

WELDIRECTORY



Stick Electrodes for Carbon and Low Alloy Steel



Lincoln's Systems Approach to Arc Welding... Since 1895

Lincoln Electric is a leading manufacturer of welding and cutting products proudly made in the USA. By combining the manufacturing of equipment and consumables with the intense study of arc dynamics, Lincoln delivers the unique solution. Lincoln provides the complete welding and cutting answer and ability to accept total system responsibility in your shop with our exclusive **Guaranteed Cost Reduction** program.

Our service and support is the best in the industry. We have over 150 factory-trained technical field representatives and over 300 local service shops that stock genuine Lincoln replacement parts. Regional distribution centers and local warehouses make sure product is available when it is needed.

Lincoln quality is an established tradition that has been earned for nearly 100 years. It is also verified on a continuing basis by such organizations as UL, CSA, AWS, ASME, ABS, NEMA, Lloyd's Register, Det Norske Veritas, U.S. Dept. of Defense, ISO, ASME-Nuclear, Bureau Veritas, Germanischer Lloyd, and others.

Welding Equipment includes power sources, wire feeders, and accessories for stick, TIG, semiautomatic and automatic welding applications as well as integrated robotic systems.

Welding Consumables include carbon steel, low alloy steel, stainless steel and hardfacing products available as stick, wire and flux.

Cutting Equipment includes the Lincoln Pro-Cut® line of plasma cutting power sources and torches, as well as the Harris line of oxyfuel torches and regulators.

Worldwide headquarters is located in Cleveland, Ohio USA, with district offices and distributors throughout the world. Lincoln Electric has over 120 International Distributors and 22 manufacturing facilities in 19 countries. Lincoln is dedicated to manufacturing quality products which meet the needs of our customers anytime, anywhere.



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HOW TO SELECT ELECTRODES

General

The serviceability of a product or structure utilizing this type of information is and must be the sole responsibility of the builder/user. Many variables beyond the control of The Lincoln Electric Company affect the results obtained in applying this type of information. These variables include, but are not limited to, welding procedure, plate chemistry and temperature, weldment design, fabrication methods and service requirements.

Code Quality

The suggested electrodes will generally meet the requirements of common government and industry codes. However, you must check the code against the deposit properties and the conformances and approvals of the specific electrode to be sure. If required, be sure the electrode is capable of producing x-ray quality welds.

Carbon and Steel Welding

Almost any E60XX or E70XX electrode can be used for most carbon steel applications. Selection for best quality and efficient production should be based on joint requirements.

High Strength and Low Alloy Steel Welding

The following table lists electrodes for welding many of the common steels. These suggestions are based on the needed mechanical properties - especially tensile and yield strength. Special requirements may necessitate different choices. For a specific weld deposit chemistry, see the alloy contents provided by electrodes with suffixes listed under "AWS Numbering System" section.

Preheat may be required when welding high strength steels. The preheat needed increases with thicker plate, rigid joints, and higher carbon and alloy contents.

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (See "HOW TO SELECT ELECTRODES" above)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A27	Carbon Steel Castings	All	(1)
A36	Structural - 36,000 Min. YS	All	(2)
A53	Carbon Steel Pipe	All	(2), (4)
A105	Forgings for Piping		LH-78 MR
A106	Carbon Steel Pipe	A, B, & C	(2)
A131	Structural for Ships	A, B, D, DS, CS, E	(1), (2)
		AH32, AH36, DH32, DH36, EH32 & EH36	(1) (3)
		AH40, DH40 & EH40	(1)
A134	Carbon Steel Pipe	See A36, A283, A285 or A570	
A135	Carbon Steel Pipe	A & B	(2), (4)
A139	Carbon Steel Pipe	A, B, C, D & E	(2), (4)
A148	Castings for Structural Steel	80-40 & -50	LH-8018-C3 MR
		90-60	LH-90 MR, Jet-LH 8018-B2 MR
		105-85 & 115-95	LH-110M MR, LH100M1 MR
A161	Carbon Steel Still Tubes	Low Carbon	LH-75 MR or LH-78 MR, (4)
	Carbon-Moly Steel Still Tubes	T1 (.5% Mo)	SA-85, 85P
A178	Electric - Resistance Welded	A, B, & C	LH-75 MR or LH-78 MR, (4)
A179	Heat Exchangers		LH-75 MR or LH-78 MR, (4)
A181	Forgings for General Service Piping	Class 60 & 70	LH-75 MR or LH-78 MR
A182	High Temperature Fittings, etc.	F1 (.5% Mo)	SA-85, 85P
		F2, F11, & F12	LH-90 MR, Jet-LH 8018-B2 MR
		& F22	Jet -LH 9018-B3 MR
A184	Bar Mats for Concrete Reinforcement	See A615, A616, A617, A706	
A192	Boiler Tube for High Pressure Service	7" max Dia.	(2), (4)
A199	Heat Exchanger Tubes	T4 & T22	Jet-LH 9018-B3 MR
		T11	LH-90 MR, Jet-LH 8018-B2 MR
A200	Refinery Still Tubes	T4 & T22	Jet-LH 9018-B3 MR
		T11	LH-90 MR, Jet-LH 8018-B2 MR
A202	Pressure Vessel - Cr. Mn Si	A	LH-8018-C3 MR
		B	LH100M1 MR

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (Continued)
(See "HOW TO SELECT ELECTRODES" on page 4)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A203	Pressure Vessel - Ni	A, B, D, & E	LH-8018-C1 MR
A209	Carbon-Moly Boiler Tubes	T1, T1a, & T1b	SA-85, 85P, LH-75MR, LH-78MR
A210	Carbon Steel Boiler Tubes	A-1	(2), (4)
		C	SA-85, 85P, LH-75MR, LH-78MR
A211	Spiral Welded Pipe	See A570	LH-75 MR or LH-78 MR, (4)
A213	Boiler Tubes	T2, T11, T12, & T17	LH-90 MR, Jet-LH 8018-B2 MR
		T22 (2.25% Cr, 1% Mo)	Jet-LH 9018-B3 MR
A214	Heat Exchanger Tubes		LH-75 MR or LH-78 MR
A216	Carbon Steel Castings - High Temperature	WCA, WCB, & WCC	(1)
A217	High Temperature Cast Fittings, etc.	WC4, WC5, & WC6	
		WC9	Jet-LH 9018-B3 MR
A225	Pressure Vessel - Mn V Ni	C	LH-110M MR
		D	LH-8018-C3 MR
A226	High Pressure Service		LH-75 MR or LH-78 MR, (4)
A234	Wrought Welding Fittings	WPB & WPC	LH-75 MR or LH-78 MR, (4)
		WP1	SA-85, 85P
		WP11 & WP12	LH-90 MR, Jet-LH 8018-B2 MR
		WP22	Jet-LH 9018-B3 MR
A242	High Pressure Structural	Groups 1, 2, 3, 4, & 5	(1), (6)
A250	Carbon-Moly Tubes	T1, T1a & T1b	SA-85, 85
		T2, T11, & T12	LH-90 MR, Jet-LH 8018-B2 MR
		T22	Jet-LH 9018-B3 MR
A252	Carbon Steel Pipe	1, 2 & 3	LH-75 MR or LH-78 MR, (4)
A266	Pressure Vessel Forgings	1, 2 & 4	(1)
		3	LH-8018-C3 MR
A283	Structural Plates	A, B, C, & D	(2)
A284	Carbon - Silicon Steel Plates	C & D	(2)
A285	Pressure Vessel Plate	A, B, & C	(2)
A299	Pressure Vessel Plate - Mn, Si		LH-8018-C3 MR
A302	Pressure Vessel - Mn Mo and Mn Mo Ni	B, C, & D	LH-100M1 MR
A328	Steel Sheet Piling		(1)
A333 & A334	Low Temperature Pipe	1 & 6	LH-75, LH-78 or LH-8018-C3 MR
		7	LH-8018-C1 MR
A335	High Temperature Pipe	P1 & P15	SA-85, 85P
		P2, P11, & P12	LH-90 MR, Jet-LH 8018-B2 MR
		P22	Jet-LH 9018-B3 MR
A336	Pressure Vessel Forgings	F1	
		F11 & F12	LH-90 MR, Jet-LH 8018-B2 MR
		F21 & F22	Jet-LH 9018-B3 MR
A350	Low Temperature Fittings, etc.	LF1	LH-75, LH-78 or LH-8018-C3 MR
		LF2	LH-75 MR, LH-8018-C3 MR
		LF5	LH-8018-C1 MR
		LF 6 Class 1 & Class 2	LH-100M1 MR
		LF 6 Class 3	LH-75, LH-78 or LH-8018-C3 MR
A352	Low Temperature Castings	LCA, LCB & LCC	LH-75 MR
		LC2	
A356	Steam Turbine Castings	1	(3)
		5, 6, 8 & 9	LH-90 MR, Jet-LH 8018-B2 MR
		10	Jet-LH 9018-B3 MR

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (Continued)
(See "HOW TO SELECT ELECTRODES" on page 4)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A366	Carbon Steel Sheets		(2)
A369	High Temperature Pipe	FPA & FPB	(4)
		FP1	SA-85, 85P
		FP2, FP11 & FP12	LH-90 MR, Jet-LH 8018-B2 MR
		FP21 & FP22	Jet-LH 9018-B3 MR
A372	Pressure Vessel Forgings	Type I	(1)
		Type II	LH-8018-C3 MR
		Type IV, V (Class 65)	LH-110M MR
A381	High Pressure Pipe	Y35, Y42, & Y46	LH-75 MR or LH-78 MR, (4)
		Y48	LH-75 MR, LH-78 MR, (2)
		Y50 & Y52	HYP, LH-75 MR, LH-78 MR
		Y56	SA70+, SA80, LH-75MR, LH-78MR
		Y60	SA70+, SA80, HYP
		Y65	SA70+, SA80
A387	Pressure Vessel Plate - CrMo	2, 11, & 12	LH-90 MR, Jet-LH 8018-B2 MR
		22	Jet-LH 9018-B3 MR
A389	High Temperature Castings	C23	LH-90 MR
		C24	Jet-LH 9018-B3 MR
A405	High Temperature Pipe	P24	Jet-LH 9018-B3 MR
A414	Pressure Vessel Sheet	A, B, C, & D	(2), (5)
		E, F, & G	(1)
A420	Low Temperature Fittings	WPL6	LH-75, LH-78, LH-8018-C3 MR
		WPL9	LH8018-C1 MR
A423	Low Alloy Tubes	1	LH-90 MR
		2	LH-8018-C3 MR
A426	High Temperature Cast Pipe	CP1	SA-85, 85P
		CP2, CP11, CP12	LH-90 MR, Jet-LH 8018-B2 MR
		CP15	SA-85, 85P
		CP21 & CP22	Jet-LH 9018-B3 MR
A442	Plate with Improved Transition Properties	55 & 60	(1)
A455	Pressure Vessel Plate - C Mn		LH-8018-C3 MR, (1), (8)
A469	Vacuum-Treated Steel Forgings	Class 1	LH-8018-C3 MR
		Class 2	LH-8018-C1 MR
		Class 3	
A470	Alloy Steel Forgings	Class 1	LH-8018-C3 MR
		Class 2	LH-8018-C1 MR
		Class 4 & 6, 8	LH-110M MR
A487	Castings for Pressure Service	10A, 4B, 8B, 13B	LH-110M MR
		11A, 12A	LH-90 MR, Jet-KLH 8018-B2 MR
		9D, 11B, 12B	LH-110M MR
		6A	LH-8018-C3 MR
A498	Condenser Tubes	See A199, A213 & A334	
A500	Structural Tubing	A, B, & C	(2)
		D	LH-75MR, LH-78 MR
A501	Structural Tubing		(2)

