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RECOMMENDED SHIELDING GASES FOR WASHINGTON ALLOY FILLER METALS

ALUMINUM WIRES & RODS	TIG: 100% Argon, or 75% Ar/25% He MIG: 100% Argon or 75% Ar/25% He (Mechanized welding on heavy plate: 100% He or 75% He/25% Ar)
COPPER BASED WIRES &RODS	100% Argon, 100% Helium or 75% Ar/25% He. Nitrogen may also be used
FLUX-CORED WIRE (mild-steel, stainless steel, buildup and hardsurfacing)	100% CO_2 or 75% AR/25% CO_2
LOW ALLOY/HIGH STRENGTH WIRES	98% Ar/2% O_2 or 75% Ar/25% CO_2
MAGNESIUM WIRES & RODS	100% Argon or 100% Helium or a mixture of the two (i.e., 75% Ar/25% He)
MILD STEEL WIRE	Short Arc for Globular Transfer: 100% CO_2 or 75% Ar/25% He Spray Transfer: Ar/O_2 (1-10% O2), Ar/CO2 (5-15% CO_2), Ar/CO2/O_2
NICKEL ALLOY WIRES & RODS	100% Argon or 75% Argon/25% Helium
STAINLESS STEEL WIRES & RODS	100% Argon, 98% Ar/2% O_2, 90% He/7.5% Ar/2.5% $C0_2$, 90% Ar/8% CO2/2% O_2
TITANIUM WIRES & RODS	100% Argon or 100% Helium or mixtures of the two (i.e., 75% Ar/25% He)

CAUTION: Protect yourself and others. Read and understand this label. ELECTRIC SHOCK can kill. FUMES and GASES can be dangerous to your health. ARC RAYS can injure eyes and burn skin.

- Read and understand the Material Safety Data Sheet (MSOS), manufacturer's instruction and your employer's safety practices.
- If MSDS not enclosed, obtain from your employer or your supplier.
- Keep your head out of the fumes.
- Use enough ventilation, or exhaust at the arc end, or both, to keep fumes and gases from your breathing zone and general area.
- Wear correct eye, ear and body protection.
- Do not touch live electrical parts.
- See American National Standard Z49.1 "Safety in Welding and Cutting", published by the American Welding Society, 550 Le Jeune Road, Miami, FL 33126, and OSHA Safety and Health Standard, 29 CFR 1910, available from U.S. Dept. of Labor, Washington, D.C. 20210.

FLUX **AND METAL C**ORED WIRES
For Mild Steel

USA E70C-3C
AWS AS.18 CLASSES E70C-3C/3M

DESCRIPTION
USA E70C-3C is a metal cored gas-shielded wire for single and multi-pass flat and horizontal fillet welds on mild steels used for field construction, erection and fabrication of heavy equipment, construction machinery, and general mild steel fabrication. USA E70C-3C is noted for its smooth, stable arc, nearly free from slag coverage, virtually free of spatter, reduced clean-up lime and excellent weld bead appearance. USA E70C-3C is also qualified to AWS specs E70C-3C and can be used with Argon rich mixed gases with CO_2, This wire can also be used out-of-position with the Pulsed MIG Process.

TYPICAL APPLICATIONS:
USA E70C-3C is used extensively in the fabrication, erection and repair of heavy structural fabrication of mild steels. It is used in applications where better wetting action than solid wire is required on heavier plate where cold-laps may be a concern. It has lower fume levels and higher deposit efficiency than most flux-cored wires. USA E70C-3C provides excellent mechanical properties on heavier plate thicknesses. USA E70C-3C is noted for its smooth arc and minimum spatter. The virtually slag-free deposits reduce clean-up time and the weld deposit efficiency of nearly 96% provides greater productivity than solid wire. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY (% - tested with 100% CO_2)

C	0.04
Mn	1.5
Si	0.54
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded – tested with 100% CO_2 Shield Gas)

Yield Point (psi)	74,000 psi
Tensile Strength (psi)	80,000 psi
% Elongation in 2”	29%
Charpy V-Notch Impact	94J (69 Ft.Lbs. at 0ºC)
	56J (41 Ft. Lbs. at -18ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ.FILLETS
.045”	200-400	200-400
.063” (1/16”)	300-500	300-500

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:
.045”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil. 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE METAL-CORED WIRES
ESAB CORE WELD 70, 71
LINCOLN OUTERSHIELD MC710XL
HOBART - NA
TRI-MARK METALLOY 70X

USA E70C-6M
AWS A5.18 CLASS E70C-6M

DESCRIPTION
USA E70C-6M is a metal cored gas-shielded wire for single and multi-pass flat and horizontal fillet welds on mild steels used for construction, erection and fabrication of heavy equipment, construction machinery, and general mild steel fabrication. USA E70C-6M is noted for its smooth, stable arc, nearly free from slag coverage, virtually free of spatter, reduced clean-up time and excellent weld beat appearance. USA E70C-6M is designed to be used with argon rich mixed gases with CO_2. This wire can also be used out-of-position with the Pulsed MIG Process using sizes 1/16” and under.

TYPICAL APPLICATIONS:
USA E70C-6M is used extensively in the fabrication, erection and repair of heavy structural fabrication of mild steels. It is often used in robotic applications where slag removal between passes is not practical. It has lower fume levels and higher deposit efficiency than most flux-cored or solid wires. USA E70C-6M provides excellent mechanical properties on heavier plate thickness of plate having tensile strengths up to 70,000 psi. USA E70C-6M is noted for its smooth arc, minimum spatter, and virtually slag-free deposits. Reduced clean-up time and the weld deposit efficiency of nearly 98% provides greater productivity than solid wire. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY %

C	0.04
Mn	1.55
Si	0.54
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80% Argon and 20% CO_2 Shield Gas)

Yield Point (psi)	77,000 psi
Tensile Strength (psi)	89,000 psi
% Elongation in 2”	27%
Charpy V-Notch	40J (29 Ft.Lbs. at -29ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 80% Argon and 20% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ.FILLETS
.045”	160-350	180-360
.063” (1/16”)	220-450	280-450

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:
.045”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil. 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE METAL-CORED WIRES
ESAB CORE WELD ULTRA, COREWELD 70
LINCOLN OUTERSHIELD MC710
HOBART N/A
TRI-MARK METALLOY 70, METALLOY 71

USA E70T-1
AWS A5.20 CLASSES E70T-1C/E70T-1M

DESCRIPTION
USA E70T-1 is a flux cored wire for single or multi-pass welds on mild steels and certain low alloy steels. USA E70T-1 is noted for its low spatter generation, high disposition rate and ease of slag removal when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas.

TYPICAL APPLICATIONS:
USA E70T-1 is used extensively in the fabrication of bridge structures, pressure vessels, earth moving equipment, general construction, shipbuilding and whenever welds are required to meet structural and nuclear codes.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.45
Si	0.50
P	0.014
S	0.013

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	78,000 psi
Tensile Strength (psi)	82,500 psi
% Elongation in 2”	25%
Charpy V-Notch Impact	50J (37 Ft.Lbs. at -18ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ.FILLETS
.045”	200-400	210-400
.063” (1/16”)	300-500	300-500

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:
.045”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil. 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE METAL-CORED WIRES
ESAB CORE WELD 70, 71
LINCOLN OUTERSHIELD MC710XL
HOBART - NA
TRI-MARK METALLOY 70X

FLUX AND METAL CORED WIRES

For Mild Steel

USA E70T - 1 EXTRA
AWS A5.20 CLASSES E70T-1C/E70T-1M

DESCRIPTION

USA E70T-1 EXTRA is a basic slag formulation flux cored wire for single or multi-pass welds on mild steels and 490N/mm2 (71.000 psi) class high strength steels. USA 70T-1 EXTRA is noted for it high deposition properties. USA E70T-1 EXTRA also provides excellent arc stability at higher current levels. It provides low spatter, excellent bead appearance and ease of slag removal. USA E70T-1 EXTRA also meets the requirements of AWS E70T- 1M. It has been designed to provide excellent feed ability when used for larger fillet leg welds of heavy thickness plates using 100% CO_2 or Argon-CO_2 mixed shield gas.

TYPICAL APPLICATIONS:

USA E70T-1 EXTRA is used extensively in the fabrication of bridge structures, pressure vessels. earth moving equipment, general construction, and shipbuilding. USA E70T-1 EXTRA is ideal for heavy thickness mild steel fabrication.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.04
Mn	1.25
Si	0.41
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	78,000 psi
Tensile Strength (psi)	82,000 psi
% Elongation in 2”	29%
Charpy V-Notch Impact	50J (37 Ft.Lbs. at -18ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100%CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	200-400	200-400
.063” (1/16”)	300-500	300-500

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD 70
LINCOLN OUTERSHIELD 70
HOBART FABCO TR70
TRI-MARK TM-11, TM-72

USA E70T-5M
AWS A5.20 CLASSES E70T-5M/E71T-5MJ

DESCRIPTION

USA E70T-5M is a basic slag formulation flux cored wire for single or multi-pass welds on mild steels and 490N/mm2 (71,000 psi) class high strength steels. USA E70T-5M is noted for its low temperature properties and excellent crack resistance. USA E70T-5M also provides low spatter, excellent bead appearance and ease of slag removal USA E70T-5M also meets the requirements of AWS E71T-5 and E71T-5MJ. It has been designed to provide excellent feed ability when used for all position welds of light, medium and heavy thickness plates using 80% Argon + balance CO_2 mixed shield gas. The deposit weld metal analysis is similar to an E7018 or E7018-1 Low Hydrogen Electrode.

TYPICAL APPLICATIONS:

USA E70T-5M is used extensively in the fabrication of bridge structures, pressure vessels, earth moving equipment, general construction and ship- building. USA E70T-5M is ideal for medium to heavy thickness mild steel fabrication when crack resistance and superior toughness are required. USA E70T-5M is often used for joining mild steel to low alloy quenched and tempered high strength steels.

TYPICAL WELD METAL CHEMISTRY %
(% - tested with 80% Ar + bal. CO_2 Shield Gas)

C	0.04
Mn	1.30
Si	0.34
P	0.015
S	0.013

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80% Ar + bal. CO_2 Shield Gas)

Yield Point (psi)	71,000 psi
Tensile Strength (psi)	80,000 psi
% Elongation in 2”	29%
Charpy V-Notch Impact	50J (37 Ft.Lbs. at -29ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ.FILLETS
.045”	200-400	200-400
.063” (1/16”)	300-500	300-500

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD T-5
LINCOLN OUTERSHIELD 75H
HOBART FABCO 85
TRI-MARK TM-55

USA E71T-1
AWS A5.20 CLASS E71T-1C/E71T-1M

DESCRIPTION

USA E71T-1 is a special formulation flux cored wire for single or multi-pass all position welds on mild steels and 490N/mm2 (71,000 psi) class high strength steels. USA E71T-1 is noted for its low spatter, smooth arc and ease of slag removal. USA E71T-1 has been designed to provide excellent feed ability when used for all position welds of light, medium and heavy thickness plates using 75-80% Arbon + balance CO_2 mixed shield gas.

TYPICAL APPLICATIONS:

USA E71T-1 is used extensively in the fabrication of bridge structures, pressure vessels, earth moving equipment, general construction, shipbuilding and whenever welds are required to meet structural and nuclear codes.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.45
Si	0.30
P	0.015
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	72,000 psi
Tensile Strength (psi)	75,000 psi
% Elongation in 2”	28%
Charpy V-Notch Impact	75J (55 Ft.Lbs. at -18ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	HORIZ. FILLETS
.045”	120-300	120-300	120-250
.063” (1/16”)	200-450	200-400	180-220

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD II-71 ULTRA
LINCOLN OUTERSHIELD 1M-H
HOBART XL-550, EXCEL ARC 71
TRI-MARK TRIPLE 7, TM-711M, 771, 772

FLUX AND METAL CORED WIRES

For Mild Steel

USA E71T-1 LF
AWS A5.20 CLASSES E 71T-1C/E71T-1M

DESCRIPTION

USA E71T-1 LF is a special formulation flux cored wire for single or multi-pass all position welds on mild steels and 490N/mm2 (71,000 psi) class high strength steels. USA E71T-1 LF is noted for its low fume generation, low spatter, and ease of slag removal. USA E71T-1 LF has been designed to provide excellent feed ability when used for all position welds of light, medium and heavy thickness plates using 100% CO_2 or 75-80% Ar + balance CO_2 shield gas.

TYPICAL APPLICATIONS:

USA E71T-1 is used extensively in the fabrication of bridge structures, pressure vessels, earth moving equipment, general construction, shipbuilding and whenever welds are required to meet structural and nuclear codes.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.45
Si	0.30
P	0.015
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	74,000 psi
Tensile Strength (psi)	80,000 psi
% Elongation in 2”	28%
Charpy V-Notch Impact	60J (44 Ft.Lbs. at -18ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100%CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045”	120-300	120-300	120-250
.063” (1/16”)	200-450	200-400	180-220

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL CORE WELD 70, 71
LINCOLN OUTERSHIELD 70, 70-h, HD70
HOBART FABCO 81, 90, RXR, 86
TRI-MARK TM-11, TM1 HE, TM 72, TMEX7

USA E71T-1M
AWS A5.20 CLASSES E 71T-1C/E71T-1M

DESCRIPTION

USA E71T-1M is a special formulation flux cored wire for single or multi-pass welds on mild steels and 490N/mm2 class (71,000 psi) high strength steels. USA E71T-1M is noted for its low spatter, smooth arc and ease of slag removal. USA E71T- 1M has been designed to provide excellent feed ability when used for all position welds of light, medium and heavy thickness plates using 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas.

TYPICAL APPLICATIONS:

USA E71T-1M is used extensively in the fabrication of bridge structures, pressure vessels, earth moving equipment, general construction, shipbuilding and whenever welds are required to meet structural and nuclear codes.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.45
Si	0.30
P	0.015
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	72,000 psi
Tensile Strength (psi)	80,000 psi
% Elongation in 2”	28%
Charpy V-Notch Impact	75J (55 Ft.Lbs. at -18ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045”	120-300	120-300	120-250
.063” (1/16”)	200-450	200-400	180-220

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD 7000, 7100.1170, 1171, 1170T-12
LINCOLN OUTERSHIELD 71, 71M, 71M-H, 712C, 71HYC
HOBART FABCO 802, 825. XL-525
TRI-MARK TM71, 71-M, 711, 711M, 771, RX71

USA E71T-GS
AWS A5.20 CLASS E 71T-GS

DESCRIPTION

USA E71T-GS is self-shielding flux cored wire for single pass all-position welds on mild steels used for field construction, erection and repair. It is often used for fabrication of mild steel sheet metal where secondary shielding gas is not practical. USA E71T-GS is used to weld mild steels and it finds acceptance for use in fabrication and repair welds on thin mild steel and galvanized steel. USA E71T- GS is noted for its smooth, stable arc, full slag coverage, low spatter generation, ease of slag removal and excellent weld bead appearance. It has relatively light penetration and tolerates rust, dirt, and oil on the work piece. The weld deposit resembles that of E6011 Electrodes.

TYPICAL APPLICATIONS:

USA E71T-GS is used extensively in maintenance for the fabrication, erection and repair of mild steel sheetmetal and is used in applications where secondary shield gas is not practical. The weld deposits are smooth and have light penetration helping to eliminate burn-throughs. The use of USA E71T-GS should be limited to non-structural applications only. USA E71T-GS is noted for its smooth arc and low spatter.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.16
Mn	0.82
Si	0.31
Al	1.3
P	0.014
S	0.005

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded)

Traverse Tension Test	75,000 psi
Longitudinal Guided Bend Test	No Defects
% Elongation in 2”	22%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.035”	60-180	60-180	50-140
.045”	80-200	80-200	80-160
.063” (1/16”)	160-270	160-270	120-220

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.035”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.045”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x10 Lb., 33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB CORE SHIELD 15
LINCOLN INNERSHIELD NR151, NR 152
HOBART FABSHIELD 23
TRI-MARK TM-123

FLUX AND METAL CORED WIRES

For Mild Steel

USA E71T-11
AWS A5.20 CLASSES E 71T-11

DESCRIPTION
USA E71T-11 is a self-shielding flux cored wire for single or limited multi-pass all-position welds on mild steels used for field construction, erection and fabrication of bridges and shipbuilding where secondary shielding gas is not practical. USA E71T-11 is used to weld mild steels and it finds acceptance for use in construction, bridges, structural fabrication, and ship building. USA E71T-11 is noted for its smooth, stable arc. full slag coverage, low spatter generation, ease of slag removal and excellent weld bead appearance.

TYPICAL APPLICATIONS:
USA E71T-11 is used extensively in the fabrication, erection and repair of structural fabrication of mild steels used in applications where secondary shield gas is not practical. The weld deposits are smooth and have good penetration. The use of USA E71T-11 should be designated for multi-pass welds on plate up to 3/8" (9.5mm) only. Welds above this thickness should not be contemplated, as the weld deposit chemistry does not maintain its mechanical properties when used for more than three passes. USA E71T-11 is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat-faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.10
Mn	1.55
Si	0.10
Al	1.2
P	0.016
S	0.006

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded)

Yield Point (psi)	72,000 psi
Tensile Strength (psi)	77,000 psi
% Elongation in 2"	22%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.035"	60-180	60-180	50-140
.045"	80-200	80-200	80-160
.063" (1/16")	160-270	160-270	120-220

A wire stick-out of 5/8" to 1" should be used.

PACKAGING:
.035"x10 Lb., 33 Lb., 44 Lb. Spool 60 Lb. Coil, 500 Lb. PP*
.045"x10 Lb., 33 Lb., 44 Lb. Spool 60 Lb. Coil, 500 Lb. PP*
.063"x10 Lb., 33 Lb., 44 Lb. Spool 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB C0RESHIELD 11
LINCOLN INNERSHIELD NR211 MP
HOBART FABSHIELD 21B
TRI-MARK TM-121

USA E71T-W
AWS A5.29 CLASS E 71T-W

DESCRIPTION
USA E71T1-W is a titania slag formulation flux cored wire for single or multi-pass all-position welds on high tensile strength weathering steels and used for field construction, erection and fabrication of bridges and shipbuilding where post-weld painting is not done. USA E71T1-W is used to weld ASTM A588 and A242 grade weathering steels. It finds acceptance for use in construction, bridges, structural fabrication, offshore oil rig fabrication and shipbuilding. USA E71T1-W is noted for its smooth, stable arc, low spatter generation, ease of slag removal and excellent weld bead appearance. The shield gas can be either 100% CO_2 or 75% Argon + 25% CO_2.

TYPICAL APPLICATIONS:
USA E71T1-W is used extensively in the fabrication, erection and repair of structural fabrication of higher strength low alloy weathering steels used in unpainted post weld service. The weld deposits are smooth and have deep penetration. USA 71T1-W is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.05
Mn	1.25
Si	0.54
Ni	0.45
Cr	0.55
Cu	0.42
P	0.013
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	75,000 psi
Tensile Strength (psi)	90,000 psi
% Elongation in 2"	28%
Charpy V-Notch Impact	50J (37 Ft.Lbs. at -30ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045"	120-350	120-320	120-250
.063" (1/16")	200-450	200-400	180-220

A wire stick-out of 5/8" to 1" should be used.

PACKAGING:
.045"x25 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063"x25 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB DUAL SHIELD 88W, 8100-W
LINCOLN OUTERSHIELD
HOBART
TRI-MARK

FLUX CORED WIRES

For Low Alloy Steel

USA E80T1-K2
AWS A5.29 CLASS E 80T1-K2

DESCRIPTION

USA E80T1-K2 is a titania slag formulation flux cored wire for single or multi-pass flat and horizontal fillet welds on 1% nickel or aluminum-killed steels used for low-temperature high-strength usage. USA E80T1-K2 wire is specially formulated to provide excellent low temperature impact properties when used to weld ASTM A302, A533 Class 1 and A537 steels. It finds acceptance for use in construction, bridges, structural fabrication, heavy equipment manufacture, offshore oil rig fabrication and shipbuilding. USA 80T1-K2 is noted for its smooth, stable arc, low spatter generation, ease of slag removal and excellent weld bead appearance. The shield gas recommended is 100% CO_2.

TYPICAL APPLICATIONS:

USA E80T1-K2 is used extensively in the fabrication, erection and repair of structural fabrication of higher strength low alloy steels used for low temperature service. The weld deposits are smooth and have deep penetration. USA E80T1-K2 is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.45
Si	0.45
Ni	1.54
P	0.013
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	80,000 psi
Tensile Strength (psi)	93,000 psi
% Elongation in 2”	25%
Charpy V-Notch Impact	110J (81 Ft.Lbs. at -20ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100%CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045”	120-320	120-320	
.063” (1/16”)	200-450	200-450	

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD II 81-K2, DUAL SHIELD II 101-TM
LINCOLN OUTERSHIELD 81K2-H
HOBART-NA
TRI-MARKTM881K2

USA E81T1-K2
AWS A5.29 CLASS E81T1-K2

DESCRIPTION

USA E81T1-KW is a titania slag formulation flux cored wire for single or multi-pass flat and horizontal fillet welds on 1% nickel or aluminum-killed steels used for low-temperature high-strength usage. USA E81T1 -KW wire is specially formulated to provide excellent low temperature impact properties when used to weld ASTM A302, A533 Class 1 and A537 steels. It finds acceptance for use in construction, bridges, structural fabrication, heavy equipment manufacture, offshore oil rig fabrication and shipbuilding. USA E81T1-K2 is noted for its smooth, stable arc, low spatter generation, ease of slag removal and excellent weld bead appearance. The shield gas recommended is 100% CO_2

TYPICAL APPLICATIONS:

USA E81T1-K2 is used extensively in the fabrication, erection and repair of structural fabrication ofhigher strength low alloy steels used for low temperature service. The weld deposits are smooth and have deep penetration. USA E81T1-K2 is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.45
Si	0.45
Ni	1.54
P	0.013
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	81,000 psi
Tensile Strength (psi)	90,000 psi
% Elongation in 2”	25%
Charpy V-Notch Impact	74J (55 Ft.Lbs. at -30ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	120-320	120-320
.063” (1/16”)	200-450	200-450

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD II 81-K2, DUAL SHIELD II 101-TM
LINCOLN OUTERSHIELD 81K2-H
HOBART-NA
TRI-MARK-NA

USA E81T1-Ni1
AWS A5.29 CLASS E 81T1-Ni1

DESCRIPTION

USA E81T1-Ni1 is a titania slag formulation flux cored wire for single or multi-pass flat or fillet welds on medium and heavy thickness 1% nickel steel plate used in petro-chemical construction, mining and earth-moving equipment, and for weathering steels where color-match is not required. USA E81T1-Ni1 is noted for its high disposition rates, low spatter generation, ease of slag removal and excellent weld bead appearance. The shield gas recommended is 100% CO_2.

TYPICAL APPLICATIONS:

USA E81T1-Ni is used extensively in the fabrication, erection and repair of structural fabrication of higher strength. Steels having a 70,000-80,000 psi tensile strength. The weld metal analysis of the deposit is similar to E8018-C3 low hydrogen electrodes. The weld deposits are smooth and have deep penetration. USA E81T1-Ni1 is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.145
Mn	1.17
Si	0.35
Ni	1.00
Mo	0.22
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Traverse Tension Test	82,000 psi
Tensile Strength (psi)	91,000 psi
% Elongation in 2”	21%
Charpy V-Notch Impact	68J (50 Ft.Lbs. at - 18ºC)
	42J (31 Ft.Lbs. at - 29ºC)

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity – 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045”	120-320	120-320	120-250
.063” (1/16”)	200-450	200-450	180-230

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUEL SHIELD 88-C3, DUEL SHIELD II 80 Ni1
LINCOLN OUTERSHIELD 81 Ni1H
HOBART XL-8Ni1
TRI-MARK TM-811NI

FLUX CORED WIRES

For Low Alloy Steel

USA E81T1-B2
AWS A5.29 CLASS E 81T1-B2

DESCRIPTION

USA E81T1-B2 is a titania slag formulation flux cored wire for single or multi-pass welds on 1.25% Cr 0.5% Mo steels used for high pressure steam pipes of boilers, oil refining processing equipment, pressure vessels and castings of the same alloy content. The weld deposits are designed to operate at high temperature service. The shild gas recommended is 100% CO_2.

PREHEAT AND POST WELD HEAT TREATMENT

A preheat of 200-350°C and a post-weld heat treatment of 680-730°C for 1 hour per inch of thickness followed by air cooling to ambient temperature is required.

TYPICAL APPLICATIONS:

USA E81T1-B2 is used extensively in the fabrication and repair of pressure vessels, petrochemical processing equipment, and piping systems. The weld metal analysis of the deposit is similar to E8018-B2 Low Hydrogen Electrodes. USA E81T1- B2 is also used to weld 0.5% Cr - 0.5% Mo, 1.0% Cr - 0.5% Mo, and 1.25% Cr - 0.5% Mo steels. The weld deposits are smooth and have deep penetration. USA B1T1-B2 is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples. This is an all-position wire and can also be used with Argon-CO2 mixed shield gas.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.04
Mn	1.08
Si	0.44
Cr	1.25
Mo	0.53
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	77,000 psi
Tensile Strength (psi)	87,000 psi
% Elongation in 2”	29%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100%CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045”	120-340	120-340	120-250
.063” (1/16”)	200-450	200-450	180-220

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil., 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD ARC 88-CM, 8000-B2
LINCOLN OUTERSHIELD 81-B2H
HOBART-NA
TRI-MARK TM-811B2

USA E91T1-B3
AWS A5.29 CLASS E 91T1-B3

DESCRIPTION

USA E91T1-B3 is a titania slag formulation flux cored wire for single or multi-pass welds on 2.25% Cr 1.0% Mo steels used for high pressure steam pipes of boilers, power generation plant equipment, oil refining processing equipment, pressure vessels and castings of the same alloy content. The weld deposits are designed to operate at high temperature service. The shield gas recommended is 100% CO_2.

PREHEAT AND POST WELD HEAT TREATMENT:

A preheat of 200-350°C and a post-weld heat treatment of 680-730° C for 1 hour per inch of thickness followed by air cooling to ambient temperature is required.

TYPICAL APPLICATIONS:

USA E91T1-B3 is used extensively in the fabrication, erection and repair of pressure vessels, petrochemical processing equipment, and piping systems. The weld metal analysis of the deposit is similar to E9018-B3 Low Hydrogen Electrodes. The weld deposits are smooth and have deep penetration. USA E91T1-B3 is noted for its smooth arc and minimum spatter. When used for horizontal fillet joints the weld bead has equal leg lengths, flat faced fillets with fine ripples. This is an all-position wire and can also be used with Argon-CO_2 mixed shield gas.

TYPICAL WELD METAL CHEMISTRY
(% - tested with 100% CO_2 Shield Gas)

C	0.045
Mn	1.18
Si	0.51
Cr	2.25
Mo	1.0
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Yield Point (psi)	77,000 psi
Tensile Strength (psi)	87,000 psi
% Elongation in 2”	24%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS	VERT.
.045”	120-340	120-340	120-250
.063” (1/16”)	200-450	200-450	180-220

A wire stick-out of 5/8” to 1” should be used.

PACKAGING:

045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB DUAL SHIELD ARC 98-CM, 9000-B3
LINCOLN OUTERSHIELD- NA
HOBART-NA
TRIMARK TM91B3, TM-911B3

USA E4140T-1
AISI/SAE 4140 (NO AWS CLASS)

DESCRIPTION

Washington Alloy USA 4140T-1 is a flux cored AISI 4140 type heat treatable low alloy steel wire with exceptionally good operating characteristics. USA4140T-1 produces dense, heat-treatable deposits with high tensile strength properties. USA 4140T-1 weld deposits match the hardening characteristics of AISI 4140 base metal. Weld deposits are approximately 44 Rockwell C as applied, and can be heat-treated producing a hardening up to Rockwell C55 with proper procedures.

TYPICAL MECHANICAL PROPERTIES

PWHT: Fully annealed, welded, post weld re-heat, oil quenched at 1600ºF, then:

Yield Point (psi)	127,000	165,000
Tensile Strength (psi)	140,000	180,000
% Elongation in 2”	18%	16%
% Reduction of Area	32%	36%
Mo	0.22	
P	0.014	
S	0.011	

TYPICAL WELD METAL ANALYSIS (%)
(% - tested with 100% Argon Shield Gas)

C	0.35
Mn	0.80
Si	0.50
P	0.012
S	0.014
Cr	0.75
Mo	0.33

TYPICAL APPLICATIONS:

USA 4140T-1 is commonly used to weld low-alloy heat-treatable AISI/SAE 4140 steel as well as steel castings with comparable hardening properties where the weld must match the heat-treating characteristic of the base metal. Typical applications are for build-up and repair of dies, forgings, and castings made from medium carbon, low alloy base metals such as AISI 4140 steel, when post- weld heat treatment or flame hardening is required.

AVAILABLE SIZES AND RECOMMENDED CURRENTS
100% CO2or 75% Argon/25% CO_2 Shield Gas

SIZE	.045”	1/16”	3/32”
Amps	160-200	200-250	375-425
Volts	24-28	23-25	26-29
Stickout	½”	¾”	1”

RECOMMENDED PROCEDURE:
(As welded - tested with 100% CO_2 Shield Gas)

Preheat of 400-600ºF with inter-pass temperature held at 400-600ºF to prevent cracking. Use as short an arc as possible and deposit stringer beads. Peening the warm deposit while it is still forgeable is helpful to reduce stress build-up.

PACKAGING:
10 lb., 33 lb. Spool, 60 lb. Coil

FLUX AND METAL CORED WIRES

For Stainless Steel

USA E308T-1
AWS A5.22 CLASS E 308T1-1/-4

DESCRIPTION

UUSA E308T-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E308T-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas. USA E308T-1 provides weld deposits with optimum ferrite content in its austentic structure resulting in low susceptibility to cracking.

TYPICAL APPLICATIONS:

USA E308T-1 is used extensively in the fabrication of stainless steel structures, pressure vessels, tanks used in food processing, chemical, refinery and restaurant equipment. USA E308T-1 can be used to weld stainless steels of similar alloy composition including AISI 201, 202, 301, 302, 304, 305 and 308..

TYPICAL WELD METAL CHEMISTRY
(Tested with 80% Argon + 20%CO_2Shield Gas)

C	0.04
Mn	1.08
Si	0.44
Cr	1.25
Ni	0.53

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80% Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	88,500 psi
% Elongation in 2”	36%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 80% Argon 20% Shield Gas

SIZE Diameter (in.)	FLAT	HORI.Z FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension: ½”-1”		

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB SHIELD-BRIGHT 308T-1
LINCOLN-N/A
McKAY 308T-1
HARRIS WELCO 410NiMo
SANDVIK 308T-1AP
KOBELCO-N/A

USA E308LT-1
AWS A5.22 CLASS E 308LT1-1/-4

DESCRIPTION

USA E308LT-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E308LT-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas. USA E308LT-1 provides weld deposits with optimum ferrite content in its austentic structure resulting in low susceptibility to cracking. The extra low carbon content of USA E 308LT-1 provides excellent resistance to intergranular corrosion and stress corrosion cracking.

TYPICAL APPLICATIONS:

USA E308LT-1 is used extensively in the fabrication of stainless steel structures, pressure vessels, tanks used in dairy, pulp and paper, textile dyeing, refinery and chemical equipment. The extra low carbon content reduces carbide precipitation. USA E308LT-1 can be used to weld stainless steels of similar alloy composition including AISI 304L, 308L, 321 and 347 and whenever welds are required to meet structural and intergranular corrosion resistance requirements

TYPICAL WELD METAL CHEMISTRY
(% - Tested with 80% Argon+20% CO_2 Shield Gas)

C	0.04
Mn	1.87
Si	0.75
Cr	19.50
Ni	10.30

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80%Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	88,500 psi
% Elongation in 2”	36%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 80% Argon 20% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension: ½”-1”		

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, store in a dry place or rebake before reuse.

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB SHIELD-BRIGHT 308L, SHIELD-BRIGHT X-TRA 308L
LINCOLN BLUE MAX FC-308L
McKAY IN-FLUX STERLING 308L, IN FLUX 308L
HARRIS WELCO 308L
SANDVIK 308LT1AP
KOBELCO DW-308L DW-308LP
TECHALLOY-N/A
NAT’L STANDARD 308L

USA E309T-1
AWS A5.22 CLASS E 309T1-1/-4

DESCRIPTION

USA E309T-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E309T-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas. The high chromium and nickel content of USA E309T-1 provides weld deposits with scaling and heat resistance in addition to corrosion resistance.

TYPICAL APPLICATIONS:

USA E309T-1 is used extensively in the fabrication of type 309 stainless steel structures, furnace parts, high temperature containers, and aircraft heaters. USA E309T-1 may be used to weld straight chromium type stainless steels (ie: 12Cr 410) when pre-heat and post-heat treatment is not possible. USA E309T-1 may also be used to join stainless steels to mild steel and for stainless cladding of mild and low alloy steels.

TYPICAL WELD METAL CHEMISTRY
(% - Tested with 80% Argon + 20% CO_2 Shield Gas)

C	0.04
Mn	1.93
Si	0.78
Cr	23.70
Ni	13.40

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80%Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	95,000 psi
% Elongation in 2”	36%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity – 80% Argon 20% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension: ½”-1”		

PACKAGING:

.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, store in a dry place or rebake before reuse.

CROSS-REFERENCE TO COMPETITIVE WIRES

ESAB – N/A
LINCOLN – N/A
McKAY – N/A
HARRIS WELCO – N/A
SANDVIK – N/A
KOBELCO - N/A
TECHALLOY - N/A
NAT’L STANDARD - N/A

FLUX AND METAL CORED WIRES

For Stainless Steel

USA EC309L
AWS A5.9 CLASS EC309L

DESCRIPTION
USA EC309L is a metal cored wire for single pass welds on thin stainless steel sheet. USA EC 309L is noted for its low spatter generation, excellent bead shape and appearance and freedom from slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or Argon + 2% Oxygen mixed shield gas. USA EC 309L provides weld deposits with excellent corrosion and porosity resistance along with superior heat resistance. The extra low carbon content of USA EC309L provides excellent resistance to intergranular corrosion and stress corrosion cracking.

TYPICAL WELD METAL CHEMISTRY
(Tested with Argon + 2% O_2 Shield Gas)

C	0.03
Mn	1.57
Si	0.48
Cr	23.95
Ni	12.40

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with Argon + 2% CO_2 Shield Gas)

Tensile Strength (psi)	81,500 psi
% Elongation in 2”	40%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - Argon + 2% O_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	140-220	140-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-260	180-260
Electrode extension: ½”-1”		

PACKAGING:
.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB SHIELD BRIGHT 309L, SHIELD BRIGHT X-TRA 309L
LINCOLN BLUE MAX FC-309L
McKAY IN-FLUX STERLING 309L TO-4/1, 309LT1-1/4
HARRIS WELCO 309LT1-1
KOBELCO DW-309L
SANDVIK 309L TO-1/4, 309LT1AP
KOBELCO DW-309L
TECHALLOY - N/A
NAT’L STANDARD 309LT0-1

USA E309LMo
AWS A5.22 CLASS E309LMoT0-1/-4

DESCRIPTION
USA E309LMoT0-1/-4 is a flux cored wire for single or multi-pass welds when joining stainless steels including those containing Molybdenum, to carbon steels. USA E309LMoT0-1/-4 is also used for the first pass deposits in cladding operations using AISI typoe 316 and 316L filter metals. USA E309LMoT0-1/-4 may also be used to provide a low carbon 22% Cr-12% Ni, 2% Mo all-weld deposit. USA E309LMoT0-1/-4 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 shield gas. USA E309LMoT0-1/-4 provides weld deposits with excellent corrosion and porosity resistance along with superior heat resistance. The extra low carbon content of USA E309LMoT0-1/-4 provides excellent resistance to intergranular corrosion and stress corrosion cracking.

TYPICAL APPLICATIONS:
USA E309LMoT0-1/-4 is used extensively in the fabrication of stainless steel automobile muffler and exhaust systems made of AISI stainless types 409 and 436. USA E309LMoT0-1/-4 may be used to weld straight chromium type stainless steels (ie: 12Cr 410) when pre-heat and post-heat treatment is not possible. USA E309LMoT0-1/-4 may also be used to join stainless steels to mild steel and for stainless cladding of mild and low alloy steels. Because of its low spatter generation, this wire is an excellent choice for robotic welding applications.

TYPICAL WELD METAL CHEMISTRY
(% - Tested with 100% CO_2 Shield Gas)

C	0.03
Mn	1.30
Si	0.45
Cr	23.70
Ni	13.00
Mo	2.70

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100% CO_2 Shield Gas)

Tensile Strength (psi)	97,500 psi
% Elongation in 2”	32%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity - 100% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension: ½”-1”		

PACKAGING:
.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB – N/A
LINCOLN – N/A
McKAY – N/A
HARRIS WELCO – N/A
SANDVIK 309MoLT0-1, 309MoLT1-1
TECHALLOY – N/A, NAT’L STANDARD – N/A

USA E312T-1
AWS A5.22 CLASS E312T1-1/-4

DESCRIPTION
USA E312T-1 is a flux cored AISI 312 type stainless steel alloy wire with exceptionally good operating characteristics. USA E312T-1 produces dense, tough deposits having the highest tensile strength of any of the austenitic stainless steels. USA E312T- 1 weld deposits match the characteristics and mechanical properties of AISI 312 base metal. Weld deposits are approximately 23 Rockwell C as applied. Machining should be done with slow feed rates as the weld deposits will work-harden up to 38 RC. USA E312T-1 deposits are resistant to heat. corrosion and wear. The unique metallurgical structure of USA E312T-1 is that of ferrite suspended in an austenite matrix. This makes the deposits extremely resistant to cracking.

TYPICAL APPLICATIONS:
USA E312T-1 is used to weld base metals of similar analysis as well as dissimilar steels. USA E312T-1 performs well on abrasion-resisting steels, manganese steels, hardening steels, spring steels, armor plate, high-yield steels and for joining high temperature steels to carbon and low alloy steels. USA E312T-1 is also an excellent choice as an underlay (buffer layer) for hard facing deposits.

TYPICAL WELD METAL ANALYSIS (%)
(Tested with DCRP, 100% CO_2 Shield Gas)

C	0.12
Mn	1.70
Si	0.50
Cr	29.50
Ni	9.50

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT

Yield Point (psi)	90,000
Tensile Strength (psi)	122,000
% Elongation in 2”	35%
Hardness (RC)	23 RC

AVAILABLE SIZES AND RECOMMENDED CURRENTS
100%CO2or 75% Ar – 25% CO_2 Shield Gas

Size:	.045”	1/16”
Amps	130-180	160-250
Volts	25-30	24-29
Stick-out	½”	¾”

RECOMMENDED PROCEDURE
Preheat is generally not required. On high carbon or high alloy steels a pre-heat of 350-400°F with inter-pass temperature held at the same heat helps to prevent under-bead cracking. Use as short an arc as possible and deposit stringer beads. Peening the warm deposit while it is still forgeable is helpful to reduce stress build-up.

PACKAGING:
10lb., 33lb. Spool, 60 lb. Coil

FLUX AND METAL CORED WIRES

For Stainless Steel

USA E316T-1
AWS A5.22 CLASS E 316T1-1/-4

DESCRIPTION
USA E316T-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E316T-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas. USA E316T-1 provides weld deposits with optimum ferrite content in its austenitic structure resulting in low susceptibility to cracking.

TYPICAL APPLICATIONS:
USA E316T-1 is used extensively in the fabrication of stainless steel structures, pressure vessels, tanks used in food processing, chemical, refinery. photographic and restaurant industries. USA E316T-1 may be used to weld stainless steels of similar alloy composition where the higher corrosion resistance and higher creep strength of this alloy comprised of 18% Cr, 12% Ni and 2.5% Mo are required.

TYPICAL WELD METAL CHEMISTRY
(Tested with 80% Argon+20% CO_2 Shield Gas)

C	0.05
Mn	1.47
Si	0.60
Cr	18.40
Ni	11.50
Mo	2.50

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80% Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	88,500 psi
% Elongation in 2”	37%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity–80% Argon 20% CO_2Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension: ½”-1”		

PACKAGING:
.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB – N/A
LINCOLN – N/A
McKAY – N/A
HARRIS WELCO – N/A
SANDVIK – N/A
TECHALLOY – N/A

NAT’L STANDARD 316TO-1

USA E316LT-1
AWS A5.22 CLASS E 316LT1-1/-4

DESCRIPTION
USA E316LT-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E316LT-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas. USA E316LT-1 provides weld deposits with optimum ferrite content as its austenitic structure resulting in low susceptibility to cracking. The extra low carbon content of USA E316LT-1 provides excellent resistance to inter- granular corrosion and stress corrosion cracking caused by carbide precipitation.

TYPICAL APPLICATIONS:
USA E316LT-1 is used extensively in the fabrication of 18% Cr 12% Ni 2% Mo stainless steel structures, pressure vessels, tanks in dairy, pulp and paper, textile dyeing, refinery and chamical equipment The extra low carbon content reduces carbide precipitation. USA E316LT-1 can be used to weld stainless steels of similar compositions when welds are required to meet higher corrosion resistance and higher creep strength requirements along with intergranular corrosion resistance requirements.

TYPICAL WELD METAL CHEMISTRY
(Tested with 80% Argon + 20% CO_2 Shield Gas)

C	0.30
Mn	1.85
Si	0.75
Cr	18.70
Ni	11.40
Mo	2.50

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80% Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	90,000 psi
% Elongation in 2”	36%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity –80%Argon 20% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension: ½”-1”		

PACKAGING:
.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, Store in a dry place or rebake before reuse.

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB SHIELD BRITE 316L. SHIELD-BRIGHT X-TRA 316L
LINCOLN BLUE MAX FC-316L
McKAY IN-FLUX STERLING 316LT1-1/4
HARRIS WELCO 316LT-1
KOBELCO DW-316L. DW316LT-1
SANDVIK 316LT0-1/4. 316LT1-1/4
TECHALLOY-N/A
NAT’L STANDARD 316LT-1

USA E317LT-1
AWS A5.22 CLASS E 317LT1-1/-4

DESCRIPTION
USA E317LT-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E317LT-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 shield gas. USA E317LT-1 provides weld deposits with optimum ferrite content as its austenitic structure resulting in low susceptability to cracking. The extra low carbon content of USA E317LT-1 provides excellent resistance to inter- granular corrosion and stress corrosion cracking caused by carbide precipitation. USA E317LT-1 also provides excellent resistance to pitting corrosion due to its higher Molybdenum content compared to USA316LT-1

TYPICAL APPLICATIONS:
USA E317LT-1 is used extensively in the fabrication of AISI type 317 stainless steel structures, pressure vessels, and tanks in dairy, pulp and paper, textile dyeing, refinery and chemical equipment. The extra low carbon content reduces carbide precipitation. USA E317LT-1 can be used to weld stainless steels of similar compositions when welds are required to meet higher resistance requirements. One key advantage of USA E317LT-1 is its excellent resistance to pitting corrosion in chlorine environments. It is also used for pollution control equipment where the corrosive attack is to severe for USA E316LT-1 filler metal.

TYPICAL WELD METAL CHEMISTRY
(Tested with 100% CO_2 Shield Gas)

C	0.30
Mn	1.85
Si	0.75
Cr	18.70
Ni	11.40
Mo	2.50

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded – tested with 100% CO_2 Shield Gas)

Tensile Strength (psi)	88,500
% Elongation in 2”	33%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity – 100% CO2Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-320	180-320
Electrode extension ½” – 1”		

PACKAGING:
.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, Store in a dry place or rebake before reuse

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB SHIELD BRITE 317L
LINCOLN - N/A
McKAY IN-FLUX 317L-T1
HARRIS WELCO - N/A
SAMDVIK 317LT0-1/4, 317LT-1/4
TECHALLOY - N/A
NAT’L STANDARD 317LT1-1/4

FLUX AND METAL CORED WIRES

For Stainless Steel

USA E347T0-1
AWS A5.22 CLASS E 347T0-1

DESCRIPTION
USA E347T0-1 is a flux cored wire for single or multi-pass welds on AISI types 304, 304L, 321 and 347 stainless steels. USA E347T0-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 shield gas. The columbium content of USA E347T0-1 provides weld deposits with improved resistance to chromium carbide precipitation and improved corrosion resistance as well as improved strength at higher temperatures.

TYPICAL APPLICATIONS:
USA E347T0-1 is used extensively in the fabrication of AISI types 321 and 347 stainless steel structures, pressure vessels, tanks in dairy, pulp and paper, textile dyeing, refinery and chemical equipment. The extra low carbon content reduces carbide precipitation. USA E347T0-1 can be used to weld stainless steels of similar compositions when welds are required to meet higher corrosion resistance and higher creep strength requirements along with intergranular corrosion resistance requirements

TYPICAL WELD METAL CHEMISTRY
(Tested with 100% CO_2 Shield Gas)

C	0.05
Mn	1.75
Si	0.83
Cr	19.50
Ni	10.50
Cb	0.54

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 100%CO_2 Shield Gas)

Tensile Strength (psi)	98,500
% Elongation in 2”	34%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity – 100% CO_2Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
	Electrode extension: 3/8”-5/8”	
.063” (1/16”)	180-320	180-320
	Electrode extension: ½”-1”	

PACKAGING:
.045”x25 Lb., 33 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x25 Lb., 33 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB CORE-BRIGHT347
LINCOLN – N/A
McKAY – N/A
HARRIS WELCO – N/A
SANDVIK 347TO-1/4, 347T1-1/4
TECHALLOY – N/A

NAT’L STANDARD 347

USA EC409TiT
AWS A5.9 CLASS EC409

DESCRIPTION
USA EC409TiT is a metal cored wire for single pass welds on thin stainless steel sheet. USA EC409TiT is noted for its low spatter generation, excellent bead shape and appearance and freedom from slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% Argon or Argon + 2% Oxygen mixed shield gas. USA EC409TiT provides weld deposits with excellent corrosion and porosity resistance along with superior heat resistance.

TYPICAL APPLICATIONS:
USA EC409TiT is used extensively in the fabrication of stainless steel automobile muffler and exhaust systems made of AISI stainless types 409 and 436. USA EC409TiT may be used as a low cost hard surfacing alloy for mild and low alloy steels. The addition of Titanium to the alloy formulation acts as a de-oxidizer which smoothes and flattens the weld bead. Because of its low spatter generation, this wire is an excellent choice for robotic welding applications.

TYPICAL WELD METAL CHEMISTRY
(Tested with Argon + 2% O_2 Shield Gas)

C	0.05
Mn	0.45
Si	0.50
Cr	12.10
Ti	0.70

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with Argon + 2% O_2 Shield Gas)

Tensile Strength (psi)	81,500 psi
% Elongation in 2”	17%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity–Argon 2% O_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	140-220	140-220
	Electrode extension: 3/8”-5/8”	
.063” (1/16”)	180-250	180-250
	Electrode extension: ½”-1”	

PACKAGING:
.045”x25 Lb., 33 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x25 Lb., 33 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, Store in a dry place or rebake before reuse.

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB – N/A
LINCOLN – N/A
McKAY – N/A
HARRIS WELCO – N/A
SANDVIK – N/A
TECHALLOY – N/A
NAT’L STANDARD – N/A

USA E410T0-1
AWS A5.22 CLASS E410T0-1/-4

DESCRIPTION
USA E410T0-1 is a flux cored wire for single or multi-pass welds on stainless steels. USA E410T0-1 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 100% CO_2 or 75-80% Argon + balance CO_2 mixed shield gas. USA E410T0-1 provides hard as- welded deposits with optimum abrasion resistance. When used as a overlay material cross-check cracking is to be expected as this is how the deposit stress relieves itself.

TYPICAL APPLICATIONS:
USA E410T0-1 is used extensively in the fabrication of 12% Cr stainless steel structures, pressure vessels, tanks used in dairy, pulp and paper, textile dyeing, refinery and chemical equipment. When used to weld AISI types 404, 405, and 410 pre-heat and post-weld heat treatment is required.

TYPICAL WELD METAL CHEMISTRY
(Tested with 80% Argon + 20% CO_2 Shield Gas)

C	0.70
Mn	0.69
Si	0.32
Cr	13.20

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded – tested with 80% Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	82,500
% Elongation in 2”	28%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity – 80% Argon 20% CO2Shield Gas

.045”	100-220	100-220
	Electrode extension: 3/8”-5/8”	
.063” (1/16”)	180-270	180-270
	Electrode extension ½” – 1”	

PACKAGING:
.045”x25 Lb., 33 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x25 Lb., 33 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, Store in a dry place or rebake before reuse.

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB – N/A
LINCOLN – N/A
McKAY – N/A
HARRIS WELCO – N/A
SANDVIK – N/A
TECHALLOY – N/A

NAT’L STANDARD 410NiMo

FLUX AND METAL CORED WIRES
For Stainless Steel

USA E410NiMoT0-4
AWS A5.22 CLASS E410NiMoT0-4

DESCRIPTION
USA E410NiMoT0-4 is a flux-cored wire for single or multi-pass welds on multi-pass welds on AISI types 403, 405, 410 and 420 and for welding CA-6NM castings stainless steels. USA E410NiMoT0-4 is noted for its low spatter generation, excellent bead shape and appearance and ease of slag removal. It has very good deposit efficiency when used for flat and fillet welds of medium and heavy thickness plates. It has been designed to be used with 80% Argon + 20% CO_2 mixed shield gas. USA E410NiMoT0-4 provides hard as-welded deposits with optimum abrasion resistance. When used as a overlay material cross-check cracking is to be expected as this is how the deposit stress relieves itself.

TYPICAL APPLICATIONS:
USA E410NiMoT0-4 is used extensively in the fabrication of 12% Cr, 4.5% Ni, and 0.5% Mo stainless steel structures. Typically, this alloy is used in fabricating and repairing hydroelectric turbines. When used to weld AISI types 404, 406 and 410 pre-heat and post-weld heat treatment is required. With correct procedures, hardness levels of less than 23 Rockwell C are possible. The deposit is fully martensitic and the hardness and tensile strength depend on the post-weld heat treatment procedures used. A stress relief of 600°C (1,115°F) for one hour is recommended to obtain maximum tensile strength.

TYPICAL WELD METAL CHEMISTRY
(Tested with 80% Argon + 20% CO_2 Shield Gas)

C	0.70
Mn	0.69
Si	0.32
Cr	13.20

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
(As welded - tested with 80% Argon + 20% CO_2 Shield Gas)

Tensile Strength (psi)	125,500
% Elongation in 2”	25%

AVAILABLE SIZES AND RECOMMENDED CURRENTS (DCEP)
Reverse Polarity – 80% Argon 20% CO_2 Shield Gas

SIZE Diameter (in.)	FLAT	HORIZ. FILLETS
.045”	100-220	100-220
Electrode extension: 3/8”-5/8”		
.063” (1/16”)	180-270	180-270
Electrode extension: ½”-1”		

PACKAGING:
.045”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
.063”x33 Lb., 44 Lb. Spool, 60 Lb. Coil, 500 Lb. PP*
*Pail-Pac Drum
Once opened, store in dry place or rebake before reuse.

CROSS-REFERENCE TO COMPETITIVE WIRES
ESAB - N/A
LINCOLN – N/A
McKAYIN-FLUX STERLING 410NiMo-T1
HARRIS WELCO 410NiMo
SANDVIK – N/A
TECHALLOY – N/A
NAT’L STANDARD 410NiMo

USA E630T0-1/-4 (17-4 PH)
AWS A5.22 CLASSES E630T0-1/-4 (Formerly 17-4 PH)

DESCRIPTION
USA E630T0-1/-4 (17-4 PH) is a flux-cored AISI 17-4 type precipitation hardening stainless steel alloy wire with exceptionally good operating characteristics. The chemistry of USA E630T0-1/-4 is equivalent to the chemistry and mechanical requirements of AWS specifications for ER630 solid wire. USA E630T0-1/-4 is designed for welding materials of similar composition including ASTM A-564 type 17-4, 15-5, 15-7, and 17-7 precipitation hardening stainless steels

TYPICAL APPLICATIONS:
USA E630T0-1/-4 is extensively used for welding stainless steels of similar analysis including types 15-5 PH and 17-4 PH. Typical applications include welding of components for aerospace applications such as landing gear covers, fuel tanks, flexible bellows joints and for shipbuilding applications including pump parts, shafts, and rudder mounting brackets.

TYPICAL WELD METAL CHEMISTRY
(Tested with DCRP, 80% Argon + 20% CO_2 Shield Gas)

C	0.035
Mn	0.450
Si	0.400
P	0.012
S	0.011
Cr	17.250
Ni	4.210
Mo	0.550

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT
PWHT: 1875-1925ºF for 30 minute solution anneal, followed by rapid cooling in air to room temperature. Reheat to aging temperature 900-1100ºF then cool to room temperature.

Yield Point (psi)	178,000
Tensile Strength (psi)	200,000
% Elongation in 2”	10%

AVAILABLE SIZES AND RECOMMENDED CURRENTS
100% CO_2or 75-80% Ar/20-25% CO_2 Shield Gas

Size:	.045”	1/16”
Amps	140-180	200-250
Volts	24-28	23-25
Stickout	½”	¾"

PACKAGING:
10 lb., 25 lb. Spool, 60 lb. Coil

USA 2553T0-3
AWS A5.22 CLASSES E2553T0-3

DESCRIPTION
USA 2553T0-3 is a flux-cored super-duplex stainless steel alloy wire with exceptional resistance to pitting and crevice corrosion. It is used in joining process piping and equipment in the chemical and petrochemical industries. Washington Alloy 2553 FC is designed for joining Cabot Ferralium 255® when a minimum PREN {Pitting Resistance Equivalent Number) of 40 is required. USA 2553T0- 3 is also used to join Carpenter 7-Mo-Plus® or Sandvik 2507® and other duplex and super-duplex stainless steels.

TYPICAL APPLICATIONS:
USA 2553T0-3 is designed to weld wrought, forged or cast super-duplex and duplex stainless steels in the solution treated condition. When welding any duplex or super-duplex stainless steel, it is important to insure that the material is cooled sufficiently rapidly after welding, particularly through the 1750°F to 1120°F range to avoid embrittlement. To insure that cooling takes place rapidly enough it is recommended that heat inputs be kept moderately low, and the inter-pass temperature between successive passes must be at no more than 250°F

TYPICAL WELD METAL CHEMISTRY (Tested with DCRP)
(Tested with 80% Argon + 20% CO_2 Shield Gas)

C	0.035
Mn	1.000
Si	0.500
P	0.015
S	0.011
Cr	26.000
Ni	8.800
Mo	3.300
Cu	1.700
N	0.230

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT

Yield Point (psi)	100,000
Tensile Strength (psi)	130,000
% Elongation in 2”	18%
Charpy V-Notch @ -58ºF	25 ft. lbs.

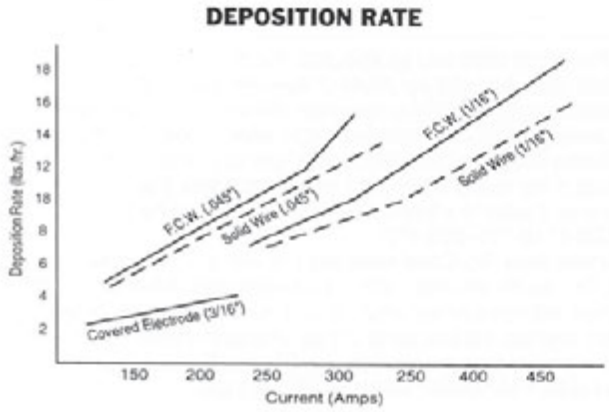
AVAILABLE SIZES AND RECOMMENDED CURRENTS
USA 2553T0-3 is a self-shielding (gasless) flux cored wire.

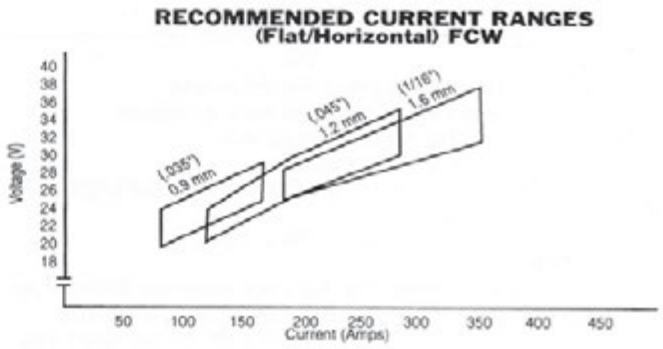
Size	.045”	1/16”
Amps	130-180	160-250
Volts	24-29	25-30
Stickout	1/2	¾”

PACKAGING:
10 lb., 25 lb. Spool, 60 lb. Coil

Ferralium 255® is a registered trademark of Cabot Corporation. Carpenter 7-Mo-Plus® is a registered trademark of Carpenter Technologies. Sandvik 2507® is a registered trademark of Sandvik Steel Co.

