Filler Metals

Selection Guide

LINCOLN ELECTRIC

The serviceability of a product or structure utilizing these suggested consumables is and must be the sole responsibility of the builder/user. Many factors must be taken into consideration when a filler metal is selected for a specific application. These factors include, but are not limited to, the type of steel, type of weld, loading on the welded joint, applicable codes, level of preheat, level of restraint, position of welding, condition of the steel, and service conditions. This guide provides matching strength filler metal options – see discussion about undermatching below. The primary focus of these suggestions is based upon the yield and tensile strength properties of the weld deposit as compared to the base metal yield and tensile strength properties. These suggested products may not meet all code or application requirements. Suggested filler metals may not always meet Charpy V-Notch (CVN) application requirements – reference comments below on CVN's.

Reference is made to ASTM and API specifications and classifications and the requisite properties specified in those documents. These specifications are subject to change, and the user should consult the latest version of these documents to ensure that these descriptions are up-to-date. These filler metal suggestions "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. Suggested electrodes in this Selection Guide include those that have deposit weld metal with different levels of diffusible hydrogen. High levels of hydrogen can cause weld metal and base metal cracking. The permissible level of hydrogen in a weld deposit is dependent on many factors, including preheat and interpass temperatures intended to be used. The user of this information must make certain that, for the suggested electrode that is selected, the preheat and interpass temperatures will be proper for the application. Suggested filler metals in this Selection Guide do not always consider notch toughness (example Charpy V-Notch properties) requirements. Not all welding products 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 products that meet the specific application requirements.

Filler Metals Selection Guide

This guide lists recommended Lincoln Electric matching strength Manual Stick (SMAW), MIG (GMAW), Submerged Arc (SAW), Self-Shielded and Gas-Shielded Flux-Cored (FCAW-S, FCAW-G) electrodes for ASTM, API and ABS classified steels. Also included is general information on each classification such as tensile strength, yield strength and steel chemistry.

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Technical Supporting Notes, Codes

Due to space consideration, technical supporting notes are listed here. Each is tied to a code used in the body of the tables which comprise the remainder of this book. The notes and codes are listed below and may be used to reference additional information regarding recommended Lincoln Electric consumables for each application. Please be sure to use the notes as an aid in selecting Lincoln Electric consumables.

SMAW

(1) Any E70X8 electrode may be used. Excalibur 7018, Jet-LH 78, Excalibur 7018-1, 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 E7018's for flat and horizontal fillet, lap, and flat butt welds.

(2) Almost any E60XX or E70XX electrodes can be used. First, select electrode based on the joint requirements. 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. 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 or 35LS.

(5) Best electrodes are Fleetweld 35, 180, 7, 37 or 47.

(6) When resistance to atmospheric corrosion and matching weathering characteristics are needed (such as on unpainted structures), use Excalibur 8018-C3 MR (1% Ni). The second choice for multipass welds is Excalibur 8018-C1 MR (2-1/4% Ni). For single pass welds, multipass welds which are not exposed, and multipass welds which do not require resistance to atmospheric corrosion and matching weathering characteristics, any E7018 electrode may be used.

(7) Fillet welds are frequently made with Excalibur 7018, Excalibur 7018-1, Jetweld LH-70, Jet-LH 78 or Excalibur 8018-C3.

(8) Jetweld LH-70 for fillets or Excalibur 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 Excalibur 7018-1 when high impact properties (CVN) down to -75°F are required.

(28) Use of Shield-Arc 90 should be limited to 3/8 in. maximum wall thickness.

SAW

(10) For single pass applications, any flux/wire combination meeting an AWS F7AX classification per AWS specification A5.17 may be used. Typically, for single pass applications, active fluxes such as 760, 761, 780 and 781 are recommended. 860, 865, 960 and 980 fluxes may also be suitable for single pass applications. The following flux/wire combinatins are classified under A5.17 and are recommended: 760/L-50, 760/L-61, 761/L-60, 761/L-61, 780/L-60, 781/L-50, 781/L-60, 781/L-61, 860/L-50, 860/L-61, 865/L-50, 865/L-61, 960/L-50, 960/L-61, 980/L-50, 980/L-61, and 980/LC-72. Refer to Lincoln Bulletin C5.10 for flux operability information.

(11) For multiple pass applications, any flux/wire combination meeting an AWS F7AX classification per AWS specification A5.17 may be used. Typically, for multiple pass applications, neutral fluxes such as 860, 865, 880M, 882, 8500 and MIL 800-H are recommended. 960 and 980 fluxes may also be suitable for multiple pass applications. The following flux/wire combinations are classified under A5.17 and are recommended: 8500/L-50, 8500/L-61, 8500/L-S3, 8600/L-50, 860/L-61, 860/L-S3, 865/L-50, 865/L-61, 880M/L-50, 880M/L-56, 880M/L-S3, 882/L-50, 882/L-56, 882/L-61, 882/L-S3, 960/L-50, 960/L-61, 980/L-50, 980/L-61, 980/LC-72, and MIL 800-H/L-S3. Refer to Lincoln Bulletin C5.10 for flux operabiity information.

(12) 880/LAC-M2, 880M/LAC-M2.

(13) MIL 800-H/LA-90, MIL 800-H/LA-100, 880M/LA-100, 880M/LA-92.

(14) 882/LAC-Ni2, 880M/LA-90, 980/LAC-Ni2.

SAW (Cont'd.)

(15) When resistance to atmospheric corrosion and matching weathering characteristics are needed (such as on unpainted structures), use 960/LA-75, AXXX10/L-61 or 880, 880M, 882/LAC Ni2. For single pass welds, multipass welds which are not exposed, and multipass welds which do not require resistance to atmospheric corrosion and matching weathering characteristics, other filler metal combinations may be used.

(26) 880, 880M/LAC B2 may be used in place of the listed Flux/Wire combinations for most applications.

(31) Filler metals suitable for undermatching strength applications use A709, Grades 70W and HPS 70W and A852 are: MIL 800-HPNi/LA-75, 860/LA-75 and 960/LA-75.

(32) 780 flux is recommended for "roundabout" applications because of its faster freezing slag.

(33) 781 flux is recommended for making high speed, single pass welds on clean plate and sheet steel.

(34) 761, 780, 860/L-70. 761 and 780 are recommended for single pass applications. 860 is recommended for multipass welds.

GMAW

(16) SuperArc L-50, SuperGlide S3, SuperArc L-54, SuperArc L-56, SuperGlide S6, Metalshield MC-6 or MC-710XL.

(29) Use LA-75 when resistance to atmospheric corrosion and matching weathering characteristics are needed. If the steel is to be painted and atmospheric corrosion resistance and matching weathering characteristics are not needed, SuperArc L-50, L-54, L-56, SuperGlide S3, S6, Metalshield MC-6 or MC-710XL may be used.

(30) LA-75 is certified to meet 80 ksi min. tensile strength with 98% Ar/2% O_2 shielding gas. LA-75 with 75-90% Ar/balance CO_2 shielding gas meets a 70 ksi min. tensile strength.

FCAW-S

(17) Any Innershield electrode may be used, with the following restrictions:
1. Innershield electrodes are not required to have specified levels of notch toughness. If code, specifications, or contract documents require notch toughness, an electrode should be selected to meet the specific requirements.
2. 0.068, 5/64 and 3/32 in. dia. NR-211-MP are restricted to maximum 1/2 in. thick carbon steel. 0.035 and 0.045 in. dia. NR-211-MP are restricted to maximum 5/16 in. thick carbon steel.
3. NR-1, NR-5, and NR-152 are typically used for high speed applications on carbon steel up to a maximum of 3/16 in. thick. NR-131 is designed for high speed, single pass welding on 12 gauge and thicker steels.

(18) Innershield: NR-203MP, NR-203 Ni(1%), NR-232, NR-305, NR-311 Ni. (Exception: NR-311 Ni is not approved for use with any A709 grade when AASHTO/AWS D1.5 is appliable.)

(19) Innershield: NR-203 Ni(1%).

(21) For vertical down applications, NR-207 or NR-207-H are the best choices. For vertical up applications, the NR-203-XX series is the best choice.

(22) When resistance to atmospheric corrosion and matching weathering characteristics are needed, use NR-203 Ni(1%). If the steel is to be painted and atmospheric corrosion resistance and matching weathering characteristics are needed, any E7XT-6, or -8 may be used.

FCAW-G

(23) Outershield 70, 70-H, XLH70, 71, 71M, 71 Elite.

(24) Outershield 81K2-H, 81Ni1-H.

(25) When resistance to atmospheric corrosion and matching weathering characteristics are needed (such as on unpainted structures), use 81K2-H or 81Ni1-H. For single pass welds, multipass welds which are not exposed, and multipass welds which do not require resistance to atmospheric corrosion and matching weathering characteristics, any E7XT-1, -5, or -9 may be used.