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (Continued)
(See "HOW TO SELECT ELECTRODES" on page 4)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A508	Pressure Vessel Forgings Quenched & Tempered	1 & 1A	(1)
		2-C1 & C2, 3-C2	LH-100M1 MR
		4N-C3	LH-110M MR
		4N-C1 & 5-C1	LH-110M MR
		22-C3	Jet-LH 9018-B3 MR
A514	Quenched & Tempered Plate	All Grades > 2-1/2"	LH-110M (7)
		All Grades 2-1/2" & under	LH-110M (7)
A515	High Temperature Pressure Vessel	60, 65 & 70	(1)
A516	Pressure Vessel Plate	55, 60, 65 & 70	(1)
A517	Pressure Vessel Quenched & Tempered	All Grades 2-1/2" & under	(7)
		All Grades 2-1/2" - 6"	LH-110M MR, (7)
A521	Closed Die Forgings	CA, CC & CC1	(1)
		AE	LH-110M MR
A523	High Pressure Pipe	A & B	LH-75 MR or LH-78 MR, (4)
A524	Seamless Carbon Steel Pipe	I & II	LH-75 MR, LH-78 MR, (2)
A529	Structural - 42,000 Min. YS	42 & 50	(1)
A533	Quenched & Tempered Plate	Class 1, Type A, B, C & D	LH-8018-C3
		Class 2, Type A, B, C & D	LH-110M & (4M)
		Class 3, Type A, B, C & D	LH-110M MR
A537	Pressure Vessel Plate	1	(1)
		2 & 3	LH-8018-C3 MR
A539	Tubing for Gas & Oil Lines	2-3/8", max Dia., 1/8" max Thick	(2), (4)
A541	Pressure Vessel Forgings	1, 1A	(1)
		2-Class 1, & 3-Class 1	LH-8018-C3
		11-Class 4	LH-90 MR, Jet-LH 8018-B2 MR
		2 Class 2, 3 Class 2	LH-100M1 MR
		22 Class 4	LH-110M MR
		4N Class 3 & 22 Class 3	LH-100M1 MR
A542	Pressure Vessel Plates Quenched and Tempered	Class 1, Type A, B & C	LH-110M MR
		Class 3, Type A, B & C	LH-110M MR
		Class 4 & 4a, Type A, B & C	LH-100M1 MR
A543	Quenched & Tempered Plate	Class 1, Type B & C	LH-110M, (7)
		Class 3, Type B & C	LH-110M MR
A556	Feedwater Heater Tubes	A2, B2 & C2	LH-75 MR, LH-78 MR, (4)
A557	Electric-Resistance Welded	A2, B2 & C2	LH-75 MR, LH-78 MR, (4)
A562	Pressure Vessel Plate		LH-75 MR, LH-78 MR
A569	Hot-Rolled Sheet		(2)
A570	Structural Sheet & Strip	30, 33, 36, 40 & 45	(2)
		50 & 55	(1)
A572	Structural Plate - Cb V	42 & 50	(1)
		60 & 65	LH-8018-C3 MR
A573	Structural Plate	58, 65 & 70	(1)
A587	Carbon Steel Pipe		LH-75 MR, LH-78 MR, (4)

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (Continued)
(See "HOW TO SELECT ELECTRODES" on page 4)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A588	High Strength Structural	All (Grades A, B, C & K)	LH-8018-C3 MR, (1), (6)
A589	Carbon Steel Pipe	Butt Welded, A & B	LH-75 MR, LH-78 MR, (4)
A595	Structural Tubing	A & B	LH-75 MR, LH-78 MR
		C	LH-75, LH-78, LH-8018-C3 MR
A606	Hot & Cold - Rolled Sheet	All	(1)
A607	High Strength, Low Alloy Sheet Hot & Cold - Rolled Sheet	45	(2)
		50, 55 & 60	(1)
		65	LH-8018-C3 MR
A611	Structural Sheet	A, B, C & D	(2)
A612	Pressure Vessel - Low Temperature		LH-8018-C3 MR or C1 MR
A615	Billet Steel Bars - Concrete Reinforcement	40	(1)
		75	LH-110M MR
A616	Rail - Steel Bars for Concrete Reinforcement	50	LH-8018-C3 MR
A617	Axle Steel for Concrete Reinforcement	40	(1)
A618	Low Alloy Structural Tubing	Ia, Ib, II, & III	LH-75 MR, LH-78 MR
A620	Drawing Quality Steel Sheet		(2)
A633	Normalized High Strength Low Alloy Structure	A, C & D	LH-8018-C3 MR, (1)
		E	LH-8018-C3 MR
A656	High Strength Structural	50 & 60	(1)
		70	LH-8018-C3 MR
A660	Cast High Temperature Pipe	WCA	LH-75 MR, LH-78 MR, (4)
		WCB & WCC	LH-75 MR, LH-78 MR
A662	Pressure Vessel - Low Temperature	A, B & C	LH-75 MR
A668	Carbon & Alloy Steel Forgings	A & B	(2)
		C	(1)
		D, E & G	LH-8018-C3 MR
		F	LH-100M1 MR
		K	LH-110M MR
A675	Steel Bars	45, 50, 55 & 60	(2)
		65 & 70	(1)
		75 & 80	LH-8018-C3 MR
A678	Quenched & Tempered Plate	A	LH-8018-C3 MR, (1)
		B	LH-8018-C3 MR
		C & D	LH-110M
A690	H-Piles & Sheet Piling		See A588
A691	Carbon & Alloy Steel Pipe	Grade designates type of plate used to make pipe. See ASTM Spec. for plate material information.	
A692	Seamless, Low Alloy Steel Tubes		SA-85, SA-85P
A694	Carbon & Alloy Steel Forgings	F42, F46, F48, F50, F52 & F56	LH-75, LH-78, LH-8018-C3 MR
		F60 F F65	LH-8018-C3 MR
A695	Bars for Fluid Power	35 Type A, B, C & D	(2)
		40 Type A, B, C & D	(3)
		45 Type A, C & D	LH-8018-C3 MR
A696	Carbon Steel Bars	B & C	LH-75 MR, LH-78 MR
		C	LH-75 MR, LH-78 MR
A706	Low Alloy Bars - Concrete Reinforcement		LH-8018-C3 MR
A707	Carbon & Alloy Steel Flanges	L1, L2 & L3 Class 1 & 2	LH-75 MR
		L4, L5, L6, Class 1, 2, 3 & 4	LH-8018-C1 MR

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (Continued)
(See "HOW TO SELECT ELECTRODES" on page 4)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A709	Structural Steel for Bridges	36 & 50	(1)
		50W	(1), (6)
		100 & 100W	LH-110-M MR
A710	Low - C Age - Hardening	A, Class 1	LH-90 MR
		A, Class 2	LH-75 MR
		A, Class 3	LH-8018-C1 MR
		B	LH-90 MR
		C, Class 1	LH-110M MR, LH-100M1 MR
A714	Low Alloy Pipe	I, II, & III	LH-75 or LH-78
		IV	LH-8018-C3 MR
		V, Type E, F & S	LH-8018-C1 MR
		VI, VII, & VIII Type E & S	LH-8018-C3 MR
A715	High Strength, Low Alloy Sheet & Strip	50	(2)
		60	(3)
		70	LH-8018-C3
		80	LH-100M1 MR
A724	Pressure Vessel Plates - Quenched & Tempered	A, B & C	LH-100M1 MR, LH-110M MR
A727	Notch-Tough Carbon Steel		LH-75 MR, LH-78 MR
A732	Castings, High Strength at Elevated Temperatures		(1)
		2Q, 5N	LH-100M1 MR
		3Q, 13Q	LH-110M MR
A734	Pressure Vessel Plates, High Strength,	Type A	LH-8018-C1 MR
	Low Alloy, Quenched & Tempered	Type B	LH-8018-C3 MR
A735	Pressure Vessel Plates	Class 1	LH-8018-C3 MR
		Class 4	LH-110M MR
A736	Pressure Vessel Plates Low - C Age - Hardening	A, Class 1	LH-100M1 MR
		A, Class 2	LH-75 MR
		A, Class 3	LH-8018-C1 MR
		C, Class 1 & 3	LH-110M MR
A737	Pressure Vessel Plates High Strength, Low Alloy	B	(1)
		C	LH-8018-C3 MR
A738	Pressure Vessel for Low Temperature Service	A	LH-8018-C3 MR
		B	LH-100M1 MR
		C	LH-8018-C3 MR
A739	Steel Bars, for Elevated Temperature or Pressure Contain Parts	B 11	LH-90 MR, Jet-LH 8018-B2 MR
		B 22	Jet-LH 9018-B3 MR
A757	Steel Castings, for Pressure Containing for Low Temperature Service	A1Q, A2Q	LH-75 MR
		B2N, B2Q, & C1Q	LH-8018-C1 MR
		D1N1, D1Q1	LH-110M MR
A758	Pipe Fittings with Improved Notch Toughness	60 & 70	LH-75 MR, LH-78 MR
A765	Pressure Vessel Forgings	I	(1)
		II	LH-75 MR
		IV	LH-8018-C3 MR
A769	Carbon & High Strength Electric Resistance	36, 40 & 45	(2)
		45W & 50W	(3), (6)
		50	(3)
		60	LH-8018-C3 MR
		80	LH-100M1 MR

SUGGESTED ELECTRODES FOR SPECIFIC STEELS (Continued)
(See "HOW TO SELECT ELECTRODES" on page 4)

ASTM Spec. No.	Description	Grades	Suggested Electrodes
A782	Pressure Vessel Plates Quenched & Tempered	Class 1	LH-100M1 MR
		Class 2	LH-110M MR
A808	High Strength, Low Alloy		LH-75 MR
A812	High Strength, Low Alloy Sheet	65	LH-100M1 MR
	Pressure Vessels	80	LH-100M1 MR, LH-110M MR
A822	Steel Tubing, Hydraulic Service		(2), (4)
A832	Pressure Vessel	21V & 22V	Jet-LH 9018-B3 MR
A841	Pressure Vessel Plates		(1)
A847	Low Alloy Tubing		LH-75, LH-78, LH-8018-C3 MR
A850	Steel Bars	Class 1 & 2	(1)
A852	Quenched & Tempered, Low Alloy Structural Plate		LH-100M1 MR
A858	Heat Treated Fittings for Low Temp. & Corrosives		LH-75, LH-78, LH-8018-C3 MR
A859	Steel Forgings, Age Hardening	Class 1 & 2	LH-8018-C1 MR
A860	High Strength Fittings	WPHY 42, 46, & 52	LH-75 MR
A871	High Strength, Low Alloy, Structural with Atmospheric Corrosion Resistance	60 & 65	LH-8018-C3 MR
A873	Steel Sheet, Pressure Vessels	Class 1, 2 & 3	Jet-LH 9018-B3L
A907	Hot-Rolled Sheet, Structural Quality	30, 33, 36 & 40	(2)
A913	High Strength, Low Alloy Shapes of Structural Quality	60 & 65	LH-8018-C3 MR
A935	Steel Sheet & Strip, High Strength Low Alloy	45	(2)
		50, 55 & 60	(1)
		65	LH-8018-C3 MR
A936	Steel Sheet & Strip, High Strength, Low Alloy	50	(2)
		60	(3)
		70	LH-8018-C3
		80	LH-100M1 MR
A945	High Strength, Low Alloy Structural Plate	50	LH-75 MR
		65	LH-8018-C3

The serviceability of a product or structure utilizing these suggested consumables is and must be the sole responsibility of the builder of the builder/user. Many variables beyond the control of The Lincoln Electric Company affect the results obtained in applying this type of information. These variable include, but are not limited to, welding procedure, plate chemistry and temperature weldment design, fabrication methods and service requirements.