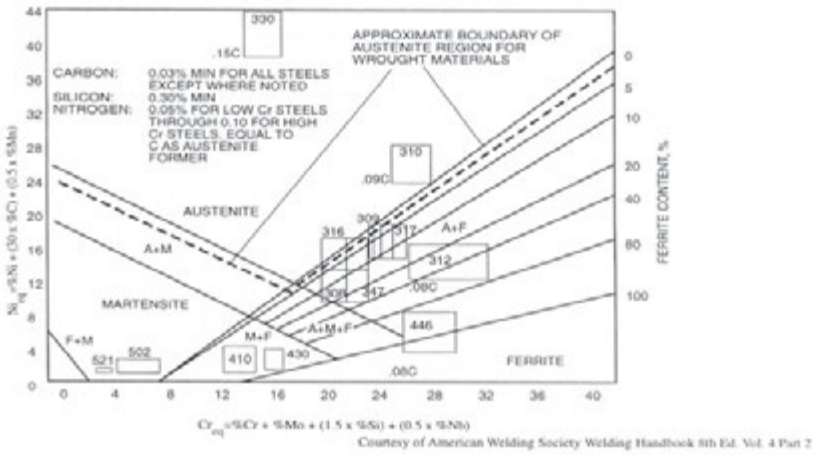
Stainless Steel Flux Cored Wire





AVAILABLE SIZES AND WELDING PARAMETERS (DC REVERSE POLARITY)[1]							
Diameter (mm)		**.035" (0.9 mm)**		**.045" (1.2 mm)**		**1/16" (1.6 mm)**	
Shielding Gas Shielding Gas		**CO_2**	**80% Ar+20% CO_2**	**CO_2**	**80% Ar+20% CO2**	**CO_2**	**80% Ar+20% CO_2**
Flat	**Amp. Volt**	**120-130 29-31**	**120-130 27-29**	**180-200 30-32**	**180-200 28-30**	**220-240 30-32**	**220-240 28-30**
Vertical-Up	**Amp. Volt**	**60-80 26-28**	**60-80 25-27**	**110-140 22-24**	**110-140 21-23**	_ _	_ _
Gas Flow Rate] Electrode Stickout		**(20L/min) (10-20 mm)**	**42 ft^3/hr 1/2 - 3/4"**				

SCHAEFFLER DIAGRAM FOR ESTIMATING THE MICROSTRUCTURE OF STAINLESS STEEL WELD METAL



Stainless Steel Flux Cored Wires Selector Chart

FEATURES

- Increased efficiency through greater deposition rates
- All-Position welding using standard MIG welding machines
- Smoother and more beautiful bead appearance
- Better arc stability yields minimal spatter
- Thin slag is virtually self-peeling revealing a beautiful and bright stain less steel color weld deposit
- X-ray quality weld deposits. No pinholes or cracks

DESCRIPTION

Washington Alloy Stainless Steel Flux Cored wires were developed for use with 100% CO_2 or 80% Ar/20%CO_2 shielding gas. The ability of operating over a wide range of current settings permits deposition rates that are nearly A times greater than covered electrodes and up to 50% greater than solid MIG wire. Although the cost per pound of Stainless

Stainless Steel Flux Cored wires that end with a "-4", such as E308LT1-4 are de-signed for use with a 20-25% CO_2/Balance Argon mixtures. Washington Alloy recom-mends 80% Ar/20% CO_2 (although you can use 75% Ar/25% CO_2) for this specifi-cation. An 80/20 mixture will give a much softer arc, resulting in virtually no spatter. The softer arc also enhances vertical welding. Weld deposits of "-4" Stainless Steel Flux Cored wires exhibit less carbon pick up and less chromium loss, which pushes up the ferrite level of the weld deposit. Keep this fact in mind when examining the desired ferrite level or considering which gas to use. Greater weld deposit toughness can be achieved by choosing an 80/20 mixture over 100% CO_2.

Steel Flux Cored wires may be more than that of coated electrodes or solid MIG wire, your cost per pound of deposited weld metal is greatly reduced because of the higher deposition efficiency and lower opera-tional costs. The true stainless steel sheath used in manufacturing Washington Alloy Flux Cored Stainless is your guar-antee of smooth per-formance, x-ray quality welds and a beautiful stainless steel bead appearance. Spatter is extremely low and slag is self-peeling.

"T1-1/T0-1" VS "T1-4/T0-4"?

Stainless Steel Flux Cored wires that end with a "-1", such as E308LT1-1 are for use with 100% CO_2 shielding gas. When using 100% CO_2, there will be a savings since CO_2 is a much cheaper gas, however
the weld deposits will lose some of their oxidizable characteristics and will even pick up more carbon from the CO_2 gas. The upside is that you will get greater penetration using CO_2 shielding gas

SPECIFICATION AWS/SFA 5.22 ALLOY	TYPICAL MECHANICAL PROPERTIES - AS WELDED		*UNDILUTED WELD METAL CHEMICAL ANALYSIS RANGES					
	Tensile Strength Minimum	Elongation Minimum	C	Cr	Ni	Mo	Mn	Si
E308T-1/-4 UNS W30831	80,000 psi	35%	0.04 -0.08	18.0 -21.0	9.0 -11.0	0.5	05 -2.5	0.4
E308LT1-1/-4 UNS W30835	75,000 psi (avg. 90,200 psi)	35% (avg.39.4%)	0.4	18.0 -21.0	90 -11.0	0.5	0.5 -2.5	0.4
E309T-1/-4 UNS W30931	80,000 psi	30%	0.10	22.0 -250	12.0 -14.0	0.5	0.5 -2.5	0.4
EC309L UNS W30935	81,500 psi (avg. 83,500 psi)	40%	0.03	22.0 -25.0	120 -14.0	0.5	0.5 -2.5	0.4
E309lMoT0-1/-4 UNS W30938	75,000 psi (avg. 95,200 psi)	25% (avg.32%)	0.04	210 -25.0	12.0 -16.0	2.0 -3.0	0.5 -2.5	0.4
E316T-1 UNS W31631	75,000 psi	30%	0.08	11.0 -20.0	2.0 -14.0	0.5 -3.0	-2.5	0.4
E316LT1-1/-4 UNS W31635	70,000 psi (avg. 93,500 psi)	30% (avg.38%)	0.04	17.0 -20.0	11.0 -14.0	2.0 -3.0	0.5 -2.5	0.4
E317LT0-1/-4 UNS W31735	75,000 psi (avg. 87,000 psi)	20% (avg.28.2%)	0.04	18.0 -21.0	12.0 -14.0	3.0 -4.0	0.5 -2.5	0.4
E347T0-1/-4' UNS W34731	75,000 psi (avg. 96,800 psi)	30% (avg.32%)	0.08	18.0 -21.0	9.0 -11.0	0.5	0.5 -2.5	0.4
E410T0-1/-4 UNS W41031	82,500 psi (1562°F x2 hrs. + *F.C.to 1094°F + **A.C.)	28%	0.70	11.0 -13.5	0.60	0.5	0.69	0.4
E410NiMoT0-1/-4 UNS W41036	146000 psi 127,000 ~,si	8% 22%	0.06	11.0 -12.5	4.0 -5.0	0.40 -0.70	1.0	0.4
	1112°F)(lhr,t"A.C,							
EC409TiT[a] UNS W40931	81,500 psi	17%	0.05	10.5 -13.5	Ti • 0.70	0.5	0.45	0.4

*F.C.:Furnace Cooling
**A.C.:Air Cooling

*Single values shown are maximums.
*All of the above contain P: 0.04 max., S:0.03 max and Cu: 0.5max.
a. Contains Titanium (Ti) in the amount of 10 x C min., 1.5 max
b. Contains: Cb+Ta(Nb): 8 x C min., 1.0 max.

Stainless Steel Flux Cored wires that end with a "-4", such as E308LT1-4 are designed for use with a 20-25% CO_2/Balance Argon mixtures. Washington Alloy recommends 80% Ar/20% CO_2 (although you can use 75% Ar/25% CO_2) for this specification. An 80/20 mixture will give a much softer arc, resulting in virtually no spatter. The softer arc also enhances vertical welding. Weld deposits of "-4" Stainless Steel Flux Cored wires exhibit less carbon pick up and less chromium loss, which pushes up the ferrite level of the weld deposit. Keep this fact in mind when examining the desired ferrite level or considering which gas to use. Greater weld deposit toughness can be achieved by choosing an 80/20 mixture over 100% CO_2.

WELDING RECOMMENDATIONS FOR OPTIMUM RESULTS

- Be sure that the wire feed drive rolls are not too tight, so as to not "crush" the flux-cored wire.
- Make sure the conduit and liner are as short as possible and that they are the correct I.D.
- Welding should be done from left to right. This will reduce spatter even further.
- The torch angle should be 10-20° from vertical to the base metal.
- Preheating is generally not needed for 300 series (austenitic) Stainless
- Steel, however, 400 series does require preheating.
- Changing the length of the wire stick-out does have a profound effect. The wire stick-out length influences arc stability, penetration, bead appearance and deposition rates. Basically you can increase the deposition rate by welding with a longer wire stick-out.

SPECIFICATIONS

AWS: A5.22
ASME:SFA5.22
ABS American Bureau of Shipping

PACKAGE OPTIONS

10 lb. (4.54 kg) spool - 8" flange .035 (0.9 mm), .045 (1.2 mm), 1/16 (1.6mm) 25 lb. (11.34 kg) spool -12" flange .035 (0.9 mm), .045 (1.2 mm), 1/16 (1.6 mm)
All 1 spool per carton Standard Pallets are 2100 lbs. (84 spools x 25 lbs./spool)

APPLICATIONS

All position welding of AISI 301, 302, 304, and 308. Produces an austenitic (non-magnetic) 19% Chromium - 9% Nickel weld deposit with a controlled ferrite.
Similar to 308HT0-1/-4 but the lower carbon content in the weld deposit greatly reduces the possibility of intergranular corrosion caused by carbide orecipitation. Commonly used on AISI 301, 302, 304, 304L and 308L
All-position welding of 25% Chromium -12% Nickel Stainless Steel. Commonly used on dissimilar metals such as joining stainless steel to carbon or low alloy steel and for welding the clad side of 18-8 stainless clad steels.
Better corrosion resistance than 309T0-1/-4, due to the lower carbon content of the weld deposit. Excellent crack resistance and oxidation resistance at extreme temperatures. Typical applications include furnaces, kiln linings, 309 wrought or cast parts.
For joining dissimilar metals of stainless steel to carbon and low alloy steels. Most commonly used as a buffer layer when cladding mild steel with 316 austenitic stainless.
For welding 18% Chromium -12% Nickel - 2.5% Molybdenum Stainless Steel. The addition of Molybdenum gives added creep resistance at elevated temperatures and corrosion resistance against "pitting" that may be caused by sulfuric and sulfurous acids, phosphoric acids and acetic acids.
An all-position wire similar to 316T0-1/-4, however the lower carbon content of the weld metal provides protection against integranular corrosion due to carbide precipitation. Commonly used in industries that manufacture rayon, dyes, paper, ink, rubber, bleaches, photographic chemicals.
All-position welding of austenitic 18% Chromium -12% Nickel - 3.5% Molybdenum Stainless Steel which is subjected to severely corrosive acids such as sulfuric or sulfurous acids and their salts. Excellent resistance to corrosion and pitting.
For Columbium stabilized grades of AISI 347 and 321 or 18/8 grades of austenitic stainless subjected to temperatures above 750°F but less than 1550°F. Also available in low carbon grade (E347LT0-1/-4) with a carbon level average of .03.
For welding AISI 403, 405, and 410 Chromium Steel. Primarily used as an overlay on carbon steel to give added resistance against corrosion, erosion or abrasion on valve seats and parts. Preheat and Postheat treatment is required for most applications.
All-position welding of 409, 410, 410S and 405 Stainless Steel. Less crack sensitive than 410T0-1/-4. Primarily used for repairing and welding CA6NM castings such as found in fluid handling equipment, valves and pump parts. Postweld heat treatment required.
For welding base metals of similar analysis. 11% Chromium with 0.70% Titanium as a stabilizer. Used extensively in the automotive industry for the fabrication of mufflers, catalytic converters and exhaust systems.

Build-Up And Hardsurfacing Flux Cored Wires

BUILD-UP AND HARDSURFACING FLUX CORED WIRES

FEATURES:	**DESCRIPTION:**	
All-Position 100% CO_2 Gas Shielded Superior Operator Appeal Excellent Circumferentially to Thin Sections and Edges .045" and 1/16" Diameters High Deposition Rates Easy Application	Washington Alloy small diameter Build-up and Hardsurfacing Flux cored Wires offer much greater deposition efficiency and are easier to use than coated electrodes. No stub loss. Greatly reduced "Down Time." Faster travel speed reduces base metal fatigue, thereby producing stronger, more durable welds than coated electrodes. Developed for use on conventional wire feed equipment and	with 100% CO_2 shielding gas, these wires offer outstanding operator appeal in any position. Circumferential welding of idlers, rollers, sprockets and wheels can be done easily when using .045". Excellent arc stability, very low spatter and a beautiful weld deposit that outlasts other brands. Slag removal is so easy and your "cost per pound" of deposited weld metal is greatly reduced.

TYPES AND DESCRIPTIONS

TYPES	DESCRIPTION
USA 250 HT (Build-up)	For building-up mild and low alloy steel parts to within 3/16"-3/8" of their original size. Weld deposits will be part ferritic - part martensitic in structure. USA 250 HT weld deposits have good compressive strength and resistance to plastic deformation. Weld deposits are easily machined in the "as welded" position. An excellent underlayment prior to hardsurfacing.
USA 300 HT (Build-up and Hardfacing Heavy Impact and Mild Abrasion)	Similar to USA 250 HT in weld deposit structure and uses. USA 300 HT offers a slightly harder weld deposit than USA 250 HT and subsequently it is often used in applications where a hardsurfacing layer is not applied over the USA 300 HT deposit. Excellent on carbon steel shovel pads, repairing battered rail and tractor parts.
USA 350 HT (Build-up and Hardfacing – Heavy Impact and Mild Abrasion)	USA 350 HT is our "general purpose" build-up and hardsurfacing wire. The weld deposit of USA 350 HT is a low alloy deposit with a martensitic structure. It is machinable and forgeable. A good balance of impact resistance and abrasion resistance as well as hardness make USA 350 HT an excellent choice where only one wire is desired for build-up and hardsurfacing. (Not to be used as an underlayment prior to subsequent hardfacing). Excellent for overlaying carbon steel shafts, gear teeth and sprockets.
USA 450 HT (Hardfacing-Metal to Metal Abrasion and Mild Impact)	USA 450 HT is designed for metal to metal abrasion involving impact such as rolling or sliding parts in earth moving equipment where lubrication is not possible. The weld deposits of USA 450 HT are martensitic in structure. Common uses would include printing and paper mill rolls, power shovel tumblers, mine car wheels, brake drums, tractor rollers, etc.
USA 600 HT (Hardfacing- Heavy Abrasion, Heavy Impact and Corrosion Resistant)	USA 600 HT offers high abrasion and heavy impact resistance on carbon, low alloy and manganese steel. Weld deposits are martensitic and corrosion resistant. USA 600 HT is designed for metal to metal and metal to earth abrasion. Weld deposits will work harden when put to service. Typical applications would include tillage tools, bucket lips, extruder screws, tamper feet, dredge cutter teeth and wherever high abrasion and heavy pounding is encountered.
USA 700 HT (Hardfacing-Heavy Abrasion and Heavy Impact)	USA 700 HT offers a harder weld deposit than USA 600 HT, but lacks the corrosion resistance. Primarily used for high metal to metal abrasion. Weld deposits are martensitic in structure and will work harden when put into service. Typical applications would include the hardsurfacing of rollers, conveyor screws, crusher rolls and mill hammers. Carbon, silicon, manganese, chromium, iron base.

Build-Up and Hardsurfacing Flux-Cored Wires

CHARACTERISTICS AND APPLICATIONS

PRODUCT	ALL-WELD-METAL COMPOSITION	HARDNESS ROCKWELL C	IMPACT RESISTANCE	ABRASION RESISTANCE	APPLICATIONS
USA 250 HT (Build-up)	Carbon Silicon Manganese Chromium Iron Base	20-26	Very Good	Poor	Underlaying for Hardsurfacing, Steelmill Wobblers and Pods, Shafting, Small Rolls, Pump Parts
USA 300 HT (Build-up)	Carbon Silicon Manganese Chromium Iron Base	28-32	Very Good	Poor	Build-up of Power Shovels and Tractor Parts, Repairing Battered Rail, Hammers
USA 350 HT (Build-up & Hardsurfacing)	Carbon Silicon Manganese Chromium Molybdenum Iron Base	34-39	Very Good	Fair	Overlaying Carbon Steel Shafts, Gear Teeth, Sprockets, Steel Shovel Pads
USA 450 HT (Hardsurfacing)	Carbon Silicon Manganese Chromium Molybdenum Iron Base	43-48	Very Good	Good	Mine Car Wheels, Tractor Rollers, Undercarriage Parts, Shovel Idlers, Rollers, and Hook Rolls
USA 600 HT (Hardsurfacing)	Carbon Silicon Manganese Chromium Molybdenum Iron Base	53-56	Excellent	Excellent	Extruder Screws, Bucket Lips, Tamper Feet, Tillage Tools, Dredge Parts, Ore Drag Lines, Muller Tires
USA 700 HT (Hardsurfacing)	Carbon Silicon Manganese Chromium Iron Base	58-61	Excellent	Excellent	Rollers, Conveyor Screws, Crusher Rolls, Mill Hammers

WELDING PARAMETRES AND DATA*

Use DC Reverse Polarity (electrode positive). The shielding gas should be 100% CO_2 welding grade, however a 75% CO_2 mixture will increase the hardness slightly. Superior properties are achieved if an interpass temperature of 300º-480ºF (480 º-580 ºF for USA 600 HT) is maintained.

WIRE DIAMETER	ELECTRODE STICKOUT	AMPS	VOLTS*
.045 (1.2 mm) 1/16 (1.6 mm)	¾” - 1-1/2” 1” – 2”	150-250 250-350	21-26 23-28
3/32” (2.4 mm) AND 7/64” (2.8 mm) AVAILABEL UPON REQUEST			

*Ideal procedure is to set the wire feed speed and find the voltage setting that will yield the smoothest performance.

PACKAGE OPTIONS

10 lb. (4.44 kg) spool—8” flange	.045 (1.2 mm)	1/16 (1.6 mm)		
33 lb. (11.35 kg) spool—12” flange	.045 (1.2 mm)	1/16 (1.6 mm)		
44 lb. (20.00 kg) spool—12” flange	.045 (1.2 mm)	1/16 (1.6 mm)		
60 lb. (27.20 kg) spool—12” I/D	.045 (1.2 mm)	1/16 (1.6 mm)	3/32 (2.4 mm)	7/64 (2.8 mm)

STAINLESS STEEL ELECTRODES AND SOLID WIRES

Washington Alloy stainless steel electrodes and wires are manufactured under the same strict quality control standards that are characteristic of all Washington Alloy products. An in-line process of manufacturing permits frequent testing of chemical composition, mechanical properties and weldability to assure that all heats of stainless steel conform to AWS and ASTM specifications. All spooled and coiled wire is further tested to make sure that cleanliness, temper, cast and helix meet Washington Alloy standards as well as AWS and ASTM requirements. There is a Washington Alloy stainless steel product for all your welding needs. MIG wires are available on 2 lb., 10 lb. and 25 lb. precision level-layer wound spools for easy, trouble-free use on all automatic or semi-automatic wire feeding units. Submerged arc welding can be achieved with Washington Alloy 60 lb. level-layer wound coils. TIG or oxyacetylene welding can be accomplished using Washington Alloy stainless steel cut lengths.

Stainless Steel **Solid Wir**e

Stainless steel welding differs from mild or carbon steel welding in that the stainless steel has low thermal conductivity and high expansion characteristics. Stainless steel expands approximately 50% more, but conducts heat 50% slower than mild or carbon steel making it much more susceptible to warping caused by temperature changes. Stainless steel is broken down into three major groups which we will briefly explain.

AUSTENITIC STAINLESS STEEL

Austenitic stainless steels include the chromium-nickel, AISI 200 and 300 series. This is the most common stainless steel group encountered and it is further divided into 7 smaller grades.

1. 1. The 18/8 grades consist of 18% chromium and 8% nickel. These grades are the most common and include AISI types 301, 302, 304, 305 and 308.
2. 2. The Manganese grades consist of the AISI 200 series (AISI 201, 202, etc.)
3. 3. The Extra Low Carbon (L) grades, which include AISI 304L and 308L, contain .03% maximum carbon to eliminate damaging carbide precipitation.
4. 4. The Stabilized grades such as AISI 321, 347, 348 contain small amounts of titanium, columbium or a tantalum-columbium combination to provide protection in severe corrosive conditions.
5. 5. The Molybdenum grades include AISI 316, 316L, 317 and 317L. These grades have a higher molybdenum content to provide greater corrosion resistance against “pitting” caused by chemical corrosion.
6. 6. The High Temperature grades, (AISI 302B, 309, 309S. 310, 310S) maintain their strength and scaling resistance at temperatures up to 2000°F.
7. 7. The Free-Machining grades include AISI 303, 303SE. These grades contain sulfur, selenium and phosphorus, making them very susceptible to porosity and cracking during welding.
8. Carbide Precipitation Carbide precipitation is a common problem encountered when welding with austenitic stainless steel. It occurs when the stainless steel is heated to temperatures in the 800°-1500°F range. At these temperatures, the carbon in the steel precipitates to the grain boundaries and unites with the chromium to form chromium carbides. When this happens, the stainless steel loses its corrosion resistance and eventually succumbs to intergranular corrosion. There are several ways to prevent or control this breakdown of corrosion resistance. The first method would be to use an electrode or wire from the Extra Low Carbon (L) grades such as USA 303L or USA 316L The lower the carbon content of the electrode or wire, the less likely carbide precipitation will occur. The second method of controlling carbide precipitation would be to select an electrode or wire from the stabilized grades such as USA 347. The columbium in USA 347 combines with the carbon before the chromium does, thereby preventing the formation of chromium carbides and preserving the corrosion resistance of the stainless steel.

MARTENSITIC STAINLESS STEEL

Martensitic stainless steel is considered a straight chromium steel that remains stable overall temperature ranges, retaining its good strength and scaling resistance at temperatures up to 1100°F. Martensitic stainless steels do not undergo carbide precipitation, however they are affected by rapid temperature changes and will produce brittle, hard and crack sensitive welds if the base metal is not preheated to at least 400°F. Preheating will minimize the temperature gradient and preserve the quality of the weld. USA 410 and 502 would be considered martensitic stainless steels.

FERRITIC STAINLESS STEEL

Ferritic stainless steel is another type of straight chromium steel. This group becomes extremely brittle and crack sensitive when subjected to the higher temperatures of welding. Therefore it is extremely important to pre-heat the base metal at a low temperature, use the lowest possible welding currents and the smallest diameter of electrode or wire. This should help to decrease the possibility of embrittlement of cracking caused by excessive grain growth. USA 430 would be considered a ferritic stainless steel.

USA 253 MA®

UNS S30815 NO AWS CLASSIFICATION

DESCRIPTION AND APPLICATIONS

USA 253 MA® is a heat-resisting austenitic stainless steel alloy wire modified with the rare earth element Cerium (Ce). USA 253 MA® is a unique alloy designed for welding 21% Cr-10% Ni grades of stainless steel including Avesta Sheffield 153 MA® (UNS S30415) and 253 MA® (UNS S30815). These special purpose 21% Cr- 10% Ni grades are now being used in petrochemical, refinery and power generating plants for fabricating and repairing tube hangers for steam super-heaters, furnace fans, ducting, dampers, muffles, retorts and pulverized coal burners in power boilers. USA 253 MA® provides weld deposits that offer excellent resistance to oxidation and scaling for service temperatures up to 2000°F (air), resistance to thermal shock. and for high creep-rupture strength. Currently, there is no AWS classification for this alloy.

TYPICAL WIRE CHEMISTRY (%)

C	0.090 max.
Mn	1.000 max.
Si	1.0-2.0
N	0.250 max.
Cr	20.0-22.0
Ni	9.00-11.00
Ce	0.08 max.
Fe	Balance

253 MA® is a registered trademark of Avesta Sheffield Steel

USA 307

AWS A5.9 Class ER307

DESCRIPTION AND APPLICATIONS

USA 307 is a high manganese austenitic stainless steel used for joining and surfacing applications involving work-hardenable steels. armour plate, heat resistant steels subjected to temperatures up to 1560°F and dissimilar steels such as austenitic manganese steels to carbon steel forgings and castings. Weld deposits are porosity free, crack and corrosion resistant.

TYPICAL WIRE CHEMISTRY (%)

C	0.12
Si	0.40
Mn	4.50
Cr	20.25
Ni	8.00
Mo	1.00

Stainless Steel **Solid Wire**

USA 308
AWS A5.9 Class ER308

DESCRIPTION AND APPLICATIONS
USA 308 is used to weld all stainless steel AISI 200 and 300 series up to and including 308. This wire is used where resistance to corrosion, impact and abrasion is required. Weld deposits will be equal or superior to the base metal.

TYPICAL WIRE CHEMISTRY (%)

C	0.04
Mn	1.84
Si	0.30
Cr	19.83
Ni	10.24

USA 308L
AWS A5.9 Class ER308L

DESCRIPTION AND APPLICATIONS
USA 308L is similar to USA 308 but contains an average .02% carbon producing a weld deposit with good resistance against intergranular corrosion caused by carbide precipitation. USA 308L is commonly used for welding AISI types 304L, 308L, 321 and 347.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	1.83
Si	0.35
Cr	19.70
Ni	9.82

USA 308LSi
AWS A5.9 Class ER308LSi

DESCRIPTION AND APPLICATIONS
USA 308LSi has a higher silicon content along with a low carbon content. The increased silicon level provides better arc stability and a smoother bead appearance while an average .02% carbon level reduces carbide precipitation. USA 308LSi produces excellent quality fillet a nd b utt welds. Typical applications would include those of USA 308 and USA 308L welding wires

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	1.83
Si	0.74
Cr	19.70
Ni	9.82

USA 309
AWS A5.9 Class ER309

DESCRIPTION AND APPLICATIONS
USA 309 is used for welding heat resistant AISI 309 and other straight chromium grades of stainless steel where preheat and postheat treatment is not possible. USA 309 wire produces sound ductile weld deposits. Other applications would include joining stainless steel to mild or carbon steels, steel overlay work and for welding AISI 304 clad stainless.

TYPICAL WIRE CHEMISTRY (%)

C	0.06
Mn	2.03
Si	0.36
Cr	23.48
Ni	13.45

USA 309L
AWS A5.9 Class ER309L

DESCRIPTION AND APPLICATIONS
USA 309L is similar to USA 309 but contains an average .02% carbon to provide a weld deposit that will offer good resistance against intergranular corrosion caused by carbide precipitation. USA 309L is excellent for buttered passes and overlay work. Typical applications include those of USA 309 welding wire.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	2.03
Si	0.36
Cr	23.48
Ni	13.45

USA 309LSi
AWS A5.9 Class ER309LSi

DESCRIPTION AND APPLICATIONS
USA 309LSi has a higher level of silicon than USA 309L combined with a carbon content lower than USA 309. The increased silicon level provides better arc stability and a smoother bead appearance while an average 02% carbon level reduces carbide precipitation. Typical applications would include those of USA 309 and USA 309L.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	2.03
Si	0.84
Cr	23.48
Ni	13.45

Stainless Steel **Solid** Wire

USA 309LMo
AWS A5.9 Class ER309LMo

DESCRIPTION AND APPLICATION
USA 309LMo offers greater corrosion resistance at elevated temperatures than USA 309L The addition of molybdenum to the chemical analysis also gives the weld deposit improved crack resistance. USA 309LMo is commonly used for welding ferritic steel plates clad with AISI 316 stainless steel. Excellent for 317L stainless and dissimilar steel applications involving sulphuric and phosphoric acids.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Si	0.40
Mn	1.50
Cr	24.00
Ni	12.50
Mo	2.70

USA 310
AWS A5.9 Class ER310

DESCRIPTION AND APPLICATIONS
USA 310 is used for welding types AISI 310, 304 clad stainless steel, ferritic and martensitic chromium steels, and for stainless steel overlay work on mild and carbon steels. USA 310 welding wire produces weld deposits of high strength and high resistance to scalling at elevated temperatures.

TYPICAL WIRE CHEMISTRY (%)

C	0.140
Mn	1.80
Si	0.50
Cr	27.00
Ni	21.10

USA 312
AWS A5.9 Class ER312

DESCRIPTION AND APPLICATIONS
USA 312 stainless steel welding wire is used for high strength and high yield steels, stainless to mild steels and AISI 304 clad stainless steel. This wire produces weld deposits of very high strength.

TYPICAL WIRE CHEMISTRY (%)

C	0.14
Mn	1.40
Si	0.50
Cr	29.90
Ni	9.00

USA 316
AWS A5.9 Class ER316

DESCRIPTION AND APPLICATIONS
USA 316 is used for welding AISI 316 stainless subjected to high temperature service such as that found in gas turbines. The addition of molybdenum gives the weld deposit high resistance to pitting caused by corrosive liquids as well as improved creep resistance at elevated temperatures

TYPICAL WIRE CHEMISTRY (%)

C	0.04
Mn	1.54
Si	0.40
Cr	18.86
Ni	12.20
Mo	2.28

USA 316L
AWS A5.9 Class ER316L

DESCRIPTION AND APPLICATIONS
USA 316L is similar to USA 316 but contains an average .02% carbon producing a weld deposit with excellent resistance against intergranular corrosion caused by carbide precipitation. USA 316L is used for welding AISI types 316L and 318 that may be exposed to organic and inorganic acids.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	1.70
Si	0.36
Cr	19.88
Ni	12.36
Mo	2.28

USA 316LSi
AWS A5.9 Class ER316LSi

DESCRIPTION AND APPLICATIONS
USA 316LSi has a higher silicon content along with a low carbon content, producing better arc stability, smoother bead appearance and excellent resistance to carbide precipitation. USA 316LSi is used for welding austenitic acid-resistant steels such as those containing 18% Cr - 8% Ni - 2-3% Mo

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	1.70
Si	0.86
Cr	19.88
Ni	12.36
Mo	2.28

Stainless Steel **Solid Wire**

USA 317L
AWS A5.9 Class ER317L

DESCRIPTION AND APPLICATION
USA 317L stainless steel wire is used to weld austenitic acid-resistant steels such as those containing 18% Cr-8% Ni - 2-3% Mo. USA 317L produces weld deposits which exhibit excellent resistance to corrosion that may be caused by organic and inorganic acids as well as pitting caused by chloride solutions.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Si	1.75
Mn	0.45
Cr	19.00
Ni	13.30
Mo	3.20

USA 318
AWS A5.9 Class ER318

DESCRIPTION AND APPLICATIONS
USA 318 is a stainless steel alloy wire designed for welding AISI 316 stabilized and 316Ti or 318 modified austenitic stainless steels. USA 318 is designed for use in applications with service temperatures up to 750ºF. The addition of sufficient amounts of the element columbium (Cb) in the formula of this alloy wire eliminates the formation of chromium carbides. The absence of chromium carbides eliminates failures due to intergranular corrosion caused by carbide precipitation. USA 318 is preferred over 316 when a complete absence of chromium carbides is necessary.

TYPICAL WIRE CHEMISTRY (%)

C	0.080 max.
Mn	1.000 max
Si	1.0-2.0
Cr	20.0-22.0
Ni	9.0-11.0
Mo	2.0-3.0
Cb	1.0 max.
Fe	Balance

USA 320
AWS A5.9 Class ER320

DESCRIPTION AND APPLICATIONS
USA 320 is used to weld similar base metals that are subjected to severe chemical corrosion. This wire provides exceptional resistance to carbide precipitation thereby preventing intergranular corrosion.

TYPICAL WIRE CHEMISTRY (%)

C	0.02
Mn	0.45
Si	0.25
Cr	19.70
Ni	33.40
Mo	2.10
Cb & Ta	0.40
Cu	3.20

USA 320LR
AWS A5.9 Class ER320LR

DESCRIPTION AND APPLICATIONS
USA 320LR is basically a modified version of USA 320, where the “residuals’’ — carbon, silicon, phosphorus and sulphur are specified at lower maximum levels. The columbium and manganese content of USA 320LR is also maintained within a tighter range. These strict controls eliminate hot cracking and microfissuring frequently encountered in austenitic stainless steel.

TYPICAL WIRE CHEMISTRY (%)

C	0.025
Cr	19.60
Ni	34.10
Mo	2.50
Cb & Ta	0.25
Mn	1.60
Cu	3.40

USA 321
AWS A5.9 Class ER 321
AMS 5689D

DESCRIPTION AND APPLICATIONS
USA 321 is a 19% chromium - 9% nickel - plus titanium stainless steel filler metal used for TIG welding base metals of similar analysis. The titanium content reduces intergranular chromium carbide precipitation thereby increasing resistance to intergranular corrosion.

TYPICAL WIRE CHEMISTRY (%)

C	0.05
Cr	19.00
Ni	9.75
Mo	0.38
Mn	1.75
Si	0.48
Ti	0.65

USA 330
AWS A5.9 Class ER330

DESCRIPTION AND APPLICATIONS
USA 330 stainless steel welding wire is used for cast and wrought base metals of similar composition. USA 330 has excellent resistance to heat and scale at temperatures as high as 800°F.

TYPICAL WIRE CHEMISTRY (%)

C	0.20
Mn	1.75
Si	0.35
Cr	16.00
Ni	35.00

Stainless Steel **Solid** Wire

USA 347
AWS A5.9 Class ER347

DESCRIPTION AND APPLICATION
USA 347 is used for welding AISI types 304, 304L, 321 and 347 where maximum corrosion resistance is required. USA 347 contains columbium which acts as a stabilizer against carbide precipitation thereby eliminating intergranular corrosion.

TYPICAL WIRE CHEMISTRY (%)

C	0.04
Mn	1.64
Si	0.40
Cr	20.20
Ni	9.85
Cb & Ta	0.86

USA 409 Cb
AWS A5.9 Class ER409Cb

DESCRIPTION AND APPLICATIONS
USA 409 Cb is a ferrific stainless steel alloy wire modified with the element columbium (Cb). USA 409 Cb is a special purpose heat-resisting alloy with excellent weld metal flow and smooth bead appearance designed for GMAW (MIG) welding of exhaust manifolds and catalytic converters in the automotive industry. This alloy wire can be used for many other applications for joning both AISI 409 and AIS 410 stainless steels using MIG, TIG or Submerged Arc processes.

TYPICAL WIRE CHEMISTRY (%)

C	0.080 max.
Mn	0.800 max
Si	1.000 max
Ni	0.600 max
Cr	10.5-13.5
Cb	0.750 max
Fe	Balance

USA 410
AWS A5.9 Class ER410

DESCRIPTION AND APPLICATIONS
USA 410 stainless steel welding wire is used to weld straight chromium steels such as AISI types 403, 405, 410, 414 and 416. It is also used as an overlay on carbon steels to give added resistance against corrosion and abrasion. Preheat and postheat treatment is required.

TYPICAL WIRE CHEMISTRY (%)

C	0.08
Mn	0.50
Si	0.40
Cr	12.90
Ni	0.40
Mo	0.15

USA 410NiMo
AWS A5.9 Class ER410NiMo

DESCRIPTION AND APPLICATIONS
USA 410 NiMo is designed for welding ASTM CA6NM castings as well as light gauge 405, 410 and 410S stainless steels. The increased nickel and molybdenum content of USA 410NiMo provides for improved corrosion resistance at elevated temperatures. Preheat and postweld heat treatment is recommended. Postweld heat treatment should not exceed 1150°F.

TYPICAL WIRE CHEMISTRY (%)

C	0.03
Mn	0.50
Si	0.40
Cr	12.10
Ni	4.00
Mo	0.60

USA 420
AWS A5.9 Class ER420
AMS 5621

DESCRIPTION AND APPLICATIONS
USA 420 is a martensitic stainless steel similar to USA 410, but with a higher level of carbon. This increased carbon content gives the weld deposit greater hardness, providing for excellent abrasion resistance as well as moderate corrosion resistance. Weld deposits will work-harden when put into service and so this filler metal is commonly used for surfacing applications. Preheat and postweld heat treatment is recommended.

TYPICAL WIRE CHEMISTRY (%)

C	0.28
Mn	0.42
Ni	0.40
Cr	13.13
Si	0.37
Mo	0.15

USA 430
AWS A5.9 Class ER430

DESCRIPTION AND APPLICATIONS
USA 430 is used for welding AISI types 403 stainless steel where maximum corrosion resistance at temperatures up to 1600°F is required. Preheat and postheat treatment is recommended.

TYPICAL WIRE CHEMISTRY (%)

C	0.07
Mn	0.52
Si	0.37
Cr	16.76
Ni	0.40
Mo	0.15

Stainless Steel **Solid Wire**

USA 17/4 PH (630)
AWS A5.9 Class ER630

DESCRIPTION AND APPLICATION
USA 17/4 (630) PH is a martensitic precipitation, age-hardening 17% chromium -4% nickel stainless steel designed for welding ASTM A564 Type 630 and other martensitic PH stainless steels such as 15-5. Weld deposits have excellent mechanical properties with high strength and hardness. USA 17/4 (630) can be used with all welding processes without preheating, however postweld heat treatment is recommended to produce weld properties comparable to the base metal. Commonly used in high temperature and abrasion resistant environments such as found in the petrochemical and aerospace industries.

TYPICAL WIRE CHEMISTRY (%)

C	0.04
Cr	16.50
Ni	4.50
Mn	0.60
Si	0.50
Cu	3.50
Cb & Ta	0.30

USA 17/7 PH

DESCRIPTION AND APPLICATIONS
USA 17/7 PH is a 17% chromium -7% nickel, precipitation-hardening stainless steel designed for MIG and TIG welding of corrosion resistant steels of similar composition where the weld deposit must have the same strength and corrosion resistance as that of the base metal. USA 17/7 PH is commonly used in cold heading and spring applications.

TYPICAL WIRE CHEMISTRY (%)

C	0.09*
Cr	17.00
Ni	7.00
Mn	1.00*
Al	1.00
Si	0.50*

*Maximum

USA 80S-B2 (515)
AWS A5.28 Class ER80S-B2
Formerly AWS A5.9 ER515

DESCRIPTION AND APPLICATIONS
USA 80S-B2 is used for gas metal arc welding of 1-1/4% chromium, 1/2% molybdenum steels and type 515 stainless steels.

TYPICAL WIRE CHEMISTRY (%)

C	0.09
Mn	0.60
Cr	1.50
Mo	0.54
Si	0.45

USA 80S-B6 (502)
AWS A5.28 Class ER80S-B6
Formerly AWS A5.9 ER502

DESCRIPTION AND APPLICATIONS
USA 80S-B6 (502) is used for welding AISI type 502 stainless steels and 5% chrome moly steels.

TYPICAL WIRE CHEMISTRY (%)

C	0.09
Mn	0.46
Si	0.36
Cr	5.70
Mo	0.54

USA 80S-B8 (505)
AWS A5.28 Class ER80S-B8
Formerly AWS A5.9 ER505

DESCRIPTION AND APPLICATIONS
USA 80S-B8 (505) is used for welding AISI type 505 stainless steels and 6-8% and 8-10% chrome moly steels.

TYPICAL WIRE CHEMISTRY (%)

C	0.10
Mn	1.00
Si	0.90
Cr	9.50
Ni	0.40
Mo	1.00
P	0.03
S	0.03

USA 90S-B3 (521)
AWS A5.28 Class ER90S-B3
Formerly AWS A5.9 ER521

DESCRIPTION AND APPLICATIONS
USA 90S-B3 is used for gas metal arc welding of 2-1/4% Cr – 1% Mo chrome moly steels and type 521 stainless steel.

TYPICAL WIRE CHEMISTRY (%)

C	0.08
Mn	0.57
Cr	2.41
Mo	0.98
Si	0.52

Stainless Steel **Solid** Wire

USA 90S-B9
AWS A5.28 Class ER90S-B9
AWS A5.23 Class EB9-B9

DESCRIPTION AND APPLICATION
Washington Alloy ER90S-B9 is a 9% Cr-1% Mo alloy wire modified with niobium (columbium) and vanadium. ER90S-B9 is designed to provide creep-rupture strength, toughness, fatigue life, oxidation and corrosion resistance at elevated service temperatures and pressures (up to 4,000 psi). The formula of ER90S-B9 is modified by the addition of vanadium, and niobium (columbium) and is manufactured with increased control of nitrogen. ER90S-B9, when subjected to proper welding procedures and post-weld heat treatment, yields deposits that result in a deposit structure of tempered martensite with precipitation of FeCr carbides (M22C6) and vanadium-rich carbon-nitrides. This allows higher operating steam temperatures and pressures and provides higher long-term creep- rupture properties. Weld deposits of ER90S-B9, unlike 12% Cr steels, can be cooled to room temperature without the risk of cold cracks. Applications for ER90S-B9 include welding many P-91 grade steels, ASTM-ASME A-213, A- 335, and A387-grade 91 martensitic steels used in fabrication of turbines, header systems, re- heat piping systems and for high temperature (1040-1112°F), high pressure (up to 4,000 psi) steam piping in electric power generating stations.

TYPICAL WIRE CHEMISTRY (%)

C	0.080
Mn	1.250
Si	0.500
P	0.010
S	0.010
Cr	9.500
Mo	1.200
V	0.150
Al	0.250
Nb	0.060
N	0.050
Ni	1.000

USA 904L (385)
AWS A5.9 Class ER385
UNS N08904

DESCRIPTION AND APPLICATIONS
Washington Alloy USA 904L is a high alloy austenitic stainless steel with extra low carbon content intended for use in severe corrosive conditions. Residual elements C, Si, P, S and N are kept at much lower levels in order to keep the weld metal from not Cracking and fissuring. USA 904L is designed for joining 20% Cr-25% Ni-4.5% Mo-1.5% Cu stainless steels used to manufacture and repair processing equipment, tanks. vessels. and process piping handling acetic acids, sulphuric acid Solutions and many Chloride containing media. Other uses include cooling units for sea water and river water purification plants and for cladding lower alloy steels when used in many corrosive media environments. USA 904L is also used for joining AISI type 317 where improved corrosive resistance in specific media is required. A shield gas of 30% argon and 70% helium is recommended for GMAW (MIG) applications.

TYPICAL WIRE CHEMISTRY (%)

C	0.025 max.
Mn	1.0-2.5
Si	0.500 max.
Ni	24.0-26.0
Cr	19.5-21.5
Mo	4.2-5.2
Cu	1.2-2.0
N	0.04

USA 2209
AWS A5.9 Class ER2209
UNS W39209

DESCRIPTION AND APPLICATIONS
USA 2209 is a stainless steel alloy wire designed for welding AISI316 stabilized and 316Ti or 318 austenitic stainless steels. USA 2209 produces duplex stainless steel weld deposits with a nearly balanced austenite-ferrite microstructure. USA 2209 weld deposits exhibit high tensile strength, improved resistance to stress corrosion cracking and greater resistance to pitting than conventional austenitic grades of stainless steel. USA 2209 is designed for welding 22% chromium duplex stainless steels such as ASME-ASTM A-182, A-276, A-479, A-789, A- 790, and A-890. 3RE60®, 44LN® and Ferralium 255® are proprietary duplex stainless steel base metals in the 22% Cr category available commercially that can be joined successfully with USA 2209. Non-proprietary grades 2205 and 2304 duplex stainless steels are also readily available, and can be joined successfully with USA 2209.

TYPICAL WIRE CHEMISTRY (%)

C	0.030 max.
Mn	0.5-2.0
Si	0.90 max.
Cr	21.5-23.5
Ni	7.5-9.5
Mo	2.5-3.5
Cb	1.0 max.
N	0.15

3RE60® is a registered trademark of Sandvik Steel Co. 44LN® is a registered trademark of Avesta Sheffield Steel Co. Ferralium 255® is a registered trademark of Cabot Corporation

STAINLESS STEEL **SOLID** WIRE
Available Sizes and Packaging

Precision level layer wound

Package	Wire Sizes (in.)	Spool Dimensions (in.)		
		O.D	Width	Arbor Hole
2 lb. spools	.023-.045	4	2	5/8
11 lb. spools	.023-1/16	8	2	2
33 lb spools	.023-1/8	12	4	2

*2 lb. spools are packaged 40 lbs. (20 spools) per carton

Level layer wound coils

Package	Wire Sizes (in.)	Coil Dimensions (in.)		
		I.D.	Width	O.D.
60 lb. coils	.035-3/16	12	4	15

Straight and cut lengths

Package	Wire Sizes (in.)	Length (in.)	Standard Cartons
50 lb. bulk carton*	.030-3/16	36	(1) 50 lb. carton (50 lbs.)
10 lb. tubes.*	.030-3/16	36	5 tubes per carton (50 lbs.)

Flag-tagging is available-please inquire.

Standard wire diameters (in.): .023, .030, .035, .045, 1/16, 3/32, 1/8, 5/32, 3/16.

FLUX AND METAL CORED WIRES

GENERAL WELDING PROCEDURES

Since the cost of stainless steel is much more than that of mild steel, it is most important that errors do not occur. Therefore prior to welding, a stainless wire brush should be used to remove all foreign matter from the base metal edge Preheating is not required when using any 300 series electrode, however preheating and an inter-pass temperature between 300-800°F is recommended when using any 400 or 500 series electrode. In stainless steel arc welding, you would use the electrode that will yield a weld deposit which is most comparable to the base metal. The arc length should be kept as small as possible without touching the electrode to the weld puddle. The welding current should be kept to a minimum or the welding speed at a maximum to reduce warping. Welding currents may be selected from the enclosed Chart. Titania coated (-16) electrodes can be used with AC or DC (reverse polarity) white the time coated (-15) electrodes are used with DC (reverse polarity) only. Stringer beads should be used for welding in the flat, horizontal and overhead positions. Vertical welding should be done using the weaving technique, but not to exceed 2-3 times the electrode diameter.

ELECTRODE COATINGS

Washington Alloy stainless steel electrodes are available with two types of coating: AC-DC (-16) titania coated electrodes are the most popular because their “dual-current” usage allows for the stocking of one type for all needs. This electrode coating provides a smooth stable are, with low spatter and complete penetration. The spray type metal transfer produces a smooth flat bead with very easy slag removal. Titania coated electrodes have exceptional starting characteristics and may be used in all positions. DC (-15) lime coated electrodes are used where a more convex bead is desirable. The lime coating allows for fast setup of weld metal making this electrode suitable for welding in all positions. This electrode produces a slag which completely Covers the weld to provide fast wetting and low spatter. Slag removal is easy.

STAINLESS STEEL ELECTRODES

Washington Alloy stainless steel electrodes are clearly marked with the appropriate AWS Classification number as well as lot number. This service is designed to protect the welder from receiving or using the wrong electrode and meets with the approval of AWS.

USA 253MA-16®

UNS S30815

DESCRIPTION:

USA 253 MA® austenitic stainless steel electrodes produce weld deposits that exhibit outstanding oxidation resistance at extreme temperatures up to 2000°F. The addition of the rare earth element cerium (Ce) and alkali oxides in the flux coating provide creep-rupture strength comparable to most nickel-chromium high temperature alloys. USA 253 MA® is a commonly used in petro-chemical, refinery and steam superheater tube hangers, furnace fans, dampers, muffles, retorts. and pulverized coal burners in power boilers.

TYPICAL WIRE CHEMISTRY (%)

C	0.080
Mn	0.600
Si	1.700
Cr	21.000
Ni	11.000
Ce	0.040
N	0.170
Fe	Balance

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield Point (psi)	102,000
Tensile Strength -0.2% offset(psi)	54,000
% Elongation in 2”	55%
Hardness	90

253 MA® is a registered trademark of Avesta Sheffield Steel Co.

SIZES, PACKAGING AND RECOMMENDED CURRENT RANGES

Dia. (in.)	Length. (in.)	Approx. pcs. per lb.	Std. Packaging (ctn.)	300 series (Amps.)	400 series (Amps.)	500 series (Amps.)
5/64	9	65	6-10 lb. tubes in 60 lb. master	30-50	—	—
3/32	12	44	6-10 lb. tubes in 60 lb. master	45-70	50-75	50-80
1/8	14	16	6-10 lb. tubes in 60 lb. master	75-110	90-120	100-135
5/32	14	10	6-10 lb. tubes in 60 lb. master	100-140	110-150	120-180
3/16	14	8	6-10 lb. tubes in 60 lb. master	120-180	120-200	185-245
1/4	14	—	6-10 lb. tubes in 60 lb. master	220-290	250-310	300-350

1/16* Electrodes are available in certain alloys – please inquire

Stainless Steel Electrodes

USA 307-15, 16
AWS A5.4 Class E307-15, 16

DESCRIPTION AND APPLICATION
USA 307 was developed for the welding of armour plate joints. This electrode produces a 18% Cr-8% Ni - 6% Mn stainless steel weld deposit that provides greater resistance to abrasion and Cracking. USA 307 electrodes are also used for welding dissimilar metals and difficult-to-weld steel. Preheat and postheat treatment is not required.

TYPICAL WIRE CHEMISTRY (%)

C	0.08
Mn	3.60
Si	0.50
Cr	20.20
Ni	9.40
Mo	1.15

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi) 90,000
Yield Strength (psi).....67,000
Elongation in 2”.....44

USA 308-15, 16
AWS A5.4 Class E308-15, 16

DESCRIPTION AND APPLICATION
USA 308 electrodes are used for welding austenitic 18% Cr. - 8% Ni stainless steel types: AISI 301, 302, 304 and steel castings of similar composition such as rust-proof or ferritic steels. USA 308 electrodes provide sound weld deposits which exhibit physical properties and corrosion resistance equal to or greater than that of the base metal. This electrode provides good striking and smooth fusion, low spatter loss and easy slag removability. Ground and polished weld deposits cannot be distinguished from the base metal. USA 308 electrodes are typically used for joint welds in dairy distillary and restaurant equipment, chemical tanks, chemical engineering applications and as a build-up for sealing faces of valves and fittings for acid, gas, water and steam.

TYPICAL WIRE CHEMISTRY (%)

C	0.060
Mn	1.530
Si	0.330
P	0.015
S	0.012
Cr	20.360
Ni	10.360

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....86,000
Yield Strength (psi).....61,000
Elongation in 2”(%).....46

USA 308L-15, 16
AWS A5.4 Class E308L-15, 16

DESCRIPTION AND APPLICATIONS
USA 308L electrodes contain extra low carbon for the welding of austenitic, low carbon 18% Cr-8% Ni stainless steels such as AISI- 304-ELC. The weld deposit of this electrode contains a maximum of 0.04% carbon, which greatly reduces the formation of chromium carbides, thereby protecting the corrosion resistant qualities of the base metal and weld. USA 308L electrodes have a high deposition rate resulting in excellent efficiency. This electrode may be used in all positions. In addition to 304-ELC, USA 308L electrodes may be used for stabilized stainless steels such as AISI 321 and 347, Joint welds in construction parts for chemical engineering and cryogenic applications.

TYPICAL WIRE CHEMISTRY (%)

C	0.030
Si	0.400
Mn	1.030
P	0.018
S	0.010
Cr	19.580
Ni	10.200

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....80,000
Yield Strength (psi).....55,000
Elongation in 2”(%).....46

Stainless Steel Electrodes

USA 308Mo-15, 16
AWS A5.4 Class E308Mo-15, 16

DESCRIPTION AND APPLICATION
USA 308Mo electrodes are used to weld armour plate joints, dissimilar metals and difficult -to-weld steel. The weld deposit of USA 308Mo contains 18% Cr- 8% Ni -6% Mn to provide greater resistance against abrasion and cracking. Preheat and postheat treatment is not required.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.08
Mn	1.65
Si	0.45
Cr	20.00
Ni	9.50
Mo	2.10

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....100,000
Yield Strength (psi).....73,000
Elongation in 2" (%).....37

USA 309-15, 16
AWS A5.4 Class E309-15, 16

DESCRIPTION AND APPLICATIONS
USA 309 electrodes are used for welding heat resistant, austenitic 309 stainless steel as well as other Cr-Ni steels of similar analysis such as AISI 405, 410, 430, 442 and 446. This electrode yields weld deposits which exhibit high strength, crack resistance and oxidation resistance at temperatures up to 2000°F. USA 309 is also used for joining mild or carbon steels to stainless steels and for welding the clad side of 18-8 stainless clad steels. Typical applications would include furnace parts, kiln linings and heat treating boxes. USA 309 electrodes have a high deposition rate and may be used in all positions.

TYPICAL WIRE CHEMISTRY (%)

C	0.080
Mn	1.640
Si	0.430
P	0.015
S	0.012
Cr	24.180
Ni	13.230

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....91,000
Yield Strength (psi).....53,000
Elongation in 2" (%).....40

USA 309-15, 16
AWS A5.4 Class E309L-15, 16

DESCRIPTION AND APPLICATIONS
USA 309L electrodes are used for welding 22% Cr-12% Ni stainless steel, mild or carbon steel to stainless steel and stainless clad steel. This electrode will produce an austenitic-ferritic, ductile weld deposit that contains a maximum of 0.04% carbon, there-by providing good crack resistance and inter-granular corrosion resistance superior to that of USA 309 electrodes. Typical applications are similar to those of USA 309, but where stronger corrosion resistance is required.

TYPICAL WIRE CHEMISTRY (%)

C	0.025
Si	0.440
Mn	1.640
P	0.020
S	0.009
Cr	24.000
Ni	13.000

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....86,000
Yield Strength (psi).....64,000
Elongation in 2" (%).....38

USA 309Cb-15, 16
AWS A5.4 Class E309Cb-15, 16

DESCRIPTION AND APPLICATIONS
USA 309Cb electrodes are used where maximum corrosion and oxidation resistance at temperatures up to 2000°F is required. The addition of columbium gives the weld deposit excellent resistance to carbide precipitation and greater strength at higher temperatures. USA 309Cb is used for welding stainless clad steel containing Cb or Ti such as AISI 347 or 321, to mild steel. It is excellent for use on airplane exhaust Systems

TYPICAL WIRE CHEMISTRY (%)

C	0.070
Mn	1.000
Si	0.500
P	0.012
S	0.012
Cr	23.000
Ni	13.000
Cb	0.850

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....100,000
Yield Strength (psi).....80,000
Elongation in 2" (%).....34

*USA 309Mo-15, 16
AWS A5.4 Class E309Mo-15, 16

DESCRIPTION AND APPLICATIONS
USA 309Mo was developed for welding 22% Cr- 12% Mi - 2.5% Mo stainless steel, austenitic stainless steel containing molybdenum to mild or carbon steel and for welding ferritic steel plates clad with AISI 316 stainless steel. This electrode yields an austenitic ferritic, crack resistant weld deposit that will provide corrosion resistance against sulfuric acid, phosphoric acid, etc. USA 309Mo weld deposits have a tensile strength greater than that of USA 309 or USA 309L. It is typically used for overlaying carbon steel giving weld deposits analogous to 316 stainless steel.

TYPICAL WIRE CHEMISTRY (%)

C	0.060
Mn	1.440
Si	0.380
P	0.012
S	0.012
Cr	23.780
Ni	13.440
Mo	2.310

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....94,000
Yield Strength (psi).....74,000
Elongation in 2" (%).....37

USA 310-15, 16
AWS A5.4 Class E310-15, 16

DESCRIPTION AND APPLICATIONS
USA 310 is considered a general purpose electrode used mainly for welding AISI 310 stainless steel but also for straight chromium stainless as well as almost any analysis of carbon and alloy steel. The weld deposit of this electrode will have an austenitic structure with a chemical analysis and oxidation resistance similar to that of the base plate. USA 310 provides easy slag removability and a flat regular bead with fine appearance. More common applications include 25% Cr - 20% Ni stainless steel, Cr-Mo stainless steel to mild steel, and the clad side of 18% Cr - 8% Ni stainless clad steel. USA 310 can be used in all positions.

TYPICAL WIRE CHEMISTRY (%)

C	0.120
Si	0.400
Mn	1.860
P	0.020
S	0.011
Cr	26.500
Ni	21.000

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....87,700
Yield Strength (psi).....52,000
Elongatsion in 2" (%).....41

Stainless Steel Electrodes

USA 308Mo-15, 16
AWS A5.4 Class E308Mo-15, 16

DESCRIPTION AND APPLICATION
USA 310Mo is similar to USA 310 but with molybdenum added for improved high tem-perature creep properties. The weld deposit is fully austenitic and corrosion resistanl. USA 310Mo elecIrodes are primarily intended for welding the clad side of 316, 316L and 317 clad steels as well as other grades of molybdenum bearing stainless steels. USA 310 Mo electrodes are used for the resurfacing of digesters in the paper industry.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.100
Mn	2.100
Si	0.450
P	0.012
S	0.012
Cr	26.000
Ni	21.000
Mo	2.250

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....90,000
Yield Strength (psi)..... 65,000
Elongation in 2” (%)..... 39
USA 310Cb-15, 16 AWS A5.4 Class E310Cb-15, 16

USA 310Cb-15, 16
AWS A5.4 Class E310Cb-15, 16

DESCRIPTION AND APPLICATIONS
USA 310Cb electrodes are similar to USA 310 but contain columbium for improved resistance against carbide precipitation at higher temperatures. USA 310Cb is used for welding AISI 304, 309, 310, 316, 321, and 347 stainless clad steels as well as for joining 25% Cr - 20% Ni - Cb stainless steels to mild or carbon steels.

TYPICAL WIRE CHEMISTRY (%)

C	0.100
Mn	2.100
Si	0.450
P	0.012
S	0.012
Cr	26.000
Ni	21.000
Cb	0.850

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....90,000
Yield Strength (psi).....65,000
Elongation in 2” (%).....35

USA 312-15, 16
AWS A5.4 Class E312-15, 16

DESCRIPTION AND APPLICATIONS
USA 312 electrodes produce a weld deposit (as welded) with the highest tensile and yield strength of any stainless arc electrode. As a result, it is one of the most widely used stainless steel electrodes for arc welding. It is used to weld dissimilar steels, abrasion resistant steels, high yield steels and for joining high temperature alloys to carbon or low alloy steels. USA 312 electrodes produce ductile, crack resistant, porosity-free, weld deposits with greater root penetration and better slag control in tight places. USA 312 is also used for Mn steels, hardening steels, armour steels, spring steels, and as a wear resistant build-up and buffer layer for hardfacing. This electrode may be used in all positions.

TYPICAL WIRE CHEMISTRY (%)

C	0.120
Mn	1.700
Si	0.600
P	0.030
S	0.020
Cr	29.500
Ni	9.000

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....120,000
Yield Strength (psi).....85,000
Elongation in 2” (%).....30

Stainless Steel Electrodes

USA 316-15, 16
AWS A5.4 Class E316-15, 16

DESCRIPTION AND APPLICATION
USA 316 electrodes are used for welding corrosion resistant austenitic Cr-Ni stainless steels containing 2-3% molybdenum. The molybdenum content of this electrode gives the weld deposit excellent corrosion resistance at elevated temperatures against pitting that may be caused by sulfuric and sulfurous acids, phosphoric acids, and acetic acids. USA 316 electrodes have good deposition efficiency, producing weld deposits with smooth bead appearance and easy slag removability. This electrode can be used in any position, however it is best suited for flat and horizontal fillet welding. USA 316 electrodes are most commonly used in industries which manufacture rayon, dye, paper, ink, rubber, bleaches, dye stuffs, photographic chemicals and as a build-up on sealing faces of valves and fittings for acid, gas, water and steam made from unalloyed or low alloyed steels.