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ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A27	Carbon Steel Castings	All	60-70	30-40
A36	Structural-36,000 Min. Yield Strength	All, Carbon Steel #	58-80	36 min
A53	Pipe-Black, Hot dipped	Type E & S, Grade A Type E & S, Grade B Type F	48 min 60 min 48 min	30 min 35 min 30 min
A105	Forgings, for Piping		70 min	36 min
A106	Pipe	A & B C	48 & 60 min 70 min	30 & 35 min 40 min
A131	Structural Steel for Ships (Recommendations are based on strength req'ts. Impact Test Temp. req'ts are as follows: Grades B & AHxx @ +32°F, Grades D & DS @ +14°F, Grades DHxx @ -4°F, & Grades CS, E & EHxx @ -40°F, EH40 and FHxx grades are normalized, thermo-mechanical control processed, or quenched & tempered. FHxx grades impact test temp are -76°F.	A, B, D, DS, CS, E (Gr A Imp't Test Temp @ +68°F) AH32, DH32 & EH32 AH36, DH36, & EH36 AH40, DH40, & EH40 FH32 FH36 FH40	58-75 64-85 71-90 74-94 64-85 71-90 74-94	34 min 46 min 51 min 57 min 46 min 51 min 57 min
A134	Pipe	See A36, A283, A285, or A570		
A135	Pipe, Electric-Resistance-Steel (5.563 in. Max Dia.)	A B	48 min 60 min	30 min 35 min
A139	Pipe, Electric-Fusion (Arc)-Welded	A B C D E	48 min 60 min 60 min 60 min 66 min	30 min 35 min 42 min 46 min 52 min
A148	Castings-Structural	80-40 & -50 90-60 105-85 & 115-95 150-135	80 min 90 min 105 & 115 min 150 min	40-50 min 60 min 85 & 95 min 135 min
A161	L Carbon & C-Mo Still Tubes for Refinery Serv. @ Elevated Temperature (Discontinued in 1999, replaced by A192)	Low Carbon T1 (0.5% Mo)	47 min 55 min	26 min 30 min
A178	Electric-Resistance-Welded Carbon Steel & C-Mn Boiler Tubes (5 in. Max Dia.)	A (Low Carbon) C (Medium Carbon) D (Carbon-Manganese)	47 min 60 min 70 min	26 min 37 min 40 min
A179	Heat Exchanger (1/8-3 in. Dia.)		47 min	26 min
A181	Forgings, for General-Purpose Piping	Class 60 Class 70	60 min 70 min	30 min 36 min
A182	High Temp. Fittings, Flanges, Valves, etc.	F1 (0.5% Mo) F2 (0.5% Cr, 0.5% Mo) F11, Class 1&2 (1.25% Cr, 0.5% Mo) F11, Class 3 (1.25% Cr, 0.5% Mo) F12, Class 1 (1% Cr, 0.5% Mo) F12, Class 2 (1% Cr, 0.5% Mo) F21 (3% Cr, 1% Mo) F22, Class 1 (2.25% Cr, 1% Mo) F22, Class 3 (2.25% Cr, 1% Mo)	70 min 70 min 60 min & 70 min 75 min 60 min 70 min 75 min 60 min 75 min	40 min 40 min 30 min & 40 min 45 min 30 min 40 min 45 min 30 min 45 min
A192	Boiler Tube for High Pressure Service	7 in. Max Dia.	47 min	26 min
A199	Heat Exchanger Tubes (1/8-3 in. Dia.)	T4 (25% Cr, 0.5% Mo) T11 (1.25% Cr, 0.5% Mo) T22 (2.25% Cr, 1% Mo)	60 min 60 min 60 min	25 min 25 min 25 min
A200	Refinery Still Tubes (2-9 in. Dia.) Discontinued in 1999, replaced by A213)	T4 (2.5% Cr, 0.5% Mo) T11 (1.25% Cr, 0.5% Mo) T22 (2.25% Cr, 1% Mo)	60 min 60 min 60 min	25 min 25 min 25 min

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SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
(1)	(10), (11)	(16)	(18)	(23)
(2)	(10), (11)	(16)	(17)	(23)
(2), (4) (2), (4) (2), (4)	(10), (11), (32) (10), (11), (32) (10), (11), (32)	(16) (16) (16)	(21) (21) (21)	(23) (23) (23)
Excalibur 7018, LH-78 MR	(10), (11), (32)	(16)	(21)	(23)
(2) (2)	(10), (11) (10), (11)	(16) (16)	(21) (21)	(23) (23)
(1), (2)	(10), (11)	(16)	(18)	(23)
(1), (3) (1), (3) (1) LH-8018-C1 MR, Excalibur 8018-C1 MR LH-8018-C1 MR, Excalibur 8018-C1 MR LH-8018-C1 MR, Excalibur 8018-C1 MR	(10), (11) (10), (11) (10), (11) 880, 880M/LAC Ni2 880, 880M/LAC Ni2 880, 880M/LAC Ni2	(16) (16) (16) LA75 LA75 LA75	(18) (18) (18)	(23) (23) (23)
(2), (4) (2), (4)		(16) (16)	(21) (21)	(23) (23)
(2), (4) (2), (4) (2), (4) (2), (4) (2), (4)	(10), (11), (32) (10), (11), (32) (10), (11), (32) (10), (11), (32) (10), (11), (32)	(16) (16) (16) (16) (16)	(21) (21) (21) (21) (21)	(23) (23) (23) (23) (23)
LH-8018-C3 MR, Excalibur 8018-C3 MR LH-90 MR, Jet-LH 8018-B2 MR, Excalibur 9018-M MR LH-110M MR, LH100M1 MR	860, 960/LA75, 860/LA85 880M/LA100, 8500/LA-82 880, 880M/LAC-M2, 882/LA-82, MIL800H/LA-100, MIL800H/LA-82	LA75 LA90, LA100, MC900 LA100, MC-1100		(24) 91K2-H
Excalibur 7018, 7018-1, LH-78 MR, (4) SA-85, Excalibur 7018-A1	(10), (11), (32) (34), (32)	(16) LA90	(21) (21)	(23) (23)
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR		(16) (16) (16)	(21) (21) (21)	(23) (23) (23)
Excalibur 7018, 7018-1, LH-78 MR, (4)		(16)		
Excalibur 7018, 7018-1, LH-78 MR, Excalibur 7018, 7018-1, LH-78 MR	(10), (11), (32) (10), (11), (32)	(16) (16)	(21) (21)	(23) (23)
SA-85, Excalibur 7018-A1 LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR Jet-LH 9018-B3 MR Jet-LH 9018-B3 MR	(34), (32) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92 MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93	LA90		
(2), (4)	(10), (32)	(16)	(21)	(23)
Jet-LH 9018-B3 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR				
Jet-LH 9018-B3 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR	MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93			