These filler metal recommendations "match" the base metal properties; that is, the yield and tensile strength are expected to meet or exceed the minimum specified properties of the steel. Matching filler metal is typically required for complete joint penetration groove welds in tension. However, fillet welds loaded in shear seldom require matching filler metal. Depending on the type of weld joint and loading, lower filler metal strengths may be acceptable or desirable for specific designs. Also, codes, specifications, or contract documents may require specific mechanical properties that these recommendations do not meet. In those cases, electrode selection should be limited to those products that meet the specific application requirements.

FOOTNOTES:

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(1)	Any E70X8 Electrode may be used. Jet-LH 78 and Jetweld LH-75 are preferred over Jetweld LH-70 for most pipe and out -of-position welding. Jetweld LH-3800 can be used in place of Jetweld LH-70 for flat and horizontal fillets, laps, and flat butt welds.
(2)	Almost any E60XX or E70XX electrodes can be used. First, select electrode based on the joint requirements. Second, not all SMAW electrodes are required to have minimum specified levels of notch toughness. If code, specifications, or contract documents require notch toughness, electrode selection should be limited to those that meet the specific application requirements.
(3)	Almost any E70XX electrode can be used. First, select electrode based on the joint requirements. Second, not all SMAW electrodes are required to have minimum specified levels of notch toughness. If code, specifications, or contract documents require notch toughness, electrode selection should be limited to those that meet the specific application requirements
(4)	Best Electrodes are Fleetweld 5P, 5P+, 35, 35LS.
(5)	Best Electrodes are Fleetweld 35, 180, 7, 37, 47
(6)	For best color match of multipass welds to the base plate on unpainted structures, use Jet-LH 8018-C3 MR (1% Ni). The second choice for multipass welds on unpainted structures is Jet-LH 8018-C1 MR (2-1/4% Ni). For single pass welds, multipass welds which are not exposed, and multipass welds which do not require close color match, any E7018 electrode may be used.
(7)	Fillet welds are frequently made with Jetweld LH-70, Jetweld LH-75, Jet-LH 78 or Jet-LH 8018-C3
(8)	Jetweld LH-70* for fillets or Jet-LH 8018-C3 are recommended for general purpose welding these steels. Jetweld LH-90 can be used particularly if the weldment is to be precipitation hardened or high weld strength is required.
(9)	Use Jet-LH-8018-C1 or Jettweld LH-75 when high impact properties down to -75 F are required.

ELECTRODE SELECTION BASED ON JOINT REQUIREMENTS

Welds on high strength and low alloy steel can often only be made with one or two specific electrodes. See page 4 for selection information. Full strength welds on carbon steel can usually be made with any of a variety of different electrodes. Selection of the best electrode for maximum welding efficiency should be based on joint requirements. Here is a three step method for considering joint requirements:

1. **Classify the joint** as "Fast-Freeze", "Fast-Fill", "Fill-Freeze", or a combination of these.
2. **Choose the electrode group** "Fast-Freeze", "Fast-Fill", "Fill-Freeze", or Low Hydrogen -- from the information below and the sketches on the following page.
3. **Review the electrodes** in the appropriate group to select the best electrode for the specific application.

"FAST-FREEZE" WELDING

The weld deposit rapidly solidifies for use in all positions. These electrodes have a high cellulose coating which produces a deep penetration, forceful spray type arc with light slag coverage.

For 3/16" to 5/8" plate, use "Fast-Freeze" electrodes.

For 5/8" and thicker plate, the "Fill-Freeze" low hydrogen electrodes are more economical because deposit rates are higher and they make welds with fewer large beads so overall cleaning time is reduced.

"FAST-FILL" JOINTS

The coating of "Fast-Fill" electrodes is 50%, by weight, iron powder, and therefore produces a larger amount of weld deposition per electrode.

Dense slag and slow cooling of the weld deposit limits these electrodes to flat or horizontal applications.

Groove, flat and horizontal fillets, and lap welds in plate over 3/16" thick are "Fast-Fill" joints.

They primarily require "Fast-Fill" electrodes with high deposit rates to fill the joint in the shortest time. "Fast-Fill" electrodes only weld level or slightly downhill (15° max.) joints. More steeply includes "Fast-Fill" joints are best welded with "Fill-Freeze" electrodes.

For the required tight fitup, plates are butted tight, a back-up strip is used, or a stringer bead is made with "Fill-Freeze" electrodes.

"FILL-FREEZE" JOINTS (Sheet Steel)

These electrodes have an increase of weld deposition compared to "Fast-Freeze", but can still be used for all position applications. These electrodes have a titania rutile or lime based coating with the addition of iron powder in some cases.

Welding sheet metal under 3/16" thick requires electrodes that weld at high travel speeds with minimum skips, misses, slag entrapment and undercut.

Fillets and laps in all positions are best welded with EXX12 or EXX13 "Fill-Freeze" electrodes because they have excellent fast travel ability.

Other types of joints are best welded with "Fast-Freeze" electrodes because they have good puddle freezing ability.

AWS NUMBERING SYSTEM

- a. The prefix "E" designates arc welding electrode.
- b. The first two digits of 4 digit numbers and the first three digits of 5 digit numbers indicate minimum tensile strength:

E60xx.....60,000 psi Tensile Strength
E70xx.....70,000 psi Tensile Strength
E110xx..110,000 psi Tensile Strength

- c. The next-to-last digit indicates position:

Exx1x.....All Positions
Exx2x.....Flat and Horizontal Positions

- d. The last two digits together indicate the type of coating and the current to be used. (See "Electrode Groups" on the following page.)

- e. The suffix (example: EXXXX-A1) indicates the approximate alloy in the deposit:

-A11/2% Mo
-B11/2% Cr, 1/2% Mo
-B21 1/4% Cr, 1/2% Mo
-B32 1/4% Cr, 1% Mo
-C12 1/2% Ni
-C23 1/4 Ni
-C31% Ni, .35% Mo, .15% Cr
-D1 & D225-.45% Mo, 1.25-2.00% Mn
-G......50 min Ni, .30 min Cr, .20 min Mo, .10 min V

(Only one of the listed elements is required for -G)

- f. The optional supplemental designators, HZR indicates (a) diffusible hydrogen (H) not exceeding "Z" ml of H₂ per 100g of deposited metal where "Z" is 4, 8 or 16 and (b) the electrode meets the requirements of an absorbed moisture (R) test.

INDEX TO ELECTRODE GROUPS

The "Fast-Freeze" Group

Exx10OrganicDC Only
 Exx11OrganicAC or DC
 Exx22OrganicAC or DC

The "Fill-Freeze" Group

Exx14Rutile & approx.
 30% Iron Powder .AC or DC
 Exx12RutileDC or AC
 Exx13RutileAC or DC

The Low Hydrogen Group with "Fast-Fill" Characteristics

Exx28Low Hydrogen & approx.
 50% Iron Powder .AC or DC

The "Fast-Fill" Group

Exx24Rutile, approx.
 50% Iron Powder .AC or DC
 Exx27Mineral & approx.
 50% Iron Powder .AC or DC

The Low Hydrogen Group with "Fill-Freeze" Characteristics

Exx18Low Hydrogen & approx.
 30% Iron Powder .DC or AC

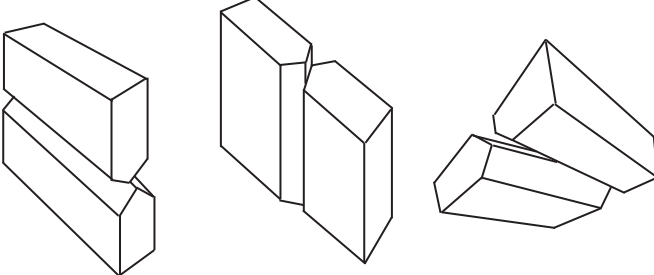
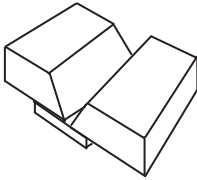
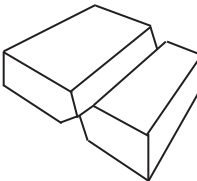
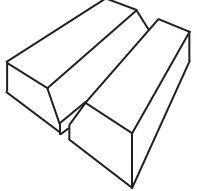
The Alloy Steel Group with "Fill-Freeze" Characteristics

Exx18Low Hydrogen & approx.
 30% Iron Powder .DC or AC

ELECTRODE SELECTION BASED ON JOINT REQUIREMENTS (Continued)

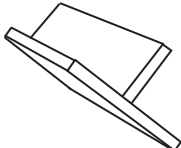
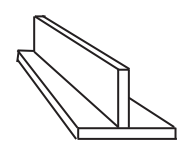
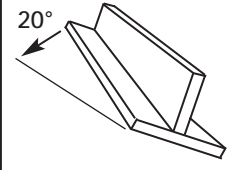
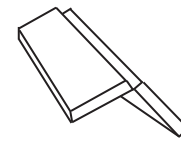
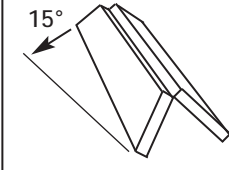
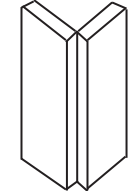
"FAST-FREEZE" JOINTS

"FAST-FILL" JOINTS

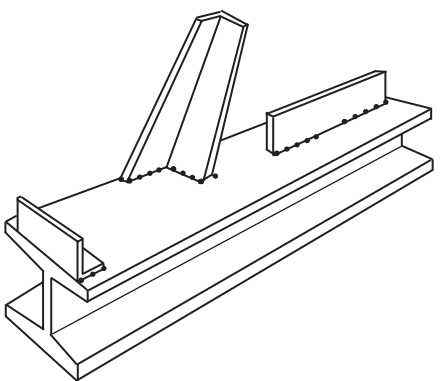
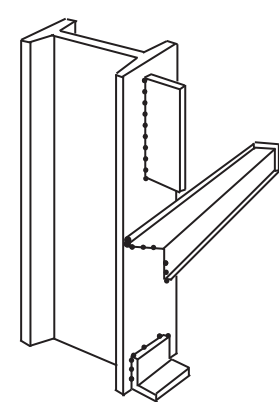
Horizontal, Vertical, Overhead	Flat	Flat	Flat
<p>3/16" to 5/8" Plate Fast-Freeze (E6010, E6011)</p> <p>Plate over 5/8" Fill-Freeze (E7018)</p>	<p>3/8" and Thicker Fast-Fill / Low Hydrogen (E6027, E7028)</p>	<p>3/8" and Thicker Root Pass Fill-Freeze (E7018) All Other Passes Fast-Fill / Low Hydrogen (E6027, E7028)</p>	<p>3/8" and Thicker Root Pass Fill-Freeze (E7018) All Other Passes Fast-Fill / Low Hydrogen (E6027, E7028)</p>
			

ELECTRODE SELECTION BASED ON JOINT REQUIREMENTS (Continued)