TYPICAL WELD METAL CHEMISTRY (% - tested with 100% CO_2)

C	0.050
Mn	1.480
Si	0.330
P	0.021
S	0.011
Cr	18.320
Ni	12.850
Mo	2480

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....86,000
Yield Strength (psi)..... 56,000
Elongation in 2” (%).....40

USA 316L-15, 16
AWS A5.4 Class E316L-15, 16

DESCRIPTION AND APPLICATION
USA 316L electrodes produce weld deposits similar to that of USA 316, but with a maximum 0.04% carbon. This extra low carbon content gives the weld deposit excellent resistance against intergranular corrosion caused by carbide precipitation. USA 316L electrodes are used for welding 18% Cr – 12% Ni - 2.5% Mo stainless steels where the corrosion resistant qualities of AISI 316L are required. This electrode has a high deposition rate and produces a weld deposit with fine bead appearance and exceptional crack-resistance. USA 316L electrodes are most commonly used in the textile, paper, cellulose, and chemical equipment industries for the fabrication of 316L, 318 and 319L stainless steel products.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.030
Mn	1.250
Si	0.480
P	0.020
S	0.012
Cr	19.060
Ni	12.120
Mo	2.160

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....86,000
Yield Strength (psi).....57,000
Elongation in 2” (%).....39

USA 317-15, 16
AWS A5.4 Class E317-15, 16

DESCRIPTION AND APPLICATION
USA 317 electrodes have a greater molybdenum content than USA 316. The increased molybdenum content results in a weld deposit with higher tensile strength at elevated temperatures, stronger resistance against pitting corrosion, and virtually immune from cracking as the deposit cools down from the molten stage. USA 317 weld deposits exhibit smooth bead appearance and easy slag removability. This electrode is typically used where strong corrosion resistance against sulfuric or sulfurous acids is required such as in the chemical, paper and textile industries.

TYPICAL WIRE CHEMISTRY (%)

C	0.050
Mn	1.900
Si	0.390
P	0.020
S	0.010
Cr	19.190
Ni	13.470
Mo	3.300

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....95,000
Yield Strength (psi).....70,000
Elongation in 2” (%).....33

Stainless Steel Electrodes

USA 317L-15,16
AWS A5.4 Class E317L-15,16

DESCRIPTION AND APPLICATION
USA 317L electrodes produce weld deposits similar to USA 317 but containing a maximum 0.04% carbon. This extra low carbon content offers increased resistance against intergranular corrosion from chloride ions. The weld deposits of USA 317L electrodes exhibit smooth bead appearance, easy slag removability and very good creep resistance at elevated temperatures. USA 317L electrodes are used mainly for the welding of 18% Cr-12% Ni - 3% Mo stainless steels. Typical applications include those similar to USA 317 electrodes,

TYPICAL WELD METAL CHEMISTRY (%)

C	0.030
Mn	1.900
Si	0.390
P	0.020
S	0.010
Cr	19.190
Ni	13.470
Mo	3.250

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....92,000
Yield Strength (psi)..... 69,000
Elongation in 2” (%).....35

USA 318-15, 16
AWS A5.4 Class E318-15,16

DESCRIPTION AND APPLICATION
USA 318 electrodes are similar to USA 316 but contain columbium to prevent the formation of chromium carbides, thereby eliminating intergranular corrosion. This electrode is used to weld AISI 318 stainless steel where a complete absence of chromium carbides is important.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.05
Mn	1.75
Si	0.40
Cr	19.50
Ni	12.50
Mo	2.30
Cb	0.55

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....95,000
Yield Strength (psi).....75,000
Elongation in 2” (%).....35

USA 320-15, 16
AWS A5.4 Class E320-15, 16

DESCRIPTION AND APPLICATION
USA 320 electrodes developed for the welding of Carpenter Stainless #20* and 20 Cb-3* stainless steels. This electrode will produce weld deposits which resist corrosion from sulfuric acid, phosphoric acid, and other chemicals. USA 320 offers resistance to pitting and cracking,

TYPICAL WELD METAL CHEMISTRY (%)

C	0.04
Mn	2.25
Si	0.25
Cr	19.70
Ni	32.90
Mo	2.15
Cb & Ta	0.50
Cu	3.10

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....84,000
Yield Strength (psi).....54,000
Elongation in 2” (%).....39

Stainless Steel Electrodes

USA 320LR-15, 16 AWS A5.4 Class E320LR-15, 16

DESCRIPTION AND APPLICATION

USA 320LR flux-coated electrodes are a modified version of USA 320 electrodes, where the “residuals” - carbon, silicon, phosphorus and sulphur are specified at lower maximum levels. Columbium and manganese are also maintained within tighter parameters. These strict controls eliminate hot cracking and microfissuring frequently encountered in austenitic stainless steel. Excellent corrosion resistance against sulfuric acid, phosphoric acid and other chemicals.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.012
Mn	1.640
Si	0.070
Cr	20.300
Ni	34.800
Mo	2.250
Cb & Ta	0.200
Cu	3.600

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....84,000
Yield Strength (psi)..... 54,000
Elongation in 2” (%).....34

USA 330-15, 16 AWS A5.4 Class E330-15, 16

DESCRIPTION AND APPLICATION

USA 330 electrodes have a high nickel content which gives the weld deposit the capability to provide excellent corrosion and oxidation resistance at extreme temperature ranges above 1800^{o}F. The weld deposit of USA 330 will exhibit high creep strength, excellent thermal shock resistance and minimal embrittling. USA 330 electrodes are used for welding cast and wrought forms of AISI 330 stainless steel.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.020
Mn	2.25
Si	0.50
Cr	14.50
Ni	34.00

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....86,0000
Yield Strength (psi).....58,000
Elongation in 2” (%).....40

USA 347-15, 16 AWS A5.4 Class E347-15, 16

DESCRIPTION AND APPLICATION

USA 347 electrodes are used to weld austenitic 18% Cr- 8% Ni stainless steels where maximum resistance to corrosion is required. USA 347 weld deposits contain columbium in the amount of 10 times the amount of carbon with a maximum of 1%), which prevents intergranular corrosion caused by carbide precipitation. USA 347 electrodes are commonly used for welding AISI 304, 321 and 347 stainless steels in the textile and cellulose industries for joint-welding mechanical parts exposed to chemical attack. Other uses include pressure vessels such as those found in chemical plants and oil refineries, dye works, and for sealing basis application in acid, gas, water, and steam valves and fittings. USA 347 produces weld deposits with smooth bead appearance and easy slag removability.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.05
Mn	1.63
Si	0.47
Cr	19.92
Ni	9.67
Cb & Ta	0.63

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....96,000
Yield Strength (psi).....64,000
Elongation in 2” (%).....36

Stainless Steel Electrodes

USA 410-15,16
AWS A5.4 Class E410-15,16

DESCRIPTION AND APPLICATION
USA 410 electrodes are used for welding AISI 410 straight chromium steels where good strength and ductility, as well as corrosion and oxidation resistance at temperatures as high as 1500°F is a requirement. USA 410 electrodes contain 12% chromium thereby producing weld deposits that are martensitic and not subject to carbide precipitation. Utilization does require preheat and postheat treatment to achieve good ductility in the welds. USA 410 is also used for welding AISI 403, 405, 414, 416 and 420 stainless steels, for overlaying carbon steels to provide corrosion, erosion and abrasion resistance, and as a buildup on sealing faces of gas, water and steam fittings which are made from unalloyed or low-alloyed steels.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.09
Mn	0.50
Si	0.40
Cr	11.80
Ni	0.30

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Tensile strength (psi).....80,000
Yield Strength (psi)..... 44,000
Elongation in 2" (%).....28

USA 410NiMo-15, 16
AWS A5.4 Class E410NiMo-15, 16

DESCRIPTION AND APPLICATION
USA 410 NiMo electrodes are similar to USA 410 electrodes but contain molybdenum and a higher nickel content for improved corrosion resistance at elevated temperatures. USA 410NiMo electrodes are used for repair welding of large 410 castings as well as light gauge 405, 410 and 410S stainless steels.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.05
Mn	0.75
Si	0.40
Cr	11.70
Ni	4.50
Mo	0.50

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Tensile strength (psi).....155,000
Yield Strength (psi).....138,000
Elongation in 2" (%).....14

USA 430-15, 16
AWS A5.4 Class E430-15, 16

DESCRIPTION AND APPLICATION
USA 430 electrodes produce weld deposits that are martensitic in structure and highly resistant to chemical corrosion and oxidation at temperatures as high as 1600º-F, USA 430 is used for welding AISI 430 stainless steel, however it is also used for welding AISI 410 that may have a chromium content on the high side. In order to obtain maximum results USA 430 electrodes require preheat and postheat treatment.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.07
Mn	0.95
Si	16.60
Cr	0.64

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Tensile strength (psi).....78,000
Yield Strength (psi).....44,000
Elongation in 2" (%).....28

USA 8018-B6 (502)
AWS A5.4 Class E8018-B6

DESCRIPTION AND APPLICATION
USA 8018-B6 electrodes are most commonly used in the oil and chemical industries for welding AISI stainless steel types 501 and 502 where high temperature resistance to corrosion and oxidation is necessary. The weld deposits of USA 8018-B6 are martensitic in grain structure and not subject to carbide precipitation. USA 8018-B6 is an air-hardenable material that requires preheat and postheat treatment if maximum results are to be achieved. Other applications would include joint welds in pipeline construction, joining low and medium alloyed quenched and tempered steel and case hardening steels containing 2-3% chromium.

TYPICAL WELD METAL CHEMISTRY (%) (Welded with DCSP, 100% Argon Shield Gas)

C	0.06
Mn	0.57
Si	0.44
Cr	4.98
Ni	0.51

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....74,000
Yield Strength (psi)..... 38,000
Elongation in 2" (%).....36

USA 8018-B8 (505)
AWS A5.5 Class E8018-B8

DESCRIPTION AND APPLICATION
USA 8018-B8 electrodes contain 9% chrome-1% molybdenum and are used for welding AISI type 505 stainless steels of the same composition. More specific applications would include welding grade P-91 pipes, tubes or castings subject to hot hydrogen service such as found in the petroleum industry. USA 8018-B8 is an air-hardened material that requires pre-heat and post-heat treatment to achieve maximum results.

TYPICAL WELD METAL CHEMISTRY (%) (Welded with DCSP, 100% Argon Shield Gas)

C	0.06
Mn	0.48
Si	0.29
Cr	9.43
Mo	1.03

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (after heat treatment at 1575ºF)

Tensile strength (psi).....74,000
Yield Strength (psi)..... 38,000
Elongation in 2" (%).....36

USA 630-15, 16
AWS A5.4 Class E630-15, 16
AMS 5827

DESCRIPTION AND APPLICATION
USA 630 is a martensitic precipitation, age-hardening 17% chromium - 4% nickel stainless steel flux-coated electrode designed for welding ASTM A564 Type 630 and other martensitic PH stainless steels such as 15-5. Weld deposits have excellent mechanical properties with high strength and hardness. Most commonly used in high temperature and abrasion resistant environments such as found in the petrochemical and aerospace industries.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.035
Mn	0.450
Si	0.400
Cr	16.350
Ni	4.750
Cb & Ta	0.200
Cu	3.300

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Dependent on post-weld heat treatment

USA E385-16 (904L-16)
AWS A5.4 Class E385-16

DESCRIPTION AND APPLICATION
USA 904L is a high alloy austenitic stainless steel electrode with extra low carbon content intended for use in severe corrosive conditions. Residual elements C, Si, P, S and N are kept at much lower levels in order to keep the weld metal from hot cracking and fissuring. USA 904L is designed for joining 20% Cr-25% Ni-4.5% Mo-1.5% Cu stainless steels used to manufacture and repair processing equipment, tanks, vessels, and process piping handling acetic acids, sulphuric acid solutions and many chloride containing media. Other uses Include cooling units for sea water and river water purification plants and for cladding lower alloy steels when used in many corrosive media environments. USA 904L is also used for joining AISI type 317 where improved corrosive resistance in specific media is required.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.025 max.
Mn	1.0-2.5
Si	0.500 max.
Ni	24.0-26.0
Cr	16.5-21.5
Mo	4.2-5.2
Cu	1.2-2.0
N	0.04

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....68,000
Yield Strength (psi)..... 82,500
Elongation in 2” (%).....36

USA 316L-15, 16
AWS A5.4 Class E2209-16

DESCRIPTION AND APPLICATION
USA 2209-16 duplex stainless steel electrodes are designed for welding 22% chromium duplex stainless steels such as 2209, 2205 and 2304.3RE60®, 44LN® and Ferralium 255® are proprietay duplex stainless steel base metals in the 22% Cr category that can also be joined successfully with USA 2209-16 electrodes. Weld deposits exhibit very high tensile strength, resistance to stress, corrosion, cracking and greater resistance to pitting. USA 2209-16 has excellent weldability with spatter-free arc, self-releasing slag and a very smooth bead appearance.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.04 max.
Mn	0.5-2.0
Si	0.90 max.
Cr	21.5-23.5
Ni	8.5-10.5
Mo	2.5-3.5
Cb	1.0 max
N	0.08-0.20

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....109,000
Yield Strength (psi).....87,000
Elongation in 2” (%).....25

3Re60® is a registered trademark of Sandvik Steel Co.44LN® is a registered trademark of Avesta Sheffield Co. Ferralium 255® is a registered trademark of Cabot Corporation

Mechanical-Property Requirements for All-Weld Metal

AWS Classification	Tensile strength, min		Elongation in 2 in. gauge length, min. percent	Heat treatment
	Ksi	MPa		
E209	100	690	15	None
E219	90	620	15	None
E240	100	690	15	None
E307	85	590	30	None
E308	80	550	35	None
E308H	80	550	35	None
E308L	75	520	35	None
E308Mo	80	550	35	None
E308MoL	75	520	35	None
E309	80	550	30	None
E309L	75	520	30	None
E309Cb	80	550	30	None
E309Mo	80	550	30	None
E310	80	550	30	None
E310H	90	620	10	None
E310Cb	80	550	25	None
E310Mo	80	550	30	None
E312	95	660	22	None
E316	75	520	30	None
E316H	75	520	30	None
E316L	70	490	30	None
E317	80	550	30	None
E317L	75	520	30	None
E318	80	550	25	None
E320	80	550	30	None
E320LR	75	520	30	None
E330	75	520	25	None
E330H	90	620	10	None
E347	75	520	30	None
E349	100	690	25	None
E410	65	450	20	a
E410NiMo	110	750	15	b
E430	65	450	20	c
E502	60	420	20	a
E505	60	420	20	a
E630	135	930	7	d
E16-8-2	80	550	35	None
E7Cr	60	420	20	a

a. Specimen shall be heated to between 1550° and 1600ºF (840 and 870°C), held for 2 hours, furnace-cooled at a rate not exceeding 100°F (55°C) per hour to 1100°F (595°C) and air cooled to ambient.

b. Specimen shall be heated to between 1100° and 1150°F(595°and 620°C), held for 1 hour, and air cooled to ambient.

c. Specimen shall be heated to between 1400° and 1450°F (760° and 790°C), held for 2 hours, and furnace-cooled at a rate not exceeding 100°F (55°C) per hour to 100°F (55°C), and air cooled to ambient.

d. Specimen shall be heated to between 1875° and 1925°F (1025° and 1050°C), held for 1 hour, air cooled to at least 60°F (15°C), and then precipitation hardened at 1135° to 1165°F(610° to 630°C), held for 4 hours, and air cooled to ambient.

Stainless Steel Electrode Selection Chart

Base Metal AISI Types	Common Designation		Recommended Washington Alloy Electrode	Alternate Washington Alloy Choices
Austenitic	201 202 301 302 302B 303 303Se 304 305	17-4 Mn 18-5 Mn 17-7 18-8 18-8 Si 18-8 F.m.* 18-8 F.m.* 19-9 18-10	308	308L, 347, 309, 309Cb, 309Mo, 310, 310Cb
	308	20-10	308	310Mo, 316, 316L, 316Cb
	304L	19-9 L	308L	347, 309Cb, 310Cb, 316Cb, 316L
	309 309S	24-12	309	309Cb, 310, 310Cb, 310Mo
	310 310S 314	25-20	310	
	25-20 25-20	310	310Cb	
	312		312	None
	316	18-12 Mo	316	316Cb, 316L, 309Mo, 317
	316L	18-12MoL	316L	None
	317	19-13 Mo	317	316, 316Cb, 309Mo, 310Mo
	321	18-8 Ti	347	308L, 309Cb, 310Cb, 316Cb
	330		330	None
	347	18-8Cb	347	308L, 309Cb, 310Cb, 316Cb
	348	18-8Cb		
Martensitic	403 410 414 416 416 Se		410	308, 308L, 347, 309
	420		430	309Cb, 310, 310Cb, 308, 308L, 347, 309
	431		309	309Cb, 310, 310Cb, 330
	502		502	308, 308L, 347, 309, 309Cb, 310, 310Cb
	405		410	308, 308L, 347, 309
Ferritic	430 430 F 430 F Se		430	309Cb, 310, 310Cb, 308, 308L, 347, 309
	442 446		309	309Cb, 310, 310Cb, 330

Chemical Composition Requirements for All-Weld Metal,[a,b] Weight Percent For Stainless Steel Coated Electrodes

Stainless Steel **Solid Wire**

AWS Classification	Cd	Cr	Ni	Mo	Cb plus Ta (Nb)	Mn	Si	P	S	N	Cu
E209c	0.06	20.5-24.0	9.5-12.0	1.5-3.0	—	4.0-7.0	0.90	0.03	0.03	0.10-0.30	0.75
E219	0.06	19.0-21.5	5.5-7.0	0.75	—	8.0-10.0	1.00	0.03	0.03	0.10-0.30	0.75
E240	0.06	17.0-19.0	4.0-6.0	0.75	—	10.5-13.5	1.00	0.03	0.03	0.10-0.20	0.75
E307	0.04-0.14	18.0-21.5	9.0-10.7	0.5-1.5	—	3.3-4.75	0.90	0.04	0.03	—	0.75
E308	0.08	18.0-21.0	9.0-11.0	0.75	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E308H	0.04-0.08	18.0-21.0	9.0-11.0	0.75	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E308L	0.04	18.0-21.0	9.0-11.0	0.75	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E308Mo	0.08	18.0-21.0	9.0-12.0	2.0-3.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E308MoL	0.04	18.0-21.0	9.0-12.0	2.0-3.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E309	0.15	22.0-25.0	12.0-14.0	0.75	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E309L	0.04	22.0-25.0	12.0-14.0	0.75	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E309Cb	0.12	22.0-25.0	12.0-14.0	0.75	0.70-1.00	0.5-2.5	0.90	0.04	0.03	—	0.75
E309Mo	0.12	22.0-25.0	12.0-14.0	2.0-3.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E310	0.08-0.20	25.0-28.0	20.0-22.5	0.75	—	1.0-2.5	0.75	0.03	0.03	—	0.75
E310H	0.35-0.45	25.0-28.0	20.0-22.5	0.75	—	1.0-2.5	0.75	0.03	0.03	—	0.75
E310Cb	0.12	25.0-28.0	20.0-22.0	0.75	0.70-1.00	1.0-2.5	0.75	0.03	0.03	—	0.75
E310Mo	0.12	25.0-28.0	20.0-22.0	2.0-3.0	—	1.0-2.5	0.75	0.03	0.03	—	0.75
E312	0.15	28.0-32.0	8.0-10.5	0.75	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E316	0.08	17.0-20.0	11.0-14.0	2.0-3.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E316H	0.04-0.08	17.0-20.0	11.0-14.0	2.0-3.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E316L	0.04	17.0-20.0	11.0-14.0	2.0-3.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E317	0.08	18.0-21.0	12.0-14.0	3.0-4.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E317L	0.04	18.0-21.0	12.0-14.0	3.0-4.0	—	0.5-2.5	0.90	0.04	0.03	—	0.75
E318	0.08	17.0-20.0	11.0-14.0	2.0-3.0	6 x C, min. to 1.00 max.	0.5-2.5	0.90	0.04	0.03	—	0.75
E320	0.07	19.0-21.0	32.0-36.0	2.0-3.0	8 x C, min. to 1.00 max.	0.5-2.5	0.60	0.04	0.03	—	3.0-4.0
E320LR	0.035	19.0-21.0	32.0-36.0	2.0-3.0	8 x C, min. to 0.40 max.	1.5-2.5	0.30	0.02	0.015	—	3.0-4.0
E330	0.18-0.25	14.0-17.0	33.0-37.0	0.75	—	1.0-2.5	0.90	0.04	0.03	—	0.75
E330H	0.35-0.45	14.0-17.0	33.0-37.0	0.75	—	1.0-2.5	0.90	0.04	0.03	—	0.75
E347	0.08	18.0-21.0	9.0-11.0	0.75	8 x C, min. to 1.00 max.	0.5-2.5	0.90	0.04	0.03	—	0.75
E349f.g.	0.13	18.0-21.0	8.0-10.0	0.35-0.65	0.75-1.2	0.5-2.5	0.90	0.04	0.03	—	0.75
E410	0.12	11.0-13.5	0.70	0.75	—	1.0	0.90	0.04	0.03	—	0.75
E410NiMo	0.06	11.0-12.5	4.0-5.0	0.40-0.70	—	1.0	0.90	0.04	0.03	—	0.75
E430	0.10	15.0-18.0	0.60	0.75	—	1.0	0.90	0.04	0.03	—	0.75
E502	0.10	4.0-6.0	0.40	0.45-0.65	—	1.0	0.90	0.04	0.03	—	0.75
E505	0.10	8.0-10.5	0.40	0.85-1.20	—	1.0	0.90	0.04	0.03	—	0.75
E630	0.05	16.0-16.75	4.5-5.0	0.75	0.15-0.30	0.25-0.75	0.75	0.04	0.03	—	3.25-4.00
E16-8-2	0.10	14.5-16.5	7.5-9.5	1.0-2.0	—	0.5-2.5	0.60	0.03	0.03	—	0.75
E7Cr	0.10	6.0-8.0	0.40	0.45-0.65	—	1.0	0.90	0.04	0.03	—	0.75

a. Analysis shall be made for the elements for which specific values are shown in the table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that the total of these other elements, except iron, is not present in excess of 0.50 percent.

b. Single values shown are maximum percentages except where otherwise specified.

c. Suffix-15 electrodes are classified with direct current, electrode positive. Suffix-16 electrodes are classified with alternating current and direct current, electrode positive. See Section A6 of the appendix. Electrodes up to and including 5/32 in. (4.0 mm) in size are usable in all positions. Electrodes 3/16 in. (4.8 mm) and larger are usable only in the flat and horizontal fillet positions.

d. Carbon shall be reported to the nearest 0.01 percent except for the classification E320LR for which carbon shall be reported to the nearest 0.05 percent.

e. Vanadium shall be 0.10 to 0.30 percent.

f. Titanium shall be 0.15 percent max.

g. Tungsten shall be from 1.25 to 1.75 percent. Courtesy: American Welding Society ANSI/AWS A5.4.

Cast Iron Electrodes

WASHINGTON ALLOY NICKEL 99
AWS/SFA 5.15 ENi-CI, AC-DC+
UNS W82001

DESCRIPTION
Washington Alloy Nickel 99 is recommended for all-position welding of thin cast iron sections where maximum machinability is required. Since the core wire is approximately 99% nickel, weld deposits are basically “soft” and can be shaped, milled, drilled, or tapped, while the color will match that of cast iron. Washington Alloy Nickel 99 Is specifically suited for repairing cracked or porous castings and to weld cast iron to itself or dissimilar metals such as low alloy and carbon steels.

APPLICATIONS
The weld deposits produced by Washington Alloy Nickel 99 have lower strength and ductility than those of 55% nickel cast iron electrodes. For this reason Washington Alloy Nickel 99 should only be used where maximum machinability of highly diluted weld metal is required or where weld stresses are not overly severe such as found in light and medium-sized castings. Common uses include thin plates, machinery parts, frames and housings.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.55
Si	0.46
Mn	0.33
P	0.017
S	0.007
Fe	0.850
Cu	0.160
Ni	Balance

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (as welded)

Tensile strength (psi).....50,000
Yield Strength (psi)..... 40,000
Elongation in 2” (%).....3-4%
Brinell Hardness.....170

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (as welded)

Sizes	Amperage
3/32 (2.4 mm) x 12”	30-70
1/8 (3.2 mm) x 14”	70-110
5/32 (4.0 mm) x 14”	90-130
3/16 (4.8 mm) x 14”	110-160

These settings are tor flat or downhand positions. For overhead welding reduce 5-15 amps and for vertical welding reduce 10-20 amps

Packaging: 10 lb. tubes / 60 lb. master carton

WASHINGTON ALLOY NICKEL 55
AWS/SFA 5.15 ENiFe-CI, AC-DC+
UNS W82002

DESCRIPTION
Washington Alloy Nickel 55 is designed for all-position joining and surfacing of cast iron, malleable iron and ductile iron to itself or dissimilar metals such as mild steel, stainless steel, wrought alloys or high nickel alloys. A core wire chemistry of approximately 55% nickel and 45% iron produces weld deposits with much lower weld shrinkage stress which in turn reduces the possibility of weld or heat-affected zone cracking. Washington Alloy Nickel 55 produces high strength, ductile weld deposits even when welding low grade cast iron containing excessive levels of phosphorus or other contaminants.

APPLICATIONS
Washington Alloy Nickel 55 is especially suited for welding heavy sections such as motor blocks, housings, machine parts, frames, defective castings and building-up worn sections. Weld deposits are machinable and the deposit color will approximate that of cast iron.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.058
Si	0.660
Mn	1.270
P	0.024
S	0.024
Fe	Balance
Cu	2.450
Ni	55.030

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (as welded)

Tensile strength (psi).....70,000
Yield Strength (psi).....53,000
Elongation in 2” (%).....6-12%
Brinell Hardness..... 190

SIZES AND RECOMMENDED CURRENT RANGES* (AC/DC+)

Sizes	Amperage
3/32 (2.4 mm) x 12”	50-80
1/8 (3.2 mm) x 14”	80-120
5/32 (4.0 mm) x 14”	110-140
3/16 (4.8 mm) x 14”	130-170

*These settings are for flat or downhand positions. For overhead welding reduce 5-15 amps and for vertical welding reduce 10-20 amps.

Packaging: 10 lb. tubes/60 lb. master carton

WASHINGTON ALLOY EST
AWS/SFA 5.15 EST, AC-DC+
UNS K01520

DESCRIPTION
Washington Alloy EST is a non-nickel, non-machinable cast iron electrode. It is the most economical way to go for repairing various kinds of cast iron precincts — providing that machinability of the weld deposit is not required and where weld shrinkage stress is not a concern. Since the core wire is steel, the weld deposits will have a higher tensile strength (65,000 psi) than Nickel 99, however a color match of the base metal should not be expected. Washington Alloy EST melts at relatively low temperatures which permit the use of low welding currents. This electrode may be used in any position utilizing AC or DC (reverse polarity).

APPLICATIONS
Commonly used on gears, motor housings, machine parts, farm equipment, large frames or any other cast iron part where appearance of the weld deposit is not important.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.150
Si	0.550
Mn	0.370
P	0.015
S	0.003
Fe	Balance

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....65,000
Yield Strength (psi).....50,000
Elongation in 2” (%).....33%
Brinell Hardness..... 350

SIZES AND RECOMMENDED CURRENT RANGES* (AC/DC)

Sizes	Amperage
3/32 (2.4 mm) x 12”	60-90
1/8 (3.2 mm) x 14”	90-130
5/32 (4.0 mm) x 14”	120-160
3/16 (4.8 mm) x 14”	150-200

*These settings are for flat or downhand positions. For overhead welding reduce 5-15 amps and for vertical welding reduce 10-20 amps.

Packaging: 10 lb. tubes/60 lb. master carton

PROCEDURES FOR SMAW OF CAST IRON

Clean the work area. Preheating is not required, however it is useful in relieving stresses and to increase machinability of the weld deposit in parts greater than 1/2” thick. 200^{0}F is an acceptable preheat temperature- Using AC or DC + (reverse polarity), hold the electrode 15° off vertical tilted toward the direction of travel, The arc length should be between 1/8” to 3/16”. Use stringer beads or the weaving technique. Holding the arc over the molten deposited metal, follow the pool but do not allow the arc to lead or get ahead of the molten pool. If the part is less than 1/4” thick use a 1” bead, 1/4” to 1/2” use a 2” bead, over 1/2” use a 3” bead. Extinguish the electrode by whipping the arc back over the deposited metal. Peen the weld deposit with a blunt instrument to relieve stress and prevent the spread of cracks on the part. Re-strike the arc on the previously deposited weld metal. On thin or complex shaped parts use the skip weld technique. Always use an electrode diameter that is small enough to permit at least two passes. Note: if there is cracking of the part, make stopholes at both ends of the joint. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is strongly recommended.

Cast Iron Wire

CASCADE 17T & 17M
AWS A5.15 Class ERNi-CI
UNS N022515

DESCRIPTION
High nickel alloy bare wire for TIG or MIG cast iron welding.

APPLICATIONS
Cascade 17T and 17M are the TIG (17T) or MIG (17M) equivalents to Cascade 17A. Developed primarily for automatic and semi-automatic welding of ductile, malleable or gray cast iron to itself or dissimilar metals such as low alloy and carbon steel, stainless steel, iron, copper Monel®, etc. Cascade 17T and 17M are excellent for the buildup of worn parts, repairing machining errors or detective castings where maximum machineability of the deposit is required.

FEATURES
Cascade 17T and 17M can be used in any position. Produces high quality welds with a minimal amount of effort. Weld deposits are strong, dense and fully machinable. Color will match that of cast iron.

SPECIFICATIONS

Tensile strength (psi)	Up to 70,000
Yield strength (psi)	Up to 46,000
Brinell Hardness	170
Elongation (%)	Approximately 12%
Reduction of area (%)	Approximately 20%

TYPICAL WIRE CHEMISTRY (%)

C	0.037
Si	0.440
Mn	0.240
Ni	Balance
Fe	0.010
Cu	0.020

PROCEDURES
Clean the joint area. Bevel heavy sections. Preheating is not required, however it is useful in relieving stresses and to increase machinability of the weld deposit in parts greater than 1/2" thick. 600°F is an acceptable preheat temperature. Use DC- (straight polarity) in TIG applications, with the oscillating technique and DC+ (reverse polarity) in MIG applications, with the stringer bead technique. The oscillating technique will produce the lowest weld metal dilution. When using the stringer bead technique, be sure to strike the arc on the edge of previously deposited weld metal. This will reduce dilution. Be sure to use flux. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is recommended.

AVAILABLE DIAMETERS

(in.)	.035	.045	1/16	3/32	1/8
(mm)	0.9	1.2	1.6	2.4	3.2

PACKAGING
10 lb. and 30 lb. spools - 0.35, 0.45, 1/16.
36" straight lengths - .035, .045, 1/16, 3/32, 1/8.
(10 lb. tubes/50 lb. master carton)

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CASCADE 18T & 18M
AWS A5.15 Class ERNiFe-CI

DESCRIPTION
A premium quality 55% Nickel-45% Iron bare wire for TIG or MIG welding of cast iron components to themselves or to steel.

APPLICATIONS
Cascade 18T and 18M are the TIG and MIG equivalents of Cascade 18A (coated electrodes). Developed for high deposition and greater welding efficiency using automatic or semi-automatic equipment. Cascade 18T/18M is excellent when doing large scale production welding of ductile (nodular) cast iron, malleable cast iron or gray cast iron to themselves or to carbon and low alloy steel. Preheating is generally not needed unless welding heavier and thicker castings. More common uses include the repair of thick and highly restrained weldments, worn or broken parts and for salvaging defective castings that require the higher tensile strength of steel, such as found in castings containing phosphorus levels greater than 0.20%.

FEATURES
Cascade 18T and 18M contain sufficient levels of carbon which promote the formation of graphite in the weld deposit, thereby reducing shrinkage stresses and in turn, reducing the possibility of heat-affected zone cracking. Weld deposits are machinable using normal methods, but can be made easier by stress relieving the part at approximately 1100°F.

SPECIFICATIONS

Tensile strength (psi)	Up to 78,000
Yield strength (psi)	Up to 59,000
Brinell Hardness	190
Elongation (%)	Approximately 10%

TYPICAL WIRE CHEMISTRY (%)

C	0.005
Si	0.100
Mn	0.690
P	<0.002
S	<0.001
Ni	54.850
Fe	Balance
Cu	0.020
Cr	0.030
Ti	<0.100

PROCEDURES
Clean the work area. Preheating is not required, although It may be useful In relieving stresses and to Increase the machinability of weld deposits in castings 1/2" or thicker. 600oF is an acceptable preheat temperature when welding gray cast Iron, but 1100 to 1200oF may be needed for very thick sections or high hardness cast Irons. Use DC- (straight polarity) in TIG applications with the oscillating technique and DC+ (reverse polarity) In MIG applications with the stringer bead technique. The oscillating technique will produce the lowest weld metal dillution. When using the stringer bead technique, be sure to strike the arc on the edge of previously deposited weld metal. This will reduce dilution Be sure to use flux. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is recommended.

(in)	.035	.045	1/16	3/32	1/8
(mm)	0.9	1.2	1.6	2.4	3.2

PACKAGING
10 lb. and 30 lb. spools - 0.35, 0.45, 1/16.
36" straight lengths - .035, .045, 1/16, 3/32, 1/8.
(10 lb. tubes/50 lb. master carton)

Wire Diameter		Shielding Gas	Voltage V	Amperage A	Wire Feed		Travel Speed	
in	mm				in/min	mm/min	in/min	mm/min
0.062	1.6	100% Argon	26-31	240-350	150-225	3.8-5.7	10-25	250-640
		75% Ar/25% CO_2	26-30	235-320	150-225	3.8-5.7	10-25	250-640
0.045	1.1	100% Argon	26-32	190-310	250-500	6.4-12.7	10-25	250-640
		75% Ar/25% CO_2	26-32	180-280	250-500	6.4-12.7	10-25	250-640
0.035	0.9	100% Argon	24-28	150-250	300-575	7.6-14.6	10-25	250-640
		75% Ar/25% CO_2	24-28	130-200	300-575	7.6-14.6	10-25	250-640

GTAW Parameters: Use DC- (Straight polarity) 100% Argon
GMAW Parameters: Use DC+ (reverse polarity) 100% Ar or 75% Ar/25% CO^2
Gas Flow: 40-60 ft3/hr. (1.1-1.7 m3/h)

Cast Iron Electrodes

Cast Iron Rod

CASCADE 17A
Arc AC/DC
All Position

DESCRIPTION
Fully-machinable cast iron electrode for repair welding of thin sections.

APPLICATIONS
Cascade 17A is a high nickel electrode used for cladding, buildup and joining all grades of cast iron to itself or dissimilar metals such as low alloy and carbon steels, stainless steels, iron, copper, Monel®, etc. Excellent for repairing and "cold welding" cracked or porous thin sections where maximum machinability of the weld deposit is required. Common uses include engine blocks, machinery parts, frames, gears and pulleys.

FEATURES
Cascade 17A is an all-position electrode which produces porosity-free, non-cracking weld deposits that will match the color of cast Iron. When properly used, the arc will penetrate through dirt and oil as well as over slag.

SPECIFICATIONS

Tensile strength (psi).....Up to 65,000
Yield Strength (psi)..... Up to 60,000
Elongation in 2" (%).....Up to 218
Brinell Hardness.....3-6%
Color match..... Excellent on cast iron

AVAILABLE SIZES AND AMPERAGE (AC/DC)

(in)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
Amps	50-70	70-100	100-130	130-160

CASCADE 18A
Arc Ac/DC+ (Reverse Polarity)
All Position

DESCRIPTION
Premium cast iron electrode for heavy sections.

APPLICATIONS
Cascade 18A is for general maintenance welding of cast iron, malleable iron and ductile (nodular) iron to themselves or dissimilar metals such as wrought alloys or high nickel alloys. Commonly used on motor blocks, gear housings, machine parts and frames. Excellent for filling holes and building up missing or worn heavy sections. Cascade 18A is recommended for "meehanite" and "Ni- Resist" alloys.

FEATURES
Cascade 18A is an all-position electrode that produces machinable, high density and crack-resistant weld deposits, especially suited for welding dirty, oil-soaked castings of unknown composition.
SPECIFICATIONS

TYPICAL WELD METAL CHEMISTRY (%)

Tensile strength (psi)...Up to 84,000
Yield strength (psi).....Up to 63,000
Brinell Hardness.....Up to 218
Elongation(%).....6-18%
Color match.....Good

AVAILABLE SIZES AND AMPERAGE (AD/AC)

(in)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
Amps	50-70	70-100	100-130	130-160

RCI
AWS A5.15 RCI

DESCRIPTION
RCI is a high-quality gray iron oxyacetylene welding rod, designed for gas welding of cast iron, general fabrication or building up new or worn surfaces on castings.

APPLICATIONS
RCI is excellent for cast iron fabrication, repair of foundry defects, filling in or building up new or worn castings. RCI produces machinable weld deposits that have the same color, composition and granular structure as the base metal (gray iron). Properly made welds will be as strong as the original casting.

FEATURES
RCI has properly balanced and controlled levels of high silicon, low manganese and increased amounts of phosphorus and sulfur. This composition insures greater fusion and tensile strength of the weld deposit. Machinable weld deposits and color match to gray cast iron.

TYPICAL CHEMICAL ANALYSIS

C	3.20-3.50
Mn	0.60-0.75
Si	2.70-3.00
P	0.50-0.75
S	0.10 Maximum
Fe	Balance

TYPICAL MECHANICAL PROPERTIES OF THE WELD DEPOSIT

AVAILABLE SIZES
3/16" (4.8 mm) x 20" (500 mm)
1/4" (6.4 mm) x 20" (500 mm)
5/16" (7.9 mm) x 20" (500 mm)
3/8" (9.5 mm) x 20" (500 mm)
All 50 lb. bulk boxes

PROCEDURES
Although not required, preheating at 800°F-1050°F will equalize the expansion and contraction strain as well as promote easy machinability of the weld deposit. For welding, use a neutral flame. Flux is recommended to cleanse the joint area. Puddle the molten metal with the flame to eliminate porosity. Back-track with the torch to relieve any strain on the weld deposit. Allow the part to cool slowly.

Copper-Base Welding Electrodes and Rods from AWS Specifications Suitable Welding Cast Irons

Classification	Type	Specification	Characteristics and use
	Cut Length Filler Metals (OFW)		
RBCuZn-A	Naval Bronze	A5.27	Naval Bronze – yellow; tin adds strength, corrosion resistance.
RBCuZn-B	Nickel Bronze	A5.27	Nickel Bronze-yellow; tin and manganese add strength, hardness and corrosion resistance.
RBCuZn-C	Low Fuming Bronze	A5.27	Low-Fuming Bronze - yellow; silicon inhibits oxidation (fuming) of zinc.
	Covered Electrodes (SMAW)		
ECuSn-A	Phosphor Bronze	A5.6	5 percent tin, hardens to 70-85 Brinell.
ECuSn-C	Copper-Tin	A5.6	8 percent tin, hardens to 85-100 Brinell,
ECuAI-A2	Copper-Aluminum	A5.6	Copper-aluminum electrodes deposit high strength, ductile weld metal; use for welding high-strength castings, surfacing.

Build-Up and Hardsurfacing Electrodes

BUILDUP 300
AD/DC+ (Electrode Positive)
Rockwell C 26-31

APPLICATIONS
Buildup 300 is commonly used for the buildup and overlaying of all ferrous metals subjected to moderate abrasion, severe impact and corrosion. Typical applications would include tractor rollers, sprockets, idlers, concrete mixer blades, bearing journals and other parts which require machinable weld deposits.

PROCEDURES
Clean the weld area. Use AC or DC+ polarity. Preheating is not required, although heavier sections should be preheated to 200-300ºF. Maintain a medium arc length and use a weaving technique or stringer beads up to twice the diameter of the electrode. Avoid the buildup of heat at any one location on the base metal. Remove slag between passes and allow the base metal to air cool. If severe abrasion is encountered, a final pass of Everwear 800 should be considered.

CHARACTERISTICS
Buildup 300 weld deposits are strong and tough, however with an average hardness of RC 26-31, they do remain machinable.

RECOMMENDED AMPERAGE (AC OR DC+)
AVAILABLE SIZES AND AMPERAGE (AC/DC)

Size	1/8	5/32	3/16	1/4
Amp.	60-130	120-180	170-240	240-300

PACKAGING
All Sizes are packaged in 10 lb. packs – 6 packs per 60 lb. master carton

OIL HARD 500
Moderate Impact/ Severe Abrasion
Rockwell C 44-47/
Oil Quenched RC 59-62

APPLICATIONS
Oil Hard 500 is used in the repair and fabrication of oil hardening tool steel dies and as an overlay on mild and alloy steels subjected to severe abrasion and moderate impact. Common applications would include trimming dies, shearing edges, cutting dies and cold blanking dies.

PROCEDURES
Clean the area to be welded. Preheat large sections 200ºF – 300ºF. Use AC or DC+ polarity. Maintaining a short arc length use stringer beads. Try to avoid the weaving technique because of potential heat build-up in the base metal. Do not allow heat color in the base metal to appear. Peen the weld deposit while hot to relieve stress and remove all slag between passes.

CHARACTERISTICS
Oil Hard 500 produces very hard and ductile weld deposits. They can be heat treated, annealed, drawn or tempered. Average hardness is RC 46 and if oil quenched at 1600°F the average hardness increases to RC 59-62. Welded deposits have a mixed metal structure of austenite and martensite.

RECOMMENDED AMPERAGE (AC OR DC+)

Size	3/32	1/8	5/32	3/16	1/4
Amp.	60-90	80-100	110-170	180-230	220-300

PACKAGING
All Sizes are packaged in 10 lb. packs – 6 packs per 60 lb. master carton

CHROM-TUNG 600
AC/DC+ (Electrode Positive)
Hardness Rockwell C 58-62

DESCRIPTION
Chrome-Tung 600 is a chromium-tungsten flux-coated hardsurfacing electrode designed to produce extremely hard weld metal deposits on parts exposed to severe mineral abrasion with low impact. The extreme hardness of Chrom-Tung 600 deposits is achieved through the formation of the chromium and tungsten carbides within the matrix of the weld deposit.

FEATURES
Chrom-Tung 600 can be used on both AC or DC machines, Excellent for hardsurfacing large surface areas using wide weave beads. Chrom-Tung 600 has good operator appeal and yields a very smooth weld bead with superb adherence. Deposition is fast and the weld deposits will last a long time.

TYPICAL APPLICATIONS
Chrom-Tung 600 is used on earth moving and rock crushing equipment, augers, asphalt feed screws, sand pumps, mixer blades and crushing or pulverizing mills. Chrom-Tung 600 is very popular in the sugar cane industry where it is used to increase the life and durability of the rotating mill.

TYPICAL WELD METAL CHEMISTRY

C	4.00
Cr	26.00
W	4.00

Hardness as welded: 58-62 RC

AVAILABLE SIZES AND OPERATING RANGES (AC/DC+)

Size	3/32	1/8	5/32	3/16
Amp.	70-90	110-130	160-190	220-250

WELDING PROCEDURES
Maintain a short arc length and hold the electrode verticle to the workpiece.

BUILD-UP AND HARDSURFACING ELECTRODES

HARDFACE 700
Considerable impact/Severe Abrasion
Rockwell C 58-62

APPLICATIONS
Hardface 700 is our most popular hardsur- facing electrode used for severe abrasion and considerable impact. Weld deposits have a martensitic structure that resists wear even in Metal-to-metal mild steel contact. Hardface 700 is most commonly used on plowshares, cultivator shoes, bucket teeth and lips, well drilling bits, cement mixer blades, shovel tracks and screw conveyors.

PROCEDURES
Use AC or DC+. Preheating is generally not required. Using the weaving technique and keeping a short arc length, deposit up to 1/4" maximum. If more than two passes will be required, it is suggested that a ''padding layer" of Buildup 300 or Tensileweld be used prior to depositing Hardface 700.

CHARACTERISTICS
When used in the flat and horizontal positions, this electrode will exhibit a stable arc and produce weld deposits that are very smooth and finely rippled. Hardness as deposited: RC 58-62

RECOMMENDED AMPERAGE (AC OR DC+)

Size	1/8	5/32	3/16	1/4
Amp.	110-130	140-170	180-210	220-300

PACKAGING
All Sizes are packaged in 10 lb. packs – 6 packs per 60 lb. master carton

EVERWEAR 800
Light Impact/Severe Abrasion/Corro- sion Resistance Rockwell C 62-65

APPLICATIONS
Everwear 800 is a hardsurfacing electrode used for severe abrasion, light impact and corrosion resistance. This electrode produces an extremely hard martensite-structure weld deposit which is not machinable in the "as- welded" condition. Everwear 800 is commonly used on mill hammers, bucket teeth, valve seats, mixers, crusher rolls, tamper rollers and other mild steel, carbon or alloy steels as well as manganese steels.

PROCEDURES
Use AC or DC+. Preheating is not required except on alloy steels. Using a short gap and a weaving technique, deposit two layers. If more than two passes are required, use Ten- sileweld or Buildup 300 to provide a padding layer prior to using Everwear 800.

CHARACTERISTICS
Everwear 800 will lay down a smooth, corrosion resistant weld deposit which will remain extremely hard even at elevated temperatures. Hardness as deposited: RC 62-65.

RECOMMENDED AMPERAGE (AC OR DC+)

Size	1/8	5/32	3/16	1/4
Amp.	90-130	140-170	190-240	220-300

PACKAGING
All Sizes are packaged in 10 lb. packs – 6 packs per 60 lb. master carton.

Manganese 900
Heavy Impact/Severe Abrasion
Rockwell C 50-55 (after workhardening)

APPLICATIONS
Hardsurfacing overlay electrode used for the fabrication and build up of high manganese and alloy steels which are subjected to heavy impact and severe abrasion. This electrode is most commonly used for repairing railroad switches, frogs and tracks, bucket teeth and lips, rock crushers, mill hammers and bulldozer parts.

PROCEDURES
When the base metal of 13% manganese steel is hardened, cut-off the hardened zone before welding. Welding should be done at the lowest possible temperature. Maintain a short to medium arc length using a slight weaving technique to make the deposit smooth and even. Water or air cool the weld metal during welding. Do not preheat manganese steels. Do not overheat the base metal. Peening is recommended to relieve stresses.

CHARACTERISTICS
Weld deposits have an austenitic structure and work harden although remaining extremely ductile. Weld deposits are machinable and forgeable.

Tensile strength	Up to 120,000 psi
Yield strength	Up to 75,000 psi
Elongation in 2"	45-60%
Hardness	RB88-92 as welded
RC50-55 after work hardening	

RECOMMENDED AMPERAGE (AC OR DC+)

Size	1/8	5/32	3/16	1/4
Amp.	75-130	125-190	175-240	230-380

WELDING PROCEDURES
All Sizes are packaged in 10 lb. packs – 6 packs per 60 lb. master carton

NI-MANG 14
AC/DC+
Rockwell c 45-50 (after workhardening)

DESCRIPTION
Ni-Mang 14 is used for rebuilding. It offers high crack resistance on austenitic manganese steels, high impact and compressive wear-resistance. Non-magnetic deposit.

TYPICAL WELD METAL CHEMISTRY (%)

C	1.0
Mn	14.0
Ni	4.0

AVAILABLE SIZES
1/8", 5/32", 3/16"

CHROME-CARB 60
AC/DC+
Rockwell C 58-60

DESCRIPTION
Chrome-Carb 60 is for high impact and abrasion wear. This electrode produces a very hard deposit even at high temperatures. Excellent compressive strength on carbon, low alloy and manganese steels.

TYPICAL WELD METAL CHEMISTRY (%)

C	3.5
Mn	2.0
Si	0.6
Cr	30.0
Ni	0.2
Mo	0.2

AVAILABLE SIZES
1/8", 5/32", 3/16"

COBALT HARDSURFACING RODS AND ELECTRODES

COBALT NO. 1 BARE
COBLAT NO. 1FC
AWS/SFA 5.21 ECoCr-C
AWS/SFA 5.13 ECoCr-C

DESCRIPTION
Cobalt #1 is designed for applications that require extreme abrasion resistance at elevated temperatures, but where impact resistance is not a consideration. Cobalt #1 has a higher carbon and tungsten content than other cobalt alloys causing the weld deposit to have a higher volume of carbides within its microstructure. Although the weld deposits of Cobalt #1 are not as "tough" as those of Cobalt #6, they are much harder and have excellent resistance to solid particle erosion.

TYPICAL APPLICATIONS
Seals, rotors, steam turbine parts, mixer blades, extrusion dies, saw blades, rolling mill guides, pump impellers, carbon scrapers. engine crossheads. hydropulper disc parts.

TYPICAL WELD METAL CHEMISTRY (%)

C	2.50
Cr	30.00
W	12.50
Co	Balance

AVAILABLE SIZES
Bare: 1/8, 5/32, 3/16, 1/4, 5/16.
Coated: 1/8, 5/32, 3/16, 1/4.

COBALT NO. 6 BARE
COBALT NO. 6 FC
AWS/SFA 5.13 RCoCr-A (Bare)
AWS/SFA 5.21 ECoCr-A (Coated)

DESCRIPTION
This is our most popular and useful cobalt alloy. Cobalt #6 offers an excellent balance between impact, heat, corrosion and metal-to-metal abrasion resistance. Outstanding anti- galling properties, superior high temperature hardness and resistance to cavitation erosion make Cobalt #6 perfect to use as valve trim in steam engines or repairing worn machine parts. Ideal for many hardsurfacing applications because of its resistance to mechanical and chemical degradation at extreme temperatures.

TYPICAL APPLICATIONS
High pressure-high temperature valves, agitators, chainsaw bars, digestors, hot oil pump parts, extruder screws, scraper knives, hot trimming dies, hot punches.

TYPICAL WELD METAL CHEMISTRY (%)

C	1.20
Cr	28.00
W	4.50
Co	Balance

AVAILABLE SIZES
Bare: 1/8, 5/32, 3/16, 1/4, 5/16.
Coated: 1/8, 5/32, 3/16, 1/4.

COBALT NO. 12 BARE
COBALT NO. 12FC
AWS/SFA 5.21 ERCoCr-B
AWS/SFA 5.13 ECoCr-B

DESCRIPTION
Cobalt #12 is similar to Cobalt #6, however Cobalt #12 offers greater resistance to hot and cold abrasion at elevated temperatures. Weld deposits are harder than Cobalt #6 deposits because of a higher carbide volume within its microstructure. Cobalt #12 is excellent for abrasion and corrosion resistance, but only moderate impact. This alloy is commonly used for cutting edges.

TYPICAL APPLICATIONS
Tipping saw blades, chipping knives, paper slitters, cutter rolls, drawing dies, turbine blades, impeller pumps, conveyor screws, valve seats, cold working tools.

TYPICAL WELD METAL CHEMISTRY (%)

C	1.50
Cr	30.00
W	8.00
Co	Balance

AVAILABLE SIZES
Bare: 1/8, 5/32, 3/16, 1/4, 5/16.
Coated: 1/8, 5/32, 3/16, 1/4.

COBALT NO. 21 BARE
COBALT NO. 21FC

DESCRIPTION
Cobalt #21 offers excellent high temperature strength and stability. The addition of molybdenum gives it work hardening capability making Cobalt #21 excellent for hot trimming dies, extrusion dies and hot shears. This alloy has good anti-galling properties and excellent resistance to cavitation erosion and corrosion thereby making Cobalt #21 an excellent choice for fluid valve seats.

TYPICAL APPLICATIONS
Hot forming dies, hot working tools, pump shafts, high pressure-high temperature valves, valve seats, mixer blades, mill cutters, pump mill screws, gas turbines

TYPICAL WELD METAL CHEMISTRY (%)

C	0.25
Cr	28.00
Mo	5.00
Ni	2.80
Co	Balance

AVAILABLE SIZES
Bare: 1/8, 5/32, 3/16, 1/4.
Coated: 1/8, 5/32, 3/16, 1/4.

COBALT F BARE
COBALT F FC

DESCRIPTION
Cobalt F is best described as a lower alloy to replace Cobalt #6 and may be used for many "less critical" applications. Cobalt F applications would include repairing sliding gates or for the sealing faces of valve seats for combustion engines. Welded deposits are machinable.

TYPICAL APPLICATIONS
Engine valves and seats, extruder screws, scraper knives, forging dies, mixer rotors, brick trimming dies.

TYPICAL WELD METAL CHEMISTRY (%)

C	1.70
Cr	26.00
Ni	23.00
W	12.50
Co	Balance

AVAILABLE SIZES
Bare: 1/8, 5/32, 3/16, 1/4, 5/16.
Coated: 1/8, 5/32, 3/16, 1/4.

Cobalt Hardsurfacing Rods and Electrodes
Typical Physical and Mechanical Properties

ALLOY	HARDNESS ROCKWELL C			WEAR RESISTANCE						Machinability	Density lbs/in3	Melting Point	Tensile Strength
	Oxy-Fuel	TIG	Metal Arc	Metal to Metal	Impact	Erosion	Corrosion	Cold Abrasion	Hot Abrasion				
Cobalt No. 1 Bare Cobalt No. 1 FC	52-55 1 layer	54-54 2 layers	50-53 2 layers	Excellent	Not Recommended	Excellent	Excellent	Excellent	Excellent	Use Carbide Tools	0.312	2300ºF	111,000 psi
Cobalt No. 6 Bare Cobalt No. 6 FC	42-45 1 layer	40-43 2 layers	39-42 2 layers	Excellent	Excellent	Excellent	Excellent	Good	Good	Use Carbide Tools	0.303	2350ºF	134,000 psi
Cobalt No. 12 Bare Cobalt No. 12 FC	48-51 1 layer	46-49 2 layers	41-44 2 layers	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Use Carbide Tools	0.308	2345ºF	141,000 psi
Cobalt No. 21 Bare Cobalt No. 21 FC	NA	25-27 2 layers	24-26 2 layers	Excellent	Excellent	Excellent	Excellent	Good	Good	Use Carbide Tools	0.300	2460ºF	117,000 psi
		45 work hardened	45 work hardened										
Cobalt F Bare Cobalt F FC	41-44 1 layer	39-42 2 layers	38-41 2 layers	Excellent	Excellent								

Cobalt Hardsurfacing Rods and Electrodes
Preheat and Postheat Treatment*

BASE METAL	PREHEAT TEMP.	POSTHEAT
Low Carbon Steel (up to 0.40%C) for thin sections only	Not Required	Air-Cool
Low Carbon Steel (up to 0.40% C) for thick sections only and High Carbon Steel (over 0.40%C) for thin sections only and Low Alloy Steels (up to 10% alloy) for thin sections only	200°-600°F	Slow-Cool
High Carbon Steels (over 0.40%C) for thick sections only and Low Alloy Steel (up to 10% alloy) for thick sections only	300°-600°F	Slow-Cool
Air-Quench Steels	1100°-1200°F	Slow-Cool
High Chromium-Nickel (Austenitic) Stainless Steels (304, 309, 316, etc.) thin sections only	Not Required	Air-Cool
High Chromium-Nickel (Austenitic) Stainless Steel (304, 309, 316, etc.) thick sections only	200°-500°F	Slow-Cool
High Chromium (Martensitic) Stainless Steel (410, 416, 420, etc.) thick sections only	400°-600°F	Maintain at 400°-600°F for 4 hrs. per 1 inch thickness, then reduce heat 90°F per hour till cool
High Chromium (Ferritic) Stainless Steel (430, 442, 446, etc.) thick sections only	200°-600°'F	Maintain at 200°-600°F for 4 hrs. per inch thickness, then reduce heat 90°F per hour till cool
High Temperature Nickel Alloys (400, 600, 601,625, 718, etc.)	200°-500°F	Stress-Relieve

• In many cases, preheating or postheat treatment is not necessary. However, it will reduce the chances of cracking in both the base metal and the weld deposit. The preheat or postheat temperatures will depend upon the carbon content of the base metal. The higher the carbon content the higher the preheat temperature.

Welding Parameters and Data

Recommended Current Settings (SMA)		
Diameter	DC+(reverse polarity)	AC
1/8 (coaled) 5/32 (coated) 3/16 (coated) 1/4 (coated)	85-100 120-150 150-175 200-250	90-120 135-160 160-180 220-270

Approximate Coverage Per Pound of Cobalt Alloys		
Thickness of Deposit (in.)	Pounds Per Square Inch	
1/8 3/16 ¼	Bare 26 17 13	Coated 18 12 9

MILD STEEL & LOW HYDROGEN/ LOW ALLOY ELECTRODES

Washington Alloy mild steel and low hydrogen electrodes are manufactured under strict quality control methods in which all heats of electrodes are tested for chemical composition, mechanical properties and weldability. This is done to ensure that all electrodes meet Washington Alloy standards as well as AWS and ASTM specifications. Washington Alloy offers more than 35 different mild steel and low hydrogen electrodes with tensile strengths of 60,000 psi to 120,000 psi. All electrodes yield good deposition efficiency and easy weldability thereby providing increased production and lower overall fabricating costs.

Washington Alloy electrodes are printed with the appropriate AWS classification number for easy identification.

AWS AND WASHINGTON ALLOY IDENTIFICATION

1. The “E” in Exxxx represents arc welding electrode.
2. The first two digits of a 4 digit number or the first three digits of a 5 digit number indicate the minimum tensile strength of the weld deposit expressed in thousands of pounds per square inch (psi). For example E70XX indicates that this electrode has a minimum tensile strength of 70,000 psi and E110XX indicates a minimum tensile strength of 110,000 psi.
3. The next-to-last digit indicates the position in which this electrode may be used. Exx1x represents all positions while Exx2x indicates that this electrode is used for flat or horizontal positions only. For example E7018 indicates that this electrode may be used in all positions while E7028 indicates that this electrode is for flat and horizontal positions only.
4. The last digit combined with the next-to-last digit indicates the type of coating on the electrode and the type of current that may be used. For example:

Electrode	Coaling	Current
Exx10	High cellulose	DC reverse polarity only
Exx11	High cellulose	AC or DC reverse polarity
Exx12	High titania (rutile)	AC or DC straight polarity
Exx13	High titania (rutile)	AC or DC either polarity
Exx14	Rutile iron powder	AC or DC either polarity
Exx16	Low hydrogen	AC or DC reverse polarity
Exx18	Iron powder - low hydrogen	AC or DC reverse polarity
Exx24	Rutile-iron powder	AC or DC either polarity
Exx27	Iron powder-iron oxide	AC or DC either polarity
Exx28	Iron powder - low hydrogen	AC or DC reverse polarity

5. Finally: the suffix of the electrode indicates the estimated alloy content of the electrode. For example:

Suffix	Alloy Content
Exxx-A1	1/2% Mo
Exxx-B1	1/2% Cr, 1/2% Mo
Exxx-B2	1-1/4% Cr, 1/2% Mo
Exxx-B3	2-1/4% Cr,1% Mo
Exxx-C1	2-1/2% Ni
Exxx-C3	1%Ni, .35%MO, .15%Cr
Exxx-G	.50% Ni, .30% Cr, ,20% Mo, .10% Vn (all minimum pct and only one is required)
Exxx-M	1.3-1.8% Mn, 1.25-2.50% Ni, .40% Cr, .25-.50% Mo, .5% Max. Vn

Summary example: E7018-A1 would indicate an (a) arc welding electrode with a (b) minimum tensile strength of 70,000 psi (c) that can be used in any position (d) with AC or DC reverse polarity. This number also indicates that it is an iron powder- low hydrogen electrode which yields a weld deposit containing 1/2% Mo.