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ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A202	Pressure Vessel Cr-Mn-Si	A (0.5% Cr) B (0.5% Cr)	75-95 81-110	45 min 47 min
A203	Pressure Vessel - Alloy Steel, Ni (Normalized) CVN Test Temp. shall be a matter of agreement between purchaser & supplier, may be as low as -100°F, which may change recommendations.	A & D (2.25% Ni & 3.5% Ni) B & E (2.25% Ni & 3.5% Ni) F (3.5% Ni)	65-85 70-90 (</=2 in.) (>2 in.) 80-100 75-95	37 min 40 min (</=2 in.) (>2 in.) 55 min 50 min
A204	Boiler & Pressure Vessel (0.5% Mo) Plates >1-1/2 in. Normalized	A B C	65-85 70-90 75-95	37 min 40 min 43 min
A209	C-Mo Boiler Tubes (1/2 -5 in. Dia.)	T1, T1a, T1b	55, 53, & 60 min	30, 28, & 32 min
A210	Carbon Steel Boiler Tubes (1/2-5 in. Dia.)	A-1 C	60 min 70 min	37 min 40 min
A211	Spiral Welded Pipe (Discontinued in 1993)	See A570		
A213	Boiler Tubes (1/8-5 in. Dia.)	T2 (0.75% Cr, 0.5% Mo) T11 (1.25% Cr, 0.5% Mo) T12 (1% Cr, 0.5% Mo) T17 (1% Cr) T21 (3% Cr, 1% Mo) T22 (2.25% Cr, 1% Mo)	60 min 60 min 60 min 60 min 60 min 60 min	30 min 30 min 30 min 30 min 30 min 30 min
A214	Heat-Exchanger Tubes (3 in. Max. Dia.)			
A216	Carbon Steel Castings - High Temp.	WCA WCB WCC	60-85 70-95 70-95	30 min 36 min 40 min
A217	Steel Castings, High Temp.	WC1 (0.5% Mo) WC4 (0.75% Cr, 0.5% Mo, 0.9% Ni) WC5 (0.75% Cr, 1% Mo, 0.8% Ni) WC6 (1.25% Cr, 0.5% Mo) WC9 (2.5% Cr, 1% Mo) WC11 (1.25% Cr, 0.5% Mo)	65-90 70-95 70-95 70-95 70-95 80-105	35 min 40 min 40 min 40 min 40 min 50 min
A225	Pressure Vessel, Mn-V-0.5% Ni	C (>2 in. Normalized) D (Normalized)	105-135 80-105	70 min 60 min
A226	High-Pressure Service (5 in. Max. Dia.) (Discontinued in 1997)		47 min	26 min
A234	Wrought Welding Fittings for Moderate & Elevated Temperatures	WPB	60-85	35 min
		WPC WP1 (0.5% Mo) WP11, Class 1 (1.25% Cr, 0.5% Mo) WP11, Class 2 (1.25% Cr, 0.5% Mo) WP11, Class 3 (1.25% Cr, 0.5% Mo) WP12, Class 1 (1% Cr, 0.5% Mo) WP12, Class 2 (1% Cr, 0.5% Mo) WP22, Class 1 (2.25% Cr, 1% Mo) WP22, Class 3 (2.25% Cr, 1% Mo)	70-95 55-80 60-85 70-95 75-100 60-85 70-95 60-85 75-100	40 min 30 min 30 min 40 min 45 min 30 min 40 min 30 min 45 min
A242	High Strength Low Alloy Structural-Cu (0.2% Cu min.) Groups listed are for Structural Shapes. For Plates & Bars, Tensile requirements are based on thickness.	Shapes-Group 1 & 2, (Plates 3/4 in. & less) Shapes-Group 3, (Plates Over 3/4 to 1-1/2 in.) Shapes-Group 4 & 5, (Plates Over 1-1/2 to 4 ft.)	70 min 67 min 63 min	50 min 46 min 42 min
A250	C-Mo Tubes (1/2-5 in. Dia.)	T1 (0.5% Mo) T1a (0.5% Mo) T1b (0.5% Mo) T2 (0.75% Cr, 0.5% Mo) T11 (1.25% Cr, 0.5% Mo) T12 (1% Cr, 0.5% Mo) T22 (2.25% Cr, 1% Mo)	55 min 60 min 53 min 60 min 60 min 60 min 60 min	30 min 32 min 28 min 30 min 30 min 30 min 30 min

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SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11) (10), (11)	LA-75, (16) LA100, MC1100		(24)
LH-8018-C1 MR, Excalibur 8018-C1 MR LH-8018-C1 MR, Excalibur 8018-C1 MR	(10), (11) (10), (11) (10), (11) (10), (11)	LA75 LA75		
(2), (4) (2), (4) (2), (4)	(34) (34) (34)	LA90 LA90 LA90		
SA-85, LH-78 MR, Excalibur 7018-A1		LA90, (16)	(21)	(23)
(2), (4) SA-85, LH-78 MR, Excalibur 7018-A1		(16) (16)	(21) (21)	(23) (23)
LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR		LA90		
Excalibur 7018, 7018-1, LH-78 MR		(16)		
(1) (1) (1)	(10), (11) (10), (11) (10), (11)	LA75, LA90 LA75, LA90 LA75, LA90	(18) (18) (18)	(23) (23) (23)
LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR LH-90 MR, Jet-LH 8018-B2 MR	(10), (11) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA92, (26)	LA90		
LH-110M MR LH-8018-C3 MR, Excalibur 8018-C3 MR	(12) 860, 960/LA75	MC1100 LA75		 (24)
Excalibur 7018, 7018-1 LH-78 MR, (4)		(16)	(21)	(23)
Excalibur 7018, LH-78 MR, (4)	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78 MR. (4) SA-85, Excalibur 7018-A1 LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR Jet-LH 9018-B3 MR	(10), (11) (34) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93	(16) LA90	(18)	(23)
(1), (6) (1), (6) (1), (6)	(10), (11), (15) (10), (11), (15) (10), (11), (15)	(29) (29) (29)	NR-203Ni1% NR-203Ni1% NR-203Ni1%	(25) (25) (25)
SA-85, Excalibur 7018-A1 SA-85, Excalibur 7018-A1 SA-85, Excalibur 7018-A1 LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR		LA90 LA90 LA90		(23) (23) (23)

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ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A252	Steel Pipe Piles	1 2 3	50 min 60 min 66 min	30 min 35 min 45 min
A266	Pressure Vessel Forgings	1 2 & 4 3	60-85 70-95 75-100	30 min 36 min 37.5 min
A283	Structural Plates Storage Tank Construction	A B C D	45-60 50-65 55-75 60-80	24 min 27 min 30 min 33 min
A284	C-Si Steel Plates (Discontinued 1994)	C & D	60 min	30 & 33 min
A285	Pressure Vessel Plate	A B C	45-60 50-70 55-75	24 min 27 min 30 min
A299	Pressure Vessel Plate Mn-Si		75-95	42min
A302	Pressure Vessel Plates >2 in. Normalized Mn-Mo (Grade A & B) Mn-Mo-Ni (Grade C & D)	A (0.5% Mo) B (0.5% Mo) C & D (0.5% Mo, 0.6% Ni) & (0.5% Mo, 0.8% Ni)	75 - 95 80-100 80-100	45 min 50 min 50 min
A328	Steel Sheet Piling		70 min	39 min
A333 & A334	Low Temperature Pipe	1 (CVN's @ -50°F, 13 ft-lb) 6 (CVN's @ -50°F, 13 ft-lb) 7 (CVN'S @ -100°F, 13 ft-lb)	55 min 60 min 65 min	30 min 35 min 35 min
A335	High Temperature Pipe	P1 (0.5% Mo) P2 (0.75% Cr, 0.5% Mo) P11 (1.25% Cr, 0.5% Mo) P12 (1% Cr, 0.5% Mo) P15 (1.4% Si, 0.5% Mo) P22 (2.25% Cr, 1% Mo)	55 min 55 min 60 min 60 min 60 min 60 min	30 min 30 min 30 min 32 min 30 min 30 min
A336	Pressure Vessel Forgings, F11-C1, C2, & C3 (1.25% Cr, 0.5% Mo), F12 (1% Cr, 0.5% Mo), F21-C3 (3% Cr, 1% Mo), F22-C3 (2.25% Cr, 1% Mo)	F1 (0.5% Mo) F11-C2, F11-C3, F11-C1, F12 F21-C3, F21-C1, F22-C3, F22-C1	70-95 70-100 60-100	40 min 30-45 min 30-45 min
A350	Low Temp. Forgings, etc. Requiring Notch Toughness Testing for Piping Components	LF1 (CVN's @ -20°F, 13 ft-lbs) LF2 (CVN's @ -50°F, 13 ft-lbs)	60-85 70-95	30 min 36 min
		LF5 Class 1 (CVN's @ -75°F) LF5 Class 2 (CVN's @ -75°F) LF6 Class 1 (CVN's @ -60°F) LF6 Class 2 (CVN's @ -60°F) LF6 Class 3 (CVN's @ -0°F)	60-85 70-95 66-91 75-100 75-100	30 min 37.5 min 52 min 60 min 60 min
A352	Low Temp. Castings for Pressure Containing Parts, Low Temperature Service, CVN's for LCA tested @ -25°F, CVN's for LCB & LCC tested @ -50°F	LCA (0.5% Ni, 0.5% Cr, 0.2% Mo) LCB & LCC (0.5% Ni, 0.5% Cr, 0.2% Mo) LC1 (0.5% Mo) LC2 (2.5% Ni)	60-95 60-95 65-90 70-95	30-40 min 30-40 min 35 min 40 min
A356	Seam Turbine Castings	1 2 (0.5% Mo) 5, 6 (0.5% & 1.25% Cr, 0.5% Mo) 8, 9 (1% Cr, 1% Mo, V) 10 (2.25% Cr, 1% Mo)	70 min 65 min 70 min 80 & 85 min 85 min	36 min 35 min 40 & 45 min 50 & 60 min 55 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4)	(10), (11), (32) (10), (11), (32) (10), (11), (32)	(16) (16) (16)	(17) (17) (17)	(23) (23) (23)
(1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11) (10), (11) (10), (11)	(16) (16) (16)	(18) (18) (18)	(23) (23) (24)
(2) (2) (2) (2)	(10), (11) (10), (11) (10), (11) (10), (11)	(16) (16) (16) (16)	(17) (17) (17) (17)	(23) (23) (23) (23)
(2)	(10), (11)	(16)	(17)	(23)
(2) (2) (2)	(10), (11) (10), (11) (10), (11)	(16) (16) (16)	(17) (17) (17)	(23) (23) (23)
LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11)	(16)	(18)	(23)
	(34) (34), 880M/L56 MIL 800-H/LA82	(16) LA75 LA75, LA100	(18)	(23) (24) (24)
(1)	(10), (11)	(16)	(17)	(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C1 MR, Excalibur 8018-C1 MR	882/L50, 880M/L50, 8500/L-S3 882/L50, L-S3	LA75 LA75	NR-207 NR-207	(24) (24)
SA-85 LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR SA-85, Excalibur 7018-A1 Jet-LH 9018-B3 MR	(34) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93	LA90		
 LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR	(34) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93	LA90		(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 7018-1, LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11) 880M/L56, L50, L-S3, 882/L50, L-S3, 8500/L-S3, L50	(16) LA75	(17) NR-207	(23) (24)
LH-8018-C1 MR, Excalibur 8018-C1 MR LH-8018-C1 MR, Excalibur 8018-C1 MR Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR	880M/LA75, L50, 8500/L-S3 880M/LA75, L50, 8500/L-S3 880M/LA75, L50, 8500/L-S3 880M/LA75, L50, 8500/L-S3 (10), (11)	LA75 LA75 LA75 LA75 LA75	NR-207 NR-207 NR-207 NR-207 NR-207	81K2-H 81K2-H 81K2-H 91K2-H 91K2-H
(1) Excalibur 7018-1 LH-8018-C1 MR, Excalibur 8018-C1 MR	(10), (11) 880M/LA75 860/L70 880, 880M/LAC Ni2	(16) LA75 LA90	(18) NR-207	(23) (24) (24)
(3) LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR	(10), (11) (34) MIL800-H,880M, 882/LA92, (26) MIL800-H,880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93	(16) LA90	(18)	(23)