"FAST-FILL" / LOW HYDROGEN, AND "FILL-FREEZE" JOINTS

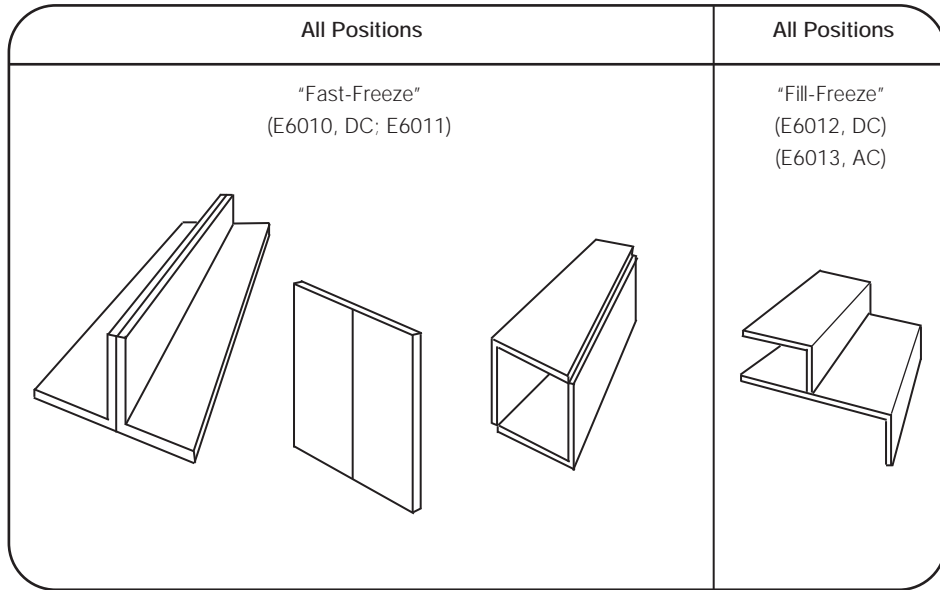
Flat	Horizontal	Inclined	Flat	Inclined	Vertical
Fast-Fill / Low Hydrogen (E7024, E7028)	Fast-Fill / Low Hydrogen (E7024, E7028)	Fill-Freeze (E7014, E7018)	Fast-Fill / Low Hydrogen (E7024, E7028)	Fill-Freeze (E7014, E7018)	3/16" - 5/8" Plate Fast-Freeze (E6010, E6011) Plate 5/8" & Over Fill-Freeze (E7018)
					

SHORT FILLET "FILL-FREEZE" AND "FAST-FREEZE" JOINTS

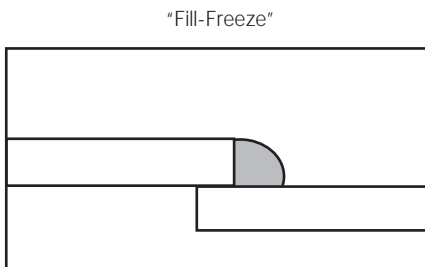
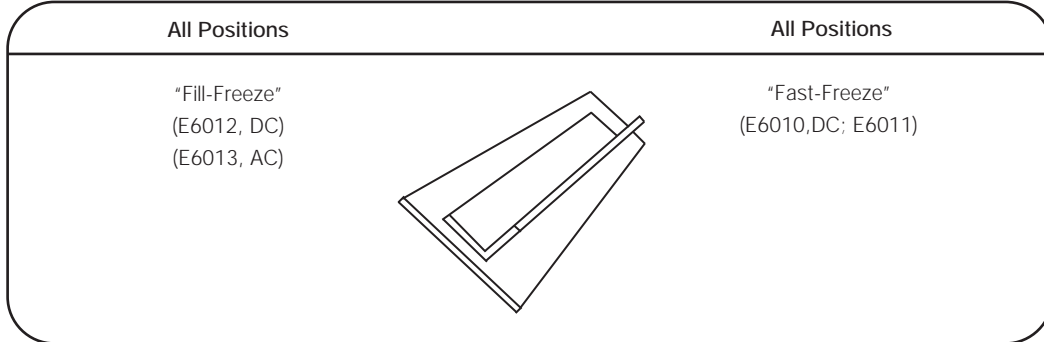
Horizontal	Horizontal, Vertical, Overhead	Horizontal, Vertical, Overhead
"Fill-Freeze" (E7014)	3/16" to 5/8" Plate "Fast-Freeze" (E6010, E6011)	Plate 5/8" & Over "Fill-Freeze" (E7018)
		

Fillet welds under 6" in length or having a change in direction on 3/16" or thicker plate.

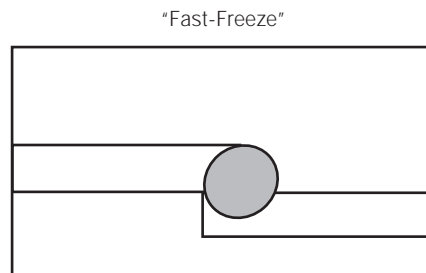
"FILL-FREEZE" JOINTS - SHEET METAL



"FILL-FREEZE" JOINTS - SHEET METAL (Continued)



Preserve Edge



Fuse Edge

THE “FAST-FREEZE” GROUP

General Applications

- Made especially for welding carbon steel.
- General purpose fabrication and maintenance welding.
- Vertical-up and overhead plate welding.
- Capable of x-ray quality welds out-of-position.
- Pipe welding - cross country, in-plant, and non-critical small diameter piping.
- Best choice on galvanized, plated, dirty, painted or greasy steel which cannot be completely cleaned. (The weld quality may be lower than on clean steel.)
- Joints requiring deep penetration such as square edge butts.
- Sheet metal edge, corner, and butt welds.

“Fast-Freeze” Characteristics

- Truly all-purpose: Particularly good for vertical and overhead.
- Light slag with little slag interference for easy arc control.
- Deep penetration with maximum admixture.
- Appearance: Flat beads have distinct ripples.

SPECIFIC ELECTRODE APPLICATIONS ⁽¹⁾

AWS Class	Product Name	Description
E6010	FLEETWELD 5P	Our basic “Fast-Freeze” electrode recommended for DC+ welding. Your best choice for dirty, rusty, painted or plated steel that cannot be completely cleaned. Good arc stability, light slag and excellent wash-in. It is particularly valuable for out-of-position applications.
E6010	FLEETWELD 5P+	Similar to the traditional Fleetweld 5P, with the added advantages of quick striking, easy slag removal, and improved final appearance. It is recommended for DC+ operation in all positions for fabrication, maintenance, and pipe welding. It is also useful for welding on steel which cannot be completely cleaned.
E6022	FLEETWELD 22	A special electrode for welding roof decking to beams with burn-through spot welds or similar applications.
E6011	FLEETWELD 35	“Fast-Freeze” electrode for use with industrial AC welders. Also, it’s the best electrode for sheet metal edge, corner and butt welds using electrode negative polarity.
E6011	FLEETWELD 35LS	An excellent low slag electrode for tack welding, particularly when the joint is to be welded with Innershield®. Also recommended for vertical down welding, making stringer beads, bridging gaps, AC pipe welding, and on applications that require an extra-low silicon deposit.
E6011	FLEETWELD 180	A lightly coated, all position electrode. It is recommended for general purpose work with 225 amp AC welders.

(1) The Lincoln Electric Company strongly recommends for weldments intended for sour gas, sour crude, or other critical service applications that the customer verifies that both the level of hardness and variation in hardness of the weld, heat affected zone, and base plate are within acceptable limits.

FOR WELDING HIGH TENSILE PIPE ⁽¹⁾

AWS Class	Product Name	Description
E8010-G	SHIELD-ARC 70+	Specifically made for vertical down welding all passes on X56 through X70 pipe where an E8010-G electrode is required. It has easy operation with a minimum of wagon tracks, windows and pin holes. It features good low temperature impact properties and can be used on pipe steels containing relatively high silicon (up to .30 silicon).
E8010-G	SHIELD-ARC 80	Similar to Shield-Arc 70+, it has even better impact properties.
E7010-A1	SHIELD-ARC [®] 85	Produces a 70,000 psi, 1/2% molybdenum weld deposit. Used for 1/2% Mo pipe steels and X42 through X56 line pipe, plus other out-of-position work that requires its strength or alloy. Can be handled vertical up or vertical down.
E7010-A1	SHIELD-ARC 85P	Similar to Shield-Arc 85, it is designed to eliminate surface pin holes in fill and cover pass welds on high strength pipe.
E7010-G	SHIELD-ARC HYP	Specifically made for vertical down welding all passes on 5L or 5LX pipe, X52 through X65. It features easy operation, minimum wagon tracks and windows, and almost no tendency for fill and cover pass pin holes.
E9010-G	SHIELD-ARC 90	Similar to Shield-Arc 80 with higher strength for X80 pipe.

(1) The Lincoln Electric Company strongly recommends for weldments intended for sour gas, sour crude, or other critical service applications that the customer verifies that both the level of hardness and variation in hardness of the weld, heat affected zone, and base plate are within acceptable limits.

WELDING TECHNIQUES

- **Polarity** - Unless otherwise specified, use DC+, electrode positive, with the Exx10's and AC with the Exx11's. The Exx11 electrodes can be used on DC+ with a current about 10% below normal AC values. Use DC- or AC with E6022. Always adjust current for proper arc action and control of the weld puddle.
- **Flat** - Hold a 1/8" or shorter arc or touch the work lightly with the electrode tip. Move fast enough to stay ahead of the molten pool. Use currents in the middle and higher portion of the range.
- **Vertical** - Use 3/16" or smaller electrodes. Vertical-down drag techniques are used by pipeliners and for single pass welds on thin steel. Vertical-up is used for most plate welding applications. Make the first vertical-up pass with either a whipping technique for fillet welds or V-butt joints.

Apply succeeding passes with a box or straight weave, pausing slightly as the edges to ensure penetration and proper wash-in. Use currents in the lower portion of the range.

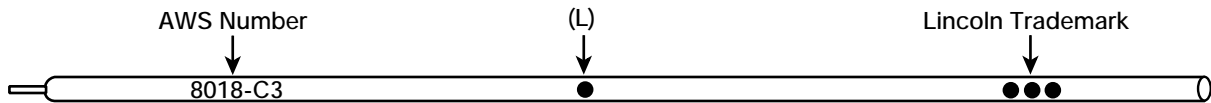
- **Overhead and Horizontal Butt Welds** - Use a 3/16" or smaller electrode. These welds are best made with a series of stringer beads using a technique similar to those described for first pass vertical-up welds.
- **Sheet Metal Edge and Butt Welds** - Use DC-, electrode negative, and hold a 1/16" or longer arc. Move as fast as possible while maintaining good fusion. Position the work 45° down-hill for fastest welding. Use currents in the middle of the range.
- **Pipe Welding ⁽¹⁾** - The procedure used should be checked for proper electrode size and polarity for the wall thickness, strength level and chemistry of the pipe being welded.

• **General Guidelines for Power Source Adjustment**

(SA- and SAE- Machines) - In general, the "Current Range" or "Current Control" switch (whether a tap or continuous control) should always be set as low as possible to get the current desired, and the "Fine Current Adjustment" or "Job Selector" control (which controls open circuit voltage) should be set as high as possible. It is usually better to set this control (for OCV) at the mid-point or higher for best arc stability and fewer pop-outs.

When using an SA-250, it will normally be necessary to set the "Current Range Selector" tap switch one position lower than used on an Classic[®] I to get the same operating characteristics.

ELECTRODE IDENTIFICATION AND OPERATING DATA



Product Name	AWS Class	(L) Lincoln	Coating Color	Electrode Polarity	Sizes & Current Ranges (Amps) (Electrodes are manufactured in those sizes for which current ranges are given)					
					3/32" Size	1/8" Size	5/32" Size	3/16" Size	7/32" Size	1/4" Size
Fleetweld 5P	E6010	---	Brick Red	DC +	40-70	75-130	90-175	140-225	200-275	220-325 (1)
Fleetweld 5P+	E6010	---	Gray	DC +	40-70	65-130	90-175	140-225	---	---
Fleetweld 22	E6022	---	Black	DC -	---	110-150	150-180	---	---	---
				AC	---	110-150	150-180	---	---	---
Fleetweld 35	E6011	---	Gray	AC	50-85	75-120	90-160	120-200	150-260	190-300
				DC ±	40-75	70-110	80-145	110-180	135-235	170-270
Fleetweld 35LS	E6011	Green	Red Brown	AC	---	80-130	120-160	---	---	---
				DC ±	---	70-120	110-150	---	---	---
Fleetweld 180	E6011	---	Brown	AC	40-90	60-120	115-150	---	---	---
				DC ±	40-80	55-110	105-135	---	---	---
Shield-Arc 85	E7010-A1	---	Pink	DC +	50-90	75-130	90-175	140-225	---	---
Shield-Arc 85P	E7010-A1	Green	Pink	DC +	---	---	---	140-225	---	---
Shield-Arc HYP	E7010-G	---	Tan	DC +	---	75-130	90-185	140-225	160-250	---
Shield-Arc 70+	E8010-G	---	Gray	DC +	---	75-130	90-185	140-225	---	---
Shield-Arc 80	E8010-G	---	Gray	DC +	---	75-130	90-185	140-225	160-250	---
Shield-Arc 90	E9010-G	---	Gray	DC +	---	75-130	90-185	140-225	---	---

(1) Range for 5/16" size is 240-400 amps.