Mild Steel and Low Hydrogen/Low Alloy Electrodes

TIPS ON WELDING WITH MILD STEEL ELECTRODES

- Redrying electrodes at 200°-500°F for 10-30 minutes is recommended.
- DC current should be used whenever possible, however if arc blow persists then AC should be used.
- A medium-length arc of approximately 1/8", maintained ahead of the weld puddle, will yield good wetting action while allowing unwanted gases to escape. This will also permit the welder to shape the bead appearance.
- Flat and horizontal welding should be done by holding the electrode at an angle 10°-15° from 90°, staying ahead of the weld puddle and using a slight back and forth whipping motion.
- Overhead welding is similar to flat and horizontal but a slight circular motion should be used in the molten crater.
- Vertical-down welding should be performed with stringer beads or a slight weave. The weld puddle can be kept in place by pointing the electrode arc upward into the puddle. Use currents in the upper portion of the recommended range.
- Vertical-up welding should be done by using the shelf or step method where welding is done by adding layer on top of layer. Do not use the whipping motion, but move the electrode slowly while pointing the arc force upward. Use currents in the lower portion of the recommended range.

TIPS OF WELDING WITH LOW HYDROGEN ELECTRODES

- Redrying electrodes at 650°-500°F for 1-2 hrs. is recommended.
- DC current should be used whenever possible.
- Use a short steady arc to obtain maximum results. (The coating of the electrode should be touching the base plate.)
- Hold the electrode at a 15° angle into the direction of travel.
- Weaving may be used, but not to exceed 3 times the diameter of the electrode.
- Whipping should not be done since it will cause porosity in a weld metal.
- A straight-forward progression is recommended for all positions.

WASHINGTON ALLOY 4130FC*

DESCRIPTION

Washington Alloy 4130FC is a flux-coated electrode designed for shielded metal arc welding of heat-treatable, low alloy steels such as the SAE 4100 series and 8630.

PREHEATING AND POSTHEATIN

A preheat temperature of 400-600°F is required for some of the higher carbon grades in order to prevent cracking. Maintain the preheat temperature between passes. Oil quench at1600°F, temper at 950°F.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.21
Mn	1.24
Si	0.40
Cr	0.49
Mo	0.19
Ni	1.30

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT*

Proper heat treatment will produce a tensile strength of 150,000 to 160,000 psi.

AVAILABLE SIZES AND RECOMMENDED CURRENT

Dia. (in.)	3/32	1/8	5/32	3/16
Lgth. (in.)	14"	14"	14"	14"
Amps F	70-100	90-160	130-220	200-300
Amps V & O	70-100	90-135	110-160	__

* Other heat-treatable , low alloy electrodes (4140 FC and 4340 FC) are available.

USA 6010

AWS A5.1 Class E6010

DESCRIPTION

USA 6010 is a high cellulose coated electrode designed to provide a smooth stable arc forceful enough to achieve deep penetration into the base metal. This electrode exhibits high deposition efficiency and low spatter loss. It produces a weld puddle that wets and spreads well, yet sets up fast enough to make this electrode ideal for vertical up or vertical down welding techniques. USA 6010 electrodes produce a flat weld bead with coarse ripples and a thin easily removable slag. USA 6010 electrodes may be used in the flat, horizontal, vertical or overhead welding positions.

TYPICAL APPLICATIONS

USA 6010 electrodes are most commonly used for out-of-position welding such as field construction, ship yards, water towers, pressure vessels, pressure pipes, steel castings, plain and galvanized steel storage tanks, etc.

TYPICAL WELD METAL CHEMISTRY (%)

DESCRIPTION

USA 6010 is a high cellulose coated electrode designed to provide a smooth stable arc forceful enough to achieve deep penetration into the base metal. This electrode exhibits high deposition efficiency and low spatter loss. It produces a weld puddle that wets and spreads well, yet sets up fast enough to make this electrode ideal for vertical up or vertical down welding techniques. USA 6010 electrodes produce a flat weld bead with coarse ripples and a thin easily removable slag. USA 6010 electrodes may be used in the flat, horizontal, vertical or overhead welding positions.

TYPICAL APPLICATIONS

USA 6010 electrodes are most commonly used for out-of-position welding such as field construction, ship yards, water towers, pressure vessels, pressure pipes, steel castings, plain and galvanized steel storage tanks, etc.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.100
Mn	0.470
Si	0.200
P	0.014
S	0.012

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi).....61,000
Tensile strength (psi).....70,000
Elongation in 2" (%).....30
Charpy V-notch at – 20°F (ft. lbs.)..... 36
Reduction in area (%).....60

AVAILABLE SIZES AND RECOMMENDED CURRENT (DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	14	14
Amps F	60-85	80-120	110-160	150-200	160-210	190-240
Amps V & O	50-70	70-110	110-150	130-170	130-190	

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 6011
AWS A5.1 CLASS E6011

DESCRIPTION
USA 6011 electrodes have the same characteristics as USA 6010; however unlike the USA 6010, this electrode may be used with small AC welders as well as DC types. USA 6011 high cellulose coated electrodes provide excellent arc stability, increased ductility, high deposition efficiency and low spatter. This electrode combines a strong arc force with fast solidification of weld metal, thereby permitting vertical or overhead as well as flat and horizontal welding positions. USA 6011 is especially suited for welding where poor groove fit-up and rusty or oily steel is present.

TYPICAL APPLICATIONS
USA 6011 is commonly used as an all purpose electrode for automobile body shops and mild steel farm equipment. Other uses would include shipbuilding, bridges, boilers, barges, railroad cars, pipes, truck frames, pressure vessels, storage tanks and galvanized steel.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.100
Mn	0.580
Si	0.370
P	0.015
S	0.013

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)	63,000
Tensile strength (psi)	72,000
Elongation in 2” (%)	29.2
Charpy V-notch at -20°F (ft. lbs.)	36
Reduction in area(%)	60

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	14	14
Amps F	65-90	80-120	130-170	170-210	170-220	200-250
Amps V & O	50-75	70-110	110-150	130-170	140-200	

USA 6012
AWS A5.1 Class E6012

DESCRIPTION
USA 6012 high titania coated electrodes were developed for usage on thin sections and poor fit-up joints where shallow penetration is required. This electrode produces a quiet arc forceful enough to prevent slag build-up during vertical down welding. USA 6012 electrodes produce smooth, uniform weld deposits with low spatter and low porosity. Maximum deposition efficiency is attained even at increased currents and travel speeds on thick and thin base plates. USA 6012 electrodes may be used in any position.

TYPICAL APPLICATIONS
USA 6012 is used for welding steel window frames, sheet steel, metal furniture, railway freight cars, automobiles, ships, barges, rolling stocks, pipes, castings and tanks. It is an excellent electrode to use for lap fillet joint welding on bottom plates in tanks.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.090
Mn	0.460
Si	0.260
P	0.014
S	0.013

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)	61,000
Tensile strength (psi)	70,000
Elongation in 2” (%)	26
Charpy V-notch at -32°F (ft. lbs.)	65
Reduction in area(%)	40

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	14	14
Amps F	65-100	85-130	110-160	160-220	200-260	210-280
Amps V & O	65-100	85-130	100-150	120-190	140-190	

USA 6013
AWS A5.1 Class E6013

DESCRIPTION
USA 6013 high titania coated electrodes produce weld deposits which are much smoother and flatter than those produced by USA 6012. This electrode was primarily designed to provide good wetting and shallow penetration for thin sheet metal applications (using smaller diameter electrodes), but with sufficient penetration for welding medium gauge steel. As a result, USA 6013 is an all- purpose electrode that provides a soft steady arc which is easily regenerated, easy slag control for vertical-down welding, low spatter and a beautiful bead appearance. USA 6013 electrodes may be used in any position with AC or DC (straight or reverse polarity).

TYPICAL APPLICATIONS
USA 6013 is commonly used for automobile bodies, truck frames and bodies, ornamental iron, metal furniture, farm implements, machinery guards, storage tanks, or wherever appearance is important or desirable.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.450
Si	0.320
P	0.014
S	0.008

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)	63,000
Tensile strength (psi)	70,000
Elongation in 2” (%)	29.7
Charpy V-notch at -32°F (ft. lbs.)	58
Reduction in area(%)	58

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	1/16	5/64	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	10	12	14	14	14	14	14
AmpsF	25-50	35-60	50-100	80-130	140-180	180-230	260-320
Amps V & O	25-50	35-60	50-90	60-110	110-160	120-160	

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 6027
AWS A5.1 Class E6027

DESCRIPTION
USA 6027 is a heavy iron powder, iron oxide coated electrode developed to provide maximum deposition efficiency and deep penetration at higher speeds. It is particularly suited for welding flat, deep groove joints as well as horizontal butt and fillet welds. USA 6027 weld deposits exhibit exceptional ductility, high impact strength and easy slag removability. This electrode provides easy operation and excellent restarting capability making it suitable for intermittent welding. USA 6027 may be used with AC or DC (straight or reverse polarity).

TYPICAL APPLICATIONS
USA 6027 electrodes are used for the welding of ship hulls, bridges, structural steels, railroad cars, earthmoving equipment and pressure vessels or pipes that have been poisoned for horizontal welding.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.060
Mn	0.850
Si	0.350
P	0.021
S	0.009

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)	63,000
Tensile strength (psi)	70,000
Elongation in 2” (%)	31.5
Charpy V-notch at -20°F (ft. lbs.)	51
Reduction in area(%)	58

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	18	18-28	18/28	18/28
Amps F	40-150	140-170	180-230	200-240	250-280

USA 7010-A1
AWS A5.5 Class E7010-A1

DESCRIPTION
USA 7010-A1 is a high cellulose electrode developed specifically for welding pipe lines. Although this electrode may be used in any position, it is best suited for vertical up or vertical down welding. USA 7010-A1 yields a forceful arc with deep penetration, producing a weld puddle that wets and spreads well, with rapid solidification. Weld deposits are of X-ray quality, with 70,000 psi tensile strengths and containing 1/2% Mo, USA 7010-A1 electrodes may be used with AC or DC (reverse polarity).

PREHEATING
When welding carbon-molybdenum steels, preheating at 300-575°F is recommended. Exact preheat temperature will depend upon the thickness and hardening characteristics of the work piece.

TYPICAL APPLICATIONS
USA 7010-A1 is most commonly used for welding carbon-moly piping used in high pressure, high temperature steam service and structural shapes, plates and castings, which have a 1/2% Mo content.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.090
Mn	0.430
Si	0.140
Mo	0.490
S	0.010
P	0.012

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)	65,000
Tensile strength (psi)	80,000
Elongation in 2” (%)	29
Charpy V-notch at -32oF (ft. lbs.)	65

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16
Lgth. (in.)	14	14	14	14
Amps F	60-90	90-120	120-160	160-200
Amps V & O	50-80	80-100	110-150	150-180

USA 7014
AWS A5.1 Class E7014

DESCRIPTION
USA 7014 is an iron powder, rutile type electrode designed to operate at higher speeds and with greater deposition efficiency than USA 6012 or USA 6013 electrodes. This electrode provides a stable arc, flat smooth bead appearance and easy slag removability. USA 7014 is used for all position, single-pass and multi-layer welding applications. AC or DC (straight or reverse polarity) may be used.

TYPICAL APPLICATIONS
USA 7014 is an all-purpose electrode used wherever the welding efficiency of USA 6012 or USA 6013 is not acceptable. Typical applications would include: ship structures, bridges, structural steels for buildings, sheet metal, ornamental iron, auto bodies and fenders, machine parts, storage tanks, etc.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.450
Si	0.320
P	0.014
S	0.008

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)	69,000
Tensile strength (psi)	79,000
Elongation in 2” (%)	30
Charpy V-notch at -32°F (ft. lbs.)	58
Reduction in area(%)	44

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	1/16	5/64	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	10	12	14	14	14	14	14	14
Amps F	35-60	45-70	50-100	90-140	150-210	200-240	210-270	250-320
Apms V&O	35-60	45-70	40-65	60-90	110-160	120-160	-	-

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 7016
AWS A5.1 Class E7016

DESCRIPTION
USA 7016 is a low hydrogen, all position electrode used for welding heavy duty steel structures and plates. This electrode provides excellent arc stability and produces X-ray quality weld deposits with higher crack resistance, elongation and ductility than other mild steel electrodes. USA 7016 yields a beautiful bead appearance with easy slag removability.

TYPICAL APPLICATIONS
Typical applications would include strength members of ship hulls, rolling stocks, machinery, bridges, free-cutting steels and medium carbon steels.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	0.980
Si	0.480
P	0.012
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)..... 69,000
Tensile strength (psi)..... 79,000
Elongation in 2" (%)..... 33.6
Charpy V-notch at -20°F (ft. lbs.)..... 109

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps F	50-100	90-130	150-190	180-230	250-300
Amps. V&O	40-80	70-100	120-160	140-180	-

USA 7016-A1
AWS A5.5 Class E7016-A1

DESCRIPTION
USA 7016-A1 is a low hydrogen, 1/2% Mo electrode used for welding carbon-molybdenum steels which are subjected to temperatures as high as 940°F, such as those found in boilers. USA 7016-A1 electrodes may be used with AC or DC (reverse polarity).

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 200-400°F and postheating at 1150-1250°F (for 1 hour), is required.

TYPICAL APPLICATIONS
C-Mo steel pipes (A335-P1), boiler and heat exchanger steel tubes (A209-T1. A161 –T1), rolled steels (A204-A,B,C), cast steels (A217-WCI) and forged steels (A182-F1,A336-F1).

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.830
Si	0.540
Mo	0.520
S	0.010
P	0.008

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relived)

Yield strength (psi)..... 80,000
Tensile strength (psi)..... 94,000
Elongation in 2" (%)..... 31

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	55-85	90-130	140-190	190-240	250-310
Amps. V&O	50-80	80-120	110-170	-	-

USA 7016HT
AWS A5.1 Class E7016

DESCRIPTION
USA 7016HT is the most popular low hydrogen electrode for welding 71,000 psi high tensile steel. This electrode may be used in any position, producing weld deposits with excellent crack resistance and slag removability. USA 7016HT also exhibits good arc regeneration. This electrode may be used with AC or DC (reverse polarity).

TYPICAL APPLICATIONS
USA 7016HT is most commonly used for ships, machinery, rolling stocks, bridges and buildings.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	1.020
Si	0.570
P	0.011
S	0.009

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi).....70,000
Tensile strength (psi).....82,000
Elongation in 2" (%).....32.6
Charpy V-notch at -32°F (ft. lbs.)..... 100

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps F	40-80	70-130	150-190	210-250	250-300
Amps V&O	30-70	70-100	120-160	130-180	-

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 7016V
AWS A5.1 Class E7016

DESCRIPTION
USA 7016V low hydrogen electrodes were specifically designed for vertical downward butt and fillet welds on mild steel. This electrode yields high deposition efficiency, producing weld deposits with excellent mechanical properties and high resistance to cracking. USA 701V welds have a very fine bead appearance, easy slag removability, and are free from undercuts. This electrode may be used with AC or DC (reverse polarity).

TYPICAL APPLICATIONS
USA 7016V is used mainly for ships, buildings, bridges, construction machinery, pressure vessels and rolling stocks.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	0.850
Si	0.450
P	0.014
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)..... 65,000
Tensile strength (psi)..... 79,000
Elongation in 2” (%)..... 32.9
Charpy V-notch at -20°F (ft. lbs.)..... 78

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	1/8	5/32	3/16	7/32
Lgth. (in.)	14	18	18	18
Amps V	100-150	160-210	220-280	260-330

USA 7016W
AWS A5.1 Class E7016

DESCRIPTION
USA 7016W low hydrogen electrodes were developed for one-side welding of pipes, as well as butt joints in general. This electrode is excellent for root-pass welding where sound bead appearance on the reverse side is assured, thereby eliminating back-chipping and saving precious man-hours. USA 7016W is suitable for vertical and overhead welding.

TYPICAL APPLICATIONS
Typical applications would include strength members in ship hulls, pressure vessels, rolling stocks, bridges and the one-side welding of pipes.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.900
Si	0.580
P	0.013
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)..... 67,000
Tensile strength (psi)..... 81,000
Elongation in 2” (%)..... 32.2
Charpy V-notch at -20°F (ft. lbs.)..... 58

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16
Lgth. (in.)	14	14	14	14
Amps F	50-100	90-140	120-180	150-240
Amps V&O	40-80	80-120	100-150	140-200
One side welding	30-65	60-110	90-140	130-180

USA 7018*
AWS A5.1 Class E7018

DESCRIPTION
USA 7018 is the most efficient general purpose, iron powder — low hydrogen electrode used for welding carbon steels, free-machining steels and low alloy steels with a minimum yield strength of 50,000 psi. USA 7018 has a very good deposition rate, providing a quiet steady arc with low spatter and medium penetration. Weld deposits are of X-ray quality with easy slag removal, exceptional mechanical properties and a smooth uniform bead appearance. USA 7018 has excellent operator appeal and may be used in any position with AC or DC (reverse polarity).

TYPICAL APPLICATIONS
USA 7018 electrodes are used for many ASTM specifications. More specific applications would include process piping, cold rolled steels such as found in heavy machinery fabrications, fired and unfired pressure vessels, shop and field welding of bridges and structural steels, cast steels, shipbuilding, just about any medium carbon, low alloy steel where the welds are subject to X-ray inspection.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.970
Si	0.570
P	0.012
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi).....72,000
Tensile strength (psi).....86,000
Elongation in 2” (%).....31
Charpy V-notch at -20°F (ft. lbs.)..... 65

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	18	18
Amps. F	55-85	90-140	130-185	190-250	230-285	250-320
Amps. V&O	50-80	80-120	110-180	160-210	-	-

* USA 7018-1 AWS A5.1 Class E7018-1 available upon request.

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 7018-A1

AWS A5.5 Class E7018-A1 (Weld deposit also meets the requirements of AWS A5.5 Class E7015-A1 and E7016-A1

DESCRIPTION

USA 7018-A1 is an iron powder, low hydro-gen electrode designed for welding low alloy, high tensile steel of 65,000 psi minimum yield strength and containing 1/2% Mo. This electrode offers the welder high deposition efficiency and produces a weld deposit with fine bead appearance, easily removable slag, low spatter and medium penetration. USA 7018- A1 weld metal solidifies rather rapidly, making this electrode suitable for out of position welding.

TYPICAL APPLICATIONS

USA 7018-A1 is typically used for the fabrication of carbon-molybdenum pipes, pressure vessels, boilers and tubing containing 1/2% Mo.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.060
Mn	0.720
Mo	0.530
Si	0.490
P	0.012
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)..... 86,000
Tensile strength (psi)..... 98,000
Elongation in 2” (%)..... 28
Charpy V-notch at -20°F (ft. lbs.)..... 87

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	70-120	100-150	120-200	200-275	275-350
Amps. V&O	55-80	80-120	100-160	180-240	-

USA 7018-B2L

AWS A5.5 Class E7018-B2L Formerly AWS A5.5 Class E8018-B2L

DESCRIPTION

USA 7018-B2L is a low hydrogen, low alloy, chrome-moly electrode containing extra low carbon and designed for welding 1/2% chromium- 1/2% molybdenum, 1% chromium- 1/2% molybdenum and 1-1/4% chromium - 1/2% molybdenum steel. The extra low carbon content improves microstructure stability during high temperature service such as found in pressure piping or boiler work. USA 7018-B2L can be used in all positions with AC or DC (reverse polarity) and offers good arc stability, easy slag removal and high deposition efficiency. Excellent mechanical properties.

PREHEATING AND POSTHEATING

Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 300-550°F and postheating at 1250-1350°F (for 1 hour) is required. Note: In many cases the lower carbon content of USA 7018B2L will permit a lower preheat temperature.

TYPICAL APPLICATIONS

USA 7018-B2L is similar in usage and applications to USA 7018-B2. More common applications would include pressure piping such as found in steam power generating equipment, petrochemical pressure vessels, chemical processing equipment and in the shipbuilding industries.

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C	0.035
Mn	0.700
Si	0.610
Cr	1.320
Mo	0.550
P	0.011
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved*)

Yield point (psi)..... 57,000
Tensile strength (psi)..... 75,000
Elongation in 2” (%)..... 24
Charpy V-notch at 72oF (ft. lbs.)..... 48
Reduction of area (%)..... 71

* 1 hour at 1275°F.

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	18	18
Amps. F	60-100	90-130	130-190	190-250	230-270	250-300
Amps. V&O	60-90	80-120	110-170	—	—	—

USA 7024

AWS A5.1 Class E7024

DESCRIPTION

USA 7024 is an iron powder, rutile coated electrode designed for high speed, single pass horizontal and flat fillet welding of mild steel. This electrode provides greater deposition efficiency and better physical properties than USA 7014 electrodes. USA 7024 offers a quiet stable arc and produces weld deposits with low spatter, free of undercuts and a “self-removing” slag. Bead appearance is superb. This electrode may be used with AC or DC (straight or reverse polarity).

TYPICAL APPLICATIONS

Ship structures, bridges, structural steels, machine bases, truck fabrication, storage tanks an rolling stocks.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.090
Mn	0.780
Si	0.350
P	0.019
S	0.014

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield Point (psi)..... 70,000
Tensile strength (psi)..... 83,000
Elongation in 2” (%)..... 28
Charpy V-notch at 32°F (ft. lbs.)..... 51
Reduction in area (%)..... 40

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14-18	14-18	18-28	18-28	18-28
Amps F	60-100	120-170	140-190	200-250	230-270	280-380

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 7028
AWS A5.1 Class E7028

DESCRIPTION
USA 7028 is an iron powder, low hydrogen electrode developed for high deposition efficiency welding of flat and horizontal fillets, as well as deep groove joints in 71,000 psi, high tensile strength steel. This electrode produces X-ray quality weld deposits which exhibit high cracking resistance and excellent mechanical properties. In addition to its high deposition rate, USA 7028 provides easy slag removability and a nice bead appearance, tree from undercuts. Welding efficiency can be further improved by using a gravity welder. This electrode can be used with AC or DC (reverse polarity).

TYPICAL APPLICATIONS
USA 7028 is used for welding strength members of ship hulls, bridges, heavy machinery parts and fired or unfired pressure vessels.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.980
Si	0.520
P	0.012
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield point (psi)	69,000
Tensile strength (psi)	80,000
Elongation in 2” (%)	31.2
Charpy V-notch at 0°F (ft. lbs.)	94
Reduction in area (5)	60

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	18-28	18-28	18-28	18-28
Amps F	90-150	160-220	200-250	220-270	290-340

USA 7048
AWS A5.1 Class E7048

DESCRIPTION
USA 7048 is an iron-powder-potassium low-hydrogen flux coated electrode developed to provide exceptional welding properties for vertical down welding application. USA 7048 electrodes are designed to weld mild, low carbon, low alloy, and free-machining steels. USA 7048 has a very good deposition rate, providing a stable arc with extremely low spatter loss with good penetration. USA 7048 is known for x-ray quality weld deposits with smooth, uniform bead appearance and ease of slag removal. USA 7048 is designed to operate on AC or DC reverse polarity (DCEP) welding current.

TYPICAL APPLICATIONS
USA 7048 is extensively used for fabrication and repair of fired and non-fired pressure vessels using ASTM A-516 or A-537 plate, process piping using ASTM A-33 or A-523 pipe, shop and field welding or bridges using ASTM A-709 plate, shipbuilding using ASTM A-131 plate, structural steels, cast steels, and cold rolled steels used in heavy machinery fabrication. USA 7048 is used anywhere welds are deemed critical and subject to x-ray inspection.

TYPICAL WELD METAL CHEMISTRY (%) (Welded with DCSP, 100% Argon Shield Gas)

C	0.070
Mn	0.970
Si	0.570
P	0.012
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relived)

Yield point (psi)	72,000
Tensile strength (psi)	86,000
Elongation in 2” (%)	31
Charpy V-notch at -20°F (ft. lbs.)	58

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Amps F	55-85	90-140	130-185	190-250	230-285	250-320
Amps V&O	50-80	80-120	110-180	160-210	-	-

USA 8016-B1
AWS A5.5 Class E8016-B1

DESCRIPTION
USA 8016-B1 is a low hydrogen electrode used for welding ½% Cr – ½% Mo steel which is subjected to high pressures and temperatures up to 1000ºF. This electrode produces a weld deposit with minimal hydrogen content and excellent crack resistance. USA 8016-B1 may be used with AC or DC (reverse polarity).

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 300-475ºF and postheating at 1150-1250ºF (for 1 hour) is required.

TYPICAL APPLICATIONS
More common uses would include boilers, chemical equipment, oil refineries, heat exchangers steel tubes (A213-T2), rolled steels and cast iron.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.810
Si	0.510
Cr	0.510
Mo	0.490
S	0.012
P	0.012

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relived)

Yield strength (psi)	86,000
Tensile strength (psi)	97,000
Elongation in 2” (%)	26
Charpy V-notch at -20°F (ft. lbs.)	79

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	55-85	90-130	130-180	190-240	250-320
Amps. V&O	40-80	80-120	110-160	-	-

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 8016-B2
AWS A5.5 Class 8016-B2

DESCRIPTION
USA 8016-B2 is an all-position, low hydro- gen electrode used for welding 1-1/4% Cr, 1/2% Mo, steel which is subjected to temperatures as high as 1000°F. USA 8016-B2 electrodes yield a forceful arc with medium penetration, producing weld deposits with low spatter, rapid solidification of weld metal and easy slag removability. USA 8016-B2 electrodes may be used with AC or DC (reverse polarity).

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at temperature between 300-550°F and postheating at 1250-1350°F (for 1 hour) is required.

TYPICAL APPLICATIONS
USA 8016-B2 is commonly used for welding piping steels (A335-P2, P11, P12) boiler and heat exchanger steel tubes (A119-T11, A200-T11, T12), rolled steel (A301-B, A387-B, C), cast steel (A217-WC6) and forged steel (A182-F11, F12, A336-F12).

TYPICAL WELD METAL CHEMISTRY (%)

C	0.060
Mn	0.650
Si	0.470
Cr	1.310
Mo	0.520
P	0.011
S	0.009

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stresses-relieved)

Yield Point (psi)	83,000
Tensile strength (psi)	94,000
Elongation in 2” (%)	26
Charpy V-notch at -20°F (ft. lbs.)	76

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	60-90	80-120	125-175	185-235	240-300
Amps. V&O	50-80	75-100	100-160	—	—

USA 8016G
AWS A5.5 Class E8016-G

DESCRIPTION
USA 8016G is an extra-low hydrogen type electrode used for welding 86,000 psi high tensile steel. This electrode produces X-ray quality welds with good crack resistance, notch toughness and a fine bead appearance. USA 8016G may be used in any position with either AC or DC (reverse polarity).

TYPICAL APPLICATIONS
USA 8016G is commonly used for welding high tensile steels such as pressure vessels, bridges, penstocks and rails.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	1.200
Si	0.800
P	0.014
S	0.070

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield Point (psi)	79,000
Tensile strength (psi)	87,000
Elongation in 2” (%)	28
Charpy V-notch at -20°F (ft. lbs.)	94

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	14
Amps. F	45-75	70-130	150-200	190-230	260-300
Amps. V&O	45-75	80-130	120-160	140-170	-

USA 8018-B2
AWS A5.5 Class E8018-B2

DESCRIPTION
USA 8018-B2 iron powder, low hydrogen electrodes are designed for welding 1/2-1-1/4% chromium and 1/2% molybdenum alloy steels which are exposed to high pressures and temperatures. This electrode has high deposition efficiency, producing X-ray quality weld deposits that meet or exceed AWS/ASTM charpy V-notch impact requirements, USA 8018-B2 electrodes yield a smooth arc, with low spatter, a fine bead appearance and exceptional mechanical properties. USA 8018-B2 may be used with AC or DC (reverse polarity)

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 300-550°F and postheating at 1250-1350°F (for 1 hour) is required.

TYPICAL APPLICATIONS
USA 8018-B2 can be used for many ASTM specifications. More common applications would include steam pipes of boilers for electric power plants, equipment found in the oil refining industry, synthetic chemical plants and ships. (A335-P2, P11, P12, A119-T11, A301-B, A217-WC6, A182-F11).

TYPICAL WELD METAL CHEMISTRY (%)

C	0.060
Mn	0.700
Si	0.610
Cr	1.320
Mo	0.550
P	0.011
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relived)

Yield Point (psi)	86,000
Tensile strength (psi)	97,000
Elongation in 2” (%)	25
Charpy V-notch at 72°F (ft. lbs.)	44
Reduction of area (%)	62

AVAILABLE SIZES AND RECOMMEND-ED CURRENTS (AC or DC+)

Dia. (in.)	3-32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	60-100	90-130	130-190	190-250	250-300
Amps. V&O	60-90	80-120	110-170	-	-

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 8018-B3L

AWS A5.5 Class E8018-B3L
Formerly AWS A5.5Class E9018-B3L

DESCRIPTION

USA 8018-B3L is a low hydrogen, low alloy, chrome-moly electrode containing extra low carbon and designed for welding 2-1/4% chromium -1% molybdenum steel. The extra low carbon content of USA 8018-B3L improves micro structure stability during high temperature service applications such as found in pressure piping or boiler work. USA 8018-B3L can be used in any position with AC or DC (reverse polarity) and offers good arc stability, low spatter and high deposition efficiency. Excellent mechanical properties and X-ray quality weld deposits.

PREHEATING AND POSTHEATING

Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 400-650°F and postheating at 1250-1350°F (for 1 hour) is required. Note: In many cases the lower carbon content of USA 8018-B3L will permit a lower preheat temperature.

TYPICAL APPLICATIONS

USA 8018-B3L is similar in usage and applications to USA 8018-B3. USA 8018-B3L is most commonly used for castings, forgings and plates of 2-1/4 chromium -1% molybdenum steel, pressure piping such as found in steam power generating equipment, boiler and heat exchanger steel tubes, marine equipment, chemical processing equipment and oil refinery equipment.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.035
Mn	0.770
Si	0.500
Cr	2.250
Mo	1.020
P	0.014
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved*)

Yield strength (psi)..... 67,000
Tensile strength (psi)..... 80,000
Elongation in 2" (%)..... 21
Charpy V-notch at -72°F (ft. lbs.)..... 42
Reduction in area (%)..... 67

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	18	18
Amps. F	60-100	90-130	130-190	190-250	230-270	250-300
Amps. V&O	60-90	80-120	110-170	—	—	—

USA 8018-C1

AWS A5.5 Class E8018-C1 (Weld deposit also meets the requirements of AWS A5.5 Class E8016-C1)

DESCRIPTION

USA 8018-C1 is a low alloy, low hydrogen, iron powder electrode designed to weld 2% nickel steels in the 70-80,000 psi range and where low temperature impact properties must be good. This electrode provides a stable arc in flat and horizontal fillet welding positions, producing weld deposits with fine bead appearance, free from undercuts and with excellent mechanical properties. USA 8018-C1 may be used with AC or DC (reverse polarity).

TYPICAL APPLICATIONS

USA 8018-C1 is commonly used for welding alloys subjected to low temperatures such as found In Industries involved with liquid ammonia, propane and other gases. More specific uses would include cast and wrought air-hardenable steels.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.060
Mn	0.980
Si	0.600
Ni	2.410
P	0.013
S	0.007

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)..... 73,000
Tensile strength (psi)..... 87,000
Elongation in 2" (%)..... 32
Charpy V-notch at -75°F (ft. lbs.)..... 94
Reduction of area (%)..... 60

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	14
Amps. F	45-75	110-150	150-190	200-240	230-270
Amps. V&O	45-75	100-140	120-170	—	—

USA 8018-C2

AWS A5.5 Class E8018-C2 (Weld deposit also meets the requirements of AWS A5.5 Class E8016-C2)

DESCRIPTION

USA 8018-C2 is a low alloy, low hydrogen, iron powder electrode designed for welding 3% nickel steel and aluminum-killed steel where low temperature impact properties must be good. This electrode offers fast and efficient deposition in all positions.

TYPICAL APPLICATIONS

USA 8018-C2 is primarily used for welding 3% nickel steels intended for low temperature service, such as found in the production or storage of propane and liquid ammonia. USA 8018-C2 is commonly used to weld ASTM A8, A203, A333 Gr.3, A334 Gr.4, A352 Gr.LC2, LC3, A350 Gr.LF3 and others. Preheating is recommended for highly hardenable steels and is used to prevent cracking during cooling.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.07
Si	0.32
Mn	1.12
Ni	3.45

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield Point (psi)..... 83,000
Tensile strength (psi)..... 94,000
Elongation in 2" (%)..... 22
Charpy V-notch at -100°F (ft. lbs.)..... 44

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	14
Amps. F	60-90	110-150	150-190	200-240	250-310
Amps. V&O	50-80	100-140	120-170	-	-

Other Low Alloy Electrodes available

USA 8018-B6 AWS A5.5 E 8018-B6 see page 33
USA 8018-B8 AWS A5.5 E 8018-B8 see page 33

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 8018-C3
AWS A5.5 Class E8018-C3 (Weld deposit also meets the requirements of AWS A5.5 Class E8016-C3

DESCRIPTION
USA 8018-C3 is a 1 % nickel, low hydrogen, iron powder electrode used for-welding high strength steels in the 70-80,000 psi tensile strength range. This electrode offers high deposition efficiency, producing excellent quality weld deposits with good impact properties even at temperatures as low as -60°F. USA 8018-C3 is also used for fillet welds on high strength quenched and tempered steels such as ASTM A514 and A517. USA 8018-C3 may be used in any position with AC or DC (reverse polarity).

TYPICAL APPLICATIONS
Cor-ten, Mayari R, LT75, N-A-Z High Tensile, V-55, Yoloy HS. military and commercial applications.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	0.910
Si	0.450
Ni	1.030
Mo	0.220
P	0.013
S	0.014

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield point (psi)..... 77,000
Tensile strength (psi)..... 87,000
Elongation in 2” (%)..... 31
Charpy V-notch at -40°F (ft. lbs.)..... 44

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	60-95	90-130	135-180	190-240	250-300
Amps. V&O	60-90	80-120	110-170	—	—

USA 8018G
AWS A5.5 Class E8018-G

DESCRIPTION
USA B01BG is an iron powder - low hydrogen electrode designed for welding 86,000 psi high tensile strength steels. This electrode offers highly efficient operational characteristics for welding in all positions. USA 8018G electrodes yield a stable arc with low spatter and produce weld deposits with good crack resistance and easy slag removability. This electrode is used with AC or DC (reverse polarity).

TYPICAL APPLICATIONS
USA 8018G is most commonly used for welding ships, bridges, tanks and buildings.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.070
Mn	1.240
Si	0.450
P	0.012
S	0.011

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield point (psi)..... 80,000
Tensile strength (psi)..... 90,000
Elongation in 2” (%)..... 30
Charpy V-notch at -20°F (ft. lbs.)..... 72

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	55-85	90-130	120-180	180-240	240-310
Amps. V&O	55-85	80-110	110-170	150-200	—

USA 9016-B3
AWS A5.5 Class E9016-B3

DESCRIPTION
USA 9016-B3 is an all-position, low hydrogen electrode designed for welding 2-1/4% Cr, 1% Mo steel. This electrode yields a forceful arc with medium penetration, producing weld deposits with low spatter; easily removable slag and a fine bead appearance. USA 9016-83 may be used with AC or DC (reverse polarity).

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 400-650°F and postheating at 1250-1350°F (for 1 hour) is required.

TYPICAL APPLICATIONS
USA 9016B-3 is most commonly used for the welding of piping steels (A335-P22), boiler and heat exchanger steel tubes (A 199-T22, A200-T22, A213-T22), rolled steels (A387-D), cast steels (A217WC), and forged steels (A182-F22, A336-F22).

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	0.780
Si	0.450
Cr	2.370
Mo	1.030
P	0.011
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Yield point (psi)..... 90,000
Tensile strength (psi)..... 103,000
Elongation in 2” (%)..... 24

AVAILABLE SIZES AND RECOMMEND-ED CURRENTS (AC or DC+)

Dia. (in.)	3-32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps F	55-85	90-130	140-190	190-240	240-300
Amps. V&O	50-80	75-115	75-115	100-160	-

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 9016-G
AWS A5.5 Class E9016G

DESCRIPTION
USA 9016G is a low hydrogen electrode developed for welding 86,000 psi high tensile steel. This electrode produces X-ray quality, Mn-Ni-Mo weld deposits which have minimal hydrogen content and good crack resistance. USA 9016G electrodes may be used with AC or DC (reverse polarity).

PREHEATING
It is recommended that the work piece be preheated at 140-180°F.

TYPICAL APPLICATIONS
USA 9016G is used for high tensile steels such as those found in pressure vessels, penstocks, bridges, vehicles and machinery.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	1.040
Si	0.580
P	0.012
S	0.008
Ni	0.630
Mo	0.260

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (stress-relieved)

Yield strength (psi)..... 88,000
Tensile strength (psi)..... 96,000
Elongation in 2" (%)..... 30.5
Charpy V-notch at -20°F (ft. lbs.)..... 101

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps F	70-100	100-130	150-190	190-240	250-300
Amps. V & O	60-90	80-120	120-160	140-180	-

USA 9018-B3
AWS A5.5 Class E908-B3 (Weld deposit also meets the requirements of E9015-B3 and E9016-B3)

DESCRIPTION
USA 9018-B3 is an all position, iron powder-low hydrogen electrode developed for welding 2-1/4% Cr-1% Mo steel which is subjected to elevated temperatures such as those found in the power piping and boiler industries. This electrode has extremely high deposition efficiency, producing X-ray quality weld deposits with mechanical properties that meet or exceed AWS-ASTM requirements. USA 9018-B3 electrodes yield a stable arc with low spatter. AC or DC (reverse polarity) may be used.

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work; piece, preheating at a temperature between 400-650°F and postheating at 1250-1350°F (for 1 hour) is required.

TYPICAL APPLICATIONS
USA 9018-B3 is used in piping steels (A335-P22), boiler and heat exchanger steel tubes (A199-T22, A200-T22, A213-T22), rolled steels (A387-D), cast steels (A217-WC) and forged steels (A182-F22, 336-F22).

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	0.770
Si	0.500
Cr	2.250
Mo	1.020
P	0.014
S	0.010

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Yield point (psi)..... 99,000
Tensile strength (psi)..... 110,000
Elongation in 2" (%)..... 21
Charpy V-notch at -75°F (ft. lbs.)..... 85

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps. F	55-85	90-130	135-185	190-250	250-320
Amps. V&O	50-80	80-120	110-170	-	-

USA 9018-B9*
AWS A5.5 Class E9018-B9

DESCRIPTION
USA 9018-B9 is a 9% Cr-1% Mo low hydrogen electrode modified with niobium (columbium) and vanadium designed to provide improved creep-rupture strength, toughness, fatigue life, oxidation and corrosion resistance at elevated operating temperatures. Fabrications of 9% Cr (P91) 12% Cr (P22) grade base metals can be made with USA E9018-B9 to allow higher operating steam temperatures and to provide higher creep-rupture properties. The weld deposits of USA E9018-B9, unlike 12% Cr steel filler metals, can be cooled to room temperature without the risk of cold cracks.

TYPICAL APPLICATIONS
The major usage of this electrode is for welding martensitic grade P91 steels used in header systems, re-heat piping and high temperature (1040-1112°F), high pressure (up to 4,000 psi) steam piping in electric power generating stations.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	1.250
Si	0.500
P	0.010
S	0.010
Cr	9.500
Mo	0.850-1.200
V	0.150
Al	0.250
Nb	0.020-0.100
N	0.020-0.070
Ni	1.000

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)
(PWHT at 1400°F for two hours (weld should be cooled to 200oF prior to PWHT)

Yield Point (psi)..... 83,000
Tensile strength (psi)..... 123,000
Elongation in 2" (%)..... 35
Charpy V-notch at 72°F (ft. lbs.)..... 45
following PWHT

AVAILABLE SIZES AND RECOMMENDED CURRENTS

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Amps. F	55-85	90-140	130-185	190-250	230-285	250-320
Amps. V&O	50-80	80-120	110-180	160-210	—	—

***E9015-B9 is also available upon request**

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 9018M
AWS A5.5 Class E9018M

DESCRIPTION
USA 9018M is an all-position, low-hydrogen, iron-powder electrode containing manganese, molybdenum and nickel. USA 9018M is designed for welding low alloy, high tensile, quenched and tempered steels such as T1, HY80 and HY90. Weld deposits have excellent impact properties and are X-ray quality.

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 140-220°F is recommended.

TYPICAL APPLICATIONS
USA 9018M is commonly used to make attachment welds on steels in the 90,000 psi tensile strength range. Typical applications would involve pressure vessels, bridges, machinery and penstocks. Base metals would include ASTM A225 Gr. B, A235 Gr. G, A288 class 2, A291 class 1, 2 and many others.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.07
Si	0.51
Mn	1.10
Ni	1.58
Mo	0.20

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield strength (psi)..... 83,000
Tensile strength (psi)..... 97,000
Elongation in 2" (%)..... 30
Charpy V-notch at -60°F (ft. lbs.)..... 65

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	14
Amps. F	50-100	90-130	140-190	190-240	250-310
Amps. V&O	40-80	80-115	110-160	140-170	—

USA 10016G
AWS A5.5 Class E10016-G

DESCRIPTION
USA 10016G is a low alloy, low hydrogen electrode used for all position welding of 100,000 psi high tensile strength steels. This electrode produces weld deposits of good notch toughness, extremely low hydrogen content and good crack resistance. USA 10016G electrodes may be used with AC or DC (reverse polarity),

PREHEATING
Depending upon the thickness and hardening characteristics of the work piece, it is recommended that it be preheated at 200-300°F.

TYPICAL APPLICATIONS
USA 10016G is used for stress-relieved weldments in T-1, N-Xtra 100, SSS100, Jailoy-S-100, HY80 as well as wrought or cast armour plates.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.080
Mn	1.050
Si	0.370
P	0.010
S	0.009
Ni	1.870
Mo	0.400

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Yield strength (psi)..... 93,000
Tensile strength (psi)..... 107,000
Elongation in 2" (%)..... 26.2
Charpy V-notch at -20°F (ft. lbs.)..... 86

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	18
Amps F	90-130	140-190	180-230	250-300
Amps. V&O	80-120	110-160	130-190	—

USA 11016G
AWS A5.5 Class E11016-G

DESCRIPTION
USA 11016G low hydrogen electrodes are used for welding 115,000 psi high tensile steel with a yield point of 100,000 psi and over. This electrode produces X-ray quality, Mn-Ni-Mo weld deposits which have minimal hydrogen content, good notch toughness and good crack resistance. USA 11016G electrodes may be used with AC or DC (reverse
polarity).

PREHEATING
Depending upon the thickness and hardening characteristics of the work piece, it is recommended that it is preheated at 250-350°F.

TYPICAL APPLICATIONS
USA 11016G electrodes are commonly used for pressure vessels, penstocks and bridges.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.08
Mn	1.28
Si	0.60
Ni	1.84
Cr	0.43
Mo	0.43

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (stress-relieved)

Yield strength (psi)..... 106,000
Tensile strength (psi)..... 121,000
Elongation in 2" (%)..... 22
Charpy V-notch at -20°F (ft.ibs)..... 86

AVAILABLE SIZES AND RECOMMEND-ED CURRENTS (AC or DC+)

Dia. (in.)	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14
Amps. F	90-130	140-190	180-230	250-300
Amps. V&O	80-120	110-150	130-190	—

Mild Steel and Low Hydrogen/Low Alloy Electrodes

USA 11018M
AWS A5.5 Class E11018M

DESCRIPTION
USA 11018M low hydrogen, iron powder electrodes are used for fast, efficient deposition of weld metal with mechanical properties equal to or exceeding that of the base metal. This electrode produces X-ray quality weld deposits with medium penetration and easy slag removability. Although USA 11018M electrodes may be used in any position, they are particularly suited for horizontal and downhand welding with either AC or DC (reverse polarity)

TYPICAL APPLICATIONS
USA 11018M electrodes were designed for welding quenched and tempered steels with tensile strengths of up to 110,000 psi such as ASTM A514 and A517, HY80, T-1, SSS-100, etc.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.08
Mn	1.49
Si	0.41
Cr	0.32
Mo	0.32
Ni	1.86

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield Point (psi)..... 104,000
Tensile strength (psi)..... 120,000
Elongation in 2” (%)..... 23
Charpy V-notch at -60^{o}F (ft. lbs.)..... 44

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	1/4
Lgth. (in.)	14	14	14	14	18
Amps F	55-85	90-130	140-190	180-230	250-300
Amps. V&O	50-80	80-120	110-150	130-190	-

USA 12018M
AWS A5.5 Class E12018M

DESCRIPTION
USA 12018M is an all-position, low-hydrogen iron powder electrode containing manganese, chromium, nickel and molybdenum. USA 12018M was developed for welding high strength steels requiring a weld deposit tensile strength of 120,000 psi minimum. The weld deposits of USA 12018M have excellent impact properties and are X-ray quality.

PREHEATING AND POSTHEATING
Depending upon the thickness and hardening characteristics of the work piece, preheating at a temperature between 140-220°F is recommended. Do not exceed the recommended preheat temperatures as excessive heat Input can cause a deterioration of impact values and the yield strength of the weld deposit.

TYPICAL APPLICATIONS
USA 12018M is designed for welding high tensile strength steels such as ASTM A148 Gr. 120-95, A238 Gr. F, A291 class 4, A514 and many other specifications all requiring a weld deposit tensile strength of 120,000 psi minimum.

TYPICAL WELD METAL CHEMISTRY (%)

C	0.08
Si	0.30
Mn	1.46
Cr	0.98
Ni	1.86
Mo	0.41

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Yield Point (psi)..... 117,000
Tensile strength (psi)..... 138,000
Elongation in 2” (%)..... 20
Charpy V-notch at -20^{o}F (ft. lbs.)..... 36

AVAILABLE SIZES AND RECOMMENDED CURRENTS (AC or DC+)

Dia. (in.)	3/32	1/8	5/32	3/16	7/32	1/4
Lgth. (in.)	14	14	14	14	14	18
Amps F	50-95	90-130	130-190	190-250	220-280	250-320
Amps. V & O	40-95	80-120	100-160	120-160	150-210	-

Chemical Requirements of Low-Alloy Weld Metal

AWS Classification[a]	Chemical Composition, Percent[b]								
	C	Mn	P	S	Si	Ni	Cr	Mo	V
Carbon-Molybdenum Steel Electrodes									
E7010-A1 E7011-A1 E7015-A1 E7016-A1 E7018-A1 E7020-A1 E7027-A1	0.12	0.60 0.60 0.90 0.90 0.90 0.60 1.00	0.03	0.04	0.40 0.40 060 0.60 0.80 0.40 0.40	—	—	0.40 to 0.65	—
Chromium-Molybdenum Steel Electrodes									
E8016-B1 E8018-B1	0.05 to 0.12	0.90	0.03	0.04	0.60 0.80	—	0.40 to 0.65	0.40 to 0.65	—
E8015-B2L	0.05	0.90	0.03	0.04	1.00	—	1.00 to 1.50	0.40 to 0.65	—
E8016-B2 E8018-B2	0.05 to 0.12	0.90	0.03	0.04	0.60 0.80	—	1.00 to 1.50	0.40 to 0.65	—
E7018-B2L	0.05	0.90	0.03	0.04	0.80	—	1.00 to 1.50	0.40 to 0.65	—
E9015-B3L	0.05	0.90	0.03	0.04	1.00	—	2.00 to 2.50	0.90 to 1.20	—
E9015-B3 E9016-B3 E9018-B3	0.05 to 0.12	0.90	0.03	0.04	0.60 0.60 0.80	—	2.00 to 2.50	0.90 to 1.20	—
E8018-B3L	0.05	0.90	0.03	0.04	0.80	—	2.00 to 2.50	0.90 to 1.20	—
E8015-B4L	0.05	0.90	0.03	0.04	1.00	—	1.75 to 2.25	0.40 to 0.65	—
E8016-B5	0.07 to 015	0.40 to 0.70	0.03	0.04	0.30 to 0.60	—	0.40 to 0.60	1.00 to 1.25	0.05
Nickel Steel Electrodes									
E8018-NM[d]	0.10	0.80 to 1.25	0.02	0.03	0.60	0.80 to 1.10	0.05	0.40 to 0.65	0.02
Manganese-Molybdenum Steel Electrodes									
E9015-D1 E9018-D1	0.12	1.25 to 1.75	0.03	0.04	0.60 0.80	—	—	0.25 to 0.45	—
E8016-D3 E8018-D3	0.12	1.00 to 1.75	0.03	0.04	0.60 0.80	—	—	0.40 to 0.65	—
E10015-D2 E10016-D2 E10018-D2	0.15	1.65 to 2.00	0.03	0.04	0.60 0.60 0.80	—	—	0.25 to 0.45	—
All other Low-Alloy Steel Electrodese									
EXX10-G[e] EXX11-G EXX13-G EXX15-G EXX16-G EXX18-G E7020-G	—	1.00 min.[f]	—	—	0.80 min.[f]	0.50 min.[f]	0.30 min.[f]	0.20 min.[f]	0.10 min.[f]
E9018-M[c]	0.10	0.60 to 1.25	0.030	0.030	0.80	1.40 to 1.80	0.15	0.35	0.05
E10018-M[c]	0.10	0.75 to 1.70	0.030	0.030	0.60	1.40 to 2.10	0.35	0.25 to 0.50	0.05
E11018-M[c]	0.10	1.30 to 1.80	0.030	0.030	0.60	1.25 to 2.50	0.40	0.25 to 0.50	0.05
E12018-M[c]	0.10	1.30 to 2.25	0.030	0.030	0.60	1.75 to 2.50	0.30 to 1.50	0.30 to 0.55	0.05
E12018-M[c]	0.10	0.80 to 1.60	0.015	0.012	0.65	3.00 to 3.80	0.65	0.20 to 0.30	0.05
E7018-W[g]	0.12	0.40 to 0.70	0.025	0.025	0.40 to 0.70	0.20 to 0.40	0.15 to 0.30	—	0.08
E8018-W[h]	0.12	0.50 to 1.30	0.030	0.040	0.35 to 0.80	0.40 to 0.80	0.415 to 0.70	—	—

Note: Single values shown are maximum percentages, except where otherwise specified.
a. The suffixes A1, B3, C2, etc. designate the chemical composition of the electrode classification.
b. For determining the chemical composition, DCEN (electrode negative) may be used where DC, both polarities, is specified.
c. These Classifications are intended to conform to classifications covered by the military specifications for similar compositions.
d. Copper shall be 0.10% max and aluminum shall be 0.05% max for E8018-NM electrodes.
e. The letters “XX” used in the classification designations in this table stand for the various strength levels (70, 80, 90, 100, 110 and 120) of electrodes.
f. In older to meet the alloy requirements of the G group, the weld deposit need minimum, as specified in the table, of only one of the elements listed. Additional chemical requirement may be us agreed between supplier and purchaser.
g. Copper shall be 0.30 to 0.60% for E7018-W electrodes.
h. Copper shall be 030 to 0.75% for E8018-W electrodes.
Courtesy: American Welding Society AWS A5.5

THE WELDING OF PLAIN CARBON STEEL & LOW ALLOY/HIGH STRENGTH STEEL

Washington Alloy supplies approximately 9 different specifications of steel MIG wire. In order to choose the correct wire for your welding needs, there are several factors to consider.

MECHANICAL PROPERTIES

It is important to know the ultimate tensile strength and impact strength (charpy V-notch) that is required of the weld deposit. USA 70S-2 through USA 70S-6 wires can be used for most carbon steel welding applications; while USA 80S-D2, 100S-1, 110S-1 and 120S-1 are used for greater tensile and impact strength. The mechanical properties are also influenced by the shielding gas used. Basically, the higher the argon level – the greater the impact strength

WELD METAL SOUNDNESS

The soundness of welds will be determined by the oxygen content, therefore you want to have the least amount of oxygen present to obtain the greatest weld metal soundness. The oxygen level can be reduced by using wires with deoxidizers. These deoxidizers would include: (Mn) manganese, (Si) silicon, (Ti) titanium, (Al) aluminum and (Zr) zirconium. The greater the deoxidizing power of the wire - the lower the oxygen content of the weld deposit. Washington Alloy MIG wires are listed in order of least deoxidizing power to greatest deoxidizing power: USA 70S- 3. 70S-4, 70S-6, 708-2, 80S-D2.

To determine which wire you should use depends upon several factors:

(1) The condition of the base metal will determine the deoxidizing power required. If the base metal is killed (fully deoxidized), then you could use USA 70S-3 wire and produce very sound weld deposits. However if the base metal has rust, mill scale, oil or other impurities on it, then you would want to use a wire with greater deoxidizing power such as USA70S-6.

(2)The lower the argon content of the shielding gas (i.e., 100% CO_2) -the greater the deoxidizing power of the wire.

(3) The greater the size of the weld puddle - the greater the deoxidizing power of the wire.

WELDING PERFORMANCE

The performance of Washington Alloy MIG wire will depend upon the shielding gas used and the manganese-silicon content of the wire.

(1) The greater the argon content of the shielding gas - the smoother the bead appearance, with minimum spatter loss.

(2) The greater the manganese and silicon content of the wire-the greater the fluidity and wettability of the weld puddle. This characteristic makes the wire more suitable for out-of-position welding and yields a nicer bead appearance.

USA 70S-2
AWS A5.18 Class ER70S-2

DESCRIPTION

USA 70S-2 is a multiple deoxidized wire containing small amounts of zirconium, titanium and aluminum in addition to the manganese and silicon deoxidizers characteristic of the steel wire group. This wire may be used for MIG or TIG welding on all grades of mild and carbon steels, producing superior quality welds with minimal porosity even over rust and mill scale. USA 70S-2 is popular for out of position welding with small diameter wires utilizing the short-circuting arc type transfer. MIG welding may he accomplished using CO_2, Argon-Oxygen mixtures or mixtures of the two.

TYPICAL APPLICATIONS

Pipes, offshore drilling rigs, structural steel work, etc.

TYPICAL WELD METAL CHEMISTRY (%)

	USA 70S-2	AWS SPEC
C	0.050	0.07 max.
Mn	1.250	0.90-1.40
Si	0.500	0.40-0.70
P	0.012	0.025 max.
S	0.012	0.035 max.
Al	0.100	0.05-0.15
Zr	0.090	0.02-0.12
Ti	0.100	0.05-0.15

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (CO_2 shielding gas)

	AWS Spec.	USA 70S-2
Yield strength (psi)	60,000 min.	71,000
Ultimate tensile strength(psi)	72,000 min.	83,000
Elongation in 2" (%)	22 min.	27.5
Charpy V-notch at-20^{o}F (ft. lbs.)	20 min.	30
Reduction of area	–	58
Average Brinell Hardness	–	140

USA 70S-3
AWS A5.18 Class ER70S-3

DESCRIPTION

USA 70S-3 is a silicon and manganese deoxidized wire used for mild and low alloy steel general purpose fabrication. A well balanced silicon and manganese content permits its use with CO_2, Argon-Oxygen mixtures, or mixtures of the two. This wire may be used for short-circuting arc (dip-transfer), buried arc, as well as spray transfer arc processes. USA 70S-3 produces quality welds with rimmed steels, better welds on semi-killed steels and excellent welds on killed steels. It yields an almost slag-free deposit which does not require cleaning for many applications thereby providing low plate preparation costs, good bead appearance and welder satisfaction.

TYPICAL APPLICATIONS

Automobile frames, earthmoving and farm equipment, sheet metal, ships and barges, railcars, trailers, ornamental iron, metal furniture, storage bins and general fabrications.

TYPICAL WELD METAL CHEMISTRY (%)

	USA 70S-2	AWS SPEC
C	0.100	0.06-0.15
Mn	1.000	0.90-1.40
Si	0.550	0.45-0.75
P	0.012	0.025 max.
S	0.012	0.035 max.

TYPICAL MECHANICAL PROPERTIES OF WELD METAL(CO^2 shielding gas)

	AWS Spec.	USA 70S-2
Yield strength (psi)	60,000 min.	62,400
Ultimate tensile strength(psi)	72,000 min.	75,500
Elongation in 2" (%)	22 min.	30.7
Charpy V-notch at-0^{o}F (ft. lbs.)	20 min.	66
Reduction of area	–	59
Average Brinell Hardness	–	130

Plain Carbon Steel and Low Alloy/ High strength Steel Wires

USA 70S-4
AWS A5.18 Class ER70S-4

DESCRIPTION
USA 70S-4 has a higher content of manganese and silicon than USA 70S-3. This gives it greater weld metal strength and good quality weld deposits in semi-killed or rimmed steels. This wire may be used with CO_2, Argon-Oxygen mixtures, or mixtures of the two. USA 70S-4 has excellent fluidity and wettability resulting in a very smooth bead contour on butt and fillet welds. This wire can be used on all CO_2, semi-automatic and automatic equipment.

TYPICAL APPLICATIONS
Joining structural steels, piping, ship steels, machinery, bridges, electric products, boiler and pressure vessel A515 in stress relieved conditions,

TYPICAL WIRE CHEMISTRY (%)

	USA 70S-4	AWS SPEC
C	0.100	0.07-0.15
Mn	1.250	1.00-1.50
Si	0.750	0.65-085
P	0.014	0.025 max.
S	0.022	0.0.5 max.

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (CO_2 shielding gas)

	AWS Spec.	USA 70S-2
Yield strength (psi)	60,000 min.	65,000
Ultimate tensile strength(psi)	72,000 min.	80,000
Elongation in2" (%)	22 min.	30
Charpy V-notch at-32°F (ft. lbs.)	–	98
Reduction of area	–	59
Average Brinell Hardness	–	130

USA 70S-6
AWS A5.18 Class ER70S-6

DESCRIPTION
USA 70S-6 contains high levels of manganese and silicon for stronger deoxidizing power where stringent cleaning procedures are not possible. This wire has been designed to provide X-ray quality porosity-free welds and the highest tensile strength (as welded) of the plain carbon steel wires. The high silicon content increases the fluidity of the weld pool, creating a smoother bead appearance and resulting in minimal post-weld grinding. USA 70S-6 is excellent where poor fit-ups or rusty and oily plates may be used.

TYPICAL APPLICATIONS
Construction work, tanks, truck bodies, farm implements, pipes, steel castings or forgings, shaft build-ups and general shop fabrications.