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A366	Carbon Steel Sheets (Discontinued 8/00, replaced with A1008)	Type A, B, & C	---	---
A369	High Temperature Forged & Bored Pipe	FPA FPB FP1 (0.5% Mo) FP2 (0.75% Cr, 0.5% Mo) FP11 (1.25% Cr, 0.5% Mo) FP12 (1% Cr, 0.5% Mo) FP21 (3% Cr, 1% Mo) FP22 (2.25% Cr, 1% Mo)	48 min 60 min 55 min 55 min 60 min 60 min 60 min 60 min	30 min 35 min 30 min 30 min 30 min 30 min 30 min 30 min
A372	Pressure Vessel Forgings, Thin-Walled, Type IV (0.2% Mo), Type V (1% Cr, 0.2% Mo)	Grade A Grade B Grade C, Grade E (Class 55) Grade D, Grade E (Class 65)	60-85 75-100 90-115 & 85-110 105-130	35 min 45 min 55 min 65 min
A381	High Pressure Pipe for Transmission Systems	Y35 Y42 Y46 Y50 Y52 Y56 Y60 Y65	60 min 60 min 63 min 62 min 64 min 66 min 71 min 75 min 77 min	35 min 42 min 46 min 48 min 50 min 52 min 56 min 60 min 65 min
A387	Pressure Vessel Plate, Cr-Mo Grades 2, 11, & 12-0.5% Mo (Class 1 Lower Tensile) (Class 2 Higher Tensile)	2 (0.75% Cr), 11 (1% Cr), & 12 (1.25% Cr) 22 (2.25% Cr, 1% Mo) 21 (3% Cr, 1% Mo)	55-85, 65-90 60-85, 75-100 60-85, 75-100	30 min, 45 min 30 min, 45 min 30 min, 45 min
A389	High Temp. Cr-Mo Castings	C23 (1.25% Cr, 0.5% Mo) C24 (1% Cr, 1% Mo)	70 min 80 min	40 min 50 min
A405	High Temperature Pipe	P24 (1% Cr, 1% Mo)	80 min	50 min
A414	Pressure Vessel Sheet (Grades A, B, C, & D - Max. Ten. = Min. Ten + 15 ksi, Grades E, F, & G - Max. Ten = Min. Ten + 20 ksi)	A, B, D, & D E, F, & G	45, 50, 55, & 60 min 65, 70, & 75 min	25, 30, 33, & 35 min 38, 42, & 45 min
A420	Low Temperature Fittings	WPL6 (CVN's @ -50°F, 25 ft-lbs) WPL9 (CVN's @ -100°F, 25 ft-lbs)	60-85 63-88	35 min 46 min
A423	Low Alloy Tubes (1/2 in. - 5 in. dia.)	1 (0.75% Cr, 0.5% Ni) 2 (0.75% Ni)	60 min 60 min	37 min 37 min
A426	High Temp. Cast Pipe	CP1 (0.5% Mo) CP2 (0.75% Cr, 0.5% Mo) CP11 (1.25% Cr, 0.5% Mo) CP12 (1% Cr, 0.5% Mo) CP15 (1.4% Si, 0.5% Mo) CP21 (3% Cr, 1% Mo) CP22 (2.25% Cr, 1% Mo)	65 min 60 min 70 min 60 min 60 min 60 min 70 min	35 min 30 min 40 min 30 min 30 min 30 min 40 min
A441	Discontinued 1989, Replaced by A572			
A442	Plate with Improved Transition Properties	55 60	55-75 60-80	30 min 32 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
(2)	(10), (11)	(16)	(17)	(23)
(4) (4) SA-85, Excalibur 7018-A1 LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR Jet-LH 9018-B3 MR	(10), (34) (10), (34) (34) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93	(16) (16) LA90	(21) (21)	(23) (23)
(1) LH-8018-C3 MR LH-110M MR LH-110M MR	(10), (11) (10), (11) 880M/LA90 (12)	(16) (16) LA90 MC1100	(17) (18)	(23) (23) (24)
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (2) SAHYP+, Excalibur 7018, 7018-1, LH-78 MR SAHYP+, Excalibur 7018, 7018-1, LH-78 MR SA70+, SA80, LH-78 MR SA70+, SA80, SAHYP+, LH-D80, LH-D90, Pipeliner 8P+ SA70+, SA80, LH-D80, LH-D90, Pipeliner 8P+	860/L60, L61 860/L60, L61 860/L60, L61 860/L60, L61 860/L60, L61 860/L60, L61 860/L60, L61 860/L60, L61	(16) (16) (16) (16) (16) (16) (16) (16)	(21) (21) (21) (21) (21) (21) (21) (21)	(23) (23) (23) (23) (23) (23) (24) (24)
LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR	MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93			
LH-90 MR Jet-LH 9018-B3 MR	MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93			
Jet-LH 9018-B3 MR	MIL800-H, 880M, 882/LA92, (26)	LA90		
(2), (5) (1)	(10), (11), (33) (10), (11), (33)	(16) (16)	(17) (17)	(23) (23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C1 MR, Excalibur 8018-C1 MR	882/L56 880M/LAC-Ni2	LA75	NR-207	81K2-H
LH-90 MR LH-8018-C3 MR, Excalibur 8018-C1 MR		(16) LA75	NR-203Ni1%	81Ni1-H
SA-85, Excalibur 7018-A1 LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR LH-90 MR, Jet-LH 8018-B2 MR SA-85, Excalibur 7018-A1 Jet-LH 9018-B3 MR Jet-LH 9018-B3 MR	(34) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93	LA90		
(1) (1)	(10), 860/L61, 880M/L50 (10), 860/L61, 880M/L50	(16) (16)	(18) (18)	(23) (23)