DC + is Electrode Positive,
DC - is Electrode Negative.

TYPICAL MECHANICAL PROPERTIES

Test procedures per appropriate AWS specification. Other specifications may have different minimum requirements and test procedures may produce different results. Low figures in the as-welded ranges below are AWS minimum requirements.

	Fleetweld 5P	Fleetweld 5P+	Fleetweld 22	Fleetweld 35	Fleetweld 35LS	Fleetweld 180	Shield-Arc 85	Shield-Arc 85P	Shield-Arc HYP	Shield-Arc 70+	Shield-Arc 80	Shield-Arc 90
As Welded												
Tensile Strength - psi	60-76,000	60-86,000	60-82,000	60-82,000	60-76,000	60-84,000	70-78,000	70-78,000	70-86,000	80-97,000	80-94,000	90-100,000
Yield Point - psi	48-65,000	48-76,000	---	48-70,000	48-62,000	48-70,000	57-71,000	57-63,000	60-74,000	67-82,000	67-83,000	77-88,000
% Elong.	22-33	22-33	---	22-34	22-34	22-35	22-30	22-27	22-30	19-31	19-26	17-26
Charpy V-Notch Toughness - ft. lbs.	20-55 @-20°F	20-63 @-20°F	---	20-76 @-20°F	20-53 @-20°F	20-53 @-20°F	52-77 @70°F	68 @70°F	34-53 @-20°F	25-38 @-50°F	49-65 @-50°F	28-46 @-50°F
Hardness, Rockwell B (avg) (1)	78-85	80-90	---	78-87	70-82	79-89	---	---	83-89	85-92	91-93	93-96
Stress Relieved @1150°F												
Tensile Strength - psi	60-69,000	---	---	60-66,000	60-65,000	---	70-84,000	70-79,000	80-82,000	80-88,000	---	---
Yield Point - psi	48-61,000	---	---	46-56,000	46-51,000	---	57-74,000	57-62,000	72-76,000	65-78,000	---	---
% Elong.	28-36	---	---	28-36	28-33	---	22-30	22-28	24-27	29-31	---	---
Charpy V-Notch Toughness - ft. lbs.	79 @ 70°F	---	---	---	120 @ 70°F	---	64 @ 70°F	68 @ 70°F	30 @ -20°F	44 @ -50°F	---	---
Hardness, Rockwell B (avg) (1)	---	---	---	---	---	---	80-95	80-87	---	---	---	---

(1) Hardness values obtained from welds made in accordance with AWS A5.1 or AWS A5.5.

CONFORMANCES AND APPROVALS

See Lincoln Electric Price Book for certificate numbers, size and position limitations and other data.

Stick Electrode	AWS A5.1 and ASME SFA-5.1 (1)	AWS A5.5 and ASME SFA-5.5 (2)	Lloyd's Grade	ABS Grade	ASME Boiler Code		Conformance Certificate Available (3)	Military Specifications
					Group	Analysis		
Fleetweld 5P	E6010	---	3	E6010	F3	A1	Yes	MIL-QQ-E-450 (4)
Fleetweld 5P+	E6010	---	---	---	F3	A1	Yes	---
Fleetweld 22	E6022	---	---	---	F3	---	Yes	---
Fleetweld 35	E6011	---	3	E6011	F3	A1	Yes	MIL-QQ-E-450 (4)
Fleetweld 35LS	E6011	---	---	E6011	F3	A1	Yes	---
Fleetweld 180	E6011	---	---	---	F3	A1	Yes	---
Shield-Arc 85	---	E7010-A1	---	---	F3	A2	Yes	---
Shield-Arc 85P	---	E7010-A1	---	E7010-A1	F3	A2	Yes	MIL-E-22200/7
Shield-Arc HYP	---	E7010-G	---	---	F3	---	Yes	---
Shield-Arc 70+	---	E8010-G	---	---	F3	---	Yes	---
Shield-Arc 80	---	E8010-G	---	---	F3	---	Yes	---
Shield-Arc 90	---	E9010-G	---	---	F3	---	Yes	---

ABS: American Bureau of Shipping
Lloyd's: Lloyd's Register of Shipping

- (1) Conforms to test requirements of AWS A5.1 and ASME SFA-5.1.
- (2) Conforms to test requirements of AWS A5.5 and ASME SFA-5.5.
- (3) "Certificate of Conformance" to AWS classification test requirements is available. These are needed for Federal Highway Administration projects.
- (4) Specification QQ-E-450a was cancelled by the General Services Administration effective December 24, 1985. Per their instructions, "Future procurements should be made in accordance with AWS A5.1".

THE “FAST-FILL” GROUP

General Applications

- Made especially for welding carbon and low alloy steel.
- For multiple pass welds including fillets and deep groove butts.
- “Fast-Fill” single pass welds especially production fillets & laps.
- Flat and slightly downhill (15° max.) positions only.
- Medium carbon crack sensitive steel when low hydrogen electrodes are not available. Preheat may be required.

“Fast-Fill” Characteristics

- Highest deposition rates of all electrodes.
- Good bead appearance: Smooth, ripple-free beads are flat or slightly convex with minimal spatter.
- Easy slag removal: Heavy slag tends to peel off.
- Shallow penetration for minimum admixture.

Value of Iron Powder

High iron powder (50% by weight) in the coating gives “Fast-Fill” electrodes their major advantage of high deposit rates. There are three basic reasons:

1. Welding heat is more efficiently used to melt coating and core wire rather than excess quantities of base metal.
2. The iron powder is added to the deposited weld metal.
3. Optimum currents are higher than with conventional electrodes.

Also, the thick coating facilitates use of the drag technique for easy operation, and the heavy slag promotes uniform cooling and a smooth bead with excellent appearance.

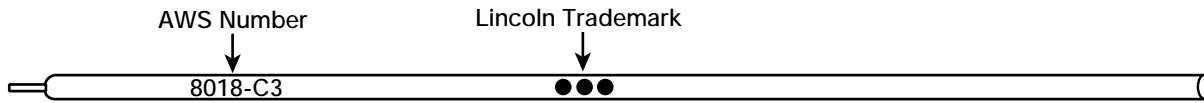
SPECIFIC ELECTRODE APPLICATIONS

AWS Class	Product Name	Description
E7024-1	JETWELD®1	Jetweld 1 is used on the applications listed above. Jetweld 1 has better impact strength, high ductility, better slag control, larger weld size and better pock-marking resistance than Jetweld 3. The imprinted electrode identification is 7024-1 to indicate that the weld deposit has a minimum of 22% elongation and CVN impact values of 20 ft-lbs at 0°F when tested per AWS A5.1-91.
E7024	JETWELD 3	Jetweld 3 is also used on the applications listed above. Jetweld 3 has slightly better slag removal, allows faster travel speeds and provides slightly higher deposition rates than Jetweld 1.
E6027	JETWELD 2	Used mostly for flat, deep groove joints primarily when x-ray quality or high notch toughness are required. Excellent wash-in and friable slag provides easy slag removal even in deep grooves.

WELDING TECHNIQUES

- **Polarity** - Use AC for highest speeds and best operating characteristics. DC can be used, but it promotes arc blow and complicates control of the molten puddle.
- **Flat** - Use a drag technique and deposit stringer beads. Travel fast enough to stay 1/4-3/8" ahead of the molten slag. Optimum currents are 5-10 amps above center of the range for most jobs. Do not exceed the center of the range for x-ray quality deposits.
- **Horizontal Fillets & Laps** - Point the electrode into the joint at an angle of 45° with horizontal and use the “Flat” techniques described above. The tip of the electrode must touch both horizontal and vertical members of the joint.

ELECTRODE IDENTIFICATION AND OPERATING DATA



Product Name	AWS Class	Coating Color	Electrode Polarity	Sizes & Current Ranges (Amps) (Electrodes are manufactured in those sizes for which current ranges are given)				
				1/8" Size	5/32" Size	3/16" Size	7/32" Size	1/4" Size
Jetweld®1	E7024-1	Gray	AC	115-175 (1)	180-240	240-300	300-380	340-440
			DC ±	100-160	160-215	220-280	270-340	320-400
Jetweld 3	E7024	Gray	AC	115-175 (1)	180-240	240-315	300-380	350-450
			DC ±	100-160	160-215	215-285	270-340	315-405
Jetweld 2	E6027	Red-Brown	AC	---	190-240	250-300	300-380	350-450
			DC ±	---	175-215	230-270	270-340	315-405

(1) Range for 3/32" size is 65-120 amps AC or 60-110 amps DC.

DC + is Electrode Positive,
DC - is Electrode Negative.

TYPICAL MECHANICAL PROPERTIES

Test procedures per appropriate AWS specification. Other specifications may have different minimum requirements and test procedures may produce different results. Low figures in the as-welded ranges below are AWS minimum requirements.

	Jetweld 1	Jetweld 3	Jetweld 2
As Welded			
Tensile Strength - psi	70-86,000	70-95,000	60-72,000
Yield Point - psi	58-79,000	58-75,000	48-60,000
% Elong.	22-31	17-29	22-35
Charpy V-Notch Toughness - ft. lbs.	20-44 @ 0°F	38-52 @ 70°F	20-54 @ -20°F
Hardness, Rockwell B (avg) (1)	85-93	82-91	78-82
Stress Relieved @1150°F			
Tensile Strength - psi	72-79,000	72-81,000	62-70,000
Yield Point - psi	60-66,000	60-71,000	50-59,000
% Elong.	22-27	17-23	22-32
Charpy V-Notch Toughness - ft. lbs.	20-44 @ 0°F	24-33 @ 20°F	79 @ 70°F

(1) Hardness values obtained from welds made in accordance with AWS A5.1.

CONFORMANCES AND APPROVALS

See Lincoln Electric Price Book for certificate numbers, size and position limitations and other data.

AWS Class (1)	Lloyd's Grade	DNV Grade	GL Grade	BV Grade	ASME Boiler Code -		ABS Grade	Conformance Certificate Available (2)	Military Specifications
					Group	Analysis			
Jetweld® 1 AWS E7024-1	1	1	1	1	F1	A1	E7024-1	Yes	---
Jetweld 3 AWS E7024	---	1	1	1	F1	A1	E7024	Yes	QQ-E-450 (4)
Jetweld 2 AWS E6027 (3)	3	3	3	3	F1	A1	E6027	Yes	QQ-E-450 (4)

ABS: American Bureau of Shipping
Lloyd's: Lloyd's Register of Shipping
DNV: Det Norske Veritas

GL: Germanischer Lloyd
BV: Bureau Veritas

(1) Conforms to test requirements of AWS A5.1 and ASME SFA-5.1.

(2) "Certificate of Conformance" to AWS classification test requirements is available. These are needed for Federal Highway Administration projects.

(3) Also meets the requirements of E6020

(4) Specification QQ-E-450 a was cancelled by the General Services Administration effective December 24, 1985. Per their instructions "Further procurements should be made in accordance with AWS A5.1."

THE “FILL-FREEZE” GROUP

General Applications

- Made especially for welding carbon steel.
- Irregular or short welds that change direction or position, and downhill fillets & laps.

- Sheet metal lap and fillet welds.
- “Fast-Fill” joints with poor fit-up.
- General purpose welding in all positions.

“Fill-Freeze” Characteristics

- Medium deposit rates and medium penetration.

- Appearance ranges from smooth and ripple-free to even with distinct ripples.
- All position operation but most widely used downhill or in the level position.
- Excellent “Fill-Freeze” characteristics of 5/64” through 3/16” sizes of E6012 and E6013 are excellent for sheet metal welding.