TYPICAL WIRE CHEMISTRY (%)

	USA 70S-6	AWS SPEC
C	0.100	0.06-0.15
Mn	1.700	1.40-1.85
Si	1.000	0.80-1.15
P	0.010	0.025 max.
S	0.015	0.035 max.

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (CO_2 shielding gas)

	AWS Spec.	USA 70S-6
Yield strength (psi)	60,000 min.	73,000
Ultimate tensile strength(psi)	72,000 min.	90,000
Elongation in 2" (%)	22 min.	25
Charpy V-notch at-20°F (ft. lbs.)	20 min.	28
Reduction of area	–	60
Average Brinell Hardness	–	160

USA 80S-D2
AWS A5.28 Class ER80S-D2

DESCRIPTION
USA 80S-D2 is designed to give high strength welds on high sulfur bearing (free- machining) steels or medium carbon steels. This wire contains additional amounts of manganese and silicon which, when alloyed with 0.50% molybdenum, produces weld deposits which have high ductility, excellent impact values and tensile strengths of approximately 100,000 psi. USA 80S-D2 is commonly used on low carbon and low alloy steels such as AISI 4130 where the tensile strengths provided by plain carbon steel wires are inadequate. A well balanced silicon content gives this wire superior arc stability, a low spatter level and a flat bead with excellent appearance. USA 80S-D2 produces X-ray quality, porosity free welds even over dirt, rust or mill scale.

TYPICAL APPLICATIONS
Farm implements, automotive parts, pipes, light-gauge steels, low alloy steels such as AISI 4130 and high yield steels such as T-1.

TYPICAL WELD METAL CHEMISTRY (%)

	USA 80S-D2	AWS SPEC
C	0.080	0.07-0.12
Mn	1.950	1.60-2.10
P	0.012	0.025 max.
Si	0.600	0.50-0.80
Mo	0.500	0.40-0.60
Ni	0.020	0.15 max

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (CO_2 shielding gas)

	AWS Spec.	USA 70S-6
Yield strength (psi)	60,000 min.	84,000
Ultimate tensile strength(psi)	72,000 min.	99,000
Elongation in 2" (%)	17 min.	22
Charpy V-notch at-20°F (ft. lbs.)	20 min.	30
Reduction of area	–	55
Average Brinell Hardness	–	163

Other Low Alloy Steel Wires available

USA 80S-B2 AWS A5.28 see page 23
USA 80S-B6 AWS A5.28 see page 23
USA 80S-B8 AWS A5.28 see page 23
USA 90S-B3 AWS A5.28 see page 23

Low Alloy/High Strength Steel Wires

USA 100S-1
AWS A5.28 Class ER100S-1

DESCRIPTION
USA 100S-1 was developed for welding high strength low alloy steel plates such as HY80, HY100 and other similar steels. This wire produces high tensile strength, high impact resistant weld deposits that retain their toughness to -70°F making it suitable for low temperature and critical applications. USA 100S-1 can be welded at an interpass temperature as low as 300°F.

TYPICAL APPLICATIONS
HY80 and HY100 steels, military vessels, all-position welding.

TYPICAL WIRE CHEMISTRY (%)

C	0.060
Mn	1.650
Si	0.350
P	0.007
S	0.008
Mo	0.350
Ni	1.750
Cr	0.100

TYPICAL MECHANICAL PROPERTIES OF WELD METAL

Yield strength (psi).....92,000
Ultimate tensile strength(psi)..105,000
Elongation in 2" (%).....17
Charpy V-notch at-60°F (ft. lbs.)...60

USA 110S-1
AWS A5.28 Class ER110S-1

DESCRIPTION
USA 110S-1 is used for welding HY100 and other high strength, low alloy steels. It is most applicable where high strength and ductility to -75°F is required. USA 110S-1 can be welded at an interpass temperature as low as 300°F.

TYPICAL APPLICATIONS
HY100 and other high strength low alloy steels.

TYPICAL WIRE CHEMISTRY (%)

C	0.070
Mn	1.600
P	0.007
S	0.009
Si	0.450
Mo	0.500
Ni	2.300
Cr	0.300

TYPICAL MECHANICAL PROPERTIES OF WELD METAL

Yield strength (psi).....98,000
Ultimate tensile strength(psi)..115,000
Elongation in 2" (%).....16
Charpy V-notch at-60°F (ft. lbs.).....65

PACKAGING
All Sizes are packaged in 10 lb. packs – 5 packs per 50 lb. master carton.

USA 120S-1
AWS A5.28 Class ER120S-1

DESCRIPTION
USA 120S-1 is used for a variety of steels where high strength and ductility and critical. It is designed to give high notch toughness, yield strength and impact resistance. USA 120S-1 can be welded at an interpass temperature as low as 300ºF while also offering high ductility to -75ºF

TYPICAL APPLICATIONS
High yield steels such as T-1, HY-100 and other steels in the 100,000 psi YS class, pressure vessels.

TYPICAL WIRE CHEMISTRY (%)

C	0.070
Mn	1.550
P	0.006
S	0.008
Si	0.350
Mo	0.550
Ni	2.400
Cr	0.450

TYPICAL MECHANICAL PROPERTIES OF WELD METAL

Yield strength (psi).....110,000
Ultimate tensile strength(psi)..125,000
Elongation in 2" (%).....15
Charpy V-notch at-60°F (ft. lbs.)...70

WASHINGTON ALLOY 4130
AISI 4130

DESCRIPTION
Washington Alloy 4130 is a low alloy, cop-per-coated steel wire designed for TIG, MIG and submerged arc welding of heat-treatable, low alloy steels such as the SAE 4100 series and 8630 as well as steel castings with similar hardening characteristics. A pre-heat temperature of 300°F-350°F is required for some of the higher carbon grades in order to prevent cracking. Many other grades can be welded without a preheat.

TYPICAL WIRE CHEMISTRY (%)

C	0.310
Mn	0.520
P	0.012
S	0.023
Si	0.280
Cr	0.930
Mo	0.200

TYPICAL MECHANICAL PROPERTIES OF WELD METAL
Proper heal treatment will produce a tensile strength of 150,000 to 160,000 psi.

RECOMMENDED SHIELDING GAS
98% Argon (Ar) and 2% Oxygen (O_2) or pure Argon (Ar)

CO_2 Gas Welding

Welding Conditions:
Since the appearance and properties of CO_2 welds vary broadly in accordance with the welding conditions, select the welding conditions carefully. Welding conditions and their effects are shown in fig. 1.

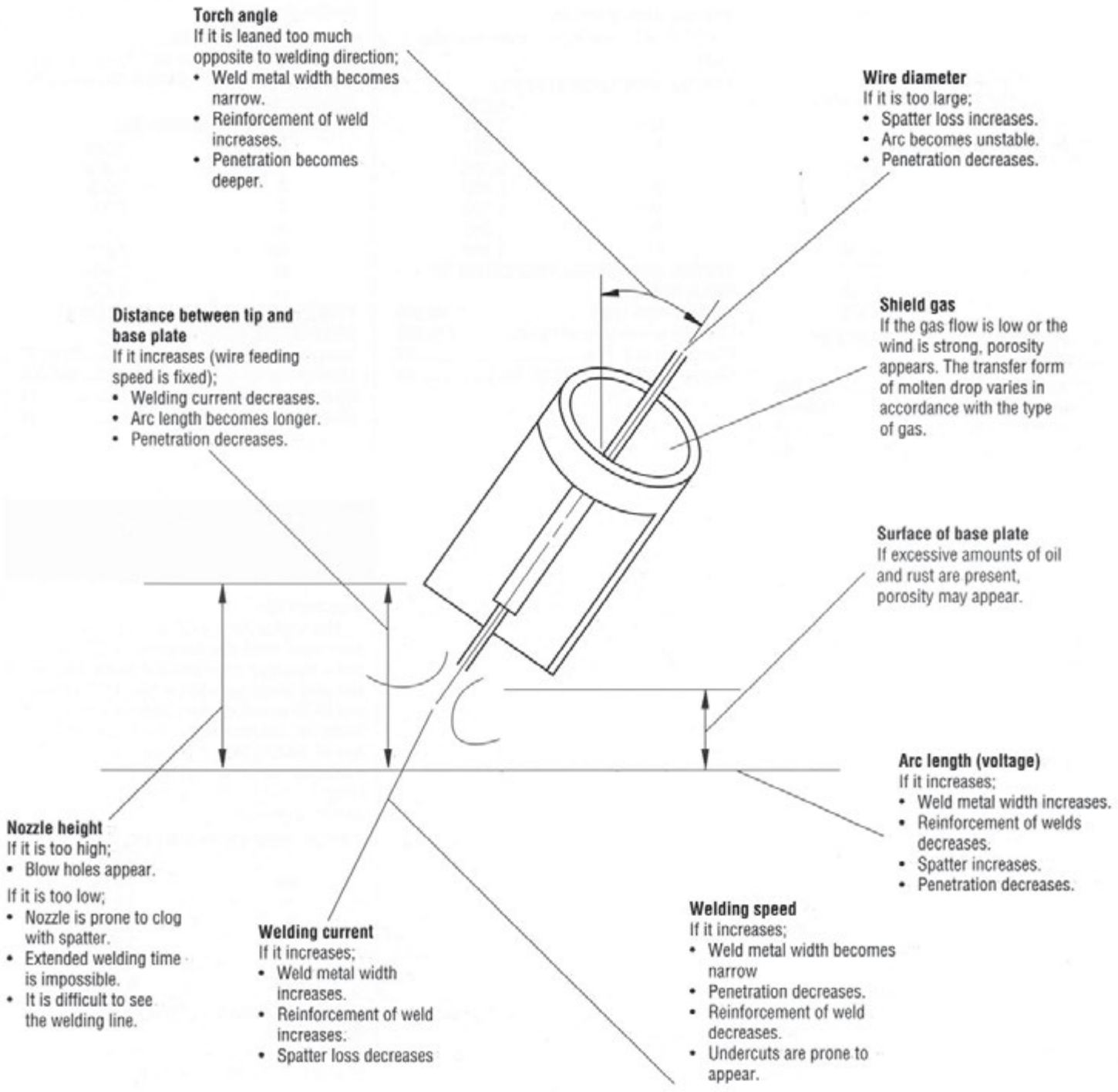


Fig. 1 Welding conditions and their effects

CO_2 Gas Welding

(1) Distance Between Tip and Base Plate
Since the distance between the tip and base plate affects the shape of welds and welding efficiency, keep it within the range described in Table 1.

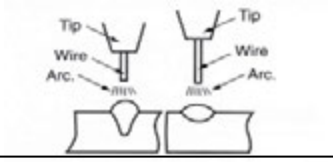


Table 1. RECOMMENDED DISTANCE BETWEEN TIP AND BASE PLATE

Welding Current (amps)	Distance between tip and base plate (in.)	Remark
<250 >250	1/4-5/8 5/8 – 1	As the current increases, the distance between the tip and base plate should also increase.

(2) Torch Angle
Torch angle and electrode manipulation methods are shown in Fig. 2. The forward method is adopted to Washington Alloy wire in general. But deeper penetration can be achieved by using

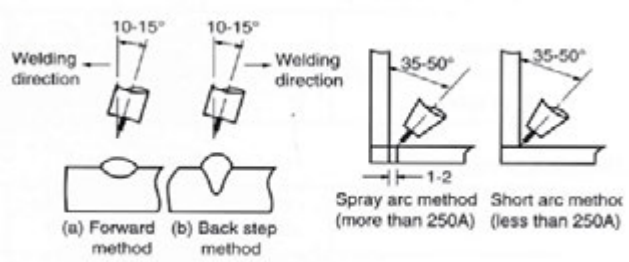


Fig. 2. Torch angle and electrode manipulation methods.

(3) Inclination of Base Plate the back-step method.
In thin plate welding, the slope downward method will provide good results. The difference of weld metal shape in accordance with the variation of the inclination of the base plate is shown in Fig. 3.

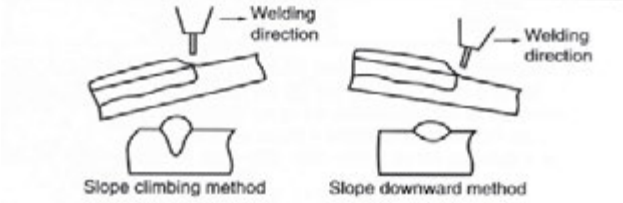


Fig. 3. Variation of weld metal shape

(4) CO_2 Gas Flow
Use CO_2 gas for welding. Flow should be at least 20 liters per minute. Increase the flow or use a wind screen against wind.

PREPARATION OF WELDING

(1) Edge Preparation
Since edge preparation is a key to the results of semi-automatic welding, remember to clean the edge as thoroughly as possible.

(2) Tack Welding
Keep the tacking pitch as shown in Fig. 4 so that the tack weld deposits will be as small as possible. Attach tab plate, (whose classification of steel and plate thickness are the same as those of base plate), to prevent possible problems during welding.

(3) Plate Preparation
Remove oil, paint, water, excessive rust and thick slag that may have adhered to the groove surface.

(4) Storage of Wire
Washington Alloy wire cannot be dryed. Since the surface of the wire is plated with copper and rust-proof treated, it is resistant to rust and moisture absorption to some extent. However do not store this material in wet or damp places.

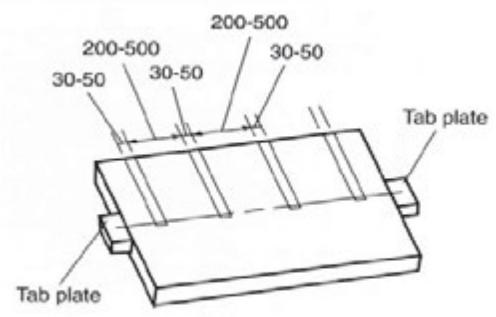


Fig. 4. Tack welding.

Plain Carbon Steel and Low Alloy/High Strength Steel Wires: Standard Wire Sizes and Available Packaging

A) Layer Wound Spool Data:

Package	Wire Size (in.)	Spool dimensions (in.)		
		O.D.	Width	Arbor Hole
2 LB Spools*	.023 – 1/16	4	2	5/8
11 LB Spools	.023 – 1/16	8	2	2
33 LB Spools	.023 – 1/16	12	4	2

B) Layer Wound Coil Data:

Package	Wire Size (in.)	Coil Dimensions (in.)		
		I.D.	Width	O.D.
60 LB Coils	0.35-3/16	12	4	15

C) Production Pail Pack:

Package	Wire Size (in.)	Outside Dimensions of Drum (in)	
		Height	Diameter
550 LBS	.0.035	31-7/8	20-3/8
550 LBS	0.045	31-7/8	20-3/8
550 LBS	1/16	31-1/8	27

*** Note: 2 lb. Spools are packaged 20 per box (40 lbs. net weight).**
10 lb. Spools are packaged 2 per box (20 lbs. net weight).
All spools and coils are individually boxed for maximum protection.

Comparison Chart

Washington Alloy	National Standard	ESAB		Hobart	Lincoln
USA 70S-2	NS-103	65			
USA 70S-3	NS-101	29S/82		HB	L-50
USA 70S-4		85			
USA 70S-6	NS-115	86		HB-28	L-56
USA 80S-D2	NS-102	83		HB-18	LA-90

RECOMMENDED AMPERAGE SETTINGS (AC or DC+)

Diameter	Amperes
030	40-120
.035	40-235
.045	100-325
1/16	300-525
3/32	500-700

Chemical Composition Requirements for Gas Metal Arc Welding **Deposit**

Chemical Composition, percent[a]												
AWS Class	Carbon	Man-ganese	Silicon	Phos-phorus	Sulfur	Nickel	Chromium	Molyb-denum	Vanadium	Titanium	Zirconium	Aluminum
GROUP A — MILD STEEL ELECTRODES												
ER70S-2	0.07	0.90 to 1.40	0.40 to 0.70	0.025	0.035					0.05 to 0.15	0.02 to 0.12	0.05 to 0.15
ER70S-3	0.06 to 0.15	0.90 to 1.40	0.45 to 0.70									
ER70S-4	0.07 To 0.15	1.00 to 1.50	0.65 to 0.85									
ER70S-6	0.07 to 0.15	1.40 to 1.85	0.80 to 1.15									
GROUP B— MANGANESE-MOLYBDENUM AND OTHER LOW ALLOY STEEL RODS AND WIRES												**AWSA5.28**
ER80S-D2[c]	0.07 to 0.12	1.6 to 2.1	0.5 to 0.8	0.025	0.025	0.15		0.4 to 0.6				
ER80S-Ni2	0.12	1.25	0.4 to 0.8	0.025	0.025	2 to 2.75						
ER100S-1	0.08	1.25 to 1.8	0.2 to 0.5	0.01	0.01	1.4 to 2.1	0.3	0.25 to 0.55	0.05	0.1	0.1	0.1
ER110S-1	0.09	1.4 to 1.8	0.2 to 0.55	0.01	0.01	1.9 to 2.6	0.5	0.25 to 0.55	0.04	0.1	0.1	0.1
ER120S-1	0.1	1.4 to 1.8	0.25 to 0.6	0.01	0.01	2 to 2.8	0.6	0.3 to 0.65	0.03	0.1	0.1	0.1

Notes:

1. Single values shown are maximums.
2. Analysis shall he made for the elements for which specific values are shown in this table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall he made to determine that the total of these other elements, except iron, is not present in excess of 0.50.
3. The maximum weight of copper in the rod or electrode due to any coating plus the residual copper content in the steel shall not exceed 0.50 for Group A items and 0.25 (or Group B items, with the exception of ER80S-D2 which has a maximum allowable amount of 0.50 copper.
4. Other elements, if intentionally added, shall be reported.
5. For requirements calling for the “G” classification (ERXXS-G), the electrode must have as a minimum one of either 0.50 percent nickel, 0.30 percent chromium, or 0.20 percent molybdenum. Footnotes:
   a) Chemical requirements for solid electrodes are based on as-manufactured composition.
   b) The suffixes B2, Ni2, etc. designate the chemical composition of the electrode and rod classification.
   c) This composition was formerly classified E70S-1B in the AWS specification A5.18-69.

Mechanical Property Requirements For Gas Metal Arc Welding **Deposit**

AWS Classification	Shielding Gas	Current and Polarityc	Tensile Strength min., psi	Yield Strength at 0.2% Offset, min	Elongation in 2 inches, min. %	Impact properties min
GROUP A—MILD STEEL ELECTRODES						
ER 70S-2 ER 70S-3 ER 70S-4 ER 70S-6	CO_2	DC reverse polarity	72,000	60,000	22	20 ft/lb at -20ºF 20 ft/lb at -0ºF not required 20 ft/lb at -20ºF
GROUP B — MANGANSE-MOLYBDENUM AND OTHER LOW ALLOY STEEL RODS AND WIRES						**AWS A5.28**
ER 80S-D2	CO_2	DC, reverse polarity	72,000	60,000	17	20 ft/lb at -20ºF
ER 80S-Ni2	Ar plus 1-5% O_2	DC, reverse Polarity	80,000	68,000	24	20 ft/lb at -80ºF
ER 100S-1	Ar plus 2% O_2	DC, reverse Polarity	100,000	88,000	16	50 ft/lb at -60ºF
ER 110S-1	Ar plus 2% O_2	DC, reverse Polarity	110,000	95,000	15	50 ft/lb at -60ºF
ER 120S-1	Ar plus 2% O_2	DC, reverse Polarity	120,000	105,000	14	50 ft/lb at -60ºF

Notes:

a. As-welded mechanical properties, except for ER80S-Ni2 which is based on Postweld heat treatment as specified in AWS A5.28 (see table 12)
b. Shielding gases are designated as follows: AO = argon, plus 1 to 5 percent oxygen; CO_2 = carbon dioxide: A = argon.
c. Reverse polarity means electrode is positive; straight polarity means electrode is negative.
d. Mechanical properties are determined from an all-weld-metal tension-test specimen.
e. For each increase of one percentage point in elongation over the minimum, the yield strength or tensile strength, or both, may decrease 1,000 psi to a minimum of 70,000 psi for the tensile strength and 58,000 psi for the yield strength.

Courtesy: American Welding Society AWS ANSI/AWS A5.18 and AWS A5.28.

SUBMERGED ARC WELDING WIRES

USA EH14
AWS A5.17 Class EH14

DESCRIPTION AND APPLICATION

USA EH14 is a high manganese submerged arc wire used for single pass or multiple pass butt and fillet welds on low alloy or mild carbon steels. This wire will produce weld deposits which exhibit mechanical properties greater than USA EL12 or EM12K and equal to or greater than those of the base metal. USA EH14 will yield tensile strengths of up to 90,000 psi with an elongation of 30%. High speed welding can be achieved even over rust and mill scale which may be present on the base metal. USA EH14 is used in the fabrication of heavy bridge sections, boilers, pressure vessels, shipbuilding and other steel structures.

TYPICAL WIRE CHEMISTRY (%)

C	0.140
Mn	2.000
Si	0.030
P	0.017
S	0.024

MECHANICAL PROPERTIES

USA EH14 is capable of producing tensile strengths of up to 90,000 psi with an elongation of up to 30%, however these figures will vary according to the base metal and flux used.

USA EM13K
AWS A5.17 Class EM13K

DESCRIPTION AND APPLICATIONS

USA EM13K is the submerged arc wire equivalent to USA 70S-3 CO_2 wire, therefore many characteristics are similar. USA EM13K contains a higher level of silicon than other submerged arc wires making it suitable for high speed, single pass welding of dirty or rusty mild steel plates. The increased silicon content reduces porosity by deoxidizing the weld pool and provides excellent wetting action, straighter bead edges and easy slag removability. More common applications would include welding of ships and barges, automobile bodies, railcars, building and bridges.

TYPICAL WIRE CHEMISTRY (%)

C	0.100
Mn	1.000
Si	0.550
P	0.012
S	0.012

MECHANICAL PROPERTIES

USA EM13K is capable of producing tensile strengths of up to 75,000 psi with an elongation of 31%, however these figures will vary according to the base metal and flux used.

USA EL12
AWS A5.17 Class EL 12

DESCRIPTION AND APPLICATIONS

USA EL12 was specifically developed for butt and heavy fillet welds on mild and medium carbon steels where “restrained” weld-ments are required. This wire contains less carbon, manganese and silicon than many other submerged arc wires, therefore yielding less strength but providing greater resistance to cracking. USA EL12 is a general purpose wire which (dependent upon the flux) may be used for both single pass and multiple pass welding. Weld deposits have excellent impact properties, a fine bead appearance and are machinable. Typical applications would include ships, bridges, machinery and structural steels. USA EL12 is particularly suited for welding sulfur banded steels.

TYPICAL WIRE CHEMISTRY (%)

C	0.110
Mn	0.450
Si	0.010
P	0.017
S	0.024

MECHANICAL PROPERTIES

USA EL12 is capable of producing tensile strengths of up to 70,000 psi with an elongation of 30%, however these figures will vary according to the base metal and flux used.

USA EM12K
AWS A5.17 Class EM12K

DESCRIPTION

USA EM12K submerged arc wire contains higher levels of carbon, manganese and silicon than USA EL12. The increased carbon content gives this wire greater tensile strength, while the increased manganese and silicon content yields improved deoxidation properties. USA EM12K will produce weld deposits with minimal porosity even over rust and mill scale that may be present on the base metal. This wire is primarily used for single pass butt and fillet welds on mild and low alloy steel plates up to 1/2” thick. More specific applications would include ASTM A537, A283, Grades A, B, or C. Since USA EM12K offers high strength/low porosity welds on many steel alloys, it is the most cost-efficient submerged arc wire to stock.

TYPICAL WIRE CHEMISTRY (%)

C	0.150
Mn	1.100
Si	0.250
P	0.017
S	0.024

WASHINGTON ALLOY WP380 FLUX
AWS A5.17 AWS A5.23

DESCRIPTION ANS APPLICATIONS

Washington Alloy WP 380 is a non-alloyed, neutral (slightly basic), calcium-silicate fused flux. WP380 is designed for joining and cladding applications for use with a very broad range of filler metals and base metals. WP 380 is extensively used in joining low alloy creep-resistant Cr-Mo steels for use at elevated temperatures, duplex and super-duplex stainless steels, martensitic and ferritic straight chromium stainless steels (including Ni-Mo grades), austenitic Cr-Ni stainless steels (including ELC grades), high alloy Cr-Ni-Mo steels, joining high alloy Cr-Ni-Mo steels to low-alloy steels (dissimilar joints), 8-10% Ni steels, 9% Cr steels (P91) and for joining or cladding with nickel alloys such as ERNiCrMo-2 (Ni 625) and ERNiCrMo-4 (Ni C-276).

PHYSICAL PROPERTIES & CHEMISTRY

Basicity:	1.3 (Bonischewski Scale)	
Chemistry:	SiO_2 + Ti O_2	32%
	CaO + MgO	35%
	$Al2O_3$	3%
	CaF_2	20%

PACKAGING

Fiber reinforced heavy wall plastic 44.1 lb. bags with both ends heat sealed. Pallet weight: 2,204.62 lbs. (910.00 Kg)

Submerged Arc Welding Wires
Standard Wire Sizes and Available Packaging

COIL DATA

Package	Wire Sizes (in.)	I.D.	Coil Dimensions (in.) Width	O.D.
60 LB Coils	.035-3/16	12	4	15

REEL DATA

Package	Wire Sizes (in.)	Reel Dimensions (in.)	
		Flange	Width
250 LB Reels	.035 -1/8	22	9-1/2
550 LB Reels	.035 -1/8	30	9-1/2

ER 70S-2 ER 70S-3 ER 70S-4 ER 70S-6	CO_2	DC reverse polarity	72,000	60,000	22	20 ft/lb at -20ºF 20 ft/lb at -0ºF not required 20 ft/lb at -20ºF

Standard diameters are (in.): .035 - .045 -1/16 - 5/64 - 3/32 -1/8 - 5/32 - 3/16 - 7/32 -1/4 - 5/16

Comparison Chart

(AWSA5.17)

Washington Alloy	ESAB	Lincoln	
EL12	80	L-60	
EM12K	29, 81	L-61,66	
EM13K/ER70S-3	29S	L-50	
EH14	36	—	

CHEMICAL-COMPOSITION REQUIREMENTS FOR SUBMERGED-ARC WIRES

AWS Classification	Chemical Composition, percent						
	Carbon	Manganese	Silicon	Sulfur	Phosphorus	Copper[2]	Total other Elements
Low Manganese Class EL12	.07 to 0.15	0.35 to 0.60	0.05	0.035	0.03	0.30	0.50
Medium Manganese Classes EM12K EM13K	0.07 to 0.15 0.07 to 0.19	0.85 to 1.25 0.90 to 1.40	0.15 to 0.35 0.45 to 0.70				
High Manganese Class EH14	0.10 to 0.18	1.75 to 2.25	0.05				

a. The copper limit is independent of any copper or other suitable coating which may be applied to the electrode.
Note 1: Analysis shall be made for the elements for which specific values are shown in this table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that the total of these other elements is not present in excess of the limits specified for “Total Other Elements” in the last column of the table.
Note 2: Single values shown are maximum percentages.

STEEL RODS FOR GAS AND TUNGSTEN INERT GAS WELDING

USA RG45
AWS A5.2 Class RG45

DESCRIPTION
USA RG45 is a copper coated gas welding rod that is used for welding ordinary low carbon steel up to 1/4" thick. It is recommended where ductility and machinability are most important. USA RG45 produces high quality welds which are ductile and free of porosity. This rod is excellent for steel sheets, plates, pipes, castings and structural shapes. No flux required.

TYPICAL CHEMICAL ANALYSIS (%)

C	0.080 max.
Mn	0.500 max.
Si	0.100 max.
P	0.035 max.
S	0.040 max.

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (as welded)
Ultimate tensile strength (psi).....52.000
Elongation in 2" (%).....22

USA RG60
AWS A5.2 Class RG60

DESCRIPTION
USA RG60 is used to produce high tensile strength quality welds on low carbon and low alloy steels such as sheets, plates, pipes of grades A and B analysis and structural shapes. It is recommended for critical welds that must respond to the same annealing and heat treatment as regular grades of cast steel. The high silicon and manganese composition removes impurities from the molten metal thereby eliminating the need for flux.

TYPICAL CHEMICAL ANALYSIS (%)

C	0.15 max.
Mn	0.90-1.40
Si	0.10-0.35
P	0.035 max.
S	0.035 max.

TYPICAL MECHANICAL PROPERTIES OF WELD METAL (as welded)
Ultimate tensile strength (psi).....62,000-67,000
Elongation in 2" (%).....20-25

Index

Silver and Phos Copper Silver Brazing Alloys

HIGH SILVER BRAZING ALLOYS

Washington Alloy offers approximately 14 different high silver brazing alloys for joining most ferrous and nonferrous metals, except aluminum and magnesium. These High Silver Brazing Alloys are manufactured from only the highest purity raw materials, thereby elim¬inating undesirable trace elements which might otherwise interfere with brazing operations. All Washington Alloy High Silver Brazing Alloys are carefully formulated to provide maximum strength and corrosion resistance when joining stainless steel, copper alloys, nickel alloys, precious metals and just about any combination of these metals.

CADMIUM VS. CADMIUM-FREE

Washington Alloy offers both cadmium-free as well as cadmium-bearing alloys. The presence of cadmium gives the alloy a lower melting range and excellent fluidity. These alloys are mostly used in electrical components, petrochemical applications, brazing and joining of mild steel, tool steel, tungsten carbide tool tips and copper or nickel alloys.

Although the cadmium-bearing alloys provide some advantages, they are potentially dangerous due to the toxicity of the fumes and are considered carcinogenic. For this reason Washington Alloy offers several cadmium-free alloys such as USA 35CF, USA 45CF, USA 56CF and USA 54CF. The cadmium-free alloys are primarily used in the fabrication of

REEL DATA

WASHINGTON ALLOY PRODUCT	APPLICABLE SPECIFICATIONS			CHEMICAL COMPOSITION						
	AMS A5.8	Federal QQ-B-654A	AMS	Ag	Cu	Zn	Cd	Ni	Sn	P
SILVER BRAZING ALLOYS										
USA 45%	BAg-1	VII	AMS4769B	45	15	16	24			
USA 50%	BAg-1 a	IV	AMS4770G	50	15.5	16.5	18			
USA 35%	BAg-2	VIII	AMS4768D	35	26	21	18			
USA 35 CF	—			35	32	33	—			
USA 30%	BAg-2a			30	27	23	20			
USA 50N	BAg-3	V	AMS4771E	50	15.5	15.5	16	3		
USA 40 NCF	BAg-4	BAg-4		40	30	28		2		
USA 45 CF	BAg-5	BAg-5		45	30	25				
USA 50 CF	BAg-6			50	34	16				
USA 56 CF	BAg-7	BAg-7		56	22	17			5	
USA 72 CF	BAg-8			72	Bal.					
USA 54 CF	BAg-13		AMS4772	54	Bal.	5		1		
USA 30 CF	BAg-20	BAg-20		30	38	32				
USA 40 CF	BAg-28			40	30	28			2	
PHOS-COPPER SILVER ALLOYS										
USA 0	BCUP-2			0	Bal.					7.2
USA 5%	BCUP-3			5	Bal.					6
USA 6F	BCUP-4			6	Bal.					7.25
USA 15%	BCUP-5			15	Bal.					5
USA 2%	BCUP-6			2	Bal.					7

PHOS-COPPER-SILVER BRAZING ALLOYS

Washington Alloy Phos-Copper-Silver Brazing Alloys (USA 0, USA 2%, USA 5%, USA 6F and USA 15%) are all manufactured to offer economy as well as consistently high standards of quality and performance. These alloys are excellent for joining copper to copper where the phosphorus content of the phos-copper-silver brazing alloy reacts with the copper of the base metal in such a way that the filler metal becomes “self-fluxing”. For this reason these alloys are used quite extensively for joining closed copper tubing in the refrigeration and air conditioning industries where flux removal after brazing is difficult to impossible. Washington Alloy Phos-Copper-Silver Brazing Alloys are also used to join copper to brass and brass to brass, however, when joining these combinations a paste flux is recom-mended. Please keep in mind that these alloys

Silver and Phos Copper Silver Brazing Alloys

dairy or food handling equipment where the use of cadmium-bearing filler metals is prohibited.

BARE OR FLUX COATED
In any brazing application, capillary action is of primary importance. To promote capillary action the joint surfaces must be cleaned of contaminants. In most cases this is done by dipping the filler metal into a jar of paste flux before applying to the joint and heat-source.

In many cases the use of paste flux can be avoided by using one of Washington Alloy flux-coated silver brazing rods such as USA 35% flux-coated, USA 45% or USA 45CF flux-coated and USA 56CF flux-coated. The extruded coating on these filler metals provides excellent cleansing action which promotes "wetting-in" and capillary flow. The coating is flexible, low-fuming and has good shelf life.

STANDARD FORMS
1/32", 3/64", 1/16", 3/32" and 1/8" bare wire diameters
18", 20" or 36" straightened and cut lengths
50 troy ounce coils (1, 3 and 5 troy ounce coils also available)
Flux-coated rods available in 1/16" and 3/32"

REEL DATA

MELTING RANGE	BRAZING TEMP. RANGE	TYPICAL APPLICATION	
Solidus	Liquidus		
1125°F	1145°F	1145°F-1400°F	Joining ferrous and non-ferrous close fitting joints, electrical components, refrigeration, petrochemical
1160°F	1175°F	1175°F-1400°F	Brazing of mild steel, tool steel and stainless steel, copper, nickel and dissimilar combinations.
1125°F	1295°F	1295°F-1550°F	Joining dissimilar combinations where joint clearances are larger or where fillets are required.
1150°F	1350°F	1350°F-1550°F	Same as USA 35% but cadmium-free.
1125°F	1310°F	1310°F-1550°F	Economical version of USA 35%. A popular general purpose brazing alloy.
1170°F	1270°F	1270°F-1500°F	Brazing tungsten carbide tool tips and stainless steel. Excellent for poor fit-ups and fillets.
1240°F	1435°F	1435°F-1650°F	Tungsten carbides, stainless steel, nickel alloys, food handling equipment since cadmium-free.
1225°F	1370°F	1370°F-1550°F	Commonly used in electrical industry, food and dairy industries since cadmium-free.
1270°F	1425°F	1425°F-1600°F	Good for bridging gaps in ferrous and non-ferrous metals. Used to braze galvanized steel.
1145°F	1205°F	1205°F-1400°F	Brazing stainless steel in food processing equipment and plants, electrical components, copper, nickel
1435°F	1435°F	1435°F-1650°F	Atmosphere or vacuum brazing of copper and steel.
1325°F	1575°F	1575°F-1775°F	For high temperature service applications up to 700°F. For brazing aircraft parts.
1250°F	1410°F	1410°F-1600°F	High brazing temperature range. For ferrous and non-ferrous base metals.
1200°F	1310°F	1310°F-1550°F	Excellent general purpose uses. Joining copper, nickel, carbon and stainless steel. Cadmium-free.
1310°F	1460°F	1350°F-1550°F	For joint clearances from .002" to .005" in plumbing, heating, air conditioning, electrical connections. Where close-fitting joints cannot be maintained. For joint clearances of .003" to .006".
1190°F	1495°F	1325°F-1500°F	For close fit-up work. Low melting point. For joint clearances of .001" to .005".
1190°F	1325°F	1275°F-1450°F	Where close fitting joints cannot be maintained but where joint ductility is critical .003" to .006". For joint clearance of .003" to .005" where lower brazing temperatures are required.
1190°F	1475°F	1300°F-1500°F	
1190°F	1450°F	1350°F-1500°F	

are not to be used on iron or steel, nickel based alloys or any alloy containing more than 10% nickel due to the possibility of phosphorus embrittlement". Basically the phosphorus of the filler metal reacts with iron or steel or nickel to create a weakening condition known as phosphorus embrittlement.

Washington Alloy Phos-Copper-Silver Brazing Alloys offer excellent corrosion resistance except when exposed to sulfurous atmospheres. Commonly used in the plumbing, heating and electrical industries.

STANDARD FORMS
Round 1/16", 3/32", 1/8", 3/16", 1/4" Square 3/32", 1/8", 3/16", 1/4". Flat 1/16" x.050 and 1/8" x.050 Lengths 18", 20" and 36"

ALUMINUM WELDING & BRAZING ALLOYS

WASHINGTON ALLOY 4043
AWS/SFA5.10ER4043
UNS A94043

DESCRIPTION AND APPLICATION
Washington Alloy 4043 (commonly referred to as AlSi5) is a 5% silicon aluminum filler metal that is available in spools or cut lengths for MIG or TIG processes. This alloy is recommended for welding 3003, 3004, 5052, 6061, 6063 and casting alloys 43, 355, 356 and 214. Washington Alloy 4043 has a melting range of 1065-1170°F and a density of .097 lbs./cu. in. The post-anodizing color tint is gray. Tensile strength average is 29,000 psi.

TYPICAL WELD METAL CHEMISTRY (%)

Si	4.5-6.0
Fe	0.80 max.
Cu	0.30 max.
Mn	0.05 max.
Mg	0.05 max.
Zn	0.10 max.
Ti	0.20 max.
Al	Balance
Others*	0.15 total max.

*Be shall not exceed 0.0008 percent.

WASHINGTON ALLOY 5356
AWS/SFA 5.10ER5356
UNSA95356

DESCRIPTION AND APPLICATION
Washington Alloy 5356 (commonly referred to as AlMg5) is a 5% magnesium aluminum filler metal that is available for MIG or TIG welding processes. The weld deposit of Washington Alloy 5356 offers much better corrosion resistance when exposed to salt water. Common applications would be base metals 5050, 5052, 5083, 5356. 5454 and 5456. The post-anodizing color tint is white. Tensile strength average is 38,000 psi.

TYPICAL WELD METAL CHEMISTRY (%)

Si	0.25 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	.05-.20
Mg	4.5-5.5
Cr	.05-.20
Zn	.10 max.
Ti	.06-.20
Al	Balance
Others*	0.15 total max.

*Be shall not exceed 0.0008 percent.

WASHINGTON ALLOY 1100
AWS/SFA 5.10 ER1100
UNS A91100

DESCRIPTION AND APPLICATION
Washington Alloy 1100 (commonly referred to as Al 99.5) is a 99% aluminum filler metal that is available in spools or cut lengths for MIG or TIG welding processes. Washington Alloy 1100 is commonly used for architectural and decorative applications, furniture, piping, deep drawing applications and spun hollow ware. Common applications would include base metals 1100, 3003, and 3003 to similar base metals or to 1060,1070, 1080 and 1350. Slight golden color after anodizing. Average tensile strength as welded is 13,500 psi.

TYPICAL WELD METAL CHEMISTRY (%)

Si & Fe	0.95 max.
Cu	0.05-0.20
Mn	0.05 max.
Zn	0.10 max.
Al	99.0 min.
Others*	0.15 total max.

*Be shall not exceed 0.0008 percent.

WASHINGTON ALLOY 5556
AWS/SFA5.10ER5556
UNS A95556

DESCRIPTION AND APPLICATION
Washington Alloy 5556 is an aluminum filler metal that contains more manganese and zinc with slightly more magnesium than Washington Alloy 5356. This gives Washington Alloy 5556 good ductility and improved crack resistance. This alloy may be used for MIG or TIG welding processes. Commonly used on base metals 5154, 5254, 5454 and 5456. The approximate melting range is 1065°-1175°F and the post-anodizing color tint will be white. The ultimate tensile strength will be approximately 46,000 psi.

TYPICAL WELD METAL CHEMISTRY (%)

Si	0.25 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	0.50-1.00
Mg	4.70-5.50
Cr	0.05-0.20
Zn	0.25 max.
Ti	0.05-0.20
Al	Balance
Others*	0.15 total max.

*Be shall not exceed 0.0008 percent.

WASHINGTON ALLOY 4047 (718)
AWS/SFA 5.10ER4047 AWS A5.8
BAISI-4
UNS A94047

DESCRIPTION AND APPLICATION
Washington Alloy 4047 (commonly referred to as “718 aluminum” or AlSi12) is an aluminum filler metal which contains approximately 12% silicon. This alloy is commonly used not only in MIG or TIG applications, but also as a general purpose brazing alloy providing a free-flowing filler metal and good corrosion resistance. Washington Alloy 4047 is recommended for welding or brazing aluminum alloys: 1060, 1350, 3003, 3004, 3005, 5005, 5050, 6053, 6061, 6951 7005 and cast alloys 710.0 and 711.0. Washington Alloy 4047 has an approximate melting range of 1070°-1080°F and the post anodizing color tint is grayish-black.

TYPICAL WELD METAL CHEMISTRY (%)

Si	11.0-13.0
Fe	0.80 max.
Cu	0.30 max.
Mn	0.15 max.
Mg	0.10 max.
Zn	0.20 max.
Al	Balance
Others*	0.15 total max.

*Be shall not exceed 0.0008 percent.

WASHINGTON ALLOY 5183
AWS/SFA 5.10 ER5183
UNS A95183

DESCRIPTION AND APPLICATION
Washington Alloy 5183 (commonly referred to as AlMg 4.5 Mn) aluminum filler metal contains alloying elements 4.3-5.0% magnesium, 0.5-1.0% manganese as well as chromium and titanium. Available in spools or cut lengths for MIG or TIG processes, this alloy is commonly used on marine compo¬nents, drilling rigs, cryogenics, railroad cars, storage tanks and unfired pressure vessels. Base metals commonly welded include 5083, 5086 and 5456 to similar base metals or to 5052, 5652 and 5056. The post-anodizing color tint is white. The approximate melting range is 1075°-1180°F and the average tensile strength as welded is 41,000 psi.

TYPICAL WELD METAL CHEMISTRY (%)

Si	0.40 max.
Fe	0.40 max.
Cu	0.10 max.
Mn	0.5-1.0
Mg	4.3-5.2
Cr	0.05-0.25
Zn	0.25 max.
Ti	0.15 max.
Al	Balance
Others*	0.15 total max.

*Be shall not exceed 0.0008%

Guide to the Choice of Filler Metal for General Purpose Welding

Guide to the Choice of Filler Metal for General Purpose Welding

Base Metal			356.0, A356.0	511.0															
			357.0,	512.0			6005.6061												1060
	201.0	319.0,333.0	A357.0	513.0	7004,7005	6009	6063,6101											1100	1070
	206.0	354.0,355.0	413.0,443.0	514.0	7039,710.0	6010	6151,6201			5154			5052	5005	3004		2014	3003	1080
	224.0	C355.0	A444.0	535.0	712.0	6070	6351,6951	5456	5454	5254i	5086	5083	5652	5050	Alc 3004	2219	2035	Alc 3003	1350
1060,1070,1080,1350	ER4145	ER4145	ER4043a,b	ER5356c,d	ER5356c,d	ER4043a,b	ER4043b	ER5356d	ER4043b,d	ER5356c,d	ER5356d	ER5356d	ER4043b,d	ER1100b,c	ER4043b,d	ER4145b,c	ER4145	ER1100b,c	ER1188b,c,h,j
1100,3003, Alc 3003	ER4145	ER4145	ER4043a,b	ER5356c,d	ER5356c,d	ER4043 a,b	ER4043b	ER5356d	ER4043b,d	ER5356c,d	ER5356d	ER5356d	ER4043b,d	ER1100b,c	ER4043b,d	ER4145b,c	ER4145	ER1100b,c	
2014,2036	ER4145e	ER4145e	ER4145			ER4145	ER4145							ER4145	ER4145	ER4145e	ER4145e		
2219	ER2319a	ER4145e	ER4145b,c	ER4043	ER4043	ER4043a,b	ER4043a,b		ER4043b	ER4043			ER4043b	ER4043a,b	ER4043a,b	ER2319a			
3004, Alc 3004		ER4043b	ER4043.b	ER5356f	ER5356f	ER4043b	ER4043b,f	ER5356d	ER5356f	ER5356f	ER5356d	ER5356d	ER5356C,f	ER5356c,f	ER5356C,f				
5005,5050		ER4043b	ER4043.b	ER5356f	ER5356f	ER4043b	ER4043b,f	ER5356d	ER5356f	ER5356f	ER5356d	ER5356d	ER5356c,d	ER5356C,f					
5052, 5652i		ER4043b	ER4043f	ER5356f	ER5356f	ER4043b	ER5356c.f	ER5356f	ER5356f	ER5356f	ER5356d	ER5356d	ER5654C,j,i						
5083			ER5356c,d	ER535d	ER5183d		ER535d	ER5183d	ER5356d	ER5356d	ER5356d	ER5183d							
5086			ER5356c,d	ER5356d	ER5356d		ER5356d	ER5356d	ER5356d	ER5356d	ER5356d								
5154,5254i			ER4043f	ER5356f	ER5356f		ER5356f	ER5356f	ER5356f	ER5654f,i									
5454		ER4043b	ER4043f	ER5356f	ER5356f	ER4043b	ER5356c,f	ER5356f	ER5554c,f										
5456			ER5356c,d	ER5356d	ER5556d		ER5356d	ER5556d											
6005,6061,6063																			
6101,6151,6201	ER4145	ER4145b,c	ER4043b,f,g	ER5356f	ER5356c,f	ER4043a,b,g	ER4043b,j,g												
6351,6951																			
6009,6010,6070	ER4145	ER4145b,c	ER4043a,b,g	ER4043	ER4043	ER4043a,b,g													
7004,7005,7039		ER4043b	ER4043b,j	ER5356f	ER5356d														
710.0,712.0																			
511.0,512.0,513.0			ER4043f	ER5356f															
514.0,535.0																			
356.0, A356.0.357.0																			
A357.0,413.0,	ER4145	ER4145b,c	ER4043b.h																
443.0, A444.0																			
319.0, 333.0,																			
354.0, 355.0,	ER4145e	ER4145b,c,h																	
C355.0																			
	ER2319a,h																		
201.0,206.0,224.0																			

NOTES:

1. Service conditions such as immersion in fresh or salt water, exposure to specific Chemicals, or a sustained high temperature (over 150°F (66°C)) may limit the choice of filler metals. Filler metals ER5183, ER5356, ER5556, and ER5654 are not recommended for sustained elevated temperature service.
2. Recommendations in this table apply to gas shielded are welding processes. For oxyfuel gas welding, only ER1188, ER1100, ER4043, ER4047, and ER4145 filler metals are ordinarily used.
3. Where no filler metal is listed, the base metal combination is not recommended for welding.

d. ER4145 may be used for some applications.
e. ER4047 may be used for some applications.
f. ER4043 may be used for some applications.
g. ER5183, ER5356, or ER5556 may be used.
h. ER2319 may be used for some applications. It can supply high strength when the weldment is postweld solution heat treated and aged.
i. ER5183, ER5356, ER5554, ER5556, and ER5654 may be used. In some cases, they provide: (1) improved color match alter anodizing treatment. (2) highest weld ductility, and (3) higher weld strength. ER5554 is suitable for sustained elevated temperature service.
j. ER4643 will provide high strength in 1/2 in. (12mm) and thicker groove welds in 6XXX base alloys when postweld solution heat treated and aged.

OTHER AVAILABLE FILLER METALS

Washington Alloy 2319.....AWS/SFA.510 ER2319
Washington Alloy 5554.....AWS/SFA5.10ER5554
Washington Alloy 5654.....AWS/SFA5.10 ER5654
Washington Alloy 4145 (716).....AWS/SFA5.10 ER4145(716)
Washington Alloy 4643.....AWS/SFA5.10 ER4643
Washington Alloy A356.0.....AWS/SFA5.10 R-A356.0
Washington Alloy A357.0.....AWS/SFA5.10 R-A357.0
Washington Alloy C355.0.....AWS/SFA5.10R-C355.0

AVAILABLE PACKAGING AND DIAMETERS

1 lb. (0.45 kg) spools: .023 (0.6 mm), .030 (0.8 mm), .035 (0.9 mm), .040 (1.0 mm), 3/64 (1.2 mm), 1/16 (1.6 mm)
4 lb. (1.81 kg) spools: .023 (0.6 mm), .030 (0.8 mm), .035 (0.9 mm). .040 (1.0 mm), 3/64 (1.2 mm), 1/16 (1.6 mm)
13 lb. (5.90 kg) spools: .023 (0.6 mm), .030 (0.8 mm), .035 (0.9 mm) .040 (1.0 mm), 3/64 (1.2 mm), 1/16 (1.6 mm), 3/32 (2.4 mm)
36 in. (914 mm) rods: .023 (0.6 mm), .030 (0.8 mm), .035 (0.9 mm), .040 (1.0 mm), 3/64 (1.2 mm), 1/16 (1.6 mm), 3/32 (2.4 mm), 1/8 (3.2 mm), 5/32 (4.0 mm), 3/16 (4.8 mm), 1/4 (6.4 mm)

Settings Data

MIG WELDING

Power Source:	DCEP - Direct Current Electrode Positive power sources which are constant-current, constant-voltage or pulsed type. Any push-pull type wire feeder.
Wire Feeders:	*Spray-Arc mode use:* 100% Argon, 100% Helium, 90% Helium-10% Argon or 75% Helium-25% Argon.
Shielding Gas:	*Short-Circuiting Arc mode use:* 100% Argon, 100% Helium or 75% Helium-25% Argon.
Preheating: Preheating:	Most GMAW applications do not require preheating.

REEL DATA

GMAW PROCEDURES FOR GROOVE WELDS IN ALUMINUM ALLOYS

Section thickness in.	Welding position[a]	Joint geometry[b]	Root opening, R in.	No. of weld passes[c]	Electrode diameter, in.	Welding current, A[d,e]	Arc voltage, V[e]	Travel speed, in./min.	Argon flow rate, ft^3/h
1/16	F	A	0	1	0.03	70-110	15-20	25-45	25
	F	F	3/32	1	0.03	70-110	15-20	25-45	25
1/32	F	A	0	1	0.030-0.047	90-150	18-22	25-45	30
	F, V, H, O.	F	1/8	1	0.03	110-130	18-23	23-30	30
1/8	F,V,H	A	0-3/32	1	0.030-0.047	120-150	20-24	24-30	30
	F, V, H, O	F	4/16	1	0.030-0.047	110-135	19-23	18-28	30
3/16	F,V,H	B	0-1/16	1F, 1B	0.030-0.047	130-175	22-26	24-30	35
	F,V,H	E	0-1/16	1	0.047	140-180	23-27	24-30	35
	O	E	0-1/16	2F	0.047	140-175	23-27	24-30	60
	F,V	G	3/32-3/16	2	0.047-0.062	140-185	23-27	24-30	35
	H, O	G	3/16	3	0.047	130-175	23-27	25-35	60
1/4	F	B	0-3/32	1F, 1B	0.047-0.062	175-200	24-28	24-30	40
	F	E	0-3/32	2	0.047-0.062	185-225	24-29	24-30	40
	V, H	E	0-3/32	3F, 1B	0.047	165-190	25-29	25-35	45
	O	E	0-3/32	3F, 1B	0.047-0.062	180-200	25-29	25-35	60
	F,V	G	1/8-1/4	3-Feb	0.047-0.062	175-225	25-29	24-30	40
	O, H	G	1/4	6-Apr	0.047-0.062	170-200	25-29	25-40	60
3/8	F	C-90°	0-3/32	1F, 1B		225-290		20-30	50
	F	E	0-3/32	2F, 1B		210-275		25-35	50
	V, H	E	0-3/32	3F, 1B	0.062	190-220	26-29	24-30	55
	O	E	0-3/32	5F, 1B		200-250		25-40	80
	F,V	G	1/4-3/8	4		210-290		24-30	50
	O,H	G	3/8	10-Aug		190-260		25-40	80
3/4	F	C-60°	0-3/32	3F, 1B	0.062-3/32	340-400	26-31	14-20	60
	F	E	0-1/8	4F, 1B	3-32	325-375	26-31	16-20	60
	V, H, O	E	0-1/16	8F, 1B	0.062	240-300	26-30	24-30	80
	F	D	0-1/16	3F, 3B	0.062	270-330	26-30	16-24	60
	V, H,O	D	0-1/16	6F,6B	0.062	230-280	26-30	16-24	80

a. F, Flat; V, Vertical; H, Horizontal; O, Overhead
b. See diagram of joints on page 77
c. F-Face; B-Back
d. Constant current power source and constant speed electrode feed unit

Settings Data

TIG WELDING

Power Source:	AC or DC designed for GTAW.
Shielding Gas:	*Argon is recommended (100% Ar)*
Tungsten:	*Pure or Zirconiated Tungsten may be used*

REEL DATA

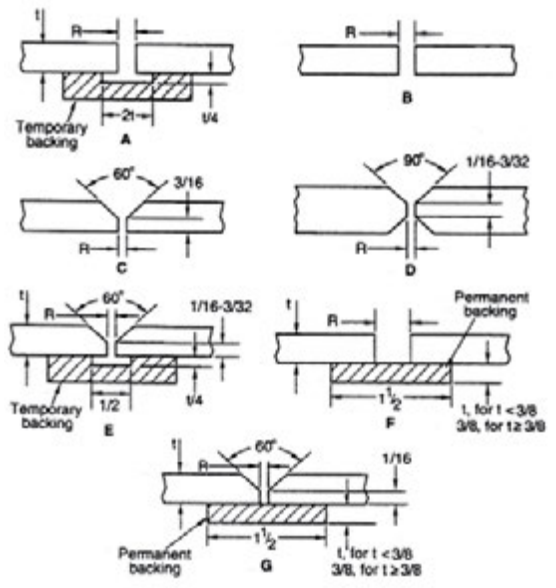
GTAW PROCEDURES FOR FilIET AND IAP WELDS IN ALUMINUM AIIOYS

Material thick-ness, in.	Weldinga posi-tion	Filler-wire diameter, in.	Electrode diam-eter, in.b	Gas cup i.d., in.	Argon flow, ft3/h	Ac,A	Travel speed, in./min.	Filler consumption, lb./100 ft.
1/16	F, H, V	3/32	1/16-3/32	3/8	16	70-100	8-10	0.5
	O	3/32	1/16-3/32	3/8	20	65-90	8-10	0.5
3/32	F	3/32-1/8	1/8-5/32	3/8	18	110-145	8-10	1
	H,V	3/32	3/32-1/8	3/8	18	90-125	8-10	1
	O	3/32	3/32-1/8	3/8	20	110-135	8-10	1
1/8	F	1/8	1/8-5/32	7/16	20	135-175	8-12	2
	H,V	1/8	3/32-1/8	3/8	20	115-145	8-10	2.5
	O	1/8	3/32-1/8	7/16	25	125-155	8-10	2
3/16	F	5/32	5/32-3/16	1/2	25	190-245	8-10	4.5
	H,V	5/32	5/32-3/16	1/2	25	175-210	8-10	5.5
	O	5/32	5/32-3/16	1/2	30	185-225	8-10	4.5
1/4	F	3/16	3/16-1/4	1/2	30	240-295	8-10	7
	H,V	3/16	3/16	1/2	30	220-265	8-10	9
	O	3/16	3/16	1/2	35	230-275	8-10	7

a. F. Flat: V. Vertical; H, Horizontal: 0, Overhead b. Pure tungsten

Courtesy: 1994-1995 Welding & Fabrication Data Book

JOINT DESIGNS FOR GAS-METAL-ARC WEIOING OF ALUMINUM



a. F. Flat: V. Vertical; H, Horizontal: 0, Overhead b. Pure tungsten

Size	Gauge	Feet/lb.
.023" (0.6 mm)	23	2083
.030" (0.8 mm)	20-1/2	1,215
.035" (0.9 mm)	19	900
3/64" (1.2 mm)	17	520
1/16" (1.6 mm)	14	290
3/32" (2.4 mm)	11	130
1/8" (3.2 mm)	8	70
5/32" (4.0 mm)	6-1/2	45
3/16" (4.8 mm)	4-1/2	31
1/4" (6.4 mm)	2	20

a. F. Flat: V. Vertical; H, Horizontal: 0, Overhead b. Pure tungsten

Causes of Operating Problems

PROBLEM	TIG WELDING	MIG WELDING
Poor Arc Starting	Circuit broken - grounding problem No shielding gas Wrong polarity Defective water-cooling cycle	Circuit broken - grounding problem No shielding gas Wrong polarity Inconsistent wire feeding
Unstable Arc	Inconsistent voltage flow Contaminated joint area Strong magnetic field Oversize electrode diameter Workpiece is too cold	Inconsistent voltage flow Contaminated joint area Strong magnetic field Conduit has too much angle Workpiece is too cold
Gray/Black surface on weld seam	Interrupted flow of shielding gas, leaks in cooling water or protective gas line system; contaminated weld joint or filler metal, nozzle stand-off distance is too large; too little, too much of contaminated shielding gas.	
	Contaminated Tungsten Electrode-caused by contact with the workpiece. Wrong selection of filler metal	Wrong torch position Arc is too long Wrong selection of filler metal
Porosity	Same as above Welding current is too low	Same as above Nozzle contaminated by too much spatter Wrong torch position Inadequate degassing of the weld pool as a result of rapid solidification Wire feed speed too slow Arc length too short Small filler metal o.d.
Lack of fusion or penetration	insufficient welding current Travel speed too fast Arc length too long Contaminated weld joint Wrong groove shape Oxides on filler or base metal	Insufficient welding current Travel speed to fast Arc length too long Contaminated weld joint Wrong groove shape Oxides on filler or base metal
Weld cracks	Wrong selection of filler metal Voltage too high Too little filler metal in joint *Wrong welding technique Contaminated joint area Shrinkage caused by design	Wrong selection of filler metal Voltage too high Too little filler metal in joint *Wrong welding technique Contaminated joint area Shrinkage caused by design

Causes of Operating Problems

PROBLEM	TIG WELDING	MIG WELDING
Dirty Welds	Inadequate shielding gas Contaminated filler metal Contaminated joint area Oxide or water stain on joint area	Inadequate shielding gas Contaminated filler metal Contaminated joint area Oxide or water stain on joint area
Burn-back (MIG WELDING)	If the wire feed speed is too low relative to the arc voltage, the welding wire will “burn-back” into the contact tip causing feeding to stop. Other possible problems are speed too fast - feeding speed too slow - wire too soft or kinked - conduit too long or kinked - worn or dirty liner - too much spatter in contact tip - voltage fluctuation - arcing in contact tip - wrong polarity - over heating of MIG gun	
Color mis-match	Wrong filler metal selection	Wrong filler metal selection

MIG WELDING BEFORE STARTING!!!
For optimum performance, consider these factors before starting:
Use U-grooved drive rolls, align drive rolls correctly, if possible - use wire straighteners; use a straight nozzle, not a curved one; use correct size contact tip and liner; don't crimp or bend the contact tube; replace or clean out contact tube/tip I.D.; check for water or gas leaks; use a proper power supply.
* Wrong welding technique solutions: Minimize stress by clamping the parts. Narrow the heat zone by increasing the traverse speed. Preheat the base metal. Use proper weld pool size. Change from convex to concave (or vice versa) bead shape. Control grain size by minimizing super heated molten metal.