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A455	Pressure Vessel Plate C-Mn		70-95	35-38 min
A469	Vacuum -Treated Steel Forgings	Class 1 Class 2 (2.5% Ni, 0.3% Mo) Class 3 (2.5% Ni, 0.3% Mo)	75 min 80 min 90 min	35 min 55 min 70 min
A470	Alloy Steel Forgings	Class 1 Class 2 (3.5% Ni, 0.75% max Cr) Class 3, 9 & 5 Class 4 & 6, 8	75 min 80 min 90 min & 90-110 105 min & 105-125	40 min 55 min 70 min 85 min
A486	Highway Bridge Castings (Discontinued 1989)			
A487	Castings-Pressure Service 1's V, 2's MnMo, 4's NiCrMo, 6's MnNiCrMo 8's(2.25% Cr, 1% Mo) & 9's (1% Cr, 0.3% Mo) 10's, 11's, 12's NiCrMo 13's & 14's NiMo, 16A Low C, MnNi	1A, 1B, 1C, 2A, 2B, 2C, 4A, 4C, 9C, 13A 10A, 4B, 8B, 13B 11A, 12A 9D, 11B, 12B 10B, 14A 16A	85-115 100-130 70-95 100-130 120-145 70-95	53-65 min 70-85 min 40 min 70-85 95-100 min 40 min
A498	Heat-Exchanger Tubes	See A199, A213 & A334		
A500	Structural Tubing	A B C D (SR 1100 F for 1 hr/in., 0.5 hr min)	45 min 58 min 62 min 58 min	45 min 42 min 46 min 36 min
A501	Structural Tubing		58 min	36 min
A508	Pressure Vessel Forgings, Quenched & Tempered	1 & 1A 2-C1 & 3 (0.75% Ni, 0.5% Mo) 2-C2, 3-C2 (0.75% Ni, 0.5% Mo) 4N-C3 (3.25% Ni, 1.75% Cr, 0.5% Mo) 4N-C1 & 5-C1 (3.25% Ni, 1.75% Cr, 0.5% Mo) 4N-C2 & 5-C2 (3.25% Ni, 1.75% Cr, 0.5% Mo) 22-C3 (2.25% Cr, 1% Mo)	70-95 80-105 90-115 90-115 105-130 115-140 85-110	36 min 50 min 65 min 70 min 85 min 100 min 55 min
A514	Quenched & Tempered Plate	All Grades >2 1/2 in. All Grades 2 1/2 in. and under	100-130 110-130	90 min 100 min
A515	High Temperature Pressure Vessel Plate	60 65 & 70	60-80 65-85 & 70-90	32 min 35 min & 38 min
A516	Pressure Vessel Plate	55 & 60 65 & 70	55-75 & 60-80 65-85 & 70-90	30 min & 32 min 35 min & 38 min
A517	Pressure Vessel, Quenched & Tempered	All Grades 2 1/2 in. & under All Grades 2 1/2 in. - 6 in.	115-135 105-135	100 min 90 min
A521	Closed Die Forgings	AA, AB, CE, CF & CF1 AC, AD & CG CA, CC & CC1 AE	75 min to 85 min 82 min to 96 min 60 min to 66 min 95 min to 105 min	37 min to 55 min 48 min to 58 min 30 min to 33 min 75 min to 80 min
A523	High Pressure Pipe (4 in. - 12 in. Dia.)	A B	48 min 60 min	30 min 35 min
A524	Seamless Carbon Steel Pipe, for Atmospheric & Lower Temps.	I II	60-85 55-80	35 min 30 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
LH-8018-C3 MR, (1), Excalibur 8018-C3 MR	(10), (11)	(16)	(18)	(23)
LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C1 MR, Excalibur 8018-C1 MR Excalibur 9018-M MR	(10), (11) 880, 880M/LAC Ni2 880M/LA100	L56, SGS-6 LA100	(18)	(23) 91K2-H
Excalibur 8018-C1, 8018-C3 MR, 9018-M MR LH-8018-C1 MR, Excalibur 8018-C1 MR Excalibur 8018-C1, 8018-C3 MR, 9018-M MR LH-110M MR	(10), (11) 880, 880M/LAC Ni2 882/LAC Ni2 (12)	(16) LA100, MC900, MC1100	(18)	(23)
Excalibur 8018-C1, 8018-C3 MR, 9018-M MR LH-110M MR LH-90 MR, Jet-LH 8018-B2 MR LH-110M MR LH-8018-C3 MR, Excalibur 8018-C3 MR	860, 880M/LA100 (12) (10), (11) (12) 860, 960/LA75	 LA100, MC1100 (16) LA100, MC1100 LA75	 (18) NR-203 Ni1%	 (23) 81Ni1-H
(2) (2) (2) Excalibur 7018, 7018-1, LH-78 MR	(10), (11) (10), (11) (10), (11) (10), (11)	(16) (16) (16) (16)	(17) (17) (17)	(23) (23) (23) (23)
(2)	(10), (11)	(16)	(17)	(23)
(1) LH-110M MR LH-110M MR LH-110M MR Jet-LH 9018-B3 MR	(10), (11) 882, 8500, MIL800-H/LA82 882, 8500, MIL800-H/LA82 (12) MIL800-H, 880M, 882/LA93	(16) LA100	(18)	(23)
LH-110M, (7) LH-110M, (7)	(12) (12)	LA100, MA1100 LA100, MC1100		
(1) (1)	(10), (11) (10), (11)	(16) (16)	(18) (18)	(23) (23)
(1) (1)	(10), (11) (10), (11)	(16) (16)	(18) (18)	(23) (23)
(7) LH-110M MR, (7)	(12) (12)			
Excalibur 9018-M MR Excalibur 9018-M MR (1) LH-110M MR	960, 860/LA75, 860/LA85 (14) (10), (11) (12)	LA75 LA90 (16) LA100	 (16)	81Ni1-H 91K2-H (23)
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4)	780/L60, L61 780/L60, L61	(16) (16)	(21) (21)	(23) (23)
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4)	(10), (11) (10), (11)	(16) (16)	(17) (17)	(23) (23)

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A529	High Strength C-Mn Steel of Structural Quality	42 50 & 55	60-85 70-100	42 min 50 min & 55 min
A533	Pressure Vessel, Quench. & Temp. Mn-Mo-Ni Type A (0.50% Mo) Type B (0.50%Mo, 0.55% Ni) Type C (0.50% Mo), 0.85% Ni) Type D (0.50% Mo, 0.30% Ni)	Class 1, Type A, B, C, & D Class 2, Type A, B, C, & D Class 3, Type A, B, C & D	80-100 90-115 100-125	50 min 70 min 83 min
A537	Pressure Vessel Plate C-Mn-Si	1 (Normalized) </=2.5 in. 1 (Normalized) >2.5 in. - 4 in. 2 & 3 Quen & Temp </=2.5 in. 2 & 3 Quen & Temp >4 in. - 6 in.	70 min 65 min 80 min 75 min 70 min	50 min 45 min 60 min & 55 min 55 min & 50 min 46 min & 40 min
A539	Tubing for Gas & Oil Lines	2-3/8 in Max. Dia., 1/8 in. Max Thickness	45 min	35 min
A541	Pressure Vessel Forgings, Quenched & Tempered Grades 2 & 3 (0.5% Mo) Grade 4N, Class 3 (1.5% Cr, 0.5% Mo) Grade 11 Class 4 (1.25% Cr, 0.5% Mo) Grade 22 Classes 3, 4, % 5 (2.25% Cr, 1% Mo)	1, 1A 2 Class 1, & 3 Class 1 11 Class 4 2 Class 2, 3 Class 2 22 Class 4 22 Class 5 4N Class 3 22 Class 3	70-95 80-105 80-105 90-115 105-130 115-140 90-115 85-110	36 min 50 min 50 min 65 min 85 min 100 min 70 min 55 min
A542	Pressure Vessel Plates, Quenched & Tempered Type A & B (2.25% Cr, 1% Mo) Type C (3% Cr, 1% Mo, +V, Ti, B)	Class 1, Type A, B, & C Class 2, Type A, B, & C Class 3, Type A, B, & C Class 4 & 4a,Type A, B, & C	105-125 115-135 95-115 85-110	85 min 100 min 75 min 55 min & 60 min
A543	Pressure Vessel Plate, Quenched & Tempered (1.5% Cr, 0.4% Mo) Type B 3% Ni, Type C 2.75% Ni	Class 1, Type B & C Class 2, Type B & C Class 3, Type B & C	105-125 115-135 90-115	85 min 100 min 70 min
A556	Seamless, Cold-Drawn Feedwater Heater Tubes (1-1/4 in. Max. Dia.)	A2 B2 C2	47 min 60 min 70 min	26 min 37 min 40 min
A557	Electric-Resistance Welded Feedwater Heater Tubes (1-1/4 in. Max. Dia.)	A2 B2 C2	47 min 60 min 70 min	26 min 37 min 40 min
A562	Pressure Vessel Plate, Carbon Steel, Mn-Ti, for Glass or Diffused Metallic Coatings		55-75	30 min
A569	Hot-Rolled Sheet, 0.15% Max C, (Discontinued 8/00, replaced with A1011)	Type A, B, & C	None Specified	None Specified
A570	Structural Sheet & Strip, Hot-Rolled Max. Thickness 0.229 in. (Discontinued 8/00, replaced with A1011)	30, 33, 36, 40, & 45, 50 & 55	49, 52, 53, 55, & 60 min 65 & 70 min	30, 33, 36, 40, & 45 min 59 & 55 miin
A572	High Strength Structural Columbium-Vanadium	42 50 55 60 65	60 min 65 min 70 min 75 min 80 min	42 min 50 min 55 min 60 min 65 min
A573	Structural Plate of Improved Toughness	58 65 70	58-71 min 65-77 min 70-90 min	32 min 35 min 42 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
(1) (1)	(10), (11) (10), (11)	(16) (16)	(17) (17)	(23) (23)
LH-8018-C3, Excalibur 8018-C3 MR LH-110M, (4) LH-110M MR	882, 8500, MIL800-H/LA82 882, 8500, MIL800-H/LA82 8500, MIL800-H/LA82	LA75 LA90 LA100, MC1100		(24) 91K2-H
(1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR (1), LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11) (10), (11) (10), 882, 8500/LA85 MIL800-H/LA-71 MIL800-H/LA-71	(16) (16) LA75 (16) (16)	(17) (17) (18) (18)	(23) (23) (24) (24) (24)
(2), (4)		(16)		
(1) LH-8018-C3, Excalibur 8018-C3 MR LH-90 MR, Jet-LH 8018-B2 MR LH-110M MR Excalibur 9018-M MR	(10), (11) (10), 880M/LA90 (10), (11) 882, 8500/LA82 (12) MIL800-H, 880M, 882/LA93	(16) LA90 (16) LA100, MC900 MC1100 MC1100	(18) (18)	(23) (24) (23) 91K2-H
LH-110M MR LH-110M MR	(12) MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93	MC1100		
LH-110M, (7) LH-110M MR	(12) MIL800-H, 880M, 8500/LA100	LA100, MC1100 LA100		 91K2-H
Excalibur 7018, LH-78 MR, (4) Excalibur 7018, LH-78 MR, (4) Excalibur 7018, LH-78 MR		(16) (16) (16)		
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR		(16) (16) (16)		
Excalibur 7018, 7018-1, LH-78 MR	(10), (11)	(16)	(18)	(23)
(2)	(10), (11)	(16)	(17)	(23)
(2) (1)		(16) (16)	(17) (17)	(23) (23)
(1) (1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR	(10, (11) (10), (11) (10), (11) 960/LA75, 860/LA85 960/LA75, 860/LA85	(16) (16) (16) LA75 LA75	(17) (17) (17)	(23) (23) (23) (24) (24)
(1) (1) (1)	(10), (11) (10), (11) (10), (11)	(16) (16) LA75, (16)	(18) (18) (18)	(23) (23) (23), (24)