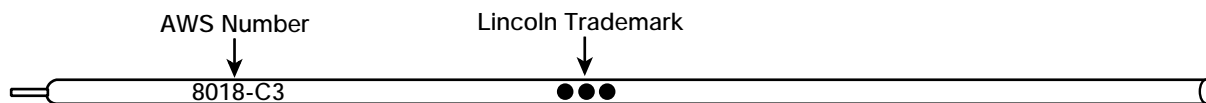
SPECIFIC ELECTRODE APPLICATIONS

AWS Class	Product Name	Description
E6012	FLEETWELD®7	Makes small beads with light slag at fast speeds. Primarily used for sheet metal fabrication and general purpose plate welding in production and maintenance especially when one electrode is used for a variety of work and most welds are in the level or downhill positions. Operates well on AC or DC.
E6013	FLEETWELD 37	Intended primarily for sheet metal welding when weld appearance and easy operation are more important than speed. Best E6013 for downhill and vertical down welding due to superior slag control using a drag technique. AC operation is excellent even with 225 amp (low open circuit voltage) welders.
E6013	FLEETWELD 37+	Similar to Fleetweld 37 with less spatter and a smoother arc. Suited for sheet metal welding in all positions using a drag technique. AC operation is excellent even with 225 amp (low open circuit voltage) welders.
E7014	FLEETWELD 47	Iron powder in the coating provides the highest deposit rates and fastest speeds of the “Fill-Freeze” electrodes. It is easy to use and has excellent operator appeal. Most frequently used for short, irregular, poorly fit, or downhill “Fast-Fill” joints and is generally used for thicker steel than E6012 or E6013 electrodes.

WELDING TECHNIQUES

- **Polarity** - Use DC- for best performance on all applications except when arc blow is a problem. To control arc blow, use AC.
- **Downhand and Downhill** - Use stringer beads for the first pass except when poor fit-up requires a slight weave. Use either stringer or weave beads for succeeding passes. Touch the tip of the electrode to the work or hold a 1/8” or shorter arc. Move as fast as possible consistent with desired bead size. Use currents in the middle to higher portion of the range.
- **Electrode Size** - Use 3/16” or smaller sizes for vertical and overhead welding.
- **Vertical-Down** - Use stringer beads or a slight weave. A drag technique should be used with Fleetweld 37, 37+ and 47. Make small beads. Point the electrode up so arc force pushes molten metal back up the joint. Move fast enough to stay ahead of the molten pool. Use currents in the higher portion of the range.
- **Vertical-Up** - Use a triangular weave for the first pass. Weld a shelf at the bottom of the joint and add layer upon layer using a straight weave pausing on each side to ensure penetration and proper wash-in. **Do not whip or take the electrode out of the molten pool.**
- **Overhead** - Make stringer beads using a drag technique with a slight circular motion in the crater. Do not weave. Travel fast enough to avoid spilling. Use currents in the lower portion of the range.
- **Sheet Metal** - Weld downhill when possible. Move as fast as possible while maintaining a continuous bead. Use currents in the middle to higher portion of the range.

ELECTRODE IDENTIFICATION AND OPERATING DATA



Product Name	AWS Class	Coating Color	Electrode Polarity	Sizes & Current Ranges (Amps) (Electrodes are manufactured in those sizes for which current ranges are given)					
				3/32" Size	1/8" Size	5/32" Size	3/16" Size	7/32" Size	1/4" Size
Fleetweld®7	E6012	Tan	DC - AC	---	80-135 90-150	110-180 120-200	155-250 170-275	225-295 250-325	245-325 275-360
Fleetweld 37	E6013	Gray	AC DC ±	75-105 (1) 70-95	110-150 100-135	160-200 145-180	205-260 190-235	--- ---	--- ---
Fleetweld 37+	E6013	Green	AC DC ±	75-105 70-95	110-150 100-135	160-200 145-180	--- ---	--- ---	--- ---
Fleetweld 47	E7014	Gray Brown	AC DC -	80-100 75-95	110-160 100-145	150-225 135-200	200-280 185-235	260-340 235-305	280-425 260-380

(1) Range for 5/64" Fleetweld 37 is 50-80 amps AC or 45-75 amps DC. 1/16" Fleetweld 37 is 20-45 amps AC or DC.

DC + is Electrode Positive,
DC - is Electrode Negative.

TYPICAL MECHANICAL PROPERTIES

Test procedures per appropriate AWS specification. Other specifications may have different minimum requirements and test procedures may produce different results. Low figures in the as-welded ranges below are AWS minimum requirements.

	Fleetweld 7	Fleetweld 37	Fleetweld 37+	Fleetweld 47
As Welded				
Tensile Strength - psi	60-84,000	60-78,000	60-89,000	70-83,000
Yield Point - psi	48-70,000	48-69,000	48-77,000	58-74,000
% Elong	17-28	17-31	17-32	17-29
Charpy V-Notch Toughness - ft. lbs.	58 @ 70°F	70 @ 70°F	61 @ RT	51 @ 70°F
Hardness, Rockwell B (avg) (1)	76-86	78-86	86-89	83-90
Stress Relieved@1150°F				
Tensile Strength - psi	67-84,000	67-74,000	---	67-77,000
Yield Point - psi	55-73,000	55-68,000	---	55-70,000
% Elong.	17-24	17-29	---	24-30
Charpy V-Notch Toughness - ft. lbs.	62 @ 70°F	---	---	51 @ 70°F

(1) Hardness values obtained from welds made in accordance with AWS A5.1.

CONFORMANCES AND APPROVALS

See Lincoln Electric Price Book for certificate numbers, size and position limitations and other data.

AWS Class (1)	Lloyd's Grade	DNV Grade	GL Grade	BV Grade	ASME Boiler Code		ABS Grade	Conformance Certificate Available (2)	Military Specifications
					Group	Analysis			
Fleetweld® 7 AWS E6012	---	---	---	---	F2	A1	E6012	Yes	QQ-E-450 (3)
Fleetweld 37 AWS E6013	3	1	1	1	F2	A1	E6013	Yes	QQ-E-450 (3)
Fleetweld 37+ AWS E6013	---	---	---	---	F2	A1	---	Yes	---
Fleetweld 47 AWS E7014	1	1	1	1	F2	A1	E7014	Yes	---

ABS: American Bureau of Shipping GL: Germanischer Lloyd
 Lloyd's: Lloyd's Register of Shipping BV: Bureau Veritas
 DNV: Det Norske Veritas

- (1) Conforms to test requirements of AWS A5.1 and ASME SFA-5.1.
- (2) "Certificate of Conformance" to AWS classifications test requirements is available. These are needed for Federal Highway Administration projects.
- (3) Specification QQ-E-450a was cancelled by the General Services Administration effective December 24, 1985. Per their instructions, "Future procurements should be made in accordance with AWS A-5.1".

THE LOW HYDROGEN GROUP

General Applications

- Made especially for welding carbon and low alloy steel.
- Capable x-ray quality and excellent mechanical properties.
- To resist cracking in medium to high carbon steels, hot short cracking in phosphorus bearing steels, and porosity in sulfur bearing steels. However, x-ray quality and mechanical properties may be lower.
- Thick sections and restrained joints on mild and alloy steel plate when shrinkage stresses tend to cause weld cracking.
- Multiple pass, vertical and overhead welds in carbon steel plate.

- Low hydrogen electrodes can produce dense, x-ray quality welds with excellent notch toughness and ductility. The low hydrogen content in the deposit reduces the danger of underbead and micro-cracking on high carbon and low alloy steels and on thick weldments. Less preheat is needed than for other electrodes.
- No baking necessary for Lincoln low hydrogen electrodes. All Lincoln low hydrogen electrodes are shipped in hermetically sealed containers which can be stored indefinitely in normal storage conditions without danger of moisture pickup (1).

(1) Moisture Pickup - Coating moisture pickup is important because it may result in hydrogen induced cracking, particularly in steels with 80,000 psi and higher yield strength. LH-75MR, LH-78MR - and the low hydrogen / low alloy group have a high resistance to coating moisture pickup and, if properly stored, will be less susceptible to this problem

LOW HYDROGEN ELECTRODES SHOULD BE STORED PROPERLY, EVEN THOSE WITH HIGH RESISTANCE TO COATING MOISTURE PICKUP.

E7018 Has "Fill-Freeze" Characteristics

- All-position operation: But quite different from "Fast-Freeze" electrodes. Weld metal freezes rapidly even through the slag remains relatively fluid.
- Medium deposit rates consistent with all-position operation provided by iron powder in the coating.
- Appearance: Flat or slightly convex beads have distinct ripples with little spatter.

E7028 has "Fast-Fill" Characteristics

- Highest deposition rates of all electrodes.
- Good bead appearance: Smooth, ripple-free beads are flat or slightly convex with minimal spatter.
- Easy slag removal: Heavy slag tends to peel off.
- Shallow penetration for minimum admixture.

SPECIFIC ELECTRODE APPLICATIONS ⁽¹⁾

AWS Class	Product Name	Description
E7018	JETWELD®LH-70	An efficient general purpose electrode suggested for all the "General Applications" listed above. Iron powder in the coating provides high deposit rates consistent with out-of-position welding.
E7018 MIL-7018-M Identified E7018-1	JETWELD LH-75 MR	Has superior impact properties at -50°F with an AWS identification of E7018-1. Features good all position handling with excellent slag removal, high resistance to coating moisture pickup and good low current operation. Increased resistance to long arc porosity.
E7018	JET-LH®78 MR	Features extra-high tensile strength in the stress-relieved condition, high resistance to coating moisture pickup and arc blow, easy all-position handling, and excellent slag removal and weld appearance.
E7018	JETWELD LH-73	Features good all-position handling and slag removal, especially on AC. Has excellent re-striking characteristics for skip and tack welding. Good low current and low open circuit voltage operation makes it ideal for use on 180 and 225 ampere machines.
E7018	LINCOLN 7018 AC	Performs equally well on AC or DC with exceptional performance when using alternating current. Capable of cold restrike. Performance is also good with low open circuit voltage power sources.
E7028	JETWELD LH-3800	For high production "Fast-Fill" applications when low hydrogen quality is required. Operates best on flat fillets and deep groove joints. Also suitable for horizontal fillet and lap welds. Excellent restriking for skip and tack welding.
E7018	EXCALIBUR 7018	E7018 with superior operating characteristics. Exceptionally clean puddle and square coating burnoff, making handling of the electrode easy in all positions. Has starting tip for improved arc initiation.
E7018-1	EXCALIBUR 7018-1	Same operating characteristics as EXCALIBUR 7018 with superior impact properties at -50°F with an AWS identification of 7018-1

(1) The Lincoln Electric Company strongly recommends for weldments intended for sour gas, sour crude, or other critical service applications that the customer verifies that both the level of hardness and variation in hardness of the weld, heat affected zone, and base plate are within acceptable limits.

WELDING TECHNIQUES

All 7018 type stick electrodes require a "drag" to 1/16" max. arc length to obtain the desired mechanical properties and weld quality. **AN ARC LENGTH OF 1/8" OR LONGER MAY RESULT IN POROSITY AND SERIOUS DETERIORATION OF IMPACT PROPERTIES.**

- **Polarity** - Use DC+, whenever possible, with 5/32" and smaller sizes of Jetweld LH-70. Use AC with the larger sizes for best operating characteristics.
- **Downhand** - On the first pass, or whenever it is desirable to reduce admixture with a base metal of poor weldability, use low currents. On succeeding passes, use currents that provide best operating characteristics. Drag the electrode lightly or hold as

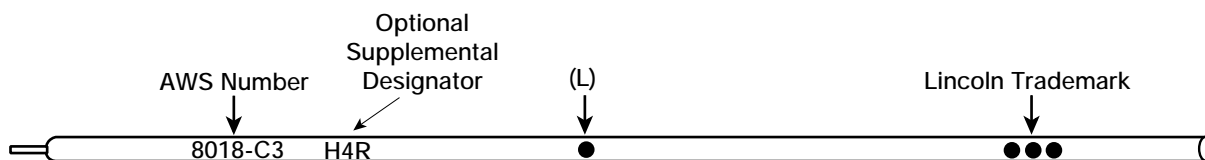
short an arc as possible, 1/16" max. when optimum impacts and x-ray quality are required. Do not use a long arc at any time because this type of electrode relies principally on molten slag for shielding. Stringer beads or small weave passes are preferred to wide weave passes. Layers should be kept as thin as possible (3/16" max.) for best properties. When starting a new electrode, strike the arc ahead of the crater, move back into the crater, and then proceed in the normal direction. Use higher currents on AC than DC. Govern travel speed by the desired bead size.