TYPICAL WELD DEPOSIT PROPERTIES

Alloy	Approximate Melting Range (°F)	Density lbs./cu. in.	Average Tensile Strength All weld-metal (as-welded)		Post Annodized Color Tint
			psi	(MPA)	
1100	1190-1215	.098	13,500	(93)	slight golden
2319	1010-1190	.100	37,500	(253)	golden
4043	1065-1170	.097	29,000	(200)	gray
4047	1070-1080	.096	27,500	(190)	gray-black
4145	970-1085	.099	27.000	(186)	gray-black
5183	1075-1180	.096	41,000	(283)	white
5356	1060-1175	.096	38.000	(262)	white
5554	1115-1195	.097	33,000	(230)	white
5556	1065-1175	.096	42,000	(290)	white
5654	1100-1190	.096	32,000	(221)	white
A356.0	1035-1135	.097	(T6) 40,000	(276)	gray
A357.0	1040-1140	.098	(T6) 46,000	(317)	gray
C355.0	1015-1150	.098	(T6) 39,000	(269)	gray

Aluminum Welding & Brazing Alloy

ALUMINUM 345
EXTRUDED MAINTENANCE & REPAIR ELECTRODE
AWS/SFA 5.3 E4043 DC+ (reverse polarity)
UNS A94043

DESCRIPTION AND APPLICATION
An extruded aluminum electrode used for low temperature production and maintenance welding of cast and wrought aluminum sheets, plates, castings and extrusions.

Typical applications include tanks, pipes, appliances, refrigeration equipment, irrigation equipment, automobile parts and parts found in the laundry, chemical and food processing industries.

An all position electrode that produces dense and porosity-free machinable weld deposits. Color match and corrosion resistance of the weld deposit is excellent. Tensile strength is approximately 34,000 psi.

PROCEDURES
Clean the area to be welded. Large or heavy sections should be beveled to a 60° or 70° vee. Align the parts to be welded by tacking the joint(s). Preheating the larger sections to 350°F will allow for a flatter bead as well as reducing the required amperage. Using DC+ reverse polarity, maintain a short arc length while tilting the electrode in the direction of travel. The weaving technique is not recommended because of the faster travel speed required when welding aluminum. Allow the part to cool then remove all slag before making multiple passes. You may want to use a stainless steel wire brush and warm water to remove any flux residue. Many times a 10% sulphuric acid solution is used in the warm water. This will give the weld deposit a cleaner more polished appearance.

SIZE	RECOMMENDED AMPERAGE (DC+)
3/32” (2.4mm) x 14” (350mm)	50-85 amps
1/8” (3.2mm) x 14” (350mm)	85-140 amps
5/32” (4.0mm) x 14”(350mm)	110-165 amps

PACKAGING
5 lb. tubes / 30 lb. master cartons or 1 lb. mini-paks.

FLUXCORED ALUMINUM
TUBULAR TORCH ALLOY

APPLICATION
An all-position, oxyacetylene welding or brazing rod used in repairing broken or cracked aluminum extrusions or castings. Typical applications would include building up machinable deposits on worn or broken parts, model work, mold/die changes and thin sheet metal.

CHARACTERISTICS
Fluxcored Aluminum is one of the most versatile torch rods. The self-contained flux offers protection from handling and moisture. A broad operating temperature range and excellent color match makes this alloy suitable for many applications. It offers good plasticity, high strength and is readily machinable.

PROCEDURES
Remove any plating, dirt, grease or surface corrosion from the area to be welded or brazed. Sand and clean the weld area throughly. The gap to be welded should not exceed 1/8”. Bevel heavy sections to form a 60° to 75° V-notch. Using a slightly carburiz-ing flame, heat the work area by keeping the flame 1” to 2” from the weld area. Continue to heat the weld area while occasionally touching the fluxcored aluminum rod to this area under the torch flame. Do this until small amounts of alloy are deposited and the filler metal starts to flow through the gap of the heated weld area. Be sure that each drop of filler metal flows out and bonds to the base metal, but do not melt the base metal. Allow the welded part to cool and wash away the flux residue with warm water and a stiff brush.

SPECIFICATIONS
Liquidus.....1100°F
Tensile strength.....32,000 psi
Color match.....Good
(Not to be anodized)

3/32 x 32”, 1/8 x 32”, 3/16 x 32”.

PACKAGING
2 lb. tubes /10 lb. master cartons or 1 lb. mini-paks.

ALU-ZINC

DESCRIPTION AND APPLICATION
For repair of zinc-based metals, pot metal, white metals and aluminum.

Washington Alloy Alu-Zinc is a self-fluxing, low temperature joining alloy that can be used with oxy-acetylene or the TIG process, using argon as the shielding gas and AC (high frequency). It is excellent to use for new fabrication, maintenance or repair work. Flux is not necessary on accessible joints.

Common uses include: aluminum windows, doors, furniture, boats, engine heads, motor housings, power mowers, farm and dairy equipment, blocks and crankcases, vacuum cleaners, carburetors, gears and pumps, jigs and fixtures, dies and matchplates, trophies and ornaments, models and patterns, antique car parts and Kirksite dies.

PROCEDURES
Remove all dirt, plating, scale or oxides from the metal surface. Preheat to 400°F+/-. Then turn the torch at an angle, using the side of the flame to continue the heat build-up, making sure that both sides of the joint are the same temperature. Begin to touch the rod to the joint area. Continue the heat build-up until the rod begins to flow, which should be around 730°F-740°F. As the rod flows into the joint, make sure to use the rod end to break up any surface skin that will most likely develop. Use a circular motion or a dipping motion to firmly rub the rod into the joint. Failing to do so may prevent the fusion of the base metal and the filler metal. After the joint is repaired, allow the part to cool at room temperature. Do not quench.

Clean up: After the repair has cooled, use a stainless steel brush or warm water to remove any surface residue. The clean, dry joint can now be plated or painted to match the original finish.

SPECIFICATIONS
Elastic limit.....33,000 psi
Tensile strength.....39,000 psi
Brinell - 500 kg load.....100
Melting range.....715°F-735°F

PACKAGING
Available sizes: 1/8 x 18 - 5 lb. tubes.

OTHER AVAILABLE FILLER METALS

Washington Alloy 2319	AWS/SFA 5.10 ER 2319
Washington Alloy 5554	AWS/SFA 5.10 ER5554
Washington Alloy 5654	AWS/SFA 5.10 ER5654
Washington Alloy 4145 (716)	AWS/SFA 5.10 ER4145(716)

MAGNESIUM

Washington Alloy offers several grades of filler metals for magnesium welding. Washington Alloy AZ 61A and AZ 92A are the most popular wires and produce superior joints with the maximum tensile strengths offered by these alloys. Available in 36" straightened and cut lengths for Gas or TIG welding and on 3/4 lb. and 10 lb. spools for MIG welding.

TIPS FOR WELDING WITH MAGNESIUM

Cleanliness of both the base metal and filler metal is extremely important when welding with magnesium.

Chemical or mechanical cleaning of the joint area and filler metal, to remove any surface oxidation, should precede any welding. This can be accomplished using a solution of 24 oz. chromic acid, 5-1/3 oz. ferric nitrate and 1/16 oz. potassium fluoride in enough water to make one gallon. Bring the solution to 70-90°F, then immerse the part for 3 minutes, rinse in hot water, then air dry. Mechanical cleaning can be done using an aluminum or stainless steel wire brush, steel wool or an aluminum-oxide abrasive cloth. Gloves should be worn when handling cleaned filler metal.

GAS TUNGSTEN ARC (TIG) AND GAS METAL ARC (MIG) WELDING

Flux is not required for TIG or MIG welding processes. Although this is convenient, it means that cleanliness of the base metal and filler metal is even more critical.

Argon is the recommended shielding gas, however, an argon-helium mixture can increase filler metal flow and penetration. Do not use pure helium as this will create undesirable results. TIG welding can be done with AC current, DC reverse polarity or DC straight polarity. AC current will give good penetration. DC reverse polarity (electrode positive) will give shallow penetration but wide weld deposits. DC straight polarity (electrode negative) will give deep penetration but narrow weld deposits. Pure, Thoriated or Zircomated Tungsten may be used.

MIG welding is done with DC reverse polarity (electrode positive). MIG welding will increase weld speed by 2 to 4 times faster than TIG welding. MIG welding is the best process for heavy gage parts.

OXYACETYLENE WELDING

Oxyacetylene welding of magnesium is not commonly used. This process should only be considered for single-pass welding on thin gauges of magnesium. A fluoride or chloride flux should be used on the base metal and filler metal in order to clean and protect the weld pool. However, be sure to remove any flux residue by washing in hot water, pickle for 2 minutes in a chrome pickle solution, then boil in a 6% solution of sodium dichro-mate for 2 hours.

References: American Welding Society ANSI/AWS A5. 19-92 Penton Publishing Co. Welding & Fabricaling Data Book 1994/95.

WASHINGTON ALLOY AZ61A
AWS/SFA5.19ERAZ61A
UNS M11611

TYPICAL CHEMICAL ANALYSIS (%)

Mg	Remainder
Al	5.8-7.2
Be	.0002-.0008
Mn	0.15-0.5
Zn	0.40-1.5
Cu	0.05 max.
Fe	0.005 max.
Ni	0.005 max.
Si	0.05 max.
Others	0.30 max.

AVAILABLE PACKAGING AND DIAM-ETERS

3/4 lb. (0.34 kg) spools:

10 lb. (4.54 kg) spools:

36 in. (914 mm) rods:

WASHINGTON ALLOY AZ92A
AWS/SFA 5.19 ER AZ92A
UNS M11922

TYPICAL CHEMICAL ANALYSIS (%)

Mg	Remainder
Al	8.3-9.7
Be	.0002-.0008
Mn	0.15-0.5
Zn	1.7-2.3
Cu	0.05 max.
Fe	0.005 max.
Ni	0.005 max.
Si	0.05 max.
Others	0.30 max.

AVAILABLE PACKAGING AND DIAM-ETERS

3/4 lb. (0.34 kg) spools

10 lb. (4.54 kg) spools:

36 in. (914 mm) rods:

OTHER AVAILABLE MAGNESIUM ALLOYS

EZ33A	(AMS 4396)	UNS M 12331	MIL-R-6944
QE22A	(AMS 4418)	UNS M18220	Fed-QQ-M-56 QE22A
AZ101A		UNS M11101	

Magnesium
Typical Physical Properties and Parameters

TYPICAL WELD DEPOSIT PROPERTIES

	AZ61A	AZ92A	EZ33A	AZ101A	QE22A
Tensile Strength (psi	44,000	25,000	23,000	22,000	40,000
Yield Strength (psi)	30,000	14,000	16,000	12,000	30,000
Elongation (% in 2")	16	2	3	2	4
Shear Strength (psi)	20,000	18,000	19,000	18,000	30,000
Brinell Hardness	60	65	50	53	78
Melting Point (°F)	1140	1110	1189	1100	1140
Weight (ft./lb.)					
3/64	744				
1/16	419	412	412	412	412
3/32	186	183	183	183	183
1/8	105	103	103	103	103

TIG (GTAW) POWER-SOURCE AC machines with a high frequency current or DC machines with continuous amperage control both in reverse polarity (electrode positive)

TUNGSTEN: Pure, Zirconiated or Thoriated Tungsten.

SHIELDING GAS: Argon or a 75% Argon, 25% Helium mixture. Helium allows for lower welding currents, but don't use Helium alone as you will get spatter and arc turbulence.

Weld Rod Dia	Amps	Gas Flow (CFT/HR)
3/32	35-125	12
1/8	160 175	15
5/32	200-250	20
3/16		20

MIG (GMAW) POWER-SOURCE DC machines in reverse polarity (electrode positive)

a. constant voltage DC machines for short circuit welding (3/16 or less)
b. constant current (drooping volt-ampere output) DC machines for spray-arc welding. (Use spray-arc for 3/16" and larger base plates.)
c. constant potential DC machines, designed to pulse the secondary current output need to be used for pulse-induced arc transfer welds. (Use pulse for base metals thinner than 3/16".)

SHIELDING GAS: Argon is preferred. Argon-Helium mixtures may be used but Helium alone will cause a lot of spatter and arc turbulence

Welding Procedure	Wire Dia.	Amps	Volts	Gas Flow (CFT/RH)	
Short-circuiting	.040	25-40	13-14	40-60	
Short-circuiting	1/16	70-95	14-16	40-60	
Short-circuiting	3/32	15-175	14-15	40-60	
Spray-arc	1/16	240	27	50-80	
Spray-arc	3/32	520-420	24-30	50-80	
Pulsed-arc	.040	50	21	40-60	Pulse voltage: 55
Pulsed-arc	1/16	10-175	24-25	40-60	Pulse volgage: 52-55
Pulsed-arc	3/32	210	29	40-60	Pulse voltage: 55

Welding speed was 24-36 inches per minute

Copper-Coated Arc Gouging Carbons for Cutting and Gouging

Washington Alloy Copper-Coated Arc Gouging Carbons are designed for cutting and gouging metals such as carbon steel, stainless steel, copper, aluminum, and some high temperature alloys. The process is one in which an air-carbon arc torch is used to create an electric arc which melts away the metal, then uses compressed air to "blow" the molten metal out of the groove.

Washington Alloy Copper-Coated Arc Gouging Carbons have a special balance of carbon and graphite covered with a thin high-purity copper coating. High density, uniform properties and dimensions produce excellent arc stability and slag-free gouges.

Washington Alloy Copper-Coated Arc Gouging Carbons are available in three styles.

1. Copper-Coated DC Pointed Carbons are the most popular style. These are for general purpose grooving and cutting-specifications listed below.
2. Jointed Copper-Coated Carbons are designed to be connected by use of "male" and "female" fittings. This capability eliminates stub loss and allows for mechanized gouging by not having to renew the electrode.
3. Flat Copper-Coated Carbons are designed for shallow penetration and scarfing. Excellent for removing rivet heads or weld deposit crowns and for getting into corners.
4. Half Round.

Physical Properties

Description	Packaging inner ctn./ mas. ctn.	Electrical Resistance (Ω/in.)	Breaking Strength (lbs./In2)	Apparent Specific Gravity	Ash Content (%)
1/8 x 12"	100/1000	0.0006	5600	1.70	0.35
5/32 x 12"	100/1000	0.0005	5600	1.70	0.35
3/16 x 12"	50/500	0.0005	5600	1.70	0.35
1/4x12"	50/500	0.0005	5500	1.70	0.38
5/16 x 12"	50/500	0.0005	5500	1.70	0.38
3/8 x 12"	50/500	0.0005	5500	1.70	0.38
1/2 x 12"	20/200	0.0006	5400	1.70	0.38

Working Properties

Description	DC Reverse Polarity (AMPS)	Metal Removal oz./in.	Consumption Rate (in./min.)	Groove	
				width (in.)	depth (in.)
1/8 x 12"	100~150	0.89	4.20	15/64	3/32
5/32 x 12"	100~200	0.97	4.00	9/32	9/64
3/16 x 12"	150~250	1.18	3.97	5/16	5/32
1/4 x 12"	200~300	1.75	3.84	25/64	13/64
5/16 x 12"	250~350	2.96	3.19	7/16	9/32
3/8 x 12"	350~450	4.4	2.70	1/2	11/32
1/2 x 12'	700~900	6.35	1.81	11/16	7/16

Arc Gouging Carbon Electrodes

Electrode Gouging Carbons **100 Pieces Each**	**TG G/C 02**	1/8 X 12"
	TG G/C 03	5/32 X 12"
	TG G/C 04	3/16 X 12"
	TG G/C 05	1/4 X 12"
	TG G/C 06	5/16 X 12"
	TG G/C 07	3/8 X 12"
	TG G/C 08	1/2 X 14"

Non Copper Coated **100 Pieces Each**	**TG G/C 05NC**	1/4 X 12" NON-COPPER CARBON
	TG G/C 06NC	5/16 X 12" NON-COPPER CARBON
	TG G/C 07NC	3/8 X 12" NON-COPPER CARBON

Hollow **100 Pieces Each**	**TG G/C/H 05**	1/4 X 12" Hollow Carbon
	TG G/C/H 06	5/16 X 12" Hollow Carbon
	TG G/C/H 07	3/8 X 12" Hollow Carbon

Jointed **100 Pieces Each**	**TG G/C/J 07**	3/8 X 17"
	TG G/C/J 08	1/2 X 17"
	TG G/C/J 09	5/8 X 17"
	TG G/C/J 10	3/4 X 17"

Flat Style **100 Pieces Each**	**TG G/CF 04**	3/16 X 5/8 X 12" (FLAT STYLE)
	TG G/CF 071	3/8 X 5/32 X 12" (FLAT STYLE)
	TG G/CF 072	3/8 X 3/16 X 12" (FLAT STYLE)

COPPER BASED WELDING & BRAZING ALLOYS

NAVAL BRONZE ALLOY NO. 470
WS A5.8 Class RBCuZn-A
UNS/CDA C47000

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
AWS A5.8 Class RBCuZn-B †ASME
UNS/CDA C68000

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 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
AWS A5.8 Class RBCuZn-C
UNS/CDA C68100

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
A5.8 Class RBCuZn-D
UNS/CDA C77300

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 where good color match is desirable. 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.

SILICON BRONZE ALLOY NO. 656
AWS A5.7 ERCuSi-A
UNS/CDA C65600

DESCRIPTION AND APPLICATIONS
Washington Alloy Silicon Bronze is a copper based tiller 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
AWS A5.7 Class ERCu
UNS/CDA 18980

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.

Copper Based Welding & Brazing Alloys

PHOS-BRONZE A ALLOY NO. 518
AWS A5.7 Class ERCuSn-A
UNS/CDA C51800

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
AWS A5.7 Class ERCuSn-C
UNS/CDA C52100

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
AWS A5.7 Class ERCuAI-AI
UNS/CDA C61000

DESCRIPTION AND APPLICATIONS
Washington Alloy Aluminum Bronze A1 is an iron-free aluminum bronze filler metal used for MIG and TIG overlay welding of bearing and wear resistant surfaces exposed to corro¬sive 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
AWS A5.7 Class ERCuAI-A2
†ASME SFA5.7 ERCuAI-A2
UNS/CDA C61800

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
AWS A5.7 Class ERCUAI-A3
UNS/CDA C62400

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
AWS A5.7 Class ERCuNIAI
UNS/CDA C63280

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.

Copper Based Welding &Brazing Alloys

MANGANESE-NICKEL-ALUMINUM BRONZE ALLOY
AWS A5.7 Class ERCuMnNiAl
UNS/CDA C63380

DESCRIPTION AND APPLICATIONS
Washington Alloy Manganese-Nickel-Altiminum 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
AWS A5.7 Class ERCuNI
UNS C71581

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. 8/20 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.) (mm)	.023 (0.6)	.030 (0.8)	.035 (0.9)	.045 (1.2)	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	1/4 (6.4)	3/8 (9.5)	MASTER CARTON
2-2-1/2#SP00LS (4")	X	X	X	X	X							20 Spools
10-12-1/2#Spools (8")	X	X	X	X	X							4 Spools
25 - 33# Spools (12")	X	X	X	X	X	X	X					1 Spool
50 - 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 (1.6 mm) 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.

COPPER-BASED FLUX-COATED ELECTRODES

RAINIER 3A

AWS A5.6 Class ECuSn-C DC
DC Reverse Polarity (Electrode +)
All-Position Phosphor (Tin) Bronze Electrode for Copper, Steel, Cast Iron and Galvanized Iron
UNS/CDA W60521

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 3A 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

AWS A5.6 Class ECu
DC Reverse Polarity (Electrode +)
High Purity Copper Electrode for Joining Copper and Overlaying Steel
UNS/CDA W60189

APPLICATIONS

Rainier 4A is a copper-cored flux-coated electrode used to surface, buildup, 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

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 700F 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

AWS A5.6 Class ECuAl-A2
DC Reverse Polarity (Electrode +)
UNS/CDA W60614

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

PROCEDURE

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.

Copper-Based Flux-Coated Electrodes

RAINIER 6A

AWS A5.6 Class ECuSi
AC-DC Reverse Polarity
(Electrode +) All Position
AC/DC All-Purpose Electrode for "Arc Brazing"
Cast Iron to Steel.
UNS/CDA W60656

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

PROCEDURE

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

AWS/SFA5.6 Class ECuNi
UNS#W60715
UNS/CDA W60715

DESCRIPTION

Washington Alloy 187 is a 70% copper-30% nickel flux-coaled 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, R405 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 (%)

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

-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
Brinell hardness.....60-80

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

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

WELDING POSITIONS

Flat, horizontal, vertical overhead.

Alloy	UNS No.	Oxfuel Gas Welding	SMAW	GMAW	GTAW	Resistance Welding	Solid-Stale Welding	Brazing	Soldering	Beam Welding
ETP Copper	C11000-C11900	NR	NR	F	F	NR	G	E	G	NR
Oxygen-Free Copper	C10200	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
Cadminium/Chromium	C16200-C18200	NR	NR	G	G	NR	F	G	G	F
Copper										
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 Bronzes	C61300									
	C61400	NR	G	E	E	G	G	F	NR	G
Silicon Bronzes	C65100									
	C65500	G	F	E	E	G	G	E	G	G

Chemical Composition of Copper Based Alloys

	Cu Copper	Zn Zinc	Fe Iron	Si Silicon	Al Alminum	Pb Lead	Mn Mangnese	P Phophrus	Ni Nickel(+Co)	Sn Tin	Total Other Elements
Naval Bronze	57.0-61.0	BAL	—	—	0	0	—	—	—	0.25-1.00	0.5
Nickel Bronze	56.0-60.0	BAL	0.25-1.20	0.04-0.15	0	0	0.01-0.50	—	0.20-0.80	0.80-1.10	0.5
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	0.5
Nickel Silver	46.0-50.0	BAL	—	0.04-0.25	0	0	—	0	9.0-11.0	—	0.5
Silicon Bronze	BAL	1	0.50	2.8-4.0	0.01	0.02	1.5	—	—	1	0.5
Deox Copper	98.0 min	—	—	0.50	0.01	0.02	0.5	0.15	—	1	0.5
Phos-Bronze A	BAL	—	—	—	0.01	0.02	—	0.100.35	—	4.0-6.0	0.5
Phos-Bronze C	BAL	0.2	0.1	—	—	0.05	—	0.3-0.35	—	7.0-9.0	0.5
Aluminum Bronze A-1	BAL	0.2	—	0.10	6.0-8.5	0.02	0.5	—	—	—	0.5
Aluminum Bronze A-2	BAL	0.02	1.5	0.10	8.5-11.0	0.02	—	—	—	—	0.5
Aluminum Bronze A-3	BAL	0.1	2.0-4.5	0.10	10.0-11.5	0.02	—	—	—	—	0.5
Nickel Aluminum Bronze	BAL	0.1	3.0-5.0	0.1	8.5-9.5	0.02	0.60-3.50	—	4.0-5.50	—	0.5
Manganese-Nickel Aluminum Bronze	BAL	0.15	2.0-4.0	0.1	7.0-8.5	0.02	11.0-14.0	—	1.5-3.0	—	0.5
Alloy 67 Copper-Nickel	BAL	—	0.40-0.75	0.25	—	0.02	1	0.02	29.0-32.0	—	0.05 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/A5.27 RBCuZn-A	1650(899)	70-90	50,000 (345)
Nickel Bronze (Manganese Bronze)	A5.8/A5.27 RBCuZn-B	1620(882)	80-110	56,000 (386)
Low Fuming Bronze (LFB or LFBFC)	A5.8/A5.27 RBCuZn-C	1630(888)	80-110	56,000 (386)
Nickel Silver	A5.8/A5.27 RBCuZn-D	1715(935)	90-110	60,000(414)
Silicon Bronze (Everdur)	A5.7 ERCuSi-A	1866(1019)	80-110	50,000 (345)
Deox Copper	A5.7/A5.27 ERCu	1967(1075)	Rockwell F25	25,000(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)

WASHINGTON ALLOY-COMMERCIAL PURE TITANIUM

AWS A5.16 Classes ERTi-1, 2, 3 and 4/AMS 4951

Washington Alloy Commercial Pure Titanium is a TIG and MIG filler metal used for welding commercial pure titanium alloys commonly found in applications requiring high temperature resistance and resistance to chemical reagents. Although there are four grades of Commercial Pure Titanium filler metals, C.P. Grade 2 (ERTi-2) is the most popular because of its good balance of strength, formability and weldability.

The most common application of Commercial Pure Titanium is the aircraft industry, where tensile strength and weight ratios are so critical. Other uses would include cryogenic and petrochemical applications such as chemical process heat exchangers, pressure vessels and piping systems, pulp bleaching systems, electro chemical and chemical storage tanks.

FILLER METAL CHEMISTRY (%)

	ERTi-1
C	0.030
0	0.100
H	0.005
N	0.015
Fe	0.100
Ti	Balance
	ERTi-2
C	0.030
0	0.100
H	0.008
N	0.020
Fe	0.200
Ti	Balance
	ERTi-3
C	0.030
0	0.10-0.15
H	0.008
N	0.020
Fe	0.200
Ti	Balance
	ERTi-4
C	0.030
0	0.15-0.25
H	0.008
N	0.020
Fe	0.300
Ti	Balance
	AMS4951
C	0.080
0	0.180
H	0.005
N	0.050
Fe	0.200
Ti	Balance

***All single values of chemical compositions shown are maximum percentage.**

MINIMUM MECHANICAL PROPERTIES

	ERTi-1	ERTi-2	ERTi-3
Tensile strength (psi)	35,000	50,000	65,000
Yield strength (0.2% offset) psi	25,000	40,000	55,000
Elongation (%)	24	20	18
ERTi-4 AMS4951			
Tensile strength (psi)	80,000	50,000	
Yield strength (0.2% offset) psi	70,000	25,000	
Elongation (%)	15	35	

WASHINGTON ALLOY ERTi-5

AWS A5.16 Class ERTi-5
AMS 4954

Washington Alloy ERTi-5 is a TIG, MIG and submerged arc filler metal used for welding 6% Aluminum - 4% Vanadium alloys. The weld deposits of Washington Alloy ERTi-5 exhibit high fatigue strength, toughness, ductility and are heat treatable. Widely used in the cryogenic, petrochemical and aircraft industry. Aircraft uses would include the airframes; turbine engine parts such as the blades, discs, wheels and spacer rings. Other applications would include industrial fans, pressure vessels, compressor blades and rocket motor cases.

FILLER METAL CHEMISTRY (%)

C	0.050 max.
O	0.180 max.
H	0.015 max.
N	0.030 max.
Fe	0.300 max.
Ti	Balance
Al	5.5-6.7
V	3.5-4.5
Yt	0.005 max.

MINIMUM MECHANICAL PROPERTIES

Tensile strength (psi) 130,000
Yield strength (0.2% offset) (psi) 120,000
Elongation (%) .10

WASHINGTON ALLOY ERTi-23

AWS A5.16 Class ERTi-23
AMS 4956

Washington Alloy ERTi-23 is comparable in chemical composition to ERTi-5, but slightly lower aluminium and lower levels of oxygen and other interstitial elements improve fabricability, weldability, and toughness. ERTi-23 is used in many high strength industrial applications such as shafts where very high strength, but better toughness and fabricability then ERTi-5 are desired.

FILLER METAL CHEMISTRY (%)

C	0.030
O	0.100
H	0.005
N	0.012
Fe	0.150
Ti	Balance
Al	5.5-6.5
V	3.5-4.5
Yt	0.005

MINIMUM MECHANICAL PROPERTIES

Tensile strength (psi).....130,000
Yield strength (0.2% offset) (psi).....120,000
Elongation (%).....10

TIPS FOR WELDING WITH TITANIUM

Welding with titanium requires extreme cleanliness. Grind or file off mill scale. Clean surface oxides with a 35% nitric - 5% hydro¬fluoric acid solution at room temperature, then rinse with water and air dry. Grease or oils should be cleaned with a nonchlorinated degreasing solvent, acetone or methanol. Light oil can be washed away with a normal household detergent, then air-dried.

Titanium is a reactive metal and as such it is sensitive to embrittlement by oxygen, nitro¬gen and hydrogen, within the weld zone area, at temperatures above 500°F. Consequently the weld metal must be protected against atmospheric contamination that may be caused by these elements. This can be most easily attained by holding the shielding gas over the weld area until it cools to approxi¬mately 600°F.

Argon is the recommended shielding gas, however an argon-helium mixture will give greater penetration although at the expense of arc stability.

MANUAL GTA WELDING

Wire Diameter (in.)	Current (A)	Voltage (V)	Travel Speed in./min.	Deposition Rate lb./h
0.0621/16	180	16	5 to15	0.50 to 0.70
0.093 3/32	190	17	5 to15	0,80 to 0.90
0.1251/8	205	19	5 to15	1.20 to 1.36

Courtesy: Penton Publishing Co.: Welding & Fabricating Data Book 1990/91.

NICKEL-BASED ALLOY MIG, TIG & SUBARC WIRES

WASHINGTON ALLOY 60
AWS A5.14 Class ERNiCu-7
UNS N04060

Washington Alloy 60 is primarily designed for MIG, TIG and submerged arc welding of nickel-copper (Monel®) alloys 400 and 404 to themselves or to each other.

Washington Alloy 60 is also used for dissimilar applications such as joining nickel-copper (Monel®) alloys to nickel base alloy 200 and for joining nickel-copper (Monel®) alloys 400 and 404 or nickel base alloy 200 to copper-nickel and copper alloys. Note: When overlaying on steel, use Washington Alloy 61 for the first layer.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	62.0-69.0
C	0.15 max.
Mn	4.0 max.
Fe	2.5 max.
S	0.015 max.
Si	1.25 Max.
Cu	Balance
Al	1.25 max.
Ti	-1.5-3.0
P	0.02 max.
Others (total)	0.50 max.

*Includes Cobalt (Co)

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....70,000
Yield strength (0.2% offset) (psi).....30,000
Elongation (%).....30

WASHINGTON ALLOY 61
AWS A5.14 Class ERNi-1
UNS N02061

Washington Alloy 61 is a high nickel filler metal used for MIG, TIG or plasma arc welding of high nickel base 200 or low carbon nickel 201 to themselves or to each other. Washington Alloy 61 is also used for joining nickel 200 and 201 to dissimilar metals such as carbon steel, stainless steel, Inconel® and Incoloy® alloys, copper-nickel alloys and Monel® alloys. Excellent for overlaying on steel and for welding cast iron. Titanium content in the wire controls weld metal porosity.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	93.0min.
C	0.15 max.
Mn	1.0 max.
Fe	1.0 max
S	0.015 max
Si	0.75 max
Cu	0.25 max
Al	1.5 max.
Ti	2.0-3.5
P	0.03 max.
Others (total)	0.50 max

*Includes Cobalt (Co)
MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....60,000
Yield strength (0.2% offset) (psi).....35,000
Elongation (%).....20

WASHINGTON ALLOY 62
AWS A5.14 Class ERNiCrFe-5
AMS 5679
UNS N06062

Washington Alloy 62 is a nickel-chromium-iron filler metal designed specifically for welding maximum 2" thick base metals of Inconel® 600 using MIG, TIG, submerged arc, plasma arc and oxyacetylene processes. (For sections larger than 2" thick use Washington Alloy 82.) The higher columbium (Cb) and tantalum (Ta) content of Washington Alloy 62 minimizes cracking in thicker base metals where high stresses are encountered.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	70.0 min.
C	0.08 max
Mn	1.0 max.
Fe	6.0-10.0
S	0.015 max.
Si	0.35 max.
Cu	0.50 max
Cr	14.0-17.0
*Cb	1.5-3.0
P	0.03 max.
Co	0.12 max.
Others (total)	0.50 max.

*Includes Tantalum (Ta): 0.30 max.

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....80,000
Yield strength (0.2% offset) (psi).....40,000
Elongation (%).....30

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered nonstandard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY 65
AWS A5.14 Class ERNiFeCr-1
UNS N08065

Washington Alloy 65 filler metal is designed for MIG or TIG welding of Incoloy® 825 to itself or to other nickel-iron-chromium-molybdenum-copper alloys.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	38.0-46.0
C	0.05 Max.
Mn	1.0 Max
Fe	22.0 min.
S	0.03 max.
Si	0.50 max
Cu	1.5-3.0
Cr	19.5-23.5
Al	0.20 max.
Ti	0.60-1.2
Mo	2.5-3.5
P	0.03 max
Others (total)	0.50 max

*Includes incidental Cobalt (Co)

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....80,000
Yield strength (0.2% offset) (psi).....35,000
Elongation (%).....25

WASHINGTON ALLOY 67
AWS A5.7 Class ERCuNi
UNS C71580

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 Monel® 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.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	29.0-32.0
Mn	1.0 max.
Fe	0.40-0.75
S	0.01 max.
Si	0.25 max
Cu	Balance
Ti	0.20-0.50
P	0.02 max.
Pb	0.02 max.
Others (total)	0.50 max.

*Includes Cobalt (Co)

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....50,000
Yield strength (0.2% offset) (psi).....20,000
Elongation (%).....30
Brinell hardness (500 kg load)..... 60-80

WASHINGTON ALLOY 82
AWS A5.14 Class ERNiCr-3
UNS N06082

Washington Alloy 82 is a nickel-chromium-iron filler metal used for MIG, TIG, submerged arc and plasma arc welding of nickel base Inconel® 600 and 601 as well as Incoloy® 800 and 800 HT to themselves or to carbon steel, stainless steel, high nickel base 200 and to nickel-copper Monel® 400. Washington Alloy 82 can also be used for joining high nickel base 200 to stainless steel, nickel-copper Monel® 400 to carbon steel and for overlaying on steel.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	67.0 min
C	0.10 max.
Mn	2.5-3.5
Fe	3.0 max.
S	0.015 max.
Si	0.50 max
Cu	0.50 max
Cr	18.0-22.0
Ti	0.75 max.
*Cb	2.0-3.0
Co	0.12 max.
P	0.03 max.

*Includes Tantalum (Ta): 0.30 max.

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....80,000
Yield strength (0.2% offset) (psi).....40,000
Elongation (%).....30

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered nonstandard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY 625
AWS A5.14 Class ERNiCrMo-3
†AMS 5837
UNS N06625

Washington Alloy 625 is a nickel-chromium-molybdenum filler metal used for MIG, TIG, submerged arc and plasma arc welding of Inconel® alloys 601, 625 and 690 as well as Incoloy® alloys 800, 825 and 800HT to themselves or to each other. Washington Alloy 625 is excellent for joining these Inconel® and Incoloy® alloys to dissimilar metals such as carbon steel, low alloy steel, ferritic and austenitic stainless steels. This filler metal produces weld deposits with excel lent corrosion and oxidation resistance against phosphoric acids, organic acids and seawater. Good resistance against pitting and stress corrosion cracking in chloride containing environments. The weld deposits exhibit high strength and fatigue resistance over a broad range of temperatures ranging from cryogenic up to 1800°F.

Washington Alloy 625 is most commonly used in the chemical processing industry, pollution control equipment, marine equipment, nuclear reactor components, pump shafts. Also used in the aerospace industry for thrust reverser assemblies, fuel nozzles, after-burners and combustion systems.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	58.0 min.
C	0.10 max.
Mn	0.50 max.
Fe	5.0 max.
S	0.015 max.
Cu	0.50 max.
Ti	0.40 max.
Cr	20.0-23.0
*Cb	3.15-4.15
Mo	8.0-10.0
Si	0.50 max.
P	0.02 max.
Al	0.40 max.
Others (total)	0.50 max.

‘Includes Tantalum (Ta)

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....110,000
Yield strength (0.2% offset) (psi).....60,000
Elongation in 2” (%).....30

WASHINGTON ALLOY 718
AWS A5.14 Class ERNiFeCr-2
†AMS 5832
UNS N07718

Washington Alloy 718 is a nickel-chromium-columbium-molybdenum filler metal designed specifically for TIG welding of Inconel® alloys 718, 706 and X-750. The weld deposit of Washington Alloy 718 offers exceptional high strength and good ductility at temperatures up to 1300°F. Good weldability and formability as well as excellent cryogenic properties account for the many applications of this filler metal. The weld deposits of Washington Alloy 718 will precipitation hard en on heat treatment. Primarily for welding aircraft high strength components and liquid rocket components exposed to cryogenic temperatures.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	50.0-55.0
C	0.08 max.
Mn	0.35 max.
Fe	Balance
S	0.015 max.
Si	0.35 max.
Cu	0.30 max.
Cr	17.0-21.0
Al	0.20-0.80
Ti	0.65-1.15
*Cb	4.75-5.50
Mo	2.80-3.30
P	0.015 max.
B	0.006 max.
Co	Incidental

*Includes Tantalum (Ta)

MINIMUM MECHANICAL PROPERTIES (age-hardened)

Tensile strength (psi).....165,000
Yield strength (0.2% offset) (psi).....135,000
Age hardened at 1325°F/8 hours,
furnace cool to 1150°F at 100°F/hour, then air cool.

WASHINGTON ALLOY C276
AWS A5.14 Class ERNiCrMo-4
UNS N10276

Washington Alloy C276 is a nickel-chromium-molybdenum filler metal developed for MIG and TIG welding of Hastelloy® C and Hastelloy® C-276 to themselves, to stainless steel or to other nickel base alloys. Washington Alloy C276 offers excellent resistance to pitting, stress-corrosion cracking and oxidizing atmospheres up to 1900°F.

This filler metal is frequently used for welding the clad side of joints on steel in the chemical, petrochemical and petroleum industries. Washington Alloy C276 offers excellent resistance to a wide range of chemicals including the corrosive effects of wet chlorine gas, hypochlorite and chlorine dioxide solutions. Other uses would include hot contaminated mineral acids, solvents, solutions (organic and inorganic) contaminated by chlorine or chlorides, dry chlorine acetic or ferric acids, seawater and brine solutions.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
C	0.02 max.
Mn	1.0 max.
Fe	4.0-7.0
S	0.03 max.
Cu	0.50 max.
P	0.04 max.
Cr	14.5-16.5
Mo	15.0-17.0
W	3.0-4.5
V	0.35 max.
Co	2.50 max.
Si	0.08 max.
Others (total)	0.50 max.

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....100,000
Yield strength (0.2% offset) (psi)..... 61

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications arc considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY 92
AWS A5.14 Class ERNiCrFe-6
†AMS 5675
UNS N07092

Washington Alloy 92 is a nickel-chromium-iron filler metal used for cladding or overlaying on steel and for joining dissimilar combinations of nickel base Inconel® and Incoloy® alloys to each other or to carbon steel and stainless steel. Excellent for joining austenitic and ferritic stainless steels to each other or to high nickel base 200, nickel-copper Monel® alloys and to carbon steel. Washington Alloy 92 can be used with MIG, TIG, submerged arc and plasma arc welding processes. The weld deposits of Washington Alloy 92 will precipitation harden on heat treatment, with the hardness determined by temperature and the length of time the weld deposit is exposed to that temperature.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	67.0 min.
C	0.08 max.
Mn	2.0-2.7
Fe	8.0 max.
S	0.015 max.
Si	0.35 max.
Cu	0.50 max.
Cr	14.0-17.0
Ti	2.5-3.5
P	0.03 max.
Others (total)	0.50 max.

*Co is incidental

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....80,000
Yield strength (0.2% offset) (psi).....40,000
Elongation (%).....30

WASHINGTON ALLOY X
AWS A5.14 Class ERNiCrMo-2
†AMS 5798
UNS N06002

Washington Alloy X is a nickel-chromium-molybdenum "superalloy" used for MIG, TIG or plasma arc welding of similar base metals such as Hastelloy® X to itself or to stainless steel, carbon steel and low alloy steels. This filler metal offers an exceptional combination of oxidation, corrosion and thermal shock resistance. The weld deposits of Washington Alloy X exhibit high temperature strength and resists weld metal fatigue at temperatures up to 2200°F. Washington Alloy X is commonly used in the aerospace industry for engine tailpipes, turbine blades, nozzle vanes and after burner components. It is also used in petro-chemical applications to combat stress corrosion cracking.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
Cr	20.5-23.0
Mo	8.0-10.0
W	0.2-1.0.
P	0.04 max.
Si	1.0 max.
Co	0.5-2.5
Fe	17.0-20.0
Mn	1.0 max.
C	0.05-0.15
S	0.03 max.
Cu	0.50 max.
Others (total)	0.50 max.

AVERAGE MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....109,500
Yield strength (0.2% offset) (psi).....55,900
Elongation in 2" (%).....45
Rockwell hardness.....B 92

WASHINGTON ALLOY
"WASPALOY"®
AMS 5828

Washington Alloy Waspaloy® filler metal is used for MIG, TIG and resistance welding of similar base metals, usually in critical applications requiring high strength at elevated temperatures. The weld deposits of this filler metal exhibit excellent mechanical properties at temperatures up to 1400°F with good oxi¬dation and corrosion resistance at temperatures as high as 1600°F. Washington Alloy Waspaloy® is commonly used in gas turbine atmospheres; turbine blades, shafts, turbine and compressor discs, spacers, fasteners and jet engine hardware. Suitable for replacing "Nimonic 90" in certain applications.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
Co	12.0-15.0
Cr	18.0-21.0
Mo	3.5-5.0
Fe	2.0 max.
C	0.02-0.10
B	0.003-0.010
Mn	0.10 max.
Si	0.10 max.
P	0.01 max.
S	0.01 max.
Ti	2.75-3.50
Al	1.20-1.60
Cu	0.10 max.
Zr	0.04 max.

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft speculations, however material supplied to both ASME and MIL specifications are considered non¬standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY W
AWS A5.14 Class ERNiMo-3
†AMS 5786
UNS N10004

Washington Alloy W filler Metal is designed for MIG, TIG, submerged arc and plasma arc welding of similar nickel-molybdenum alloys such as Hastelloy® W. However this "super alloys used in high temperature service applications. The weld deposit of Washington Alloy W exhibits good mechanical properties up to 1800°F, power it does exhibit poor oxidation resistance above 1400°F and it should not be used for service application in excess of 750 hours. Washington Alloy W is used in the aerospace industry for jet engine repair and maintenance, gas turbine parts and rotor hubs.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
Mo	23.0-26.0
Cr	4.0-6.0
Fe	4.0-7.0
Si	1.0 max
W	1.0 max
C	0.12 max
Mn	1.0 max
P	0.04 max
S	0.03 max
Co	2.50 max
V	0.60 max
Cu	0.50 max
Others (total)	0.50 max

*Co is incidental

MINIMUM MECHANICAL PROPERTIES (as welded)

Tensile strength (psi).....100,000
Elongation in 2" (%).....25

WASHINGTON ALLOY 600
AMS 5687

Washington Alloy 600 is a high nickel-high chromium filler metal designed to provide high strength weld deposits with good oxidation and corrosion resistance in severely corrosive environments subjected to elected temperatures. The weld deposits of Washington Alloy 600 have excellent resistance to stress corrosion cracking at subzero, room and elected temperature. Washington Alloy 600 is commonly used for nuclear reactor components, chemical and food processing equipment, heat treatment furnace components and heat exchangers. Also used for aircraft engines and exhaust equipment.

TYPICAL FILLER METAL CHEMISTRY (%)

*Ni	Balance
C	0.10 max
Mn	1.0 max.
Fe	6.0-10.0
S	0.015 max.
Cr	14.0-17.0
Si	0.50 max.
Cu	0.50 max.
Others (total)	0.50 max.

Includes Cobalt (Co)

WASHINGTON ALLOY 617
AWS A5.14 Class ERNiCrCoMo-1
UNS N06617

Washington Alloy 617 is a nickel chromium cobalt molybdenum filer metal designed primarily for MIG and TIG welding of Inconel® 617 base material. Excellent for high temperature applications involving dissimilar metals such as joining Inconel® 600, 601 and Incoloy® 800 HT. Washington Alloy 617 weld deposits have excellent mechanical stability, oxidation and corrosion resistance as well as good stress rupture properties at temperatures up to 2000°F. This filler metal is commonly used in the aerospace industry for engine components, after burners, turbine seals; heat treating equipment and many other high temperature service applications.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
Cr	20.0-24.0
Mo	8.0-10.0
Cu	0.500 max.
Fe	3.0 max.
Ti	0.60 max.
C	0.05-0.15
Mn	1.0 max.
P	0.03 max.
S	0.015 max.
Si	1.0 max.
Co	10.0-15.0
Al	0.80-1.50
Others (total)	0.50 max.

Tensile strength (psi).....90,000
Elongation in 2" (%).....41

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable spec fiction. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based and Cobalt-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY R-41
AMS 5800

Washington Alloy R-41 is a nickel-chromium-cobalt-molybdenum filler metal used for MIG, TIG and resistance welding of Rene® 41 base metal. The weld deposits of Washington Alloy R-41 offer excellent strength and oxidation resistance in the 1000^0 F to 1800^0 F range. This filler metal is commonly used for jet and rocket engine components such as turbine wheels, turbine wheels, turbine blades, afterburner parts, combustion chamber liners; airframe and missile components.

TYPICAL FILLER METAL CHEMISTRY (%)

C	0.12 max.
Mn	0.10 max.
Si	0.50 max.
S	0.015 max.
Cr	18.0-20.0
Ni	Balance
Co	10.0-12.0
Fe	5.0 max.
Mo	9.0-10.5
Ti	3.0-3.3
Al	1.4-1.6
B	0.003-0.010
Other (total)	0.02 max.

WASHINGTON ALLOY 31*
AMS 5789

Washington Alloy 31 is a cobalt case filler metal designed for Haynes® Stellite® No. 31 to itself or to nickel base or stainless steel alloys. The weld deposits of Washington Alloy 31 have good stress-rupture resistance and creep strength properties. Excellent for oxidizing and reducing atmospheres up to 2100^oF.Washington Alloy 31 has an “as-cast” tensile strength of 63,200 psi with a 15% elongation at 1500^oF. Primarily used in the aerospace industry for welding gas turbines and other jet engine components.

TYPICAL FILLER METAL CHEMISTRY (%)

Co	Balance
Ni	9.5-11.5
Cr	24.5-26.5
W	7.0-8.0
Fe	2.0 max.
Mn	1.0 max.
C	0.45-0.55
P	0.04 max.
S	0.04 max.
Si	1.0 max.

*Note: This filler metal is also available as a flux-coated electrode for shielded metal arc welding.

WASHINGTON ALLOY L605*
AMS 5796
(AMS 5795B for Flux-Coated Electrode)

Washington Alloy L605 is a cobalt base filler metal used for MIG, TIG and plasma arc welding of Haynes® NO. 25 to itself or to nickel base or stainless steel alloys. This filler metal yields a weld deposit with excellent resistance to oxidation and carburization at temperatures up to 1900^oF. Washington Alloy L605 has good fabricability and is used for industrial furnace applications such as furnace muffles and is used for industrial furnace applications such as furnace muffles and liners in high temperature kilns. Also used in jet engine components such as turbine blades, combustion chamber, turbine rings and afterburner parts. (Commonly referred to as alloy No. 25.)

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	9.0-11.0
Co	Balance
Cr	19.0-21.0
W	14.0-16.0
Fe	3.0 max.
C	0.05-0.15
Si	1.0 max.
Mn	1.0-2.0
P	0.030 max.
S	0.030 max,

*Note: This filler metal is also available as a flux-coated electrode for shielded metal arc welding.

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specification, however material supplied to both ASME and MILL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY N155*
AMS 5794
†(AMS 5795D for Flux-Coated Electrode)

Washington Alloy N155 filler metal is designed for MIG, TIG and resistance welding of Multimet® 155 base metal to itself or to nickel base or stainless steel alloys. This filler metal produces weld deposits with excellent oxidation and corrosion resistance in reducing conditions such as weak hydrochloric acid solutions and sulfuric acids. Washington Alloy N155 weld deposits offer excellent resistance to stress up to 1500°F and moderate resistance to stress up to 2000°F. Washington Alloy N155 is most commonly used in the aerospace industry for jet engine parts including tailpipes, afterburner parts, turbine blades, nozzles and combustion chambers

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	19.0-21.0
Co	18.5-21.0
Cr	20.0-22.50
Mo	2.5-3.5
W	2.0-3.0
Fe	Balance
C	0.10 max.
N	0.10-0.20
*Cb	0.75-1.25
Si	1.0 max.
Mn	1.0-2.0
P	0.04 max.
S	0.03 max.

*Includes Tantalum (Ta)

*Note: This filler metal is also available as a flux-coated electrode for shielded metal arc welding.

WASHINGTON ALLOY 188
AMS 5801

Washington Alloy 188 is a cobalt base filler metal used for MIG, TIG and resistance welding of Haynes® No. 188 base metal to itself or to nickel base or stainless steel alloys. The weld deposits of this filler metal exhibit high temperature strength and post aging ductility at temperatures up to 2100°F. Excellent oxi¬dation resistance is provided by the addition of lanthanum (La) to the filler metal analysis.
Washington Alloy 188 is most commonly used for gas turbines, airframes, chemical environments and nuclear applications. Also used to weld transition ducts, flame holders, combustion cans and liners in jet engines

TYPICAL FILLER METAL CHEMISTRY (%)

Co	Balance
Cr	20.0-24.0
Ni	20.0-24.0
W	13.0-16.0
Fe	3.0 max.
C	0.05-0.15
Si	0.20-0.50
Mn	1.25 max.
La	0.3-0.15
P	0.02 max.
S	0.015 max.

WASHINGTON ALLOY B-2
AWS A5.14 Class ERNiMo-7
UNS N10665

Washington Alloy B-2 is a nickel-molybdenum filler metal used for MIG and TIG welding of Hastelloy® B-2 to itself, to steel or to other nickel-base alloys. The weld deposits of this filler metal exhibit excellent corrosion resistance to many chemicals, with particularly high resistance to hydrochloric acids at all concentrations and temperatures, to aluminum chloride catalysts and other reducing chemicals. Washington Alloy B-2 offers excellent resistance to pitting and stress corrosion cracking commonly caused by sulphuric, acetic, phosphoric and hydrochloric acids. Oxidation resistance to 1500°F and usable strength up to 2000°F.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
Mo	26.0-30.0
C	0.02 max.
Mn	1.0 max.
Fe	2.0 max.
Cu	0.50 max.
Si	0.10 max.
Co	1.0 max.
Cr	1.0 max.
W	1.0 max.
P	0.04 max.
S	0.03 max.
Others (total)	0.50 max.

MINIMUM MECHANICAL PROPERTIES (as welded).

Tensile strength (psi).....110,000 min.
Elongation in 2" (%).....55 min.

† Washington Alloy Nickel-Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specification, however material supplied to both ASME and MILL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based and Cobalt-Based Alloy MIG, TIG & Subarc Wires

WASHINGTON ALLOY C22®
AWS A5.14 Class ERNiCrMo-10
UNS N06022

DESCRIPTION

Washington Alloy C22® is a nickel chromium molybdenum alloy wire designed for joining Hastelloy® C22®, 625, 825 or combinations of these alloys, or other Ni-Cr-Mo alloys to themselves or to stainless steels. Washington Alloy C22® is equivalent to Hastelly® C22® and is also used extensively for overlays and cladding of lower alloy steels. Washington Alloy C22® weld deposits offer better overall resistance to weld metal corrosion than most other Ni-Cr-Mo alloys such as C276, C4 and 625. Washington Alloy C22® has outstanding resistance to pitting, crevice corrosion and stress-corrosion cracking. This alloy is used in chemical processing application involving ferric and cupric and inorganic, chlorine formic and acetic acids, acetic anhydride, sea water, and brine solutions.

TYPICAL FILLER METAL CHEMISTRY (%)

Cr	20.0-22.5
Mo	12.5-14.5
Fe	2.0-6.0
W	2.5-3.5
Cu	0.500 max.
V	0.350 max.
Co	2.500 max.
C	0.015 max.
Mn	0.500 max.
Si	0.080 max.
Ni	Balance

TYPICAL MECHANICAL PROPERTIES (as welded)

Yield point (psi).....76,500
Tensile strength (psi).....113,000
Elongation in 2” (%).....47

Hastelloy® and C22® are registered trademarks of Haynes International

WASHINGTON ALLOY G30®
AWS A5.14 Class ERNiCrMo-11
UNS N06030

DESCRIPTION

Washington Alloy G30® is equivalent to Hastelly® G30® and is designed for welding alloys of similar composition (G30) including alloys G and G3. Washington Alloy G30 is commonly used for joining, overlaying and cladding of low alloy steels, carbon steels, stainless steels and nickel alloys in parts exposed to phosphoric acid in various solutions, and many other environments containing highly oxidizing acids. Applications include welding and cladding of processing equipment for nuclear fuel re-processing, nuclear waste reprocessing, pesticide and fertilizer manufacturing.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	Balance
Cr	28.0-31.5
Fe	13.0-17.0
Co	5.000 max.
Mo	4.0-6.0
W	1.5-4.0
Cu	1.0-2.4
Cb+Ta	0.3-1.5
C	0.030 max.
Mn	1.500 max.
Si	0.800 max.

TYPICAL MECHANICAL PROPERTIES (as welded)

Yield point-2% offset (psi).....68,000
Tensile strength (psi).....102,000
Elongation in 2” (%).....36

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WASHINGTON ALLOY 69 (X750)
AWS A5.14 Class ERNiCrFe-8
UNS N07069 AMS 5778

DESCRIPTION

Washington Alloy 69 (X750) is a special purpose age-hardening nickel-chromium-iron alloy wire with the addition of 2-1/2% titanium for higher strength at temperatures in the 1600°F range. Washington Alloy 69 (X750) weld deposits exhibit excellent resistance to oxidizing combustion gases at these high temperatures, making this alloy suitable for welding jet engine turbine and aircraft parts such as the turbine blades and aircraft parts such as the turbine blades and vanes, turbine disks and turbine springs. This alloy steels and for welding of lower alloy steels clad with Ni-Cr-Fe alloys.

TYPICAL FILLER METAL CHEMISTRY (%)

Ni	70.0 min.
Cr	14.0-17.0
Fe	5.0-9.0
Ti	2.0-2.75
Cb+Ta	0.70-1.20
Al	0.40-1.0
C	0.080 max
Mn	1.000 max.
Si	0.500 max.
Cu	0.500 max.

TYPICAL MECHANICAL PROPERTIES (as welded)

Yield point-2% offset (psi).....90,000
Tensile strength (psi).....125,000
Elongation in 2” (%).....5
Age Hardening.....1950°F/2 hrs., air cooled followed by 1300°F/20 hrs., air cooled

WASHINGTON ALLOY A-286
AMS 5804 UNS S30815

DESCRIPTION

Washington Alloy A-286 is a nickel-chromium-molybdenum-titanium-vanadium-boron super alloy that produces a dense, fine-grained structure with excellent resistance to heat and corrosion. Washington Alloy A-286 is designed to weld sheet, plate, and tubes of similar chemistry (15 Cr, 25.5 Ni, 1.2 Mo, 2.1 Ti, 0.30 V, 0.006 B). Washington Alloy A-286 responds to solution heat treatment and is used extensively for fabricating military jet engine exhaust systems, marine propulsion systems and rebuilding turbine shafts.

TYPICAL FILLER METAL CHEMISTRY (%)

C	0.08 max.
Mn	2.00 max
Si	1.00 max.
Cr	13.0-16.0
Mo	1.00-1.50
Ni	24.0-27.0
Ti	1.90-2.30
V	0.10-0.50
B	0.001-0.10

TYPICAL MECHANICAL PROPERTIES (as welded)

Yield point-2% offset (psi).....90,000
Tensile strength (psi).....122,000
Elongation in 2” (%).....30
Hardness (BHN).....200

Guide to Available AMS Alloys

AMS#	GRADE	MIL-R-5031B CLASS		AMS#	GRADE	MIL-R-5031B CLASS
4182	5056 Aluminum			5698	Inco® X-750	
4184	4145 Aluminum			5774	AM350	
4185	4047 Aluminum			5776	410 Stainless Steel	
4190	4043 Aluminum			5778	Inco®69	14
4191	2319 Aluminum			5780	AM355	
4395	AZ92A Magnesium			5782	19-9W M0(349)	6
4396	EZ33A Magnesium			5784	29CR-9NI (312)	
4701	Copper Annealed			5786	Hastelloy®W	12
4730	Monel® 400			5787	Hastelloy®W coated	
4951	Commercial Pure Titanium			5789	Stellite® 31	
4953	5AL2.5 SN Titanium			5794	N-155	9
4954	6AL4V Titanium Standard			5796	L-605	13
4955	8AL-1MO-1V Titanium			5798	Hastelloy® X	
4956	6AL4V Titanium ELI			5799	Hastelloy® X coated	
5555	Nickel 205			5800	Rene 41®	
5621	420			5801	Haynes® 188	
5660	Incoloy®901			5804	A-286 Standard	
5675	Inco®92			5813	WHP 15-7 Standard	
5676	Nichrome V	7		5817	Greek Ascoloy	
5679	Inco©62	8A		5821	410 Stainless Steel Mod	
5680	347 Stainless Steel	5A		5823	Jethete	
5683	Inco®42			5824	17-7PH	
5684	132			5825	17-4PH	
5685	305 Safety Wire			5827	630-15,16	
	HAST-B	10		5828	Waspaloy®	
5687	Inco®600			5832	Inco® 718	
	HAST-C-276	11		5836	82	
5689	321 Stainless Steel			5837	Inco® 625	
5690	316 Stainless Steel	4		5840	PH 1308 MO	
5694	310 Stainless Steel	3		6350	4130	
5697	304 Stainless Steel			6458 6451 6462 6466	17-22-AS 6130 Premium 6130 Standard 502	

† Washington Alloy Nickel Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

NICKEL BASED ALLOY FLUX COATED ELECTRODES

WASHINGTON ALLOY 182
AWS/SFA 5.11 Class ENiCrFe-3
W86182

DESCRIPTION
Washington Alloy 182 is a "General Purpose" nickel-chromium-iron flux-coated electrode used for joining many dissimilar combinations of nickel base alloys, of the nickel chromium type, to themselves or to stainless or mild steels. This electrode will consistently produce x-ray quality and machinable weld deposits. Excellent for welding Inconel® 600 to itself or to carbon steel and stainless steel; or high chromium Incoloy® 800 to nickel-copper Monel® 400 or nickel or nickel base alloy 200. Washington Alloy 182 is also used for joining nickel base alloy 200 to stainless steel and nickel-copper Monel® 400 to carbon steel.