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A587	Low Carbon Steel Pipe, Chem. Industry		48 min	30 min
A588	High Strength Structural, with Atmospheric Corrosion Resistance (Recommended consumables are the same regardless of thicknesses)	All Structural Shapes & Plates 4 in. & Under Plates over 4 in. to 5 in. Plates over 5 in.	70 min 67 min 63min	50 min 46 min 42 min
A589	Seamless & Welded Carbon Steel Water-Well Pipe	Butt Welded A B	48 min 48 min 60 min	30 min 30 min 35 min
A592	Pressure Vessels, Quenched & Tempered, Forged Fittings	A (0.75% Cr), E (1.75% Cr, 0.5% Mo), F (0.5% Cr, 0.5% Mo)	Up to 2.5 in. 115-135 >2.5 in. - 4 ft. 105-135	Up to 2.5 in. 100 min >2.5 in. - 4 ft. 90 min
A595	Structural Tubing	A B C (Weather Resistant, Cu, Cr, Ni)	65 min 70 min 70 min	55 min 60 min 60 min
A606	Sheet, Hot & Cold Rolled, High-Strength, Low-Alloy, Atmospheric Corrosion Resistant	Hot Rolled (As Rolled & Annealed or Normalized) Cold Rolled (Cut Lengths & Coils)	70 & 65 min 65 min	50 & 45 min 45 min
A607	Sheet, High Strength, Low Alloy Co or V or Both Cold Rolled or Hot Rolled (Discontinued 8/00, replaced with A1008 & A1011)	45 50, 55, & 60 65 70	60 min 65 & 70 min 80 min 85 min	45 min 50 & 55 min 65 min 70 min
A611	Structural Sheet (Discontinued 8/00, replaced with A1008)	A & B C Types 1 & 2 D Types 1 & 2 E (Full Hard Product)	42 & 45 min 48 min 52 min 82 min	25 & 30 min 33 min 40 min 80 min
A612	Pressure Vessel Plate for Low Temperature Service	0.5 & Under >0.5	83-105 81-101	50 min 50 min
A615	Billet Steel Bars, Concrete Reinforcement (0.376 in - 2.257 in. Dia.)	40 60 75	70 min 90 min 100 min	40 min 60 min 75 min
A616	Rail-Steel Bars For Concrete Reinforcement (Max 1.410 in. Dia.) (Discontinued 9/99, replaced with A996)	50 60	80 min 90 min	50 min 60 min
A617	Axle-Steel for Concrete Reinforcement (Max 1.410 in. Dia.) (Discontinued 9/99, replaced with A996)	40 60	70 min 90 min	40 min 60 min
A618	Low Alloy Structural Tubing	Ia, Ib, II, </=3/4 in. Wall Thickness Ia, Ib, II, >3/4 in. Wall Thickness III	70 min 67 min 65 min	50 min 46 min 50 min
A620	Steel Sheet, Drawing Quality, Special Killed (Discontinued 8/00, replaced with A1008)		40 min	20 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
Excalibur 7018, 7018-1, LH-78 MR, (4)		(16)	(17)	(23)
LH-8018-C3 MR, (1), (6), Excalibur 8018-C3 MR, (1), (6)	AXXX10/L61, 880, 880M/LAC-Ni2 960, 860/LA75 (15)	(29)	(22)	(23), (25)
Excalibur 7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1 LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR, (4)		(16) (16) (16)	(17) (17) (17)	(23) (23) (23)
Excalibur 7018, 7018-1, LH-78 MR Excalibur 7018, 7018-1, LH-78 MR Excalibur 7018, 7018-1, LH-78 MR, LH-8018-C3 MR		(16) (16) LA75	(17) (17) (19)	(23) (23) 81Ni1-H
(1) (1)	(10), (11) (10), (11)	(16) (16)	(17) (17)	(23) (23)
(2) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) (10), (11) (14) (14)	(16) (16) LA90 LA90	(17) (17)	(23) (23) (24) (24)
(2) (2) (2) Excalibur 9018-M MR	(10), (11) (10), (11) (10), (11) (14)	(16) (16) (16) LA90, MC900	(17) (17) (17)	(23) (23) (23) 91K2-H
LH-8018-C3 MR, C1 MR, Excalibur 8018-C3 MR, C1 MR LH-8018-C3 MR, C1 MR, Excalibur 8018-C3 MR, C1 MR	(10) (10), 880M/L56	LA75 LA75		(24) (24)
(1) Excalibur 9018-M MR LH-110M MR	LA90	(16) LA100, MC1100	(18) 91K2-H	(23)
LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR		LA75 LA90		(24) 91K2-H
(1) Excalibur 9018-M MR		(16) LA90	(18)	(23) 91K2-H
Excalibur 7018, 7018-1, LH-78 MR Excalibur 7018, 7018-1, LH-78 MR Excalibur 7018, 7018-1, LH-78 MR	(10), (11) (10), (11) (10), (11)	(16) (16) (16)	(18) (18) (18)	(23) (23) (23)
(2)		(16)	(18)	(23)

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A633	Normalized High Strength Low Alloy Structural	A C D E</=2.5 in. & >2.5 in. - 4 in. E>4 in.	63-83 70-90 & 65-85 70-90 & 65-85 80-100 75-95	42 min 50 min & 46 min 50 min & 46 min 60 min & 55 min 55 min
A656	High Strength, Low Alloy Structural	50 60 70 80	60 min 70 min 80 min 90 min	50 min 60 min 70 min 80 min
A660	Cast Pipe, for High Temperature Service	WCA WCB WCC	60 min 70 min 70 min	30 min 36 min 40 min
A662	Pressure Vessel, Low & Moderate Temp.	A (CVN Req - 15 ft-lbs @ -75°F) B (CVN Req - 15 ft-lbs @ -50°F) C (CVN Req - 15 ft-lbs @ -50°F)	58-78 65-85 70-90	40 min 40 min 43 min
A668	Carbon & Alloy Steel Forgings Minimum Tensiles & Yields Requirements vary with size of forging.	A (Untreated) B (Annealed, or normal, or normal & temp.) C (Annealed, or normal, or normal & temp.) D (Normal, annealed, or normal & temp.) E (Normal & temp, or double normal & temp.) F (Quenched & temp, or normal, quench, & temp.) G (Annealed, or normal, or normal & temp.) H (Normal & temp.) J (Normal & temp, or normal, quench & temp.) K (Normal, quench & temp.) L (Normal, quench, & temp.) M (Normal, quench, & temp.) N (Normal, quench, & temp.)	47 min 60 min 66 min 75 min 83 & 85 min 82, 85 & 90 min 80 min 90 min 90 & 95 min 100 & 105 min 110, 115, & 125 min 135, 140 & 145 min 160, 165 & 170 min	 30 min 33 min 37 min 43 & 44 min 48, 50 & 55 min 50 min 58 & 60 min 65 & 70 min 75 & 80 min 85, 95, 105 min 110, 115, & 120 min 130, 135 & 140 min
A672	Steel Pipe for High-Pressure Service at Moderate Temperatures	Grade designates type of plate used to make pipe. See ASTM Spec. for plate material information.		
A675	Steel Bars	45 50 55 60 65 70 75 80 90	45-55 50-60 55-65 60-72 65-77 70-85 75-90 80 min 90 min	22.5 min 25 min 27.5 min 30 min 32.5 min 35 min 37.5 min 40 min 55 min
A678	Quenched & Tempered Structural Plate	A B C [<3/4 in., 3/4 - 1-1/2 in., 1-1/2 - 2 in.]	70-90 80-100 85-105, 90-110, 95-115 90-110	50 min 60 min 65, 70, & 75 min 75 min
A690	H-Piles & Sheet Piling		70 min	50 min
A691	Carbon and Alloy Steel Pipe, (> 16 in. Dia.)	Grade designates type of plate used to make pipe. See ASTM Spec. for plate material information.		