- **Vertical** - Weld vertical-up with 5/32" and smaller sizes. Use a triangular weave for heavy single-pass welds. For multi-pass welds, first deposit a stringer bead using a slight weave. Deposit additional layers with a side-to-side weave, hesitating at the sides long

enough to fuse out any small slag pockets and minimize undercut. **Do not use a whip technique or take the electrode out of the molten pool.** Travel slow enough to maintain the shelf without causing metal to spill. Use currents in the low to middle portion of the range, depending on joint design and plate thickness.

- **Overhead** - Use 5/32" and smaller electrodes. Deposit stringer beads using a slight circular motion in the crater. Motions should be slow and deliberate. Move fast enough to avoid spilling weld metal, but do not be alarmed if some slag spills. Use currents in the lower portion of the range.
- **Jetweld LH-3800** - For a description of welding techniques for this "Fast-Fill" electrode, see page 18.

ELECTRODE IDENTIFICATION AND OPERATING DATA



Product Name	AWS Class	Optional Supplemental Designator	(L) Lincoln	Coating Color	Electrode Polarity	Sizes & Current Ranges (Amps) (Electrodes are manufactured in those sizes for which current ranges are given)						
						3/32" Size	1/8" Size	5/32" Size	3/16" Size	7/32" Size	1/4" Size	5/16" Size
Jetweld LH-70	E7018	H4R	---	Gray	DC +	70-100	90-150	120-190	170-280	210-330	290-430	375-500
					AC	80-120	110-170	135-225	200-300	260-380	325-440	400-530
Jetweld LH-73	E7018	H8	Green	Gray DC +	AC 70-115	75-120 100-140	105-150 120-185	130-200 ---	---	---	---	---
Jetweld LH-75MR	E7018	H4R	---	Gray	DC +	70-110	95-160	120-190	180-270	250-330	300-400	---
					AC	80-110	100-170	135-225	210-290	270-370	325-420	---
Jet-LH 78 MR	E7018 (white numbers)	H4R	---	Gray	DC +	85-110	110-160	130-200	180-270	250-330	300-400	---
					AC	90-110	120-170	140-230	210-290	270-370	325-420	---
Jetweld LH-3800	E7028	H8	---	Gray Brown	AC	---	---	180-270	240-330	275-410	360-520	---
					DC +	---	---	170-240	210-300	260-380	---	---
Lincoln 7018 AC	E7018	H8	---	Gray	AC	75-120	105-150	130-200	---	---	---	---
					DC +	70-115	100-140	120-185	---	---	---	---
EXCALIBUR 7018	E7018	H4R	---	Gray	DC +	70-110	90-160	130-210	180-300	---	---	---
					AC	80-120	100-160	140-210	200-300	---	---	---
EXCALIBUR 7018-1	E7018-1	H4R	---	Gray	DC +	70-110	90-160	130-210	180-300	---	---	---
					AC	80-120	100-160	140-210	200-300	---	---	---

DC + is Electrode Positive.
DC - is Electrode Negative.

TYPICAL MECHANICAL PROPERTIES

Test procedures per appropriate AWS specification. Other specifications may have different minimum requirements and test procedures may produce different results. Low figures in the as-welded ranges below are AWS minimum requirements.

	Jetweld LH-70	Jetweld LH-73	Jetweld LH-75 MR	Jet-LH 78 MR	Jetweld LH-3800	Lincoln 7018 AC	EXCALIBUR 7018	EXCALIBUR 7018-1
As Welded								
Tensile Strength - psi	70-87,000	70-97,000	70-89,000	70-90,000	70-91,000	70-87,000	70-88,000	70-88,000
Yield Point - psi	58-77,000	58-86,000	58-74,000	58-80,000	58-76,000	58-86,000	58-73,000	58-73,000
% Elong.	22-34	22-32	22-35	22-33	22-31	22-32	22-35	22-35
Charpy V-Notch Toughness - ft. lbs.	20-160 @ -20°F	20-56 @ -20°F	20-150 @ -50°F	20-125 @ -20°F	20-60 @ 0°F	20-56 @ -20°F	20-220 @ -20°F	20-130 @ -50°F
Hardness, Rockwell B (avg) (1)	83-92	90-94	82-90	83-92	83-93	90-94	80-92	80-92
Stress Relieved @1150°F								
Tensile Strength - psi	65-74,000	---	70-82,000	71-85,000	72-89,000	---	70-80,000	70-80,000
Yield Point - psi	55-60,000	---	61-78,000	56-73,000	60-77,000	---	56-65,000	56-65,000
% Elong.	24-34	---	28-35	27-33	22-29	---	30-36	30-36
Charpy V-Notch Toughness - ft. lbs.	120 @ -20°F	---	110 @ -50°F	80 @ -20°F	85 @ 70°F	---	200 @ -20°F	125 @ -50°F

(1) Hardness values obtained from welds made in accordance with AWS A5.1.

CONFORMANCES AND APPROVALS

See Lincoln Electric Price Book for certificate numbers, size and position limitations and other data.

AWS Class (1)	Lloyd's Grade	DNV Grade	GL Grade	BV Grade	ASME Boiler Code -		ABS Grade	Conformance Certificate Available (2)	Military Specifications
					Group	Analysis			
LH-70 AWS E7018	3H, 3YH5	3YH5	3YH5	3YHHH	F4	A1	E7018	Yes	MIL-E-22200/1
LH-73 AWS E7018	---	---	---	---	F4	A1	---	Yes	---
LH-75 MR AWS E7018-1	3H, 3YH5	---	---	---	F4	A1	E7018-1	Yes	MIL-E-22200/10
LH-78 MR AWS E7018	3H, 3YH5	3YH5	3YH5	3YHHH	F4	A1	E7018	Yes	---
LH-3800 AWS E7028	2H, 2YH5	2YHH	2YH10	2YHH	F1	A1	E7028	Yes	---
7018 AC AWS E7018	---	---	---	---	F4	A1	---	Yes	---
EXCALIBUR 7018	3, 3YH5	3YH5	3YH5	3YHHH	F4	A1	E7018M 3, 3YH5	Yes	---
EXCALIBUR 7018-1	3, 3YH5	3YH5	3YH5	3YHHH	F4	A1	E7018M 3, 3YH5	Yes	---

ABS: American Bureau of Shipping GL: Germanischer Lloyd
 Lloyd's: Lloyd's Register of Shipping BV: Bureau Veritas
 DNV: Det Norske Veritas

(1) Conforms to test requirements of AWS A5.1 and ASME SFA-5.1.

(2) "Certificate of Conformance" to AWS classifications test requirements is available. These are needed for Federal Highway Administration projects.

THE LOW HYDROGEN, LOW ALLOY STEEL GROUP

General Applications

All position fabrication and repair welding of the alloy steels that require the specific mechanical or chemical properties of one of these electrodes. Specifically for use in cryogenics, high temperature applications, and for x-ray quality requirements. For more specific electrode recommendations, see the list of ASTM steels on pages 4, 5 & 6.

These electrodes have Low Hydrogen "Fill-Freeze" operating characteristics similar to Jetweld LH-70.

For high tensile pipe welding electrodes, see the section entitled "For Welding High Tensile Pipe" in the "Fast-Freeze" group section.

Welding Weathering Steel (ASTM A242 or A588)

For best color match of multipass welds to the base plate on unpainted structures, use Jet-LH 8018-C3 MR (1% Ni). Other electrodes suitable for multipass welds on unpainted structures are Jet-LH 8018-C1 MR (2-1/4% Ni) and Jetweld LH-90 MR (1-1/4% Cr, 1/2% Mo). For single pass welds, multipass welds which are not exposed, and multipass welds which do

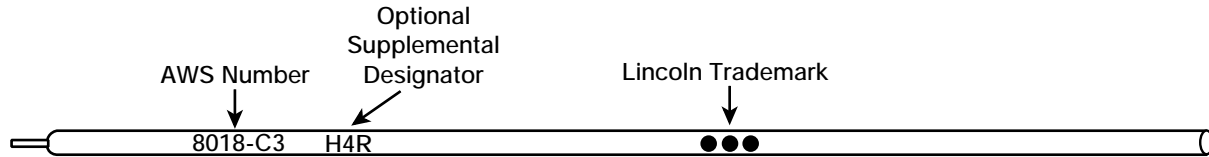
not require a close color match, Jetweld LH-70 (E7018) may be used.

- All Position Operation: but quite different than "Fast-Freeze" electrodes. Weld metal freezes rapidly even through slag remains relatively fluid.
- High Deposit Rates: Consistent with all-position operation provided by iron powder in the coatings.
- Appearance: Flat or slightly convex beads have distinct ripples with little spatter.
- Slag Removal: Moderately heavy slag is easy to remove.
- Moisture Pickup: For information on moisture pickup see "Low Hydrogen" group section, and refer to Lincoln Bulletin M629, "Storing and Redrying Manual Electrodes" for details.

SPECIFIC ELECTRODE APPLICATIONS

AWS Class	Product Name	Description
E8018-B2	JETWELD®LH-90 MR	Capable of producing 1-1/4% chromium, 1/2% molybdenum deposit commonly required for high temperature, high pressure piping. Also meets the requirements of E9018-G for welding some high strength (90,000 psi tensile) steels.
E8018-B2	JET-LH 8018-B2 MR	Capable of producing a 1-1/4% chromium, 1/2% molybdenum deposit for welding power piping, tubes, boilers and castings when design temperatures exceed 850°F.
E9018-B3	JET-LH 9018-B3 MR	Capable of producing a 2-1/4% chromium, 1% molybdenum deposit for welding power piping, tubes, boilers and castings when design temperatures exceed 850°F.
E8018-C3	JET-LH®8018-C3 MR	Capable of producing an 80,000 psi tensile strength weld for general purpose welding many high strength alloys and a 1% nickel deposit for welding low temperature alloys that require good notch toughness down to -60°F. Also used for fillet welds on high strength (110,000 psi tensile) quenched and tempered steels, ASTM A514 and A517.
E8018-C1	JET-LH®8018-C1 MR	Capable of producing a 2-1/4% nickel deposit with notch toughness of 20 ft-lbs at -75°F for welding low temperature alloys frequently used on storage, piping and transportation equipment for liquid ammonia, propane, and other gases.
MIL-10018-M1	JETWELD LH-100M1 MR	Capable of producing yield strength levels of 82-110,000 psi. Excellent notch toughness down to -60°F in either the flat or vertical-up position. The lower yield and tensile strength as well as the lower weld metal hardenability allows for the use of lower preheat and interpass temperatures when welding critical HY-80 structures.
E11018-M	JETWELD LH-110M MR	Capable of producing the 110,000 psi tensile strength deposit needed for full strength welds on the quenched and tempered steels ASTM A514 and A517 (T-1, SSS-100, etc.)