APPLICATIONS
Since Washington Alloy 182 is so versatile, it can be used for countless applications. However more common applications include the chemical or petrochemical industries and the nuclear industry where it is used to weld dissimilar joints between vessels and primary piping. Washington Alloy 182 is often used for welding the clad side of nickel-chromium-iron clad steel and for re-surfacing steel.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	59.0 min.
C	0.10 max.
Mn	5.0-9.5
Fe	10.0 max.
S	0.015 max.
Cu	0.50 max.
Si	1.0 max.
Cr	13.0-17.0
Ti	1.0 max.
*Cb	1.0-2.5
Co	0.12 max.
Others	0.50 max.

*Includes Tantalum (Ta) 0.30 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....80,000 min.
Yield strength (psi).....45,000 min.
Elongation in 2° (%).....30 min.
Avg. Charpy V-notch impact value.....60 ft.-lbs. @ -320°F

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

3/32 (2.4mm).....75-100 amps
1/8 (3.2mm).....100-140 amps
5/32 (4.0mm).....140-180 amps
3/16 (4.8mm).....170-210 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

WASHINGTON ALLOY 112
AWS/SFA5.11 Class ENiCrMo-3
W86112

DESCRIPTION
Washington Alloy 112 is a nickel-chromium-molybdenum flux-coated electrode designed for shielded metal-arc welding of Inconel® 625 or 601, for high strength welds on 9% nickel steels and for overlaying carbon steel. Washington Alloy 112 is also used for joining dissimilar combinations of steels or stainless steels to nickel-iron-chromium alloys such as Incoloy® 800 or 801.

APPLICATION
More common uses of Washington Alloy 112 include the nuclear industry where it is used for pressure vessel superheaters, steam separators and tube plates. This electrode is commonly used in cryogenic installations; chemical and petrochemical applications; and for heat treatment and case hardening indus¬trial furnace parts. More specific uses include joining Inconel® 625, 718, X-750 and 706 to 9% nickel steels; for welding Incoloy® 825 to carbon steel, stainless steel and low alloy steel; for joining Inconel® 625, Monel® K-500, Incoloy® 800 and 825 to Inconel® 706, 718 and X-750; and for joining Incoloy® 825 and 800.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	55.0 min.
C	0.10 max.
Mn	1.0 max.
Fe	7.0 max.
S	0.02 max.
Cr	20.0-23.0
*Cb	3.15-4.15
Mo	8.0-10.0
Si	0.75 max.
Co	0.12 max.
Others	0.50 max.

*Includes Tantalum (Ta)

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....110,000 min.
Yield strength (psi).....60,000 min.
Elongation in 2" (%).....30 min.
Avg. Charpy V-notch impact value.....41 ft.-lbs. @-300°F

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

3/32 (2.4mm).....70-95 amps
1/8 (3.2mm).....100-135amps
5/32 (4.0mm).....130-175 amps
3/16 (4.8mm).....175-210 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

WASHINGTON ALLOY 141
AWS/SFA5.11 Class ENi-1
W82141

DESCRIPTION
Washington Alloy 141 is a high nickel con¬tent flux-coated electrode designed for weld¬ing wrought and cast forms of commercially pure nickel to themselves or to steel. This electrode is commonly used for dissimilar welding applications involving nickel base alloys 200 or 201 to iron base and nickel base alloys. Washington Alloy 141 is excellent for overlaying on steel and for welding the clad side of nickel clad steel.

APPLICATIONS
Typical applications of Washington Alloy 141 would involve the chemical industry, soda fabrication, fatty acid fabrication, vinyl chloride production, sodium metal silicate production and within the paper industry. Washington Alloy 141 should be considered where high resistance to corrosion and high temperatures is required.

TYPICAL WELD METAL CHEMISTRY (%)

*Ni	92.0 min.
C	0.10 max.
Mn	0.75 max.
Fe	0.75 max.
S	0.02 max.
Si	1.25 max.
Ti	1.0-4.0
Al	1.0 max.
Cu	0.25 max.
Others	0.50 max.

Includes Cobalt (Co)

MINIMUM MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....60,000 min.
Yield strength (psi).....30,000 min.
Elongation in 2" (%).....20 min.

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)
3/32 (2.4mm).....65-90 amps
1/8 (3.2mm).....85-130 amps
5/32 (4.0mm).....110-160 amps
3/16 (4.8mm).....170-220 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

† Washington Alloy Nickel Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy Flux Coated Electrodes

WASHINGTON ALLOY 190
AW/SFA5.11 Class ENiCu-7
UNS W84190

DESCRIPTION
Washington Alloy 190 flux-coated elec¬trodes are designed for shielded metal arc welding of nickel-copper Monel® 400 and 404 to themselves and to steel. This electrode is perfect for joining many nickel-copper alloys to copper, copper-nickel, carbon steel and low alloy steel. Washington Alloy 190 is also used for overlaying on steel and for weld¬ing the clad side of joints in steel clad with a nickel-copper alloy.

APPLICATIONS
Washington Alloy 190 is a very popular electrode. Most common uses include elec-troplating and chemical pickling equipment, polyvinylchloride production plants, sea water desalination plants and in waste water treatment plants.

TYPICAL WELD METAL CHEMISTRY (%)

*Ni	62.0-69.0
C	0.15 max.
Mn	4.0 max.
Fe	2.5 max.
S	0.015 max.
Si	1.5 max.
Cu	Balance
Ti	1.0 max.
Al	0.75 max.
P	0.02 max.

*Includes Cobalt (Co)

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....70,000 min.
Yield strength (psi).....30,000 min.
Elongation in 2" (%).....30 min.
Avg. Charpy V-notch impact
impact value.....89 ft.-lbs. @ 68°F

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)
3/32 (2.4mm).....70-90 amps
1/8 (3.2mm).....90-125 amps
5/32 (4.0mm).....110-160 amps
3/16 (4.8mm).....155-185 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

WASHINGTON ALLOY "A"
AWS/SFA5.11 Class ENiCrFe-2
W86133

DESCRIPTION
Washington Alloy "A" is a nickel-chromium-iron flux-coated electrode designed primarily for shielded metal arc welding of Incoloy® 800 to itself or to 9% nickel steels. This electrode is used for welding a variety of dissimilar wrought or cast forms of carbon steel, austenitic and ferritic stainless steel, and nickel-chromium Inconel® 600 to them¬selves or to each other. Washington Alloy "A" is frequently used for joining Incoloy® 800 to high nickel alloys 200 and 201 or to nickel-copper Monel© 400 and K-500.

APPLICATIONS
Washington Alloy "A" is excellent for over¬laying nickel-chromium alloy on steel. More common applications include the welding of 5% and 9% nickel steel transport or storage tanks used for cryogenic products. The chem¬ical or petrochemical industries use Washington Alloy "A" for many applications such as valve seats and gates, coal gasifica¬tion and wet process desulphurization equipment.

TYPICAL WELD METAL CHEMISTRY (%)

Ml	62.0 min.
C	0.10 max.
Mn	1.0-3.5
Fe	12.0 max.
S	0.02 max.
Si	0.75 max.
Cr	13.0-17.0
Mo	0.5-2.50
*Cb	0.5-3.0
Co	0.12 max.

'Includes Tantalum (Ta) 0.30 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....80,000 min.
Yield strength (psi).....40,000 min.
Elongation in 2" (%).....30 min.
Avg. Charpy V-notch impact
value.....60 ft.-lbs. @-320°F

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)
3/32 (2.4mm).....70-90 amps
1/8 (3.2mm).....100-135 amps
5/32 (4.0mm).....130-180 amps
3/16 (4.8mm).....190-220 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

WASHINGTON ALLOY FC-276
AWS/SFA5.11 Class ENiCrMo-4
UNS W80276

DESCRIPTION
Washington Alloy FC-276 is a flux-coated electrode designed for welding low carbon nickel-chromium-molybdenum Hastelloy® C and Hastelloy® C-276 to themselves or to stainless steel or nickel base alloys. This elec-trode offers excellent resistance to pitting, stress-corrosion cracking and oxidizing up to 1900°F. Washington Alloy FC-276 is used for welding the clad side of joints in steel clad with low carbon nickel-chromium-molybde¬num alloys.

APPLICATIONS
This highly versatile corrosion-resistant electrode is most commonly used in chemical process applications such as ferric and cupric chlorides, solvents, chlorine, sea water and brine solutions, acetic acids, mineral acids and wet chlorine gas.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	Balance
C	0.02 max.
Mn	1.0 max.
Fe	4.0-7.0
S	0.03 max.
Cu	0.50 max.
P	0.04 max.
Cr	14.5-16.5
Mo	15.0-17.0
W	3.0-4.5
V	0.35 max.
Co	2.5 max.
Si	0.20 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....100,000
Elongation in 2" (%).....25

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)
3/32 (2.4mm).....60-80 amps
1/8 (3.2mm).....80-110 amps
5/32 (4.0mm).....105-135 amps
3/16 (4.8mm).....125-165 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

† Washington Alloy Nickel Based and Cobalt-Based Alloys can he certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of Inquiry.

Nickel-Based Alloy Flux Coated Electrodes

WASHINGTON ALLOY 187
AWS/SFA5.6 Class ECuNi

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 Monel® 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 (%)

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

*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

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 PROCEDURES
Flat, horizontal, vertical, overhead.

WASHINGTON ALLOY 117
AWS A5.11 Class ENiCrCoMo-1
UNS W86117

DESCRIPTION
Washington Alloy 117 is a nickel-chromi¬um-cobalt-molybdenum flux-coated electrode designed for shielded metal-arc welding of Inconel® 617 to itself or to dissimilar metals such as Inconel® 600, 601 and Incoloy® 800 HT. The weld deposits of Washington Alloy 117 have excellent mechanical stability, oxidation and corrosion resistance as well as good stress rupture properties at temperatures above 1500°F up to 2100°F.

APPLICATIONS
Washington Alloy 117 is commonly used to weld cast alloys such as HK-40, HP and HP-45 modified. Excellent for joining Inconel® 617 to steel in high temperature applications. Washington Alloy 117 is used in the aerospace industry for engine components, after-burners, turbine seals; heat-treating equipment and many other high temperature ser¬vice applications.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	Balance
Cr	21.0-26.0
Mo	8.0-10.0
Cu	0.50 max.
Fe	5.0 max.
*Cb	1.0 max.
C	0.05-0.15
Mn	0.30-2.50
P	0.03 max.
S	0.015 max.
Si	0.75 max.
Co	9.0-15.0
Other (totals)	0.50 max.

*Includes Tantalum (Ta)

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....90,000 min.
Elongation in 2" (%).....25 min.

AVAILABLE SIZES AND OPERATING RANGES (DCELECTRODE POSITIVE)
3/32 (2.4mm).....60-80 amps 22-24 volts
1/8 (3.2mm).....80-110 amps 22-24 volts
5/32 (4.0mm).....105-135 amps 23-25 volts
3/16 (4.8mm).....125-165 amps 24-26 volts

WELDING PROCEDURES
All positions for 3/32 and 1/8.
5/32 and 3/16 for flat position only.

WASHINGTON ALLOY 132
AWS/SFA5.11 Class ENiCrFe-1
†AMS 5684

DESCRIPTION
Washington Alloy 132 is a nickel-chromium-iron flux-coated electrode designed primarily for welding Inconel® 600 and Incoloy® 825. Common ASTM base metals that can be joined are ASTM B163, B166, B167 and B168.

APPLICATIONS
Washington Alloy 132 offers corrosion resistance over a wide range of environments ranging from cryogenic temperatures to approximately 1500°F (820°C). This allows Washington Alloy 132 to be used in the chemical and food processing industries as well as for heat exchangers and evaporators. The most common use of this electrode would be for welding the clad side of joints in steel clad with Inconel® 600 and for surfacing steel.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	62.0 min.
C	0.08 max.
Mn	3.5 max.
Fe	11.0 max.
S	0.015 max.
Si	0.75 max.
Cr	13.0-17.0
Cu	0.50 max.
*Cb	1.5-4.0
P	0.03 max.

*Includes Tantalum (Ta): 0.30 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile strength (psi).....80,000 min.
Yield strength (psi).....40,000 min.
Elongation in 2" (%).....30 min.

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)
3/32 (2.4mm).....70-90 amps
1/8 (3.2mm).....100-135 amps
5/32 (4.0mm).....130-135 amps
3/16 (4.8mm).....190-220 amps

WELDING PROCEDURES
Flat, horizontal, vertical, overhead.

† Washington Alloy Nickel Based and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. II is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

Nickel-Based Alloy Flux Coated Electrodes

WASHINGTON ALLOY 135

DESCRIPTION

Washington Alloy 135 is a nickel-iron-chromium flux-coated electrode used primarily for welding Incoloy® 825 to itself or to other similar base metals such as nickel-iron-chromium-molybdenum-copper alloys.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	35.0-40.0
C	0.08 max.
Mn	1.25-2.50
Fe	Balance
S	0.03 max.
Si	0.75 max.
Cu	1.0-2.50
Cr	26.5-30.5
Mn	2.75-4.50
P	0.03 max.
Others (total)	0.50 max.

MINIMUM MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....85,000.
Elongation in 2* (%).....30.

WASHINGTON ALLOY "B"

AWS/SFA5.11 Class ENiCrFe-4
UNS W86134

DESCRIPTION

Washington Alloy "B" is a nickel-chromium-iron flux-coated electrode very similar to Washington Alloy "A", however Washington Alloy "B" offers two distinct features that are not available with Washington Alloy "A". Washington Alloy "B" offers a higher yield and tensile strength and it is formulated to operate with AC current, a feature that will allow Washington Alloy "B" to combat magnetic arc blow.

APPLICATIONS

Washington Alloy "B" is designed for shielded metal arc welding of 9% nickel steel such as ASTM A333, A334, A353, A522 and A553. However it can also be used for joining Incoloy® 800 to itself or to high nickel alloys 200 and 201. For joining Incoloy® 800 to 9% nickel steels or to nickel-copper Monel® 400 and K-500.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	60.0 min
C	0.20 max.
Mn	1.0-3.5
Fe	12.0 max.
S	0.02 max.
Si	1.0 max.
Cr	13.0-17.0
Mo	1.0-3.5
*Cb	1.0-3.5
Cu	0.50 max.

Includes Tantalum (Ta): 0.30 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....95,000 min.
Elongation in 2" (%).....20 min.

AVAILABLE SIZES AND OPERATING RANGES (AC/DC+ ELECTRODE POSITIVE)

3/32 (2.4mm).....70-90 amps
1/8 (3.2mm).....100-135 amps
5/32 (4.0mm).....130-180 amps
3/16 (4.8mm).....190-220 amps

WELDING PROCEDURES

Flat, horizontal, vertical, overhead.

WASHINGTON ALLOY B-2 FC

AWS/SFA5.11 Class ENiMo-7
UNS W80665

DESCRIPTION

Washington Alloy B-2 FC is a nickel-molybdenum flux-coated electrode developed specifically for welding similar base metals such as Hastelloy® B-2 to itself or to steel and nickel alloys. Common base metals that can also be welded would include ASTM B333, B335, B619, B622 and B626 all of which have UNS number N10665. Washington Alloy B-2 has a controlled low level of carbon, iron and cobalt which together with the nickel and molybdenum gives this electrode excellent resistance to pitting and stress corrosion cracking commonly caused by acids. AP

PLICATIONS

The most common application of Washington Alloy B-2 would be in the chemical processing industries on parts exposed to all concentrations and temperatures of hydrochloric acid. It is also used on parts subjected to sulphuric, phosphoric and acetic acids. Washington Alloy B-2 should not be used in the presence of cupric or ferric salts which may develop where iron or copper bearing alloys have come in contact with acids.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	Balance
Mo	26.0-30.0
C	0.02 max.
Mn	1.75 max.
Fe	2.25 max.
Si	0.2 max.
Co	1.0 max.
Cr	1.0 max.
W	1.0 max.
P	0.04 max.
S	0.030 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile strength (psi).....100,000 min.
Hardness.....Rockwell B-98 avg.
Elongation in 2" (%).....25 min.

AVAILABLE SIZES AND OPERATING RANGES (DC ELECTRODE POSITIVE)

3/32 (2.4mm).....60-80 amps 22-24 volts
1/8 (3.2mm).....80-110 amps 22-24 volts
5/32 (4.0mm).....105-135 amps 23-25 volts
3/16 (4.8mm).....125-165 amps 24-26 volts

WELDING PROCEDURES

Flat position only.

† Washington Alloy Nickel Based and Cobalt-Based Alloys can he certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification require¬ments at the time of inquiry.

Nickel-Based Alloy Flux Coated Electrodes

WASHINGTON ALLOY X FC
AWS/SFA5.11 Class ENiCrMo-2
AMS 5799 UNS W86002

DESCRIPTION
Washington Alloy X FC is a nickel-chromium-molybdenum electrode developed for shielded metal-arc welding of similar base metals such a Hastelloy® X to themselves or to stainless steels, carbon steels and low alloy steels. Washington Alloy X FC offers an exceptional combination of oxidation, corrosion and thermal shock resistance. This electrode exhibits high temperature strength and prevents weld metal fatigue at temperature as high as 1100ºF

APPLICATIONS
Washington Alloy X FC is commonly used in the chemical process industry for retorts, muffles, catalyst support grids, furnace baffles. It is also used for engine tailpipes, turbine blades, afterburner components, nozzle vanes, cabin heaters and other aircraft related parts.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	Balance
Cr	20.5-23.0
Mo	8.0-10.0
W	0.20-1.0
P	0.04 max.
Si	1.0 max.
Co	0.50-2.50
Fe	17.0-20.0
Mn	1.0 max.
C	0.05-0.15
S	0.03 max.
Cu	0.50 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)

Tensile Strength (psi).....95,000 min.
Rockwell hardness.....B 92 avg.
Elongation in 2" (%).....20

AVAILABLE SIZES AND OPERATING RANGES (DC+ELECTRODE POSITIVE)
3/32 (2.4 mm).....60-80 amps 22-24 volts
1/8 (3.2 mm)….....80-110 amps 22-24 volts
5/32 (4.0 mm)….....105-135 amps 23-25 volts
3/16 (4.8 mm)….....125-165 amps 24-26 volts

WELDING PROCEDURES
Flat position only.

WASHINGTON ALLOY W FC
AWS/SFA5.11 Class ENiMo-3
AMS 5787

DESCRIPTION
Washington Alloy W FC is a nickel-molybdenum flux-coated electrode designed specifically for welding Hastelloy® W it itself or to a variety of other alloys used in high temperature service applications. Washington Alloy WFC is excellent for joining dissimilar combinations of cobalt, nickel and iron-base alloys.

APPLICATIONS
Washington Alloy W FC is most commonly used for jet engine repair and maintenance, gas turbine parts and rotor hubs. This electrode will provide good mechanical properties up to 1800ºF, however it does exhibit poor oxidation resistance above 1400ºF and it should not be used for service applications in excess of 750 hours.

TYPICAL WELD META CHEMISTRY (%)

Ni	Balance
Mo	23.0-27.0
Cr	2.5-5.5
Fe	4.0-7.0
Si	1.0 max.
W	1.0 max.
C	0.12 max.
Mn	1.0 max.
P	0.04 max.
S	0.03 max
Co	2.5 max.
V	0.60 max.
Cu	0.50 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile Strength (psi).....100,000 min.
Elongation in 2" (%).....25 min.

AVAILABLE SIZED AND OPERATING RANGES (DC+ELECTRODE POSITIVE)
3/32 (2.4 mm)….....60-80 amps 22-24 volts
1/8 (3.2 mm)….....80-110 amps 22-24 volts
5/32 (4.0 mm)….....105-135 amps 23-25 volts
3/16 (4.8 mm)….....125-165 amps 24-26 volts

WELDING PROCEDURES
Flat position only.

WASHINGTON ALLOY C22®
AWS A5.11 Class ENiCrMo-10
UNS W86022

DESCRIPTION
Washington Alloy C22® coated electrodes have excellent dissimilar welding characteristics when joining various combinations of alloys C22, 625, 825 and many other nickel-chromium-molybdenum and stainless steel alloys. Commonly used for overlay work and for cladding of steel, Washington Alloy C22 weld deposits offer better overall resistance to weld metal corrosion than other nickel-chromium-molybdenum alloys, such as C276, C4 and 625. Outstanding resistance to pitting, crevice-corrosion and stress-corrosion cracking.

APPLICATIONS
Washington Alloy C22® coated electrodes are commonly used in applications involving ferric and cupric chlorides, hot contaminated media-both organic and inorganic, chlorine, formic and acetic acids, acetic anhydride, sea-water, brine solutions and many other chemical-processing applications.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	Balance
Cr	20.0-22.5
Mo	12.5-14.5
Fe	2.0-6.0
W	2.5-3.5
Co	2.5 max.
C	0.02 max
Mn	1.0 max
Si	0.2 max.
Cu	0.5 max
V	0.35 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile Strength (psi).....115,000
Elongation in 2" (%).....40
Hardness, Rb.....100

AVAILABLE SIZES AND OPERATING RANGES (DCEP) (DC+)
3/32 (2.4mm).....50-75 amps
1/8 (3.2mm).....75-100 amps
5/32 (4.0mm).....80-140 amps
3/16 (4.8mm).....125-150 amps
C-22® trademark of Haynes International

† Washington Alloy Nickel Base and Cobalt-Based Alloys can be certified to most commercial and aircraft specifications, however material supplied to both ASME and MIL specifications are considered non-standard and must be tested to the applicable specification. Such testing will necessitate additional charges to the buyer. It is the responsibility of the buyer to state these ASME or MIL specification requirements at the time of inquiry.

WASHINGTON ALLOY G30®
AWS A5.11 Class ENiCrMo-11
UNS W86030

DESCRIPTION
Washington Alloy G30® coated electrodes are used for welding alloys of similar composition (G30) including predecessor alloys G and G3, which G30® replaced. Washington Alloy G30® is commonly used for overlaying on steel and various dissimilar combinations of low alloy steel, carbon steel, stainless and nickel alloys in parts exposed to phosphoric, sulfuric, various nitric acid solutions and many other environments containing highly oxidizing acids.

APPLICATIONS
Washington Alloy G30® coated electrodes are commonly found being used in various acid service applications, nuclear fuel reprocessing, nuclear waste reprocessing, pesticide and fertilizer producers.

TYPICAL WELD METAL CHEMISTRY (%)

Ni	Balance
Cr	28.0-31.5
Fe	13.0-17.0
Co	5.0 max.
Mo	4.0-6.0
W	1.5-4.0
Cu	1.0-2.4
Cb+Ta	0.3-1.5
C	0.03 max.
Mn	1.5 max.
Si	1.0 max.

TYPICAL MECHANICAL PROPERTIES OF WELD DEPOSIT (as welded)
Tensile Strength (psi).....85,000 min.
Elongation in 2” (%).....25 min

AVAILABLE SIZES AND OPERATING RANGES (DC+ELECTRODE POSITIVE)
3/32 (2.4 mm).....40-65 amps
1/8 (3.2mm).....6.-90 amps
5/32 (4.0mm).....90-125 amps
3/16 (4.8 mm).....125-160 amps
G30® is a trademark of Haynes International

SPECIAL PURPOSE ELECTRODES

ARMORWELD 307

AC/DC ± (Straight or Reverse Polarity)
A 19% Chrome/9% Nickel Flux-coated Electrode

APPLICATION

Armorweld 307 is designed to produce moderate strength-crack resistant weld deposits in armor plate and between dissimilar steels such as 14% manganese steel to carbon steel forgings or castings. THE PERFECT ELECTRODE TO USE ON "DIFFICULT TO WELD STEELS." Excellent for joining wear resistant steel plates of high tensile strength, for welding stainless steel to carbon steel and for building up rails. Commonly used in mining and dredging equipment as well as within steel manufacturing facilities.

FEATURES

Armorweld 307 deposits offer excellent toughness and corrosion resistance. Weld deposits remain crack-resistant without any preheat or postheat treatment. Heat resistance up to 1460°F. Impact properties remain strong down to -150°F. Weld deposits are non-magnetic and they are machinable in the "as-welded" condition, however Armorweld 307 deposits do work-harden (up to RC52) when put into service. Beautiful welds with AC current!

TYPICAL WELD METAL CHEMISTRY (%)

Hardness (as welded).....200 HB
Hardness (work-hardened).....500 HB
Tensile Strength.....93,000 psi
Yield Strength.....68,000 psi
Elongation in 2".....40%

AVAILABLE SIZES AND RECOMMENDED AMPERAGE

3/32 (2.4 mm).....65-70 Amps
1/8 (3.2 mm).....95-120 Amps
5/32 (4.0 mm).....110-160 Amps
3/16 (4.8 mm).....150-190 Amps

*TENSILEWELD

APPLICATIONS

Tensileweld is the ultimate AC-DC electrode to use where high strength and porosity-free welds are required. Weld deposits are impact, abrasion, heat and corrosion resistant. Tensileweld is especially formulated to weld dissimilar steels; high carbon, tool and die steels; stainless steels; spring and coil steels; pressure vessels and aircraft steels. It is the perfect electrode to use where the alloy content of the base metal is unknown. Typical applications would include the underlayment of hardfacing alloys in mining applications, rebuilding shafts and agitator blades in turbines, framed, cast steel parts and gears.

PROCEDURES

Clean the work area. Thick sections should be beveled. A preheat of 400ºF is recommended for carbon and cast steels. AC or DC reverse polarity is used. Maintain a short arc, slightly inclined in the direction of movement and use stringer beads. Peening is recommended.

CHARACTERISTICS

Tensileweld has a high deposition rate. Weld deposits are smooth, ductile, porosity-free and take on a shiny appearance.

TYPICAL WELD META CHEMISTRY (%)

Tensile strength.....Up to 120,000 psi
Yield strength.....Up to 90,000 [so
Elongation in 2".....Up to 30%
Hardness.....200 Brinell

RECOMMENDED AMPERAGE (AC OR DC+)

Size	3/32	1/8	5/32	3/16
Amp.	40-90	75-125	100-150	140-240

PACKAGING.

6-10 lb. tubes in 60 lb. master carton.

*Also available in 36" straightened and cut lengths for TIG applications.

ALUMINUM 345

Extruded Maintenance & Repair Electrode
AWS/SFA 5.3 E4043 DC+ (Reverse Polarity)
UNS A94043

DESCRIPTION AND APPLICATIONS

An extruded aluminum electrode used for low temperature production and maintenance welding of cast and wrought aluminum sheets, plates, castings and extrusions.

Typical applications include tanks, pipes, appliances, refrigeration equipment, irrigation equipment, automobile parts and parts found in the laundry, chemical and food processing industries.

An all position electrode that produces dense and porosity-free machinable weld deposits. Color match and corrosion resistance of the weld deposit is excellent. Tensile strength is approximately 34,000 psi.

PROCEDURES

Clean the area to be welded. Large or heavy sections should be beveled to a 60 or 75 vee. Align the parts to be welded by tacking the joint(s). Preheating the larger sections to 350ºF will allow for a flatter bead as well as reducing the required amperage. Using DC+ reverse polarity, maintain a short arc length while tilting the electrode in the direction of travel. The weaving technique is not recommended because of the faster travel speed required when welding aluminum. Allow the part to cool, then remove all slag before making multiple passes. You may want to use a stainless steel wire brush and warm water to remove any flux residue. Many times a 10% sulphuric acid solution is used in the warm water. This will give the weld deposit a cleaner, more polished appearance.

SIZE	RECOMMENDE AMPERAGE (DC+)
3/32" (2.4 mm) × 14" (350 mm)	50-85 amps
1/82" (3.2 mm) × 14" (350 mm)	85-140 amps
5/32" (4.0 mm) × 14" (350 mm)	110-165 amps

PACKAGING

5 lb. tubes / 30 lb. master cartons or 1 lb. mini-paks.

SPECIAL PURPOSE ELECTRODES

USA CHAMFER ROD
AC/DC- (Straight Polarity)

APPLICATION
USA Chamfer Rods are used for gouging, beveling and veeing out of excess metal in ferrous and nonferrous materials. This rod is most commonly used for removing old weld metal and sharp edges prior to subsequent welding operation. USA Chamfer Rods may be used with little or no oxygen/air present.

PROCEDURES AND CHARACTERISTICS
USA Chamfer Rods may be used with either AC or DC (straight polarity) on any welding machine. Use the recommended amperage and hold the electrode at t low angle, pushing it rapidly forward, while applying slight pressure on the work. One pass will produce a clean groove, removing material equal to the diameter of the chamfer rod. Deeper grooves may be obtained by making multiple passes. USA Chamfer Rods produce a “blowing action” which removes all unwanted material (including dirt, grease, oil, etc.) from the base metal. It requires no gases or special equipment such as air compressors.

RECOMMENDE AMPERAGE (AC OR DC-)

Size	3/32	1/8	5/32	3/16
Amp.	120	170	230	350

PACKAGING
All sizes are packaged in 50 lb. cartons.

USA CUTROD

APPLICATIONS
USA Cutrod is a fast-working electrode used for cutting and piercing all metals including austenitic steels and cast iron. This electrode is frequently used for removing rivets and bolts, enlarging openings, trimming metals, etc.

PROCEDURES AND CHARACTERISTICS
USA Cutrod may be used with AC or DC (straight polarity) on most welding machines. Using the recommended amperage, hold the electrode at a 45° angle, strike the arc and use a “sawing” technique to cut through the base metal. Be sure to keep the arc gap as short as possible. To pierce holes, simply hold the electrode vertical, strike the arc and push through the base metal, removing the electrode immediately once the hole is made. The size of the hole may be increased by moving the electrode in a circular motion. USA Cutrod does not require gases or special equipment such as air compressors.

RECOMMENDED AMPERAGE (AC OR DC-)

Size	3/32	1/8	5/32	3/16
Amp.	120	170	230	300

PACKAGING
All sizes are packaged in 50 lb. cartons.

ALU-ZINC

DESCRIPTION AND APPLICATIONS
For repair of zinc-based metals, pot metal, white metals and aluminum.

Washington Alloy Alu-Zinc is a self-fluxing, low temperature joining alloy that can be used with oxy-acetylene or the TIG process, using argon as the shielding gas and AC (high frequency). It is excellent to use for new fabrication, maintenance or repair work. Flux is not necessary on accessible joints.

Common uses include: aluminum windows, doors, furniture, boats, engine heads, motor housings, power mowers, farm and dairy equipment, blocks and crankcases, vacuum cleaners, carburetors, gears and pumps, jigs and fixtures, dies and matchplates, trophies and ornaments, models and patterns, antique car parts and Kirksite dies.

PROCEDURES
Remove all dirt, plating, scale or oxides from the metal surface. Preheat to 400°F+/-. Then turn the torch at an angle, using the side of the flame to continue the heat build-up, making sure that both sides of the joint are the same temperature. Begin to touch the rod to the joint area. Continue the heat build-up until the rod begins to flow, which should be around 730°-740°F. As the rod flows into the joint, make sure to use the rod end to break up any surface skin that will most likely develop. Use a circular motion or a dipping motion to firmly rub the rod into the joint. Failing to do so may prevent the fusion of the base metal and the filler metal. After the joint is repaired, allow the part to cool at room temperature. Do now quench.

Clean up: After the repair has cooled, use a stainless steel brush or warm water to remove any surface residue. The clean, dry joint can now be plated or painted to match the original finish.

SPECIFICATIONS
Elastic Limit.....33,000 psi
Tensile Strength.....39,000 psi
Brinnel-500 kg load.....100
Melting range.....715 -735 F

PACKAGING
Available sizes: 1/8×18 — 5 lb. tubes.

USA FLUXCORED ALUMINUM
Tubular Torch Alloy

APPLICATIONS
An all-position, oxyacetylene welding or brazing rod used in repairing broken or cracked aluminum extrusions or castings. Typical applications would include building-up machinable deposits or worn or broken parts, model work, mold/die changes and thin sheet metal.

CHARACTERISTICS
Fluxcored aluminum is one of the most versatile torch rods. The self-contained flux offers protection from handling and moisture. A broad operating temperature range and excellent color match makes this alloy suitable for many applications. It offers good plasticity, high strength and is readily machinable.

PROCEDURES
Remove any plating, dirt, grease or surface corrosion from the area to be welded or brazed. Sand and clean the weld area thoroughly. The gap to be welded should not exceed 1/8”. Bevel heavy sections to form a 60° to 75° V-notch Using a slightly carburizing flame, heat the work area by keeping the flame 1” to 2” from the weld area. Continue to heat the weld area while occasionally touching the fluxcored aluminum rod to this area under the tourch flame. Do this until small amounts of alloy are deposited and the filler metal starts to flow through the gap of the heated weld area. Be sure that each drop of filler metal flows out and bonds to the base metal, but do not melt the base metal. Allow the weld part to cool and wash away the flux residue with warm water and a stiff brush.

SPECIFICATIONS
Liquidus.....1100ºF
Tensile Strength.....32,000 spi
Color Match.....Good
(Not to be anodized)

PACKAGING
Available sizes: 3/32 ×32, 1/8 × 32, 3/16 × 32; — 2lb. tubes/10 lb. master cartons or 1 lb. mini-packs.

Special Purpose Electrodes

RAINIER 1G AND 1G FC
Torch/Neutral Flame

DESCRIPTION
A general purpose rod for brazing cast iron, steel, copper, brass, bronze and galvanized iron.

APPLICATIONS
Rainier 1G and 1G FC is designed for torch brazing of ferrous and non-ferrous metals such as cast iron, copper alloys and steel to themselves or each other. Galvanized parts can be brazed with no damage to the zinc coating. Excellent for yellow brass and bronze castings. Recommended for “rush jobs” or temporary applications involving dissimilar metals or where rust is present.

FEATURES
The chemical analysis of Rainier 1G and 1G FC is formulated to produce sound, porosity free deposits with a minimum of fuming. Deposits are strong, easily machined and work hardened with use.

SPECIFICATIONS
Tensile strength (psi).....Up to 72,000
Elongation(%).....Up to 26
Brinell hardness.....120
Working temperature.....1450ºF to 1650ºF
Color match.....Good on brass/bronze
Machinability.....Excellent

AVAILABLE SIZES

(in.)	1/ 16	3/32	1/8	5/32	3/16	1/4
(mm)	1.6	2.4	3.2	4.0	4.8	6.0

PACKAGING
1 lb. packs, 5 lb. packs, 10 lb. tubes.

PROCEDURES
Clean joint area. Bevel crack or heavy sections. Utilizing a slightly oxidizing flame, preheat the part to be brazed. Dip Rainier 1G into bronze brazing flux and then back to the joint area. Apply the torch, keeping it in constant motion so as to not overheat the base metal. The molten drops of Rainier 1F (and flux) will follow the heat of the torch flame. Keep adding Rainier 1G (and flux), one molten drop at a time until the joint is filled. When using Rainier 1G FC, additional flux is not required. Removal of flux residue between passes is not necessary. Allow the joint to cool slowly and remove slag with a chipping hammer and wire brush

RAINIER 2G AND 2G FC
Torch/Neutral Flame

DESCRIPTION
High strength — thin flowing brazing rod for all ferrous and non-ferrous metals.

APPLICATIONS
Rainier 2G and 2G FC is used to produce high strength (up to 100,000 psi), wear-resistant deposits on close-fitted joints such as found in sheet metal work. Excellent for repairing small parts as in broken drill bits, attaching carbide tips, repairing mill cutters or radiators. Rainier 2G and 2G FC is commonly used as a replacement alloy for more expensive silver brazing alloys. Other uses include bicycle repairs, furniture, ornamental railings and for joining galvanized and stainless steel parts.

FEATURES
Rainier 2G and 2G FC is an excellent choice for quick inexpensive repair jobs where high strength and crack-resistant joints are needed. Rainier 2G and 2G FC wets out very smooth under relatively low brazing temperatures and solidifies rapidly when the torch is turned away. Deposits are easily machined and work hardened when used. Rainier 2G and 2G FC is also used to build up surfaces.

SPECIFICATIONS
Tensile strength (psi).....Up to 100,000
Elongation(%).....Up to 28
HB hardness.....Up to 220
Working temperature.....1300ºF to 1750ºF
Remelt temperature.....1750ºF (minimum)
Machinability.....Excellent

AVAILABLE SIZES

(in.)	1/ 16	3/32	1/8	5/32	3/16	1/4
(mm)	1.6	2.4	3.2	4.0	4.8	6.0

PACKAGING
1 lb. packs, 5 lb. packs, 10 lb. tubes.

PROCEDURES
Clean joint area. Bevel heavy sections. Thin joints may be brazed without preparation other than usual cleaning. Since Rainier 2G or 2G FC is a thin flowing alloy — a joint clearance of .001” to .003” will maximize the deposit strength. Cover the joint area with No. 2 Flux. Utilizing a slightly oxidizing (neutral) flame, preheat the part to be brazed until the flux is liquefied. Hold Rainier 2G to ht flame cone, adding enough alloy to fill the joint. If the base metal turns red, remove the torch and allow it to cool before proceeding. No. 2 Flux is not required if using Rainier 2G FC. Remove slag with a chipping hammer and wire brush.

COLUMBIA 7G
Meets AWS A5.8 Class BCuP-2
Torch/Neutral Flame, Propane

DESCRIPTION
Self-fluxing, copper to copper brazing rod.

APPLICATION
Columbia 7G is a fast and easy to use phosphorus-copper brazing rod designed for close fitting joints of only .001” to .0015” wide in copper, brass or bronze parts. Excellent for tube and pipe joints in plumbing, air conditioning and refrigeration applications. Also used in the repair of stranded or solid electrical conductors. Columbia 7G is not intended for use on steel or alloys containing more than 30% nickel.

FEATURES
Columbia 7G contains just the proper balance of phosphorus and copper which act as self-fluxing agents and provide for excellent capillary action in tight fitting joints. No special preparation to use, no clean-up problems later. Economy-speed-strength-ductility are the features that make Columbia 7G one of the most widely used brazing alloys.

GENERAL CHEMISTRY

P	7.25
Cu	Balance

SPECIFICATIONS
Tensile strength (psi).....Up to 40,000
Elongation in 2” (%).....19
Melting range.....Solidus 1310 F
Flow Point 1350 F
Liquidus:1460 F

AVAILABLE SIZES

(in.)	.050×1/8	1/16	3/32	1/8
(mm)	1.4×3.2	1.6	2.4	3.2

PACKAGING
1 lb. packs, 5 lb. packs, 10 lb. tubes.

PROCEDURES
Clean the joint area. The joint clearance should not exceed .0015”. Flux in not necessary in copper to copper joint, however flux should be used on brass or bronze. Utilizing a neutral (slightly oxidizing) flame and a large torch tip, preheat the joint area to a dull red color. Apply Columbia 7G by melting off a drop at a time. Remove the torch as soon as the joint is filed. Do not remelt the deposit Clean the deposit with hot water and a stiff brush. A bright copper color can be obtained by dipping the part in a solution of 10% sulfuric acid/90% water. Rinse in hot water.

Special Purpose Electrodes

COLUMBIA 8G
Meets AWS A5.8 Class BCuP-3
Torch/Neutral Flame, Propane

DESCRIPTION
Economical phos-copper-silver brazing alloy.

APPLICATIONS
Columbia 8G is designed for moderately fitted joints of .002”-.003” clearance in copper to copper and copper to brass or bronze. Common applications involve tubing or pipes of copper radiators, air conditioners, refrigerators, plumbing, marine and electrical components. Not to be used on ferrous metals.

FEATURES
Columbia 8G is an economical alternative to 15% silver alloys. The 5% silver content of Columbia 8G allows for a lower brazing temperature and higher ductility. High corrosion and heat resistance. Excellent electrical conductivity. Deposits may be tinned or electroplated by dipping.

GENERAL CHEMISTRY

Ag	5
P	6
Cu	Balance

SPECIFICATIONS
Tensile strength (psi).....Up to 45,000
Elongation in 2” %).....23-25
Melting range.....Solidus 1190^0 F
Flow Point 1350^0 F
Liquidus: 1495^0 F

AVAILABLE SIZES

(in.)	.050×1/8	1/16	3/32	1/8
(mm)	1.4×3.2	1.6	2.4	3.2

PACKAGING:
1 lb. packs, 5 lb. packs, 10 lb. tubes.

PROCEDURES
Clean the joint area. The joint clearance should not exceed .003”. Flux is not necessary in copper to copper joints, however flux should be used on brass or bronze and heavy sections. Utilizing a neutral (slightly oxidizing) flame and a large torch tip, preheat the joint area to a dull red color. Apply Columbia 8G by melting off a drop at a time. Remove the torch as soon as the joint is filled. Do not remelt the deposit. Clean the deposit with hot water and a stiff brush. A bright copper color can be obtained by dipping the part in a solution of 10% sulfuric acid - 90% water. Rinse in hot water.

COLUMBIA 9G
Torch/Neutral Flame, Propane

DESCRIPTION
Phos-copper-silver alloy for poor fit-ups.

APPLICATIONS
Columbia 9G is very similar to Columbia 8G, however it does contain more silver (6%). The increased silver content allows for a slightly lower operating temperature and makes Columbia 9G more suitable for varying or “greater than recommended” clearances of .002”-.003”. Most commonly used in copper to copper and copper to brass or bronze tubing or pipes such as found in radiators, air conditioners, refrigerators, plumbing, marine and electrical components. Not to be used on ferrous metals.

FEATURES
Columbia 9G is basically a more versatile alloy than Columbia 8G. Subsequently Columbia 9G would be the better choice of filler metal. Extremely ductile with high thermal and electrical conductivity. Corrosion resistant. Deposits may be tinned or electroplated by hot dipping.

GENERAL CHEMISTRY

Ag	6
P	6
Cu	Balance

SPECIFICATIONS
Tensile strength (psi).....Up to 45,000
Elongation in 2” (%).....23-25
Melting range.....Solidus 1190 F

AVAILABLE SIZES

(in.)	.050×1/8	1/16	3/32	1/8
(mm)	1.4×3.2	1.6	2.4	3.2

PACKAGING:
1 lb. packs, 5 lb. packs, 10 lb. tubes.

PROCEDURES
Clean the joint area. The joint clearance should not exceed .003”. Flux is not necessary in copper to copper joint, however flux should be used on brass or bronze and heavy sections. Utilizing a neutral (slightly oxidizing) flame and a large touch tip, preheat the joint area to a dull red color. Apply Columbia 9G by milting of a drop at a time. Remove the torch as soon as the joint is filled. Do not remelt the deposit. Clean the deposit with hot water and a stiff brush. A bright copper color can be obtained by dipping the part in a solution of 10% sulfuric acid – 90% water/ Rinse in hot water.

COLUMBIA 10G
Meets AWS A5.8 Class BCuP-6
Torch/Neutral Flame, Propane

DESCRIPTION
All purpose – 15% silver brazing alloy.

APPLICATIONS
Columbia 10G is the most popular and versatile of the phosphorus-copper-silver brazing alloys. In addition to joining copper to copper and copper to brass or bronze, Columbia 10G may also be used to braze silver, tungsten and molybdenum. This alloy is most commonly used in the commercial and domestic plumbing industry where some municipalities require a 15% silver alloy. Other uses include radiators, air conditioners, refrigerators, marine and electrical components. Not recommended for use on steel or alloys containing more than 10% Nickel.

FEATURES
Columbia 10G is excellent on joints with a clearance of .001”-.005”. The higher silver content and lower phosphorus content give Columbia 10G higher ductility and a lower working temperature range. Good vibration and shock resistance. Medium to high tensile strength.

GENERAL CHEMISTRY

Ag	15
P	5
Cu	80

SPECIFICATIONS
Melting range.....Solidus 1190^0 F
Flow Point 1300^0 F
Liquidus: 1475^0 F

AVAILABLE SIZES

(in.)	.050×1/8	1/16	3/32	1/8
(mm)	1.4×3.2	1.6	2.4	3.2

PACKAGING:
1 lb. packs, 5 lb. packs, 10 lb. tubes.

PROCEDURES
Clean the joint area. The joint clearance should not exceed .006”. Flux is not necessary in copper to copper joints, however flux should be used on brass or bronze as well as tungsten and molybdenum applications. Flux should also be used on heavy sections. Utilizing a neutral (slightly oxidizing) flame and a large torch tip, preheat the joint area to a dull red color. Apply Columbia 10G by melting off a drop at a time. Remove the torch as soon as the joint is filled, do not remelt the deposit. Clean the deposit with hot water and a stiff brush. A bright copper color can be obtained by “hot-dipping” the part in a solution of 10% sulfuric acid - 90% water. Rinse in hot water.

Special Purpose Electrodes

COLUMBIA 11G & 11G FC
Torch/Neutral Flame, Propane

DESCRIPTION
High strength silver brazing alloy for ferrous and nonferrous metals.

APPLICATIONS
Columbia 11G is a 35% cadmium free silver alloy designed for general purpose brazing of ferrous and nonferrous metals such as carbon steels, stainless steels, nickel, Monel®, nickel silver, copper, brass and bronze. Commonly used on machine shop small fixtures, instruments and delicate parts. Recommended for electrical, air conditioning, heating and ventilating work.

FEATURES
Columbia 11G has a wide operating range between melting and flow points. This feature creates a sluggish flow. Making Columbia 11G suitable for loose fit-ups and large fillets. Columbia 11G offers high strength and ductility. Excellent on small parts and dissimilar metal combinations. Contains no cadmium. More economical than Columbia 12G.

GENERAL CHEMISTRY

Ag	35
Zn	33
Cu	Balance

SPECIFICATIONS
Tensile strength (psi).....65,000
Melting range.....Solidus 1125^0 F
Liquidus: 1195^0 F
Color (as brazed).....Brassy, yellow brass

AVAILABLE SIZES

(in.)	1/32	3/64	1/16	3/32	1/8
(mm)	0. 8	1.2	1.6	2.4	3.2

PACKAGING:
Coils — all diameters. 18” lengths — 1/16, 3/32, 1/8.

PROCEDURES
Clean the joint area. For maximum strength deposits maintain a joint clearance of not more than .005”. Clamp the parts to maintain alignment. Cover the area thoroughly with silver brazing flux (additional flux is not required when using Columbia 11G FC). Utilizing a neutral (slightly oxidizing) flame, preheat the part broadly until the flux liquifies. Apply Columbia 11G by melting off a drop at a time. Remove the torch as soon as the joint is filled. Do not remelt the deposit. Allow the part to cool slowly then clean the deposit with warm water.

COLUMBIA 12G & 12G FC
Meets AWS A5.8 Class Bag-5
Torch/Carburizing Flame, Propane

DESCRIPTION
Thin flowing silver alloy for ferrous, nonferrous and dissimilar metals.

APPLICATIONS
Columbia 12G is a 45% cadmium free silver alloy used for general purpose brazing of iron, steel, nickel, stainless steel, alloy steel, copper, brass, bronze, dissimilar alloys, silver, etc. Columbia 12G is excellent for tight fitting joints and delicate parts where a thin flowing capillary action is required. Performs well on lap joints, “T” joint, flange joints and butt joints. Ideal on light gauge metal. Not to be used on aluminum, magnesium or zinc die cast.

FEATURES
Columbia 12G offers excellent fluidity and super capillary action on highly alloyed metals. All joints will have superior strength, ductility and nice appearance. Columbia 12G has the lowest working temperature of the silver brazing alloys.

GENERAL CHEMISTRY

Ag	45
Cu	30
Zn	25

SPECIFICATIONS
Tensile strength (psi).....Up to 60,000
Melting range.....Solidus 1225^0 F
Liquidus: 1370^0 F
Color (as brazed).....Yellow white

AVAILABLE SIZES

(in.)	1/32	3/64	1/16	3/32	1/8
(mm)	0.8	1.2	1.6	2.4	3.2

PACKAGING:
Coils — all diameters. 18” length in 1/16, 3/32, 1/8.

PROCEDURES
Clean the joint area. Maximum strength deposits can be obtained by keeping the joint clearance less than .003” wide. Clamp the parts to maintain alignment. Cover the area thoroughly with silver brazing flux Columbia 12G FC). Utilizing a slightly carburizing flame, preheat the part broadly until the flux liquefies. Apply Columbia 12G by melting off a drop at a time. Remove the torch as soon as the joint is filled. Do not remelt the deposit. Allow the part to cool slowly then clean the deposit with warm water.

COLUMBIA 13G & 13G FC
Meets AWS A5.8 Class BAg-7
Torch/Carburizing Flame, Propane

DESCRIPTION
Premium silver brazing rod for delicate steel parts.

APPLICATIONS
Columbia 13G is a cadmium free 56% silver brazing alloy developed primarily for use in the food and dairy industry. Columbia 13G provides high strength joints in ferrous and nonferrous metals such as carbon steels, copper alloys, nickel alloys, stainless steel and high speed steels (where higher brazing temperatures could be damaging to the base metal). Commonly used in tubing instruments and control devices of laboratory apparatus. Do not use on aluminum, magnesium and zinc die cast alloys.

FEATURES
Columbia 13G is a low melting, thin flowing and non-toxic alloy. Deposits will be a close color match on stainless steel. Columbia 13G will minimize stress corrosion on nickel or nickel base alloys at low brazing temperatures. Joints will have the maximum strengths offered by any of the silver brazing alloys. Resists pitting.

GENERAL CHEMISTRY

Ag	56
Cu	22
Zn	17
Sn	5

SPECIFICATIONS
Tensile strength (psi).....Up to 65,000
Melting range.....Solidus 1145^0 F
Liquidus: 1205^0 F
Electrical conductivity.....Good
Color (as brazed).....White

AVAILABLE SIZES

(in.)	1/32	3/64	1/16	3/32	1/8
(mm)	0.8	1.2	1.6	2.4	3.2

PACKAGING:
Coils — all diameters. 18” lengths in 1/16, 3/32, 1/8

PROCEDURES
Clean the joint area. Maximum strength deposits can be obtained by keeping the joint clearance less than .003” wide. Clamp the parts to maintain alignment. Cover the area thoroughly with silver brazing flux (additional flux is not required when using Columbia 13G FC). Utilizing a slightly carburizing flame, preheat the part broadly until the flux liquefies. Apply Columbia 13G by melting off a drop at a time. Remove the torch as soon as the joint is filled. Do not remelt the deposit. Allow the part to cool slowly. Clean the deposit with warm water.

Special Purpose Electrodes

COLUMBIA 14G
Torch, Propane, Soldering Iron Furnace

DESCRIPTION
Acid core, cadmium free-lead free general purpose silver bearing solder.

APPLICATIONS
Columbia 14G is a low temperature silver bearing solder used for joining stainless steel, Monel®, cast iron, nickel, copper, brass and bronze. Columbia 14G is ideal for stainless steel food handling equipment where a good color match and conformance to FDA requirements is necessary. Ideal for electrical work and instrument assembly where higher conductivity (than that offered by lead-tin solders) is required. Common applications include stainless steel tanks, sinks, pipes, tubing and jewelry. Not to be used on aluminum, magnesium or zinc die cast alloys.

FEATURES
Columbia 14G contains no lead, cadmium, zinc or antimony. Deposits are bright and shiny — will not discolor or tarnish. Columbia 14G offers higher tensile strength than lead-tin solders. Deposits are corrosion resistant and can be chrome plated.

SPECIFICATIONS
Tensile strength (psi).....Up to 15,000
Working temperature.....430ºF
Color match.....Good on stainless steel
Corrosion resistance.....Good
Electrical conductility.....Excellent

AVAILABLE SIZES

(in.)	3/64	1/16	3/32	1/8
(mm)	1.2	1.6	2.4	3.2

PACKAGING:
1 lb., 5lb., 20 lb. spools.

PROCEDURES
Clean the joint area. Although Columbia 14G is self-fluxing, the use of additional flux will improve flowing. Heat indirectly with just about any heating method. Keep the torch (or other heating source) in constant motion and back from the workpiece. Melt off the solder and draw through the joint with continued heating. Remove the heating source as soon as the joint is filled and a bright shiny deposit is visible. Allow the part to coop slowly and remove the flux residue with warm water.
Note: use a soft carburizing flame if torch brazing and be sure there is no contamination from other solders if using a soldering iron.

CASCADE 15A
Arc AC/DC+ (Reverse Polarity)
All-Positions

DESCRIPTION
High strength, non-nickel cast iron electrode.

APPLICATIONS
Cascade 15A is the most economical electrode for repairing cast iron parts where machinability of the weld deposit is not required. Commonly used on ornamental iron, gears, motor housings, machine parts, farm equipment and large frames. Excellent for castings impregnated with oil, grease, chemicals and other contaminants.

FEATURES
Cascade 15A performs well in any position. Weld deposits are non-porous and have a tensile strength of approximately 65,000 psi. The weld deposit color will be grey cast iron. Cascade 15A deposits are non-machinable.

SPECIFICATIONS
Tensile strength (psi).....65,000
Yield Strength (psi).....50,000
Brinell hardness.....300
Deposit.....Magnetic
Color match.....Grey cast iron

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
Amps	60-90	90-130	120-160	150-200

PROCEDURES
If possible, clean the joint area. Bevel or gouge out heavy sections. Preheating is not required, however it is useful in relieving stress within the weld deposit in parts greater than ½" thick. Using AC or DC+ (reverse polarity), hold the electrode 15 off vertical tilted toward the direction of travel The arc length should be between 1/8" to 3/16". Use stringer beads or the weaving technique. Holding the arc over the molten deposited metal, follow the pool but do not allow the arc to lead or get ahead of the molten pool. If the part is less than ¼" thick use a 1" bead, ¼: to ½" use a 2" bead, over ½" use a 3" to 4" bead. Extinguish the electrode by whipping the arc back over the deposited mental. Peen the weld deposit with a blunt instrument to relieve stress and prevent the spread of cracks on the part. Re-strike the arc on the previously deposited weld metal. On thin or complex shaped parts use the skip weld technique. Always use an electrode diameter that is small enough to permit at least two passes.

Note: If there is cracking of the part, make stopholes at both ends of the joint. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is strongly recommended.

CASECADE 17A
Arc AC/DC- (Straight Polarity)
All-Position

DESCRIPTION
Fully-machinable cast iron electrode for repair welding of thin sections.

APPLICATIONS
Cascade 17A is a high nickel electrode used for cladding, buildup and joining all grades of cast iron to itself or dissimilar metals such as low alloy and carbon steels, stainless steels, iron, copper, Monel®, etc. Excellent for repairing and "cold welding" cracked or porous thin sections where maximum machinability of the weld deposit is required. Common uses include engine blocks, machinery parts, frames, gears and pulleys.

FEATURES
Cascade 17A is an all-position electrode which produces porosity-free, non-cracking weld deposits that will match the color of cast iron. When properly used, the arc will penetrate through dirt and oil as well as over slag.

SPECIFICATIONS
Tensile strength (psi).....Up to 50,000
Yield strength (psi).....Up to 40,000
Brinell hardness.....Approximately 160
Elongation (%).....Approximately 30
Color match.....Excellent on cast iron

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	80-120	100-140	120-170

PROCEDURES
Clean the work area. Preheating is not required, however it is useful in relieving stresses and to increase machinability of the weld deposit in parts greater than 1/2" thick. 200°F is an acceptable preheat temperature. Using AC or DC- (straight polarity), hold the electrode 15° off vertical tilted toward the direction of travel. The arc length should be between 1/8" to 3/16". Use stringer beads or the weaving technique. Holding the arc over the molten deposited metal, follow the pool but do not allow the arc to lead or get ahead of the molten pool. If the part is less than 1/4" thick use a 1" bead, 1/4" to 1/2" use a 2" bead, over 1/2" use a 3" to 4" bead. Extinguish the electrode by whipping the arc back over the deposited metal. Peen the weld deposit with a blunt instrument to relieve stress and prevent the spread of cracks on the part. Re-strike the arc on the previously deposited weld metal. On thin or complex shaped parts use the skip weld technique. Always use an electrode diameter that is small enough to permit at least two passes.

Note: If there is cracking of the part, make stopholes at both ends of the joint. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is strongly recommended.

Special Purpose Electrodes

CASCADE 17T & 17M
Meets AWS A5.15 Class ERNi-CI
TIG/MIG

DESCRIPTION
High nickel alloy bare wire for TIG or MIG cast iron welding.

APPLICATIONS
Cascade 17T and 17M are the TIG (17T) or MIG (17M) equivalents to Cascade 17A. Developed primarily tor automatic and semi-automatic welding of ductile, malleable or gray cast iron to itself or to dissimilar metals such as low alloy and carbon steel, stainless steel, iron, copper, Monel®, etc. Cascade 17T and 17M are excellent for the buildup of worn parts, repairing machining errors or defective castings where maximum machinability of the deposit is required.

FEATURES
Cascade 17T and 17M can be used in any position. Produces high quality welds with a minimal amount of effort. Weld deposits are strong, dense and fully machinable. Color will match that of cast iron.

SPECIFICATIONS
Tensile strength (psi).....Up to 70,000
Yield strength (psi).....Up to 46,000
Brinell hardness.....150
Elongation (%).....Approximately 12
Reduction of area(%).....Approximately 20

AVAILABLE SIZES

(in.)	.035	.045	1/16	3/32	1/8
(mm)	0.9	1.2	1.6	2.4	3.2

PACKAGING:
10 lb. and 30 lb. spools — .035, .045
1/16. 36" straight lengths — .035, .045, 1/16, 3/32, 1/8.

PROCEDURES
Clean the joint area. Bevel heavy sections. Preheating is not required, however it is useful in relieving stresses and to increase machinability of the weld deposit in parts greater than 1/2" thick. 600°F is an acceptable preheat temperature. Use DC- (straight polarity) with the oscillating technique and DC+ (reverse polarity) with the stringer bead technique. The oscillating technique will produce the lowest weld metal dilution. When using the stringer bead technique, be sure to strike the arc on the edge of previously deposited weld metal. This will reduce dilution. Be sure to use flux. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is recommended.

CASCADE 18A
Arc AC/DC+ (Reverse Polarity)
All-Position

DESCRIPTION
Premium cast iron electrode for heavy sections.

APPLICATIONS
Cascade 18A is for general maintenance welding of cast iron, malleable iron and ductile iron to themselves or dissimilar metals such as wrought alloys or high nickel alloys. Commonly used on motor blocks, gear housings, machine parts and frames. Excellent for filling holes and building up missing or worn heavy sections. Cascade 18A is recommended for "meehanite" and "Ni-Resist" alloys.

FEATURES
Cascade 18A is an all-position electrode that produces machinable, high density and crack-resistant weld deposits. Especially suited for welding dirty, oil-soaked castings of unknown composition.