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
LH-8018-C3 MR, (1), Excalibur 8018-C3 MR, (1) LH-8018-C3 MR, (1), Excalibur 8018-C3 MR, (1) LH-8018-C3 MR, (1), Excalibur 8018-C3 MR, (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), 860, 882/L61, 880M/L50 (10), 860, 882/L61, 880M/L51 (10), 860, 882/L61, 880M/L52 880M/L56, AXXX10/L61, 860/LA-71 880M/L56, AXXX10/L61, 860/LA-71	(16) LA75, (16) LA75, LA90 LA75, LA90 LA75, LA90	(17) (18) (18)	(23) (23) (23) (24) (24)
(1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) (10), (11) (10), 880M/LA-71 (14), 880M, MIL800-H/LA100	(16) (16) LA75, LA90 LA90, MC900, LA100	(18) (18)	(23) (23) (24) 91K2-H
Excalibur7018, 7018-1, LH-78 MR, (4) Excalibur 7018, 7018-1, LH-78 MR Excalibur 7018, 7018-1, LH-78 MR	(10), (11) (10), (11) (10), (11)	(16) (16) (16)	(18) (18) (18)	(23) (23) (23)
Excalibur 7018-1 Excalibur 7018-1 Excalibur 7018-1	8500/L-S3 8500/L-S3 8500/L-S3	LA75 LA75 LA75	NR-207 (19) (19)	(24) (24) (24)
(2) (2) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR Excalibur 9018-M MR LH-110M MR	(10), (11) (10), (11) (10), (11) (10), (11) (14) (14) (14) (13) (13) (14) (14)	(16) (16) (16) LA75, (16) LA75, LA90, MC900 LA75, LA90 LA75, LA90 LA90, MC900 LA90, MC900 LA100, MC1100 LA100, MC1100	(17) (17) (17)	(23) (23) (23) (24) 91K2-H (23) (23) 91K2-H 91K2-H
(2) (2) (2) (2) (1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) (10), (11) (10), (11) (10), (11) (10), (11) (10), (11) (10), (11) (14) (13)	(16) (16) (16) (16) (16) (16) (16) LA75, LA90 LA90, MC900	(17) (17) (17) (17) (17) (17) (17)	(23) (23) (23) (23) (23) (23) (23) (24) 91K2-H
LH-8018-C3 MR, (1) LH-8018-C3 MR LH-110M LH-110M	(10), (11) (10), (11) 8500/LA85 8500/LA85	(16) LA75, LA90 LA100, MC1100 LA100, MC1100	(18)	(23) (24) 91K2-H 91K2-H
See A588	See A588	See A588	See A588	See A588

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A692	Seamless L.A. Steel Tubes, 1/2% Mo. (5 in. Max. Dia.)	64-84	42 min	SA-85
A694	Carbon & Alloy Steel Forgings	F42	60 min	42 min
		F46	60 min	46 min
		F48	62 min	48 min
		F50	64 min	50 min
		F52	66 min	52 min
		F56	68 min	56 min
		F60 F65 F70	75 min 77 min 82 min	60 min 65 min 70 min
A695	Bars, for Fluid Power	35 Type A, B, C, & D 40 Type A, B, C, & D 45 Type A, B, C, & D 50 Type A, B, C, & D	60 min 70 min 80 min 90 min	35 min 40 min 45 min 50 min
A696	Carbon Steel Bars - Pressure Piping Components	B	60 min	35 min
		C	70 min	40 min
A706	Low Alloy Bars for Concrete Reinforcement		80 min	60 min, 78 max
A707	Carbon & Alloy Steel Flanges for Low Temp. Service Impact Test Temperatures - L1 @ -20° F	L1, Class 1 & 2 L2, Class 1, 2, & 3 L3, Class 1, 2, & 3	60 & 66 min 60, 66, & 75 min 60, 66, & 75 min	42 & 52 min 42, 52, & 60 min 42, 52, & 60 min
	L2 & L3 @ -50°F L4, L5, & L6 @ -80°F L7 & L8 @ -100°F	L4, Class 1, 2, & 3 L5, Class 1, 2, 3, & 4 L6, Class 1, 2, 3, & 4 L7, Class 1, & 2 L8, Class 1, 2, 3, & 4	60, 66, & 75 min 60, 66, 75, & 90 min 60, 66, 75, & 90 min 60 & 66 min 60, 66, 75, & 90 min	42, 52, & 60 min 42, 52, 60,&75 min 42, 52, 60,&75 min 42 & 52 min 42, 52, 60,&75 min
A709	Structural Steel For Bridges. For bridge fabrication, AASHTO/AWS D1.5 is often applicable. The filler metals listed for A709 include those options that meet both the strength requirements for the application, as well as meeting the requirements of D1.5-2002.	36 (Similar to A36) 50 (Similar to A572, Grade 50) 50S (Similar to A992) 50W, Type A, B, & C (Similar to A588) 70W (Similar to A852) HPS 50W HPS70W 100, 100W, </=2-1/2 in. (Similar to A514) 100, 100W, 2-1/2 in. to 4 in. (Similar to A514)	58 min & 58-80 65 min 65 min 70 min 90-110 70 min 90-110 110-130 100-130	36 min 50 min 50-65 50 min 70 min 50 min 70 min 100 min 90 min
A710	Low-C Age-Hardening Gr. A (0.85% NI, 0.75% Cr, + Cu, Mo, Cb), Gr B (1.25% Ni + Cu & Cb), Gr C (0.85% Ni, +Mo, Cu, & Cb) Class 1-As-rolled & Precipitation Heat Treated Class 2-Normalized & Precipitation Heat Treated Class 3-Quenched & Precipitation Heat Treated	A, Class 1 (CVN Req't 20 ft-lb @ -50°F A, Class 2 (CVN Req't 50 ft-lb @ -50°F A, Class 3 (CVN Req't 50 ft-lb @ -80°F B (As-Rolled & Precipitation Heat Treated) C, Class 1 C, Class 3 (CVN Req't 50 ft-lb @ -80°F)	90 min 60, 65, & 72 min 70, 75, & 85 min 88 & 90 min 100 min 90 & 95 min	80 & 85 min 50, 55, 60&65 min 60, 65 & 75 min 75, 80, 82, 85 min 90 min 80 & 85 min
A714	Low Alloy Pipe Type F - Furnace Butt Welded Type E - Electric-Resistance Welded Type S - Seamless Grades I, II, & III - Class 2 Pipe Grades IV, V, VI, VII & VIII Class 4 Pipe (Class 4 - 4 times Corrosion Resistance of Carbon Steel)	I II III IV (0.2 - 0.5% Ni, 1% Cr) V, Type F & Type E, S (2% Ni) VI, Type E&S (0.75% Ni, 0.33% max Cr, 0.15% Mo) VII, Type E & S (0.24 - 1.3% Cr, 0.68% Ni) VIII, Type E & S (0.5% Ni)	70 min 70 min 65 min 58 min 55 min & 65 min 65 min 65 min 70 min	50 min 50 min 50 min 36 min 40 min & 46 min 46 min 45 min 50 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
		LA90		
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR	(10), (11)	(16)	(18)	(23)
LH-8018-C3 MR, LH-D80, LH-D90	(10), (11)	(16)	(18)	(23)
LH-8018-C3 MR, LH-D80, LH-D90	(10), (11)	(16)	(18)	(23)
Excalibur 9018-M MR	880M, 882, 960/LA92, 880M/LA90	LA90		81K2-H
(2)	(10), (11)	(16)	(17)	(23)
(3)	(10), (11)	(16)	(17)	(23)
LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11)	LA75, LA90		(24)
Excalibur 9018-M MR	(13)	LA90, MC900		91K2-H
Excalibur 7018, 7018-1, LH-78 MR		(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78 MR		(16)	(18)	(23)
LH-8018-C3 MR		LA75, LA90		(24)
Excalibur 7018-1	(10), (11)	(16)	(18)	(23)
Excalibur 7018-1	960, 860, 880M/LA75	LA75	NR-207	81K2-H
Excalibur 7018-1	960, 860, 880M/LA75	LA75	NR-207	81K2-H
LH-8018-C1 MR, Excalibur 8018-C1 MR	880M/LA75	LA75	NR-207	91K2-H
LH-8018-C1 MR, Excalibur 8018-C1 MR	880M/LA100	LA75	NR-207	91K2-H
LH-8018-C1 MR, Excalibur 8018-C1 MR	880M/LA100	LA75	NR-207	91K2-H
	880M/LAC-Ni2			
(1)	(10), (11)		(18)	(23)
(1)	(10), (11)		(18)	(23)
(1)	(10), (11)	(16)	(17)	(23)
(1), (6)	(15)		(22)	(25)
Excalibur 9018-M MR	MIL800HPNi/LA85, (31)			91K2-H
(1), (6)	(15)			(22) (25)
Excalibur 9018-M MR	MIL800HPNi/LA85, (31)			
LH-110M MR	(12)	MC1100		
LH-110M MR	(12)	MC1100		
Excalibur 9018-M MR	880M/LA100	LA100		91K2-H
Excalibur 7018-1	880M/LA75	LA75	NR-207	
LH-8018-C1 MR, Excalibur 8018-C1 MR	880M/LA100			
Excalibur 9018-M MR	(14)	LA90		91K2-H
LH-110M MR	(13)	LA100, MC1100		
	(12)	LA100		
Excalibur 7018, 7018-1, LH-78 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78 MR	(10), (11)	(16)	(18)	(23)
Excalibur 7018, 7018-1, LH-78 MR	(10), (11)	(16)	(18)	(23)
LH-8018-C3 MR, Excalibur 8018-C3 MR	860/LA75	LA75	NR-203 Ni1%	81Ni1-H
LH-8018-C1 MR, Excalibur 8018-C3 MR	880, 880M/LAC-Ni2			
LH-8018-C3 MR, Excalibur 8018-C3 MR	860/LA75	LA75	NR-203 Ni1%	81Ni1-H
LH-8018-C3 MR, Excalibur 8018-C3 MR	860/LA75	LA75	NR-203 Ni1%	81Ni1-H
LH-8018-C3 MR, Excalibur 8018-C3 MR	860/LA75	LA75	NR-203 Ni1%	81Ni1-H