ELECTRODE IDENTIFICATION AND OPERATING DATA



Product Name	AWS Class	Optional Supplemental Designator	Coating Color	Electrode Polarity	Sizes & Current Ranges (Amps)					
					(Electrodes are manufactured in those sizes for which current ranges are given)					
					3/32" Size	1/8" Size	5/32" Size	3/16" Size	7/32" Size	1/4" Size
Jetweld LH-90 MR	E8018-B2	H4R	Gray	DC +	---	110-150	130-190	180-270	---	---
				AC	---	120-170	140-225	210-290	---	---
Jet-LH 8018-B2 MR	E8018-B2	3/32 H4 1/8-5/32 H4R	Gray	DC +	70-100	100-140	120-190	---	---	---
				AC	85-120	110-150	135-200	---	---	---
Jet-LH 9018-B3 MR	E9018-B3	3/32 H4 1/8-5/32 H4R	Gray	DC +	70-100	100-140	120-190	---	---	---
				AC	85-120	110-150	135-200	---	---	---
Jet-LH 8018-C3 MR	E8018-C3	H4R	Gray-Brown	DC +	---	110-150	130-190	180-270	250-330	300-400
				AC	---	120-170	140-225	210-290	270-370	325-420
Jet-LH 8018-C1 MR	E8018-C1	H4R	Gray-Brown	DC +	---	90-150	120-180	180-270	---	250-350
				AC	---	110-160	140-200	200-300	---	300-400
Jetweld LH-100M1MR	---	---	Gray	DC +	70-100	95-155	120-190	180-270	---	---
				AC	80-110	100-170	135-225	210-290	---	---
Jetweld LH-110M MR	E11018-M	H4R	Gray	DC +	70-110	90-155	120-190	160-280	190-310	230-360
				AC	80-110	100-170	135-225	200-310	240-350	290-410
Lincoln 10718 MR	---	---	Gray	DC+	70-110	100-140	120-190	200-265	---	---
				AC	80-120	110-150	130-200	210-275	---	---

DC + is Electrode Positive,
DC - is Electrode Negative.

MECHANICAL PROPERTY REQUIREMENTS

Requirements of AWS A5.5 and ASME SFA-5.5

	Jetweld-LH 90 MR & Jet-LH 8018-B2 MR	Jetweld LH 90 MR	Jet-LH 8018-C3 MR	Jet-LH 8018-C1 MR	Jetweld LH 110M/MR	Jet-LH 9018-B3 MR
As Welded Tensile Strength - psi	Not Required	Not Required	80,000 min	Not Required	110,000 min	Not Required
Yield Point - psi	Not Required	Not Required	68-80,000	Not Required	98-110,000	Not Required
% Elong.	Not Required	Not Required	24% min	Not Required	20% min	Not Required
Charpy V-Notch Toughness - ft. lbs.	---	---	20 @ -40°F	---	20 @ -60°F	---
Stress Relieved Tensile Strength - psi	@ 1275°F 1 hr 80,000 min	@ 1150°F 1 hr 90,000 min	Not Required	@ 1150°F 1 hr 80,000 min	Not Required	@ 1275°F 1 hr 90,000 min
Yield Point - psi	67,000 min	77,000 min	Not Required	67,000 min	Not Required	77,000 min
% Elong.	19% min	17% min	Not Required	19% min	Not Required	17% min
Charpy V-Notch Toughness - ft. lbs.	Not Required	Not Required	---	20 @ -75°F	---	Not Required

MECHANICAL PROPERTY REQUIREMENTS ⁽¹⁾ (Continued)

Requirements of MIL-E-22200/1 (ships), MIL-E-22200/10 (ships), and PPD 802-6337513

	Jet-LH-8018-C3 MR MIL-8018-C3	Jetweld LH-100M1 MR MIL-10018-M1	Jetweld LH-110M MR MIL-11018-M
As Welded			
Tensile Strength - psi	80,000 min	Not Required	110,000 min
Yield Point - psi	68-80,000	82-110,000	98-110,000
% Elong.	24% min	20% min	20% min
Charpy V-Notch Toughness - ft. lbs.	20 @ -20°F	60 @ 0°F 35 @ -60°F	35 @ -60°F
Stress Relieved			
Tensile Strength - psi	@ 1150°F 2 hr Not Required	@ 1125°F 1 hr Not Required	@ 1025°F 1 hr Not Required
Yield Point - psi	65,000 min	80,000 min	95,000 min
% Elong.	24% min	20% min	20% min
Charpy V-Notch Toughness - ft. lbs.	20 @ -20°F	20 @ -60°F	20 @ -60°F

(1) The Lincoln electrodes meet the minimum property requirements shown above when welded and tested in accordance with the appropriate specification. Other tests and other procedures may produce different results.

MECHANICAL PROPERTIES TEST RESULTS ⁽¹⁾

	Jetweld LH-90 MR	Jet-LH 8018-C3 MR	Jet-LH 8018-C1 MR	Jetweld LH-100M1 MR
As Welded	(AWS)	(AWS-MIL)	(AWS)	(MIL)
Tensile Strength - psi	97-107,000	80-94,000	80-95,000	101-116,000
Yield Point - psi	84-97,000	68-80,000	67-81,000	82-110,000
% Elong.	17-24	24-30	19-25	20-24
Charpy V-Notch Toughness - ft. lbs.	40 @ 70°F	20-109 @ -40°F	30-60 @ -75°F	72-112 @ 0°F, 43-76 @ -60°F
Hardness, Rockwell B (avg) (2)	95-97	85-93	84-90	---
Stress Relieved	(AWS E8018-B2) (AWS E9018-G)	(MIL)	(AWS)	(MIL)
Tensile Strength - psi	@ 1275°F 1 hr @ 1150°F 1 hr	@ 1150°F 2 hr	@ 1150°F 1 hr	@ 1125°F 1 hr
	80-98,000 90-107,000	75-84,000	80-96,000	99-111,000
Yield Point - psi	67-93,000 77-95,000	66-73,000	66-81,000	88-104,000
% Elong.	19-27 17-24	24-32	19-32	20-26
Charpy V-Notch Toughness - ft. lbs.	50-115 @ 70°F 44-70 @ 70°F	20-120 @ -20°F	20-85 @ -75°F	36-61 @ 60°F 65-93 @ 0°F
Hardness, Rockwell B (avg) (2) - ft. lbs.	93-99	93-99	85-95	---

(1) These property ranges were obtained from welds made and tested in accordance with AWS A5.5 (and ASME SFA-5.5), MIL-E-22200/1, or MIL-E-22200/10 as indicated. They show the potential for the electrodes but the ranges are not guaranteed because other tests and other procedures may produce different results.

(2) Hardness values obtained from welds made in accordance with AWS A5.5.

MECHANICAL PROPERTIES TEST RESULTS ⁽¹⁾ (Continued)

	Jetweld LH-110M MR	Jet-LH 8018-B2 MR	Jet-LH 9018-B3 MR
As Welded	(AWS-MIL)	(AWS)	(AWS)
Tensile Strength - psi	110-128,000	112-121,000	136-147,000
Yield Point - psi	98-109,000	100-107,000	122-131,000
% Elong.	20-24	17-24	15-22
Charpy V-Notch Toughness - ft. lbs.	38-58 @ -60°F	69-92 @ 70°F	51-58 @ 70°F
Hardness, Rockwell B (avg) (2)	99-109	---	---
Stress Relieved	(MIL)	(AWS)	(AWS)
Tensile Strength - psi	@ 1125°F 1 hr 110-120,000	@ 1275°F 1 hr 93-103,000	@ 1275°F 1 hr 100-114,000
Yield Point - psi	95-107,000	81-93,000	86-100,000
% Elong.	20-26	25-28	21-25
Charpy V-Notch Toughness - ft. lbs.	20-45 @ -60°F	63-108 @ -20°F	37-65 @ -20°F

- (1) These property ranges were obtained from welds made and tested in accordance with AWS A5.5 (and ASME SFA-5.5), MIL-E-22200/1, or MIL-E-22200/10 as indicated. They show the potential for the electrodes but the ranges are not guaranteed because other tests and other procedures may produce different results.
- (2) Hardness values obtained from welds made in accordance with AWS A5.5.

CONFORMANCES AND APPROVALS

See Lincoln Electric Price Book for certificate numbers, size and position limitations and other data.
Conforms to test requirements of AWS - A5.5 and ASME SFA-5.5

AWS Class (1)	ASME Boiler Code -		ABS Grade	Conformance Certificate Available (3)	Military Specifications
	Group	Analysis			
Jetweld LH-90 MR (1) AWS E8018-B2	F4	A3	---	Yes	---
Jet-LH 8018-C3 MR AWS E8018-C3	F4	A10	E8018-C3	Yes	MIL-E-22200/1
Jet-LH 8018-C1 MR AWS E8018-C1	F4	A10	E8018-C1	Yes	---
Jetweld LH-100M1 MR ---	---	---	---	---	MIL-E-22200/10
Jetweld LH-110M MR AWS E11018-M	F4	A12	E11018-M	Yes	MIL-E-22200/1
Jet-LH 8018-B2 MR AWS E8018-B2	F4	A3	---	Yes	---
Jet-LH 9018-B3 MR AWS E9018-B3	F4	A4	---	Yes	---

ABS: American Bureau of Shipping

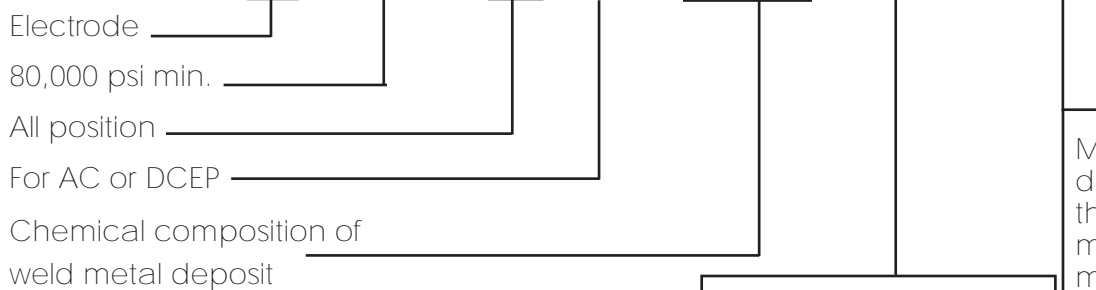
- (1) Conforms to test requirements of AWS A5.5 and ASME SFA-5.5.
- (2) Also conforms to requirements for E9018-G.
- (3) "Certificate of Conformance" to AWS classifications test requirements is available. These are needed for Federal Highway Administration projects.

AWS NUMBERING SYSTEM

E6010



E8018-B1H4R



Diffusible hydrogen designator indicates the maximum diffusible hydrogen level obtained with the product.

Moisture resistant designator indicates the electrode's ability to meet specific low moisture pickup limits under controlled humidification tests.

Position

1. Flat, Horizontal, Vertical, Overhead
2. Flat and Horizontal only
3. Flat, Horizontal, Vertical Down, Overhead

Types of coating and current

Digit	Type of Coating	Welding Current
0	cellulose sodium	DCEP
1	cellulose potassium	AC or DCEP or DCEN
2	titania sodium	AC or DCEN
3	titania potassium	AC or DCEP
4	iron powder titania	AC or DCEN or DCEP
5	low hydrogen sodium	DCEP
6	low hydrogen potassium	AC or DCEP
7	iron powder iron oxide	AC or DCEP or DCEN
8	iron powder low hydrogen	AC or DCEP

DCEP – Direct Current Electrode Positive
 DCEN – Direct Current Electrode Negative

Chemical Composition of Weld Deposit

Suffix	% Mn	% Ni	% Cr	% Mo	% V
A1				1/2	
B1			1/2	1/2	
B2			1-1/4	1/2	
B3			2-1/4	1	
C1		2-1/2			
C2		3-1/4			
C3		1	.15	.35	
D1 & D2	1.25-2.00			.25-.45	
G ⁽¹⁾		.50	.30 min.	.20 min.	.10 min.

(1) Only one of the listed elements is required.

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