SPECIFICATIONS
Tensile strength (psi).....Up to 80,000
Yield Strength (psi).....Up to 60,000
Brinell hardness.....Approximately 200
Elongation in 2" (%).....Approximately 20
Color match.....Good

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
Amps	40-70	80-110	100-140	120-170

PROCEDURES
Clean the work area. Preheating is not required, however it is useful in relieving stresses and to increase machinability of the weld deposit in parts greater than ½" thick, 200^0 F is an acceptable preheat temperature. Using AC or DC- (straight polarity), hold the electrode 15 off vertical tilted toward the direction of travel. The arc length should be between 1/8" to 3/16" Use stringer beads or the weaving technique. Holding the arc over the molten deposited metal. Peen the weld deposit with a blunt instrument to relieve stress and prevent the spread of cracks on the part. Re-strike the arc on the previously deposited weld metal. On thin complex shaped parts use the skip weld technique. Always use an electrode diameter that is small enough to permit at least two passes.

Note: If there is cracking of the part, make stopholes at both ends of the joint. Do not let the part become too hot during welding. Remove slag often. Gradual cooling of the weld metal is strongly recommended.

CASECADE 17 ANC
Arc AC/DC- (Straight Polarity)
All-Position

DESCRIPTION
Non-conductive coating cast iron electrode

APPLICATIONS
Cascade 17 ANC is similar to Cascade 17A, however a special non-conductive coating eliminates the problem of accidental side arcing when welding through limited access holes or in confined areas. Commonly used for cladding, build-up and joining all grades of cat iron to itself or dissimilar metals such as low alloy and carbon steels, stainless steels, iron, copper, monel®, etc. Excellent for producing fully machinable weld deposits on engine blocks, pump housings, end bells and other "hard-to-reach" worn or broken parts.

FEATURES
The non-conductive coating of Cascade 17 ANC makes this electrode the primary choice for repairing castings that are in deep holes or out-of-position. Cascade 17 ANC produces porosity-free, non-cracking weld deposits that will match the color of cast iron. When properly used the soft, stale arc will penetrate through dirt and oil. Excellent on cracked or porous thin sections.

SPECIFICATIONS
Tensile strength (psi).....Up to 65,000
Elongation (%).....Approximately 30
Brinell hardness.....Approximately 175
Color match.....Excellent on cast iron

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32
(mm)	2.4	3.2	4.0
Amps	35-75	50-120	75-140

PROCEDURES
Clean the work area. Preheating is nor required, however it is useful in relieving stresses and to increase machinability of the weld deposit in parts greater than ½" thick. 200 F is an acceptable preheat temperature. Using AC or DC- (straight polarity), hold the electrode 15 off vertical tilted toward the direction of travel. The arc length should be between 1/8" to 3/16". Use stringer beads or the weaving technique. Holding the arc over the molten deposited metal, follow the pool but do not allow the arc to lead or get ahead of the molten pool. If the part is less than ¼" thick use a 1" bead, ¼" to ½" use a 2" bead, over ½" use a 3" to 4" bead. Extinguish the electrode by whipping the arc back over the deposited metal. Peen the weld deposit with a blunt instrument to relieve stress and prevent the spread of cracks on the part. Re-strike the arc on the previously deposited weld metal. On thin or complex shaped parts use the skip weld technique. Always use an electrode diameter that is small enough to permit at least two passes.

See note on previous column.

Special Purpose Electrodes

SUPER 100
Arc AC/DC± (Straight or Reverse Polarity)
All-Position

DESCRIPTION
General purpose — deep penetrating mild steel electrode for low carbon steel.

APPLICATIONS
Super 100 is a thinly-coated mild steel electrode designed for deep penetrating, pass-over-pass welding without excessive slag interference. Excellent over rust, oil, dirt, grease and cement or where poor groove fit-ups are a problem. Super 100 is most commonly used on pipes, storage tanks, automobile and truck frames, bridges, building structures, shipbuilding, galvanized steel, farm implements and many other mild steel uses.

FEATURES
The special coating of Super 100 was designed for low amperage settings on AC machines, however it will produce high strength, non-porous welds with either AC or DC (straight or reverse polarity). The strong arc force and "fast-freeze" weld deposit make Super 100 excellent for vertical-up or down and overhead pipe welding. Super 100 has good arc stability even at higher amperage settings when greater deposition efficiency is desired. Slag-removal is easy.

SPECIFICATIONS
Tensile strength (psi).....Up to 78,000
Yield strength (psi).....Up to 64,000
Elongation in 2" (%).....Approximately 25

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32	3/16
(mm)	2.4	3.2	4.0	4.8
Amps	35-80	60-110	90-145	120-180

PROCEDURES
Clean joints always provide the best welding conditions. AC or DC (reverse polarity for deep penetration, straight polarity for a more shallow penetration and flatter bead). An arc length or approximately 1/8" should be maintained ahead of the weld puddle. Flat and horizontal welding should be done by holding the electrode at a slight angle in the direction of travel and using a slight back and forth whipping motion.

Overhead welding should be done in a manner similar to flat and horizontal but a slight circular motion should be used in the molten metal.

Vertical-down welding should be performed using stringer beads or a slight weave. The weld puddle will be kept in place by pointing the electrode arc upward into the puddle.

Vertical-up welding should be done by using the shelf or step method where welding is done by adding layer on top of layer. Do not use the whipping motion, but move the electrode slowly while pointing the arc force upward.

SPEEDWELD 300
Arc AC/DC ± (Straight or Reverse Polarity)
All-Position

DESCRIPTION
High speed-high deposition mild steel electrode for carbon steel.

APPLICATIONS
Speedweld 300 is designed for high-speed, high deposition welding of mild and low carbon steel where strength, appearance and weld integrity is critical. Excellent for dissimilar gauges and poor fit-ups in sheets, plates, beams, angles and channels. Commonly used on ornamental iron, railing, furniture, automobile bodies, storage tanks, machine parts, sheet metal and structural steel for building.

FEATURES
The unique coating of Speedweld 300 gives a spatter-free, quiet arc that will produce x-ray quality weld deposits. Speedweld 300 is a favorite among fabricators of ornamental iron railings and furniture because of the smooth bead contour which usually requires painting. Operating at relatively low amperage makes Speedweld 300 suitable for thin sheet metal applications where heat distortion must be kept to minimum. Speedweld 300 can be used on either AC or DC machines.

SPECIFICATIONS
Tensile strength (psi).....Up to 76,000
Yield Strength (psi).....Up to 65,000
Elongation in 2" (%).....Approximately 25
Penetration.....Medium

AVAILABLE SIZES AND AMPERAGE

(in.)	1/16	5/64	3/32	1/8	5/32	3/16
(mm)	1.6	2.0	2.4	3.2	4.0	4.8
Amps	20-50	25-80	40-100	60-140	110-210	120-240

PROCEDURES
Clean joints always provide the best welding conditions. AC or DC (straight or reverse polarity) may be used. DC reverse polarity will produce the deepest penetration. DC straight polarity deposits will be similar to those produced by AC current. An arc length of 1/8" should be maintained ahead of the weld puddle. Flat and horizontal welding should be done by holding the electrode at an angle 20 -45 from perpendicular in the direction of travel and using a slight back and froth whipping motion.

For vertical-down welding use higher current settings with stringer beads or a slight weave technique. The weld puddle will be kept in place by pointing the electrode arc upward into the puddle.

Vertical-up welding should be done using lower current settings and the shelf or step method where welding is done by adding layer on top of layer. Do not use the whipping motion, but move the electrode slowly while pointing the arc force upward.

Overhead welding should also be done using lower current settings and in a manner similar to flat and horizontal but with a slight circular motion in the molten metal.

Special Purpose Electrodes

SUPER 500
Arc AC/DC± (Straight or Reverse Polarity)
All-Position

DESCRIPTION
High performance mild steel electrode for mild, low alloy and medium carbon steel.

APPLICATIONS
Super 500 is the easiest-to-use, all-position electrode designed to operate at lower amperage and with lower open-circuit AC voltage (DC straight or reverse polarity may be also use). Super 500 is excellent for painted or galvanized surfaces and light sheet metal work. Ideal for joining dissimilar gauges or where poor fit-up is a problem. Commonly used to fill holes and build-up over-machined or worn parts. More common uses include sheets, plates, angle iron, beams, pipes and machine parts. Excellent for repairing auto-mobile or truck bodies and farm implements.

FEATURES
Super 500 has a wide operating range. Low amperage settings with the smaller diameter electrodes eliminate warpage and distortion when welding thin sections. Higher amperage settings with the larger diameter electrodes allow for medium penetration and welding over rust, oil and grease. Super 500 has great re-strike capability which makes it excellent for short spot welds. A soft steady arc and good wetting action allows for a smoother bead appearance with fine ripples making Super 500 truly superior maintenance and repair electrode.

SPECIFICATIONS
Tensile strength (psi).....Up to 83,000
Yield strength (psi).....Up to 67,000
Elongation in 2" (%).....Approximately 24

AVAILABLE SIZES AND AMPERAGE

(in.)	1/16	5/64	3/32	1/8	5/32	3/16
(mm)	1.6	2.0	2.4	3.2	4.0	4.8
Amps	20-25	25-60	35-80	65-125	90-160	120-210

PROCEDURES
Clean joint always provide the best welding conditions. AC is best for preventing arc blow. DC+ (reverse polarity) produces deep penetration; DC- (straight polarity) should be used on thinner gauges. An arc length of approximately 1/8" should be maintained ahead of the weld puddle. Flat and horizontal welding should be done by holding the electrode at a slight angle in the direction of travel and using a gentle back and forth whipping motion.

Overhead welding should be done in a manner similar to flat and horizontal but a slight circular motion should be used in the molten metal.

Vertical-down welding should be performed using stringer beads or a slight weave. The weld puddle will be kept in place by pointing the electrode arc upward into the puddle.

Vertical-up welding should be done by using the shelf or step method where welding is done by adding layer on top of layer. Do not use the whipping motion, but move the electrode slowly while pointing the arc force upward. Slag is easily removed with a chipping hammer.

SUPER 700
Arc AC/DC+ (Reverse Polarity)
All-Position

DESCRIPTION
Premium high strength, low hydrogen electrode for high stress steels.

APPLICATIONS
Super 700 was designed for all-position welding of crack sensitive steels such as "free-machining" steels that contain high levels of sulfur. Ideal for joining cold rolled steel, enameling steel, carbon steel, low and medium alloy high tensile steels. Super 700 is commonly used in structural steel fabrication of beams, angles, channels, plates, pipes and other structures where high stress may exist. Super 700 is often used as an inexpensive alternative to high cost alloys.

FEATURES
Super 700 is specially formulated to produce deposits that are dense, crack-free, ductile and x-ray quality. Preheating is not a requirement to prevent underbead cracking, thereby elimination this costly time consuming process. Super 700 has a very quiet arc and very little spatter with either AC or DC+ (reverse polarity). High deposition efficiency and easy slag removal.

SPECIFICATIONS
Tensile strength (psi).....Up to 80,000
Yield Strength (psi).....Up to 68,000
Elongation in 2" (%).....Approximately 30-40
Penetration .....Medium

AVAILABLE SIZES AND AMPERAGE

(in.)	3/32	1/8	5/32	3/16	¼
(mm)	2.4	3.2	4.0	4.8	6.0
Amps	50-110	100-150	130-200	210-280	300-375

PROCEDURES
Clean the work area of all contaminants. Bevel heavy sections to a 60 Vee. DC+ (reverse polarity) is a recommended, however an AC machine with sufficient open circuit voltage can be used. Using a short arc length, hold the electrode at a slight angle in the direction travel. A slight weaving technique may be used, but not to exceed 3 times the diameter of the electrode. Do not use the whipping technique since it will cause porosity in the weld metal. A straight forward progression is recommended for all positions. Remove slag between passes, but allow for high carbon steels to cool slowly before removing slag.

TOOL, DIE & MOLD STEELS
GTAW (TIG) WIRES

WASHINGTON ALLOY 4130
Heat Treatable Low Alloy Steel
AISI/SAE 4130 (No AWS Class)

DESCRIPTION
Washington Alloy 4130 is a chromium-molybdenum low alloy GTAW (TIG) wire that produces dense, heat-treatable deposits having high tensile strength and medium elongation. Washington Alloy 4130 weld deposits match the hardening characteristics of the base metal. Weld deposits are approximately 32-36 Rockwell C as applied, and can be readily machined and then heat-treated producing a hardening up to Rockwell C 42-45 using proper procedures.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600° F, then:

	Tempered at 1150° F	Tempered at 950° F
Yield Point (psi)	168,000	188,000
Tensile Strength (psi)	190,000	200,000

TYPICAL WELD METAL CHEMISTRY (%)
(GTAW Welded with DCSP, 100% Argon Shield Gas)

C	0.25
Mn	1.25
Si	0.40
P	0.013
S	0.015
Cr	0.50
Ni	1.30
Mo	0.20

TYPICAL APPLICATIONS
Washington Alloy 4130 is commonly used to weld low-alloy heat-treatable steels such as AISI/SAE 4130 and 8630, as well as steel castings with comparable hardening characteristics. Typical applications are for tool and die block construction and repair, construction and repair of tools, dies and molds having similar chemistries, as well as welding of oil-field piping and valve equipment, rolled high tensile plate, and foundry repair of high-tensile castings. Washington Alloy 4130 also responds well to flame hardening procedures.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to 50 lb. master carton.

Vacuum Melted AMS (Aerospace) Grade 4130 is also available upon request.

WASHINGTON ALLOY 4140
Heat Treatable Low Alloy Steel
AISI/SAE 4140 (No AWS Class)

DESCRIPTION
Washington Alloy 4140 is a chromium molybdenum low alloy flux-cored GTAW (TIG) Wire with slightly higher carbon than Washington Alloy 4130. Washington Alloy 4140 produces dense, heat-treatable deposits having higher tensile strength and somewhat lower elongation. Washington Alloy 4140 weld deposits match the hardening characteristics of the base metal. Weld deposits are approximately 36 Rockwell C as applied, and can be heat-treated producing a hardening up to Rockwell C 46 with proper procedures.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600° F, then:

	Tempered at 1150° F	Tempered at 950° F
Yield Point (psi)	157,000	195,000
Tensile Strength (psi)	180,000	220,000

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.35
Mn	0.80
Si	0.50
P	0.012
S	0.014
Cr	0.75
Mo	0.33

TYPICAL APPLICATIONS
Washington Alloy 4140 is commonly used to weld low-alloy heat-treatable AISI/SAE 4140 steel as well as steel castings with comparable hardening properties where the weld must match the heat-treating characteristic of the base metal. Typical applications are for build-up and repair of dies, forgings, and castings having similar chemistries, as well as welding of oil-field piping and valve equipment, and rolled high tensile plate made from medium carbon, low alloy base metals such as AISI 4140 steel, when post-weld heat treatment or flame hardening is required.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

WASHINGTON ALLOY 4340
Heat Treatable Low Alloy Steel
AISI/SAE 4340 (No AWS Class)

DESCRIPTION
Washington Alloy 4340 is a chromium-molybdenum low alloy flux-cored GTAW (TIG) wire that produces dense, shock resistant, heat treatable deposits having high tensile strength, medium elongation, and good compressive strength. Washington Alloy 4340 weld deposits match the hardening characteristics of the AISI/SAE 4340 base metal. Weld deposits are approximately 44 – 48 Rockwell C as applied. The weld deposits can be heat treated producing hardness of up to Rockwell C 52 using proper procedures.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600°F, then:

	Tempered at 1150°F	Tempered at 950°F
Yield Point (psi)	168,000	250,000
Tensile Strength (psi)	200,000	289,000

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.35
Mn	0.85
Si	0.50
P	0.011
S	0.014
Cr	0.78
Ni	1.80
Mo	0.25

TYPICAL APPICATIONS
Washington Alloy 4340 is used to weld low alloy heat treatable steels such as AISI/SAE 4340 and 4330, as well as steel castings with comparable hardening characteristics. Typical applications are for medium hard, tough weld deposits and include welding of forgings, castings, plastic molds, composite dies, die casting dies, crank shafts, gears, axles and for build up under harder weld deposits. Washington Alloy 4340 also responds well to flame hardening procedures.

AVAILABLE SIZES
.035 x 36
.045 x 36
.063 (1/16) x 36”
.093 (3/32) x 36”
.125 (1/8) x 36”

PACKING
10 lbs. tubes, 5 tubes to a 50 lbs. master carton.

TOOL, DIE & MOLD STEELS
GTAW (TIG) WIRES

WASHINGTON ALLOY 6150
Heat Treatable Low Alloy Steel
AISI/SAE 6150 (No AWS Class)

DESCRIPTION
Washington Alloy 6150 is a chromium molybdenum-vanadium-carbon medium alloy GTAW (TIG) wire that produces dense, heat-treatable deposits having higher tensile strength and slightly lower elongation than the AISI4100 series wires. Washington Alloy 6150 weld deposits match the hardening characteristics of the AISI 6150 base metal. Weld deposits are approximately 48 Rockwell C as applied, and can be heat-treated producing hardness up to Rockwell C 57 with proper procedures.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600° F, then:

	Tempered at 1150° F
Yield Point (psi)	160,000
Tensile Strength (psi)	190,000

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.50
Mn	0.85
Si	0.48
P	0.011
S	0.013
Cr	0.85
Mo	0.38
V	0.20
Cu	0.15

TYPICAL APPLICATIONS
Washington Alloy 6150 is commonly used to weld medium alloy heat-treatable AISI/SAE 6150 steels as well as steel castings with comparable hardening characteristics where the weld must match the heat-treating characteristics of the base metal. Typical applications are for build-up and repair of stamping dies (including GM 190, Chrysler NP 2088, Ford M3A76A grades), forgings, and castings made from medium carbon, medium alloy steels (such as AISI 6150) when post-weld heat treatment or flame hardening is required.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to 50 lb. master carton.

WASHINGTON ALLOY 8620
Heat Treatable Low Alloy Steel
AISI/SAE 8620 (No AWS Class)

DESCRIPTION
Washington Alloy 8620 is a low alloy chromium-molybdenum-nickel-carbon low alloy GTAW (TIG) wire that produces dense, shock-resistant heat-treatable deposits having very high tensile strength, medium elongation, and good compressive strength. Washington Alloy 8620 weld deposits match the hardening characteristics of the AISI/SAE 8620 base metal. Weld deposits are approximately 25-30 Rockwell C as applied, and can be heat-treated producing hardness up to Rockwell C 42 with proper procedures.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600° F, then:

	Tempered at 1150° F
Yield Point (psi)	92,000
Tensile Strength (psi)	108,000

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.20
Mn	0.81
Si	0.25
P	0.011
S	0.014
Cr	0.51
Ni	0.52
Mo	0.22
Cu	0.21

TYPICAL APPLICATIONS
Washington Alloy 8620 is designed to join, build-up or underlay prior to hard facing low-alloy heat-treatable AISI 8620 steel components, as well as steel castings and forgings with similar analysis and hardening characteristics. Typical applications are for medium hard, tough weld deposits and include welding of forgings, castings, and plastic molds and for build-up under harder weld deposits, particularly those with higher carbon contents.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

WASHINGTON ALLOY AH-2
Air Hardening Tool Steel
AISI/SAE A-2 (No AWS Class)

DESCRIPTION
Washington Alloy AH-2 is a high carbon, high chromium air-hardening tool steel alloy GTAW (TIG) wire that produces dense, heat-treatable deposits which respond to the hardening procedures for AISI type A-2 tool steel. The weld deposits are resistant to high abrasion, mild impact and wear. Washington Alloy AH-2 weld deposits match the hardening characteristics of AISI A-2 base metal and can also be used for joining and building-up of AISI A-2 through A-8 Tool Steel parts. Weld deposits are approximately 38-42 Rockwell C as applied, and can be multiple heat-treated, annealed, drawn or tempered.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600^0 F, then:

	Tempered at 1150^0 F	Tempered at 950^{0}F
Yield Point (psi)	130,000	175,000
Tensile Strength (psi)	150,000	200,000

*Due to the many proprietary A-2 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.55
Mn	0.50
Si	2.95
P	0.011
S	0.013
Cr	9.50
Mo	0.38
V	0.20

TYPICAL APPLICATIONS
Washington Alloy AH-2 is commonly used for repairs and alterations to air-hardening tool steel punches, blanking dies, forming dies, coining dies, forming dies, and for fabrication of composite dies and up-grading wear areas on lower alloys.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

Tool, Die and Mold Steels

WASHINGTON ALLOY D-2
Air Hardening Tool Steels
AISI/SAE D-2 (No AWS Class)

DESCRIPTION
Washington Alloy D-2 is a high carbon, high chromium air-hardening tool steel ally GTAW (TIG) wire that produces dense, fine-grained, heat-treatable deposits with resistance to abrasion and mild impact. Washington Alloy D-2 weld deposits match the hardening characteristics of AISI type D-2 tool steel. Washington Alloy D-2 can also be used for joining, and building-up A-8, D-2, D-3 and D-4 tool steels. Weld deposits are approximately 58-60 Rockwell C as applied, and can be multiple heat-treated, annealed, drawn or tempered.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600° F, then:

	Tempered at 900° F	Tempered at 450⁰ F
Yield Point (psi)	160,000	195,000
Tensile Strength (psi)	180,000	225,000

*Due to the many proprietary D-2 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	1.55
Mn	0.60
Si	0.95
P	0.011
S	0.013
Cr	12.00
Mo	0.80
V	0.85

TYPICAL APPLICATIONS
Washington Alloy D-2 is commonly used for repairs ad alterations to air-hardening tool steel cold-working shears, tool steel punches, slitter knives, blanking dies, extrusion dies, trimming dies, coining dies, forming dies, and for fabrication of composite dies using lower alloy based and fro upgrading wear areas on lower alloys.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to 50 lb. master carton.

WASHINGTON ALLOY OH-1
Oil Hardening Tool Steel
AISI/SAE OH-1 (No AWS Class)

DESCRIPTION
Washington Alloy 4140 is a chromium molybdenum low alloy flux-cored GTAW (TIG) Wire with slightly higher carbon than Washington Alloy 4130. Washington Alloy 4140 produces dense, heat-treatable deposits having higher tensile strength and somewhat lower elongation. Washington Alloy 4140 weld deposits match the hardening characteristics of the base metal. Weld deposits are approximately 36 Rockwell C as applied, and can be heat-treated producing a hardening up to Rockwell C 46 with proper procedures.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1600⁰ F, then:

	Tempered at 1150⁰ F	Tempered at 950⁰ F
Yield Point (psi)	157,000	195,000
Tensile Strength (psi)	180,000	220,000

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.35
Mn	0.80
Si	0.50
P	0.012
S	0.014
Cr	0.75
Mo	0.33

TYPICAL APPLICATIONS
Washington Alloy 4140 is commonly used to weld low-alloy heat-treatable AISI/SAE 4140 steel as well as steel castings with comparable hardening properties where the weld must match the heat-treating characteristic of the base metal. Typical applications are for build-up and repair of dies, forgings, and castings having similar chemistries, as well as welding of oil-field piping and valve equipment, and rolled high tensile plate made from medium carbon, low alloy base metals such as AISI 4140 steel, when post-weld heat treatment or flame hardening is required.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

WASHINGTON ALLOY WH-1
Water Hardening Tool Steel
AISI/SAE WH-1 (No AWS Class)

DESCRIPTION
Washington Alloy WH-1 is a high carbon-chromium-vanadium water-hardening tool steel alloy GTAW (TIG) wire that produces dense, fine-grained, heat-treatable deposits with resistance to abrasion and mild impact in cold-working service. Washington Alloy WH-1 weld deposits match the hardening characteristics of AISI type W-1 tool steel. Typically, Washington Alloy WH-1 weld deposits utilize a “differential hardening characteristic” to form a hard, wear-resistant surface or “case”, and a softer, shock-resistance core. Washington Alloy WH-1 can also be used for joining and building-up AISI W-1 through W-5 grades of water-hardening tool steels. Weld deposits are approximately 58-60 Rockwell C as applied, and can be multiple heat-treated, annealed, drawn or tempered.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, post weld re-heat, oil quenched at 1450⁰ F, then:

	Tempered at 900⁰ F	Tempered at 450⁰ F
Yield Point (psi)	140,000	175,000
Tensile Strength (psi)	160,000	195,0000

*Due to the many proprietary W-1 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	1.00
Mn	0.40
Si	0.95
P	0.011
S	0.013
Cr	0.50
V	0.20

TYPICAL APPLICATIONS
Washington Alloy WH-1 is commonly used for repairs and alterations to water-hardening tool steels primarily in tempers 9-11 used on cold-working blanking dies, trimming dies, coining dies, forming dies, trimming dies, coining dies, forming dies, press-brake forming tools and for fabrication of composite dies using lower alloy bases and for upgrading wear areas on lower alloys.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

Tool, Die and Mold Steels

WASHINGTON ALLOY M-2
High Speed Tool Steels
AISI/SAE M-2 AWS A5.13 Class RFe5A

DESCRIPTION
Washington Alloy M-2 is a carbon-chromium-tungsten high-speed tool steel alloy GTAW (TIG) wire that produces dense, fine-grained heat-treatable deposits with resistance to abrasion, frictional wear and mild impact. Washington Alloy M-2 weld deposits retain maximum hardness up to operating temperatures of 1,100°F. Washington Alloy M-2 weld deposits correspond to the same hardening procedures as AISI type M-2 tool steel. Washington Alloy M-2 can also be used for joining, and building-up AISI M-1 through M-44 types of high-speed tool steel. Weld deposits are approximately 61-63 Rockwell C as applied, and can be multiple heat-treated, annealed, drawn or tempered.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, then quenched at 2200^0 F, and then:

	Tempered at 1,200^0+ F	Tempered at 850^0 F
Yield Point (psi)	160,000	195,000
Tensile Strength (psi)	180,000	225,000

*Due to the many proprietary M-2 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.75
Mn	0.60
Si	0.80
P	0.011
S	0.013
Cr	5.50
Mo	4.50
V	1.80
W	6.60

TYPICAL APPLICATIONS
Washington Alloy M-2 is commonly used for repairs and alterations to high-speed tool steel shear blades, cutting dies and similar tool steel shear blades, cutting dies and similar tools where cutting edge retention is critical. Washington Alloy M-2 is also used for fabrication of composite dies using lower alloy bases and for upgrading wear areas on lower alloys.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to 50 lb. master carton.

WASHINGTON ALLOY H-12
Hot Work Tool Steel
AISI/SAE H-12 (No AWS Class)

DESCRIPTION
Washington Alloy H-12 is a 5% chromium hot working tool steel alloy GTAW (TIG) wire that produces dense, fine-grained, heat-treatable deposits with resistance to abrasion and mild impact in hot or cold-working service. Washington Alloy H-12 weld deposits match the hardening characteristics of AISI type H-12 tool steel. Weld deposits are approximately 52-54 Rockwell C as applied, and can be multiple heat-treated, annealed, drawn or tempered.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, then quenched in oil at 1850 F, then:

	Tempered at 1000^0 F	Tempered at 500^0 F
Yield Point (psi)	198,000	205,000
Tensile Strength (psi)	230,000	295,000

*Due to the many proprietary H-12 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.35
Si	0.95
P	0.011
S	0.013
Cr	5.50
Mo	1.50
V	0.20
W	1.50

TYPICAL APPLICATIONS
Washington Alloy H-12 is adapted for repairs and alterations to all AISI “H” Series tool steels used on hot-working blanking dies, and press-brake forming tools. Tools used for cold cutting an trimming have superior resistance to chipping when welded with Washington Alloy H-12. Washington Alloy H-12 can be used for heavy build-up, if necessary

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

WASHINGTON ALLOY H-13
Tungsten-Free Hot Work Tool Steel
AISI/SAE H-13 (No AWS Class)

DESCRIPTION
Washington Alloy H-13 is a 5% chromium, tungsten-free hot work tool steel alloy GTAW (TIG) wire that produces dense, fine-grained, heat-treatable deposits with resistance to abrasion, frictional wear and mild impact in water-cooled hot working service. Washington Alloy H-13 weld deposits retain maximum hardness with continuous operating temperatures of 1,000°F. Washington Alloy H-13 is not as susceptible to brittleness common to grades H20-H26 when used at the normal working hardness of RC 45 to 55. Likewise, the higher alloy content of H20 through H26 types make them unsuitable for water-cooled service. Washington Alloy H-13 weld deposits correspond to the same hardening procedures as AISI type H-13 tool steel. Weld deposits are approximately 54-57 Rockwell C as applied, and can be multiple heat-treated, annealed, drawn or tempered.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, then quenched in oil at 1925^0 F, then:

	Tempered at 1,200^0 F	Tempered at 850^0 F
Yield Point (psi)	180,000	225,000
Tensile Strength (psi)	210,000	300,000

*Due to the many proprietary H-13 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%)
(Welded with DCSP, 100% Argon Shield Gas)

C	0.35
Si	0.25
P	0.011
S	0.013
Cr	5.30
Mo	1.50
V	1.00

TYPICAL APPLICATIONS
Washington Alloy H-13 is especially adapted to hot die work of all kind, particularly for white metal (aluminum, magnesium, and Zinc) extrusion dies and die-casting dies, forging dies, mandrels and hot shears.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

Tool, Die and Mold Steels

WASHINGTON ALLOY P-20
Low Carbon Mold Steel
AISI/SAE P-20 (No AWS Class)

DESCRIPTION
Washington Alloy P-20 is a specially formulated premium alloy tool steel wire that produces dense, fine-grained, heat-treatable deposits on pre-hardened AISI P-20 plastic mold steels. Outstanding characteristics of Washington Alloy P-20 weld deposits are its machinability, polishability, and excellent texturing capability. Additionally, Washington Alloy P-20 provides uniform chrome plating properties. The deposits are nitridable and also provide excellent flame hardening characteristics. Washington Alloy P-20 weld deposits are approximately 31 RC (290/325 BHN) as applied, and can be carburized (flame hardened) to 58 RC with almost no hardness drop-off across the entire width and depth of the weld. Washington Alloy P-20 responds to ion nitriding that provides high hardness of 60 RC with no distortion or dimensional changes of large molds or deep cavities.

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
Yield Point (psi)	140,000*
Tensile Strength (psi)	160,000*

*Due to the many proprietary P-20 mold steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%) (Welded with DCSP, 100% Argon Shield Gas)

C	0.35
Mn	1.50
Si	0.40
P	0.011 max.
S	0.003 max.
Cr	1.80
Ni	1.00
Mo	0.50

TYPICAL APPLICATIONS
USA P-20 is commonly used for repairs and alterations to standard, premium and modified grades of pre-hardened AISI P-20 plastic mold steels for dies, molds, and holder blocks used in compression or injection molding of ABS, thermosetting, SMC, GMT, Flax PP and transparent melts.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to 50 lb. master carton.

WASHINGTON ALLOY M-250
Maraging Tool Steel
AISI/SAE Maraging 250 (No AWS Class)

DESCRIPTION
Washington Alloy M-250 is a nickel-chrome-molybdenum alloy GTAW (TIG) wire. It is specially formulated to produce an as-welded hardness of Rockwell C 30-32 which allows for complete machining operations prior to maraging (age hardening). After machining, finished parts are slowly re-heated to 1,750 F and, following a rapid cooling in air, subjected to maraging at 900 F for three hours producing a hardness of Rockwell C 48-52

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
PWHT: fully annealed, welded, then quenched in oil at 1850^0 F, then:

Yield Point (psi)	95,000*
Tensile Strength (psi)	120,000*

*Due to the many proprietary maraging tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%) (GTAW Welded with DCSP, 100% Argon Shield Gas)

C	0.009
Mn	0.040
Si	0.020
Cr	1.00
Ni	18.110
Mo	4.870
P	0.004
Zr	0.005
Al	0.090
B	0.002
Co	7.900
H	0.0001
N	0.0029
O	0.001
S	0.001
Ti	0.480

TYPICAL APPLICATIONS
Washington Alloy M-250 is commonly used for repairs, build-up and alterations to hot working dies made from all grades of maraging steels for aluminum, magnesium and zinc die casting dies, rubber injection molding dies and molds, forging dies and holder blocks.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

WASHINGTON ALLOY S-7
Shock Resisting Tool Steel
AISI/SAE S-7 (No AWS Class)

DESCRIPTION
Washington Alloy S-7 is carbon-silicon-chromium-tungsten-molybdenum alloy GTAW (TIG) wire that produces a dense, fine-grained structure with high strength and ductility even in hardness up to Rockwell C 60. The deposit is completely heat-treatable using AISI S-7 procedures. Washington Alloy S-7 deposits retain their hardness in working environments up to 600° F. The hardness of Washington Alloy S-7 as welded is Rockwell C 54-57

TYPICAL MECHANICAL PROPERTIES (Stress Relieved)
Yield Point (psi)	110,000*
Tensile Strength (psi)	165,000*

*Due to the many proprietary S-7 tool steel formulations available, always contact the tool steel manufacturer for recommendations on heat treatment procedures.

TYPICAL WELD METAL CHEMISTRY (%) (Welded with DCSP, 100% Argon Shield Gas)

C	0.50
Mn	0.80
Si	1.50
Cr	1.50
Mo	0.50
W	2.50

TYPICAL APPLICATIONS
Washington Alloy S-7 is primarily used for repair, build-up and alterations to blanking dies, bending dies, trimmer dies, and coining dies. Washington Alloy S-7 deposits perform extremely well on medium hot (600^0 F) and cold work applications where repetitive high shock loading and metal-to-metal wear is present such as rivet sets, heading dies, hammer faces, punches and shear blades and chisel points.

AVAILABLE SIZES
.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING
10 lb. tube, 5 tubes to a 50 lb. master carton.

WASHINGTON ALLOY TENSILEWELD TIG

For Joining Tool Steels and Dissimilar Steels

DESCRIPTION

Washington Alloy Tensileweld TIG is a chromium-nickel alloy wire that produces a unique austenitic-ferritic structure that has dense. Fine-grained delta ferrite in a rich austenitic matrix. This results in extremely crack-resistant, tough welds having very high strength (up to 122,000 psi) coupled with up to 35% elongation. The deposits are readily machined having a hardness of 22-23 RC (236 BHN). The weld deposits are non heat-treatable but work-harden and provide resistance to heat, corrosion, abrasion, and impact. Washington Alloy Tensileweld can be used for joining, and building-up all AISI types of tool steels. Washington Alloy Tensileweld TIG is an excellent underlay (buffer layer) for harder deposits.

TYPICAL MECHANICAL PROPERTIES (As Welded)

Yield Point (psi)	90,000
Tensile Strength (psi)	122,000
Elongation in 2” (%)	35
Hardness (RC)	23 RC

TYPICAL WELD METAL CHEMISTRY (%)

(Welded with DCSP, 100% Argon Shield Gas)

C	0.12
Mn	1.70
Si	0.50
Cr	29.5
Ni	9.50

TYPICAL APPLICATIONS

Washington Alloy Tensileweld TIG is commonly used for repairs and alteration to steel casting, forgings, gears, tools and dies, shear blades. Washington Alloy Tensileweld is often used for structural repairs to tools and dies with only the top two or three passes being made of the matching tool steel base metal. In applications where dissimilar steels are to be welded, Washington Alloy Tensileweld performs flawlessly, every time.

AVAILABLE SIZES

.035 × 36”
.045 × 36”
.063 (1/16”) × 36”
.093 (3/32”) × 36”
.125 (1/8”) × 36”

PACKAGING

10 lb. tube, 5 tubes to 50 lb. master carton.

Tool, Die and Mold Steels – Weld Metal Selection

A.I.S.I./S.A.E. BASE METAL TYPE (PARTIAL LIST)	TYPICAL APPLICATIONS	PREHEAT RANGE FOR WELD REPAIRS	POST WELD HEAT TREAT-MENT	HARDNESS AS WELDED	WELD METAL GTAW BARE ROD
Low Alloy High Tensile, Cr-Mo SAE 4130 heat Treatable Steel, SAE 4118, SAE 6140, Forgings, Castings, Plastic Molds, Dies.	Welding and overlaying Medium and High Carbon Steels, Chrome Moly Steels, Bandsaw, Blades, etc. –GM 190, Chrysler NP 2088, Ford M3A76A, Stamping Dies.	Up to ½ inch thick – 300^0 F ½ to 1.0 inch thick – 400^0 F over 1 inch thick – 450^0 F	Use 4130 Procedures	36-38 RC, hard as welded-Flame hardens to 45-47 RC, also responds to 4130 Heat Treatment.	Washington Alloy 4130
Low Alloy High Tensile, Cr-Mo SAE 4140 Hat Treatable steel, SAE 4135, SAE 4142, Forgings, Castings, Plastic Molds, Dies.	Welding and overlaying Medium and High Carbon Steels, Chrome Moly Steels, 4100 and 4300 series – GM 190, Chrysler NP 2088, for M3A76A, Stamping Dies	Up to ½ inch thick – 350^0 F ½ to 1.0 inch thick – 450^0 F Over 1 inch thick – 500^0 F	Use 4140 Procedures	44-48 RC, hard as welded – Flame hardens to 55 RC, also responds to 4140 Heat Treatment.	Washington Alloy 4140
Low Alloy High Tensile, Cr-Mo SAE 4340 Heat Treatable Steel, SAE 4320, 4300 series Forgings, Castings, Plastic Molds, Dies.	Welding and overlaying Medium and High Carbon Steels, Chrome Moly Steels, SAE 4300 series – GM 190, Chrysler NP 2088, Ford M3A76A, Stamping Dies	Up to ½ inch thick – 550^0 F 1\2 to 1.0 inch thick -550^0 F Over 1 inch thick – 550^0 F	Use 4340 Procedures	47-49 RC, hard as welded-Flame Hardens to 55 RC, also responds to 4340 Heat Treatment.	Washington Alloy 4340
Low Alloy High Tensile, C, Cr, V SAE 6150 Heat Treatable Steel, SAE 4100, 4300 series Forgings, Castings, Plastic Molds, Dies.	Welding and overlaying Medium and High Carbon Steels, Chrome Moly Steels, SAE 6150 series – GM 190, Chrysler NP 2088, Ford M3A76A, Stamping Dies	Up to ½ inch thick – 550^0 F 1\2 to 1.0 inch thick -550^0 F Over 1 inch thick – 550^0 F	Use 6150 Procedure	47-49 RC, hard as welded-Fame hardens to 55 RC, also responds to 6150 Heat Treatment	Washington Alloy 6150
Low Alloy High Tensile, Cr, Mo, Ni SAE 8620 Heat treatable Steel, SAE 8600 series Forgings, Casting, Plastic Molds, Dies.	Welding and overlaying Medium and High Carbon Steels, Chrome Moly Steels, SAE 6150 series – GM 190, Chrysler NP 2088, Ford M3A76A, Stamping Dies	Up to 1\2 inch thick –200^0 F 1\2 to 1.0 inch thick–300^0 F Over 1 inch thick–350^0 F	Use 8620 Procedures	47-49 RX, hard as welded – Flame hardens to 55 RC, also responds to 8620 Heat Treatment.	Washington Alloy 8620
Alloy Tool Steels Ni, Co, Mo types Maraging 250 solution Heat Treatable Steels for repair or composite fabrication of Dies, Molds, mandrels, Dummy Blocks, etc.	Welding and overlaying all types of Tool Steels, deposits are in solution treated condition. Further heat treatment (aging) at 950 F harden up to 49 RC. Using Maraging 250 procedures, hardness of up to 58 RC with excellent polishability.	Preheating is not required welding Maraging Steels, however, preheat other steels according to their recommended pre-heats.	Aging at 900-950 °F at 3 hr. per inch of thickness. Use Maraging 250 Procedures.	30-32 RC as welded. Solution Heat Treats at 900-950 F for 3 hours up to 55-58 RC, also responds to Maraging 250 Procedures.	Washington Alloy Maraging 250
Dissimilar Tool Steels – High Strength, crack resistant, non-heat treatable, Austenitic-Ferritic alloy with excess Delta Ferrite.	Welding Dies and Tools where further heat treatment is not used. Excess Delta Ferrite causes carbon pick up from some steels increasing hardness to advantage.	Up to 1\2 inch thick–200^0 F 1\2 to 1.0 inch thick–300^0 F Over 1 inch thick – 350^0 F	Stress relieve at preheat temperature for 1 hr. per inch of thickness, then slow cool.	22-23 RC as welded. May pick up carbon from some Steels increasing hardness (first pass) substantially.	Washington Tensileweld TIG
Low Carbon Steel – For machinable deposits on Low Carbon Steels, Added Mn, Si, Ti, and Al provide increased deoxidizing properties.	Welding deposits are dense, free from porosity, machinable with excellent appearance. Triple de-oxidized filler metal with 83,000 psi tensile and 27.5% elongation.	Preheat other steels according to their recommended preheats.	Stress relieve at preheat temperature for 1 hr. per inch of thickness, then slow cool.	15-16 RC as welded.	Washington Alloy ER70S-2
Corrosion Resisting Mold Steels, Precipitation Hardening Stainless Steel Mold bases, Cavities for Plastics and Rubber Molds, even With Corrosive PVC plastics	Welding deposits have uniform hardness in all dimension, excellent toughness, corrosion resistance and compressive strength. Welds are shrinkage free, and free from decarburization and scale.	No preheat is required when welding Precipitation Hardening Stainless Steels. Welds should be stress relieved for 1 hr. per inch of thickness	Preheat to 925^{0}F for 1 hr. per inch of thickness. Slow cool in mica to reduce stresses.	38-42 RC as welded. Use 17-4 PH Procedures.	Washington Alloy 17-4 PH

Tungsten Electrodes

2% THORATED **EWTH-2** **10 Pieces Each**	**TTU 2% TUNGSTEN 03**	.040 X 7
	TTU 2% TUNGSTEN 04	1/16 X 7
	TTU 2% TUNGSTEN 05	3/32 X 7
	TTU 2% TUNGSTEN 06	1/8 X 7
	TTU 2% TUNGSTEN 07	5/32 X 7
	TTU 2% TUNGSTEN 08	3/16 X 7"

RARE EARTH **EWG** **10 Pieces Each**	**TTU 3TH 04**	1/16 X 7
	TTU 3TH 05	3/32 X 7
	TTU 3TH 06	1/8 X 7

PURE TUNGSTEN **EWP** **10 Pieces Each**	**TTU P/T 03G**	.040 X 7
	TTU P/T 04G	1/16 X 7
	TTU P/T 05G	3/32 X 7
	TTU P/T 06G	1/8 X 7
	TTU PT 07G	5/32 X 7

2% CERIATED **EWCE-2** **10 Pieces Each**	**TTU C/T 03**	.040 X 7
	TTU C/T 04	1/16 X 7
	TTU C/T 05	3/32 X 7
	TTU C/T 06	1/8 X 7
	TTU C/T 07	5/32 X 7

2% LANTHANUM **EWLA-2** **10 Pieces Each**	**TTU L/T 03**	.040 X 7
	TTU L/T 04	1/16 X 7
	TTU L/T 05	3/32 X 7
	TTU L/T 06	1/8 X 7

1 1/2% LANTHANUM **EWLA-1.5** **10 Pieces Each**	**TTU GL/T 03**	.040 X 7
	TTU GL/T 04	1/16 X 7
	TTU GL/T 05	3/32 x 7
	TTU GL/T 06	1/8 X 7
	TTU GL/T 07	5/32 X 7

ZIRCONATED **EWZR-1** **10 Pieces Each**	**TTU Z/T 03**	.040 X 7
	TTU Z/T 04	1/16 X 7
	TTU Z/T 05	3/32 X 7
	TTU Z/T 06	1/8 X 7
	TTU Z/T 07	5/32 X 7
	TTU Z/T 08	3/16 X 7"

Helmets & Helmet Parts/Accessories

AUTO DARKENING HOOD	**WA H700**	BLACK 2 X 4 AUTO DARKENING
	WA H700/LS	SILVER 2 X 4 AUTO DARKENING
	WA H700/S	GUN METAL 2 X 4 AUTO DARKENING
	WA H700MB	MATTE BLACK 2 X 4 AUTO DARKENING
	WA H800	BLACK 4 X 5 AUTO DARKENING
	WA H800D	BLACK 4 X 5 DIGITAL AUTO DARKENING

LIFT FRONT HELMET	**WA H750**	2 X 4 1/4 LIFT FRONT HELMET
	WA H754	4 1/2 X 5 1/14 LIFT FRONT HELMET

REPLACEMENT FILTERS	**WA H700-ADF PRO**	2 X 4 AUTO DARKENING REPLACEMENT FILTER
	WA H800-ADF	4 X 5 AUTO DARKENING REP;LACEMENT FILTER

REPLACEMENT LENS	**WA H700-IL**	INNER COVER LENS FOR H700
	WA H700-OL	OUTER COVER LENS FOR H700
	WA H700-OL/3	3 PACK OUTER COVER LENS FOR H700
	WA H700-L/KIT	5 OUTER LENSE & 2 INNER LENS KIT FOR H700
	WA H800-IL	INNER COVER LENSE FOR H800
	WA C215	4 1/2 X 5 1/4 OUTER COVER PLATE FOR H800

FILTER PLATE **2" X 4 1/4"**	**WA FP24-4**	FILTER PLATE 2 X 4 1/4" SHADE 4
	WA FP24-5	FILTER PLATE 2 X 4 1/4" SHADE 5
	WA FP24-8	FILTER PLATE 2 X 4 1/4" SHADE 8
	WA FP24-9	FILTER PLATE 2 X 4 1/4" SHADE 9
	WA FP24-10	FILTER PLATE 2 X 4 1/4" SHADE 10
	WA FP24-11	FILTER PLATE 2 X 4 1/4" SHADE 11
	WA FP24-12	FILTER PLATE 2 X 4 1/4" SHADE 12
	WA FP24-13	FILTER PLATE 2 X 4 1/4" SHADE 13
	WA FP24-14	FILTER PLATE 2 X 4 1/4" SHADE 14

FILTER PLATE **4 1/2" X 5 1/4"**	**WA FP45-8**	FILTER PLATE 4 1/2 X 5 1/4 SHADE 8
	WA FP45-9	FILTER PLATE 4 1/2 X 5 1/4 SHADE 9
	WA FP45-10	FILTER PLATE 4 1/2 X 5 1/4 SHADE 10
	WA FP45-11	FILTER PLATE 4 1/2 X 5 1/4 SHADE 11
	WA FP45-12	FILTER PLATE 4 1/2 X 5 1/4 SHADE 12
	WA FP45-13	FILTER PLATE 4 1/2 X 5 1/4 SHADE 13
	WA FP45-14	FILTER PLATE 4 1/2 X 5 1/4 SHADE 14

Helmets & Helmet Parts/Accessories

MAGNIFYING LENS	**WA ML-75**	MAGNIFYING LENS .075 DIOPTGER (2 X 4 1/4)
	WA ML-100	MAGNIFYING LENS 1.00 DIOPTGER (2 X 4 1/4)
	WA ML-125	MAGNIFYING LENS 1.25 DIOPTGER (2 X 4 1/4)
	WA ML-150	MAGNIFYING LENS 1.50 DIOPTGER (2 X 4 1/4)
	WA ML-175	MAGNIFYING LENS 1.75 DIOPTGER (2 X 4 1/4)
	WA ML-200	MAGNIFYING LENS 2.00 DIOPTGER (2 X 4 1/4)
	WA ML-225	MAGNIFYING LENS 2.25 DIOPTGER (2 X 4 1/4)
	WA ML-250	MAGNIFYING LENS 2.50 DIOPTGER (2 X 4 1/4)
	WA ML-275	MAGNIFYING LENS 2.75 DIOPTGER (2 X 4 1/4)
	WA ML-300	MAGNIFYING LENS 3.00 DIOPTGER (2 X 4 1/4)

HELMET ACCESSORIES	**WA H700-HG**	REPLACEMENT HEADGEAR FOR H700 & H800
	WA H700-HD	HARD HAT ADAPTER
	WA H700-MK	MOUNT KIT FOR H700 HEAD GEAR
	WA H800-RK	H800 ADF RETAINING KIT
	WA H754 ASSEMBLY	4 1/2 X 5 1/4 FLIP UP ASSEMBLY FOR H754
	WA H754 HG	H754 REPLACEMENT HEAD GEAR

Ground Clamps & Electrode Holders

GROUND CLAMPS **J: Jackson Style** **L: Lenco Style** **T: Tweco Style**	**WA ECM 30R**	250 AMP MAGNETIC GROUND CLAMP
	WA ECM 50R	400 AMP MAGNETIC GROUND CLAMP
	WA GC200J	J-200 AMP GOUND CLAMP
	WA GC200L	L-200 AMP BRASS GROUND CLAMP
	WA GC200T	T-200 AMP BRASS GROUND CLAMP
	WA GC300J	J-300 AMP BRASS GROUND CLAMP
	WA GC300L	L-300 AMP BRASS GROUND CLAMP
	WA GC300T	T-300 AMP BRASS GROUND CLAMP
	WA GC500J	J-500 AMP BRASS GROUND CLAMP
	WA GC500L	L-500 AMP BRASS GROUND CLAMP
	WA GC500T	T-500 AMP BRASS GROUND CLAMP
	WA GL300L	L-300 AMP STEEL GROUND CLAMP
	WA GL400L	L-400 AMP STEEL GROUND CLAMP
	WA GL500L	L-500 AMP STEEL GROUND CLAMP
	WA GCWG60C	GROUND CLAMP C-CLAMP

ELECTRODE HOLDERS **J: Jackson Style** **L: Lenco Style** **T: Tweco Style** **B: Bernard Style**	**WA EH200J**	J-200 AMP ELECTRODE HOLDER
	WA EH200L	L-200 AMP ELECTRODE HOLDER
	WA EH200SK	200 AMP ELECTRODE HOLDER
	WA EH200T	T-200 AMP ELECTRODE HOLDER
	WA EH250L	L-250 AMP ELECTRODE HOLDER
	WA EH250T	T-250 AMP ELECTRODE HOLDER
	WA EH300J	J-300 AMP ELECTRODE HOLDER
	WA EH300L	L-300 AMP ELECTRODE HOLDER
	WA EH300T	T-300 AMP ELECTRODE HOLDER
	WA EH350L	L-350 AMP ELECTRODE HOLDER
	WA EH350T	T-350 AMP ELECTRODE HOLDER
	WA EH400B	B-400 AMP ELECTRODE HOLDER
	WA EH500L	L-500 AMP ELECTRODE HOLDER
	WA EH500T	T-500 AMP ELECTRODE HOLDER
	WA EH600B	B-600 AMP ELECTRODE HOLDER

Accessories

BRUSHES	**WA WIRE BRUSH BR**	WIRE BRUSH W/ BRASS WIRE
	WA WIRE BRUSH SS	WIRE BRUSH W/ STAINLESS STEEL WIRE
	WA WIRE BRUSH ST	WIRE BRUSH W/ STEEL WIRE

CABLE CONNECTOR	**WA CC100**	4-1 CABLE CONNECTOR SET
	WA CC100-F	CABLE CONNECTOR 4-1 FEMALE
	WA CC100-M	CABLE CONNECTOR
	WA CC300	1/0 - 4/0 CABLE CONNECTOR SET
	WA CC300-F	CABLE CONNECTOR 2MBP FEMAILE
	WA CC300-M	CABLE CONNECTOR 2MBP MALE
	WA CC400	3/0 - 4/0 CABLE CONNECTOR SET
	WA CC400-F	CABLE CONNECTOR 4MBP FEMALE
	WA CC400-M	CABLE CONNECTOR 4MBP MALE

CHIPPING HAMMERS	**TU CHIPG B.**	CHISEL & BRUSH W/ SPRING HANDLE
	TU CHIPG S.	CHISEL & PICK CHIPPING HAMMER
	TU CHIPG S2	CROSS-CHISEL & PICK W/ SPRING HANDLE
	TU CHIPG W.	CHISEL & PICK W/ WOODEN HANDLE
	WA CHIPG HMR	PLASTIC CHIPPING HAMMER W/ BRUSH
	WA CHWH-20	CONE & CHISEL W/ WOODEN HANDLE - LARGE

CABLE LUG	**WA CL 10-20**	1/0 - 2/0 INTERNAL SOLDER ON
	WA CL 30-40	3/0 - 4/0 INTERNAL SOLDER ON
	WA CL-TE-10F	CABLE LUG TE-10F
	WA CL-TE-1AF	CABLE LUG TE-1AF
	WACL-TE-20F	CALBE LUG TE-20F
	WA CL-TE-2AF	CABLE LUG TE-2AF
	WA CL6-2	INTERNAL SOLDER ON TERMINAL
	WA CLH-L	3/0 - 4/0 CALBE LUG HAMMER ON LARGE
	WA CLH-M	1/0 -2/0 CABLE LUG HAMMER ON MEDIUM
	WA CLH-S	6-2 CABLE LUG HAMMER ON SMALL
	WA CLS-L	3/0 - 4/0 CALBE LUG SOLDER ON LARGE
	WA CLS-M	1/0 -2/0 CABLE LUG SOLDER ON MEDIUM
	WA CLS-S	6-2 CABLE LUG SOLDER ON SMALL

Accessories

CHEMICALS	**WC ANT SPAT 01**	16 OZ AEROSOL ANTI-SPATTER
	WC GREEN SPAT 02	SPATTER SPATTER 1 GALLON
	WC GREEN SPAT 03	SPATTER SPATTER 5 GALLON
	WC NOZ DIP 01	16 OZ NOZZLE DIP
	WC SPRAY GALV 01	12 OZ SPRAY GALVANIZING

CYLINDER CAPS (24 EACH PER CASE)	**WA CCACT**	ACETYLENE COURSE THREAD
	WA CCAFT	ACETYLENE FINE THREAD
	WA CCOCT	OXYGEN COURSE THREAD
	WA CCOFT	OXYGEN FINE THREAD

CYLINDER/MIG CARTS	**WA CYT-14CH**	CYLINDER TROLLY CYT-14CH
	WA CYT-8CH	CYLINDER TROLLEY CYT-8CH
	WA MIG-CARTS	MIG CART BLU W/O HANDLE
	WA MIG-PLASMA CARTS	MIG PLASMA CART

FLOW GAUGES	**WA FG1530**	FLOW GAUGE 1.5" DOUBLE SCALE, 30 cfh
	WA FG1550	FLOW GAUGE 1.5" DOUBLE SCALE, 50 cfh
	WA FG230	FLOW GAUGE 2" DOUBLE SCALE, 30 cfh
	WA FG250	FLOW GAUGE 2" DOUBLE SCALE, 50 cfh
	WA FG2530	FLOW GAUGE 2.5" DOUBLE SCALE, 30 cfh
	WA FG2550	FLOW GAUGE 2.5" DOUBLE SCALE, 50 cfh

GOGGLES	**WG 209**	SHADE 5 (2 X 4 1/4" LIFT FRONT)
	WG SG231	CLEAR PERFORATED, SAFTETY GOGGLES
	WG SG234	CLEAR VENTED, SAFTEY GOGGLES

GOUGING TORCH	**TG K1000A**	GOUGING TORCH WITH 7' CABLE

HOSE	**WA TH 05R 25**	GRADE R TWIN HOSE: 25'
	WA TH 05R 50	GRADE R TWIN HOSE: 50'
	WA TH 05R 100	GRADE R TWIN HOSE: 100'

Accessories

MACHINE COUPLING	**WA MCM8-F**	MACHINE COUPLING M-8 FEMALE
	WA MCM8-M	MACHINE COUPLING M-8 MALE
	WA MCM10-F	MACHINE COUPLING M-10 FEMALE
	WA MCM10-M	MACHINE COUPLING M-10 MALE
	WA MCM12-F	MACHINE COULING M-12 FEMALE
	WA MCM12-M	MACHINE COUPLING M-12 MALE

MAGNETIC HOLDERS	**WA MAG-M**	MEDIUM MAGNETIC HOLDER
	WA MAG-L	LARGE MAGNETIC HOLDER
	WA MI-EHS-M	MAGNETIC ELECTRODE HOLDER STAND
	WA MI-MTS-M	MAGNETIC MIG TORCH HOLDER STAND
	WA MI-TTS-M	MAGNETIC TIG HOLDER STAND

PLIERS/WRENCHES	**WA MIG PLIER**	MIG WELDING PLIERS
	WA TW-5	TANK WRENCH 5
	WA TW-20	TANK WRENCH 20
	WA TW-250	TANK WRENCH 250
	WA WR1013	TEN MOUTH WRENCH

PRESSURE GAUGES	**WA PG1530**	1 1/2" X 30 PSI
	WA PG15100	1 1/2" X 100 PSI
	WA PG15200	1 1/2" X 200 PSI
	WA PG15400	1 1/2" X 400 PSI
	WA PG154000	1 1/2" X 4000 PSI
	WA PG15 LENS	1 1/2" LEXAN GAUGE COVER
	WA PG230	2" X 30 PSI
	WA PG2100	2" X 100 PSI
	WA PG2200	2" X 200 PSI
	WA PG2400	2" X 400 PSI
	WA PG24000	2" X 4000 PSI
	WA PG2 LENS	2" LEXAN GAUGE COVER
	WA PG2530	2 1/2" X 30 PSI
	WA PG25100	2 1/2 X 100 PSI
	WA PG25200	2 1/2 X 200 PSI
	WA PG25400	2 1/2 X 400 PSI
	WA PG254000	2 1/2 X 4000 PSI
	WA PG25 LENS	2 1/2" LEXAN GAUGE COVER

Accessories

ROD OVENS	**WA EQ 20Si**	20 LB ROD OVEN
	WA EQ-50SI	50 LBS ROD OVEN
	WA EQ 50SiW	50 LBS ROD OVEN W/ WHEELS

SOAPSTONE	**TU SOAPSTONE 01**	FLAT SOAPSTONE
	TU SOAPSTONE 03	ROUND SOAPSTONE
	TU SOAPSTONE 04	SQUARE SOAPSTONE
	WA FLAT HOLDER	FLAT SOAPSTONE HOLDER
	WA ROUND HOLDER	ROUND SOAPSTONE HOLDER

SPARK LIGHTERS	**WA FL308**	TRIPLE FLINT LIGHTER
	WA FL308R	TRIPLE FLINT RENEWAL
	WA SPARKLIGHTER-S	SPARKLIGHTER SINGLE FLINT
	WA FL508R	SINGLE FLINT RENEWAL 5 PACK
	WA MI-SL-PIEZO	ELECTRONIC STRIKER (LIGHTNIN' BUG)
	WA SPARK STICK	ZAP STICK W/ LANYARD
	WA SPARK STICK RP	ZAP STICK RETAIL PACK (20 SPARK STICKS)

TIP CLEANERS	**WA TIP STD**	STANDARD TIP CLEANER
	WA TIP L	LONG TIP CLEANER
	WA TIP KING	KING TIP CLEANER
	WA TIP CLEAN ASST RP	TIP CLEANER RETAIL PACK (24 STD, 20 KING, 20 LONG)