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A715	High Strength, Low-Alloy Sheet & Strip (Discontinued 8/00, replaced with A1008 & A1011)	50 60 70 80	60 min 70 min 80 min 90 min	50 min 60 mn 70 min 80 min
A724	Pressure Vessel Plates Quenched & Tempered C-Mn-Si Steel	A B C	90-110 95-115 90-110	70 min 75 min 70 min
A727	Notch-Tough Carbon Steel Forgings		60-85	36 min
A732	Castings, for High Strength at Elevated Temperatures	1A, 2A, 3A 2Q, 5N 4A, 6N (0.4% Mo) 3Q, 13Q 11Q (1.75% Ni), 4Q	60, 65, 75 min 85 min 90 min 100 &105 min 120 & 125 min	40, 45, & 48 min 60 & 55 min 90 & 85 min 85 & 90 min
A734	Pressure Vessel Plates, High Strength, Low Alloy, Quenched & Tempered	Type A (1% Ni, 1% Cr, 0.35% Mo, for use @ -80°F) Type B (for use @ -20°F)	77-97 77-97	65 min 65 min
A735	Pressure Vessel Plates Low C-Mn-(0.4%) Mo-Cb for Moderate & Lower Temperature Service	Class 1 Class 2 Class 3 Class 4	80-100 85-105 90-110 95-115	65 min 70 min 75 min 80 min
A736	Pressure Vessel Plates Low-C Age-Hardening Gr A (0.85% Ni, 0.75% Cr, + Cu, Mo, Cb) Gr C (0.85% Ni, + Cu, Mo, Cb)	A, Class 1 A, Class 2 A, Class 3 C, Class 1 C, Class 3	90-110 60-80 to 72-92 70-90 to 85-105 100-120 90-110 to 95-115	80 min 50 min to 65 min 60 min to 75 min 90 min 80 min to 85 min
A737	Pressure Vessel Plates, High-Strength, Low-Alloy	B C	70-90 80-100	50min 60 min
A738	Pressure Vessel, Heat Treated, C-Mn-Si, for Moderate & Low Temperature Service	A (</= 2.5 in. Norm or Q & T, >2.5 in. Q & T) B (All Thicknesses Quenched & Tempered) C (All Thicknesses Quenched & Tempered)	75-95 85-102 70-90 to 80-100	45 min 60 min 46, 55, & 60 min
A739	Steel Bars, for Elevated Temperature or Pressure Contain Parts	B 11 (1.25% Cr, 0.5% Mo) B 22 (2.25% Cr, 1% Mo)	70-95 75-95	45 min 45 min
A757	Steel Castings, for Pressure Containing, for Low Temperature Service Q's - Quenched & Tempered N's - Normalized & Tempered	A1Q, A2Q (CVN's @ -50°F) B2N, B2Q (2.5% Ni), (CVN's @ -100°F) C1Q (1.75% Ni, 0.2% Mo), (CVN's @ -50°F) D1N1, D1Q1 (2.5% Cr, 1% Mo) D1N2, D1Q2 (2.5% Cr, 1% Mo)	65 & 70 min 70min 75 min 85 & 115 min 95 & 125 min	35 & 40 min 40 min 55 min 55 min 75 min
A758	Pipe Fittings with Improved Notch Tough.	60 70	60-85 70-95	35 min 38 min
A765	Pressure Vessel Forgings with Mandatory CVN Req'ts CVN Test Temperature - Grades 1 & IV @ -20° F, Grade II @ -50° F, Grade III @ -150° F	I II III (3.5% Ni) IV	60-85 70-95 70-95 80-105	30 min 36 min 37.5 min 50 min
A769	Carbon & High-Strength Electric Resistance Welded Steel Structural Shapes W indicates Steel Grades having Atmospheric Corrosion Resistance Approx. 2 times that of Carbon Structural Steel with Copper. Class 1 - General Structural use for Static Loads Class 2 - Structural use where Fatigue Loading Occurs	36 40 45 45W 50 50W 60 80	53 min 55 min 60 min 65 min 65 min 70 min 75 min 90 min	36 min 40 min 45 min 45 min 50 min 50 min 60 min 80 min
A782	Pressure Vessel Plates, Quenched & Tempered Mn-Cr-Mo-Si-Zr	Class 1 (0.75% Cr, 0.4% Mo) Class 2 (0.75% Cr, 0.4% Mo) Class 3 (0.75% Cr, 0.4% Mo)	97-119 107-129 115-136	80 min 90 min 100 min
A808	High-Strength, Low-Alloy, Structural C-Mn-Cb-V, CVN's @ -50°F		60, 65, & 65 min	42, 46 & 50 min

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
(2) (3) LH-8018-C3, Excalibur 8018-C3		(16) (16) LA75 LA90, MC900	(17) (17)	(23) (23) (24) 91K2-H
LH-110M MR LH-110M MR LH-110M MR	8500/LA85 8500/LA85 8500/LA85	LA100, MC1100 LA100, MC1100 LA100, MC1100		91K2-H 91K2-H 91K2-H
Excalibur 7018, 7018-1, LH-78 MR	(10), (11)	(16)	(18)	(23)
(1) Excalibur 9018-M MR LH-110M MR	(10), (11) (13) (14) (12)	(16) LA75 LA90, LA10 LA100, MC1100	(18)	(23) (24) 91K2-H
LH-8018-C1 MR, Excalibur 8018-C1 MR Excalibur 9018-M MR	8500, 880M/LA85 8500/L-S3	LA100 LA75		81K2-H 81K2-H
LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR Excalibur 9018-M MR LH-110M MR	(23) 880M/LA90 880M/LA90 MIL800-H, 880M/LA100	LA75 LA90 LA90, MC900 LA100, MC900		81K2-H 81K2-H 91K2-H 91K2-H
 Excalibur 7018-1 LH-8018-C1 MR, Excalibur 8018-C1 MR LH-110M MR LH-110M MR	(14) (10), (11) (14) (12) (12)	LA100 (16) LA75 LA100, MC1100 LA100, MC1100	(18)	91K2-H (23) (24)
(1) LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11) (10), (13)	(16) LA75, LA