AlB-A2, PHB Nickel Bronze (300º)	AlB-A2, PHB (600º)	AlB-A2, PHB (600º)	AlB-A2 (300º)	AlB-A2 (300º)	AlB-A2 (400º)	AlB-A2 (150º)	AlB-A2 (400º)	AlB-A2 (500º)	AlB-A2 (400º)
Navy G						AlB-A2, PHB (600º)	AlB-A2, PHB (600º)	AlB-A2 (150º)	AlB-A2 (500º)	AlB-A2, PHB (500º)	AlB-A2, PHB (600º)	AlB-A2, PHB (600º)	AlB-A2, PHB (600º)	AlB-A2, PHB (600º)
Red Brass							AlB-A2, PHB (400º)	AlB-A2 (150º)	AlB-A2 (600º)	AlB-A2 (600º)	PHB (600º)	AlB-A2 (600º)	AlB-A2 (600º)	AlB-A2, PHB (600º)
Copper Nickel								Alloy 67 ERCuNi	AlB-A2 (600º)	AlB-A2 (400º)	AlB-A2 (150º)	AlB-A2 (400º)	AlB-A2 (500º)	AlB-A2 (400º)
Nickel Aluminum Bronze									CuNiAl (300º)	AlB-A2 (400º)	AlB-A2 (300º)	AlB-A2 (400º)	AlB-A2 (500º)	AlB-A2 (400º)

Temperature in parentheses is the recommended preheat and interpass (Fahrenheit) temperature.

Recommended Tungsten Electrodes for GTAW are 2% Thoriated, 2% Ceriated, 2% Lanthanum or E3 (EWG).

Notes: PHB = Phosphor Bronze; Deox = Deoxidized Copper; SB = Silicon Bronze; AlB-A2 = Aluminum Bronze A-2; CuNiAl = Copper Nickel Aluminum Bronze; Alloy 67 = Copper Nickel 67

Current: SMAW DC Reverse (electrode positive) Polarity
GMAW DC Reverse (electrode positive) Polarity with 100% Argon or a 75-25% Argon/Helium mixture.
GTAW DC Straight (electrode negative) Polarity and ACHF using 100% Argon or Helium.

Washington Alloy has implemented a certified Quality Management System scope in accordance with ISO 9001

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RECOMMENDED WELDING AMPERAGE

	Electrode Diameter	Amperes*
SMAW	3/32"	50-110
(DCRP)	1/8"	90-160
(Electrode+)	5/32"	130-180
	3/16"	150-225

	Wire Diameter	Voltage	Amperes*
GMAW	.035"	20-26	100-200
(DCRP)	.045"	22-28	100-250
(Electrode+)	1/16"	29-32	250-400
	3/32"	32-34	350-500

	Wire Diameter	Amperes* (DCEN)	Amperes* (ACHF)
GTAW	1/16"	70-120	70-150
(DCSP)	3/32"	120-160	140-230
(Electrode-)	1/8"	170-230	225-320
or ACHF	5/32"	220-280	175-300
	3/16"	280-330	200-320

*Use low range for iron- or nickel-based alloys; middle range for bronze alloys; high range for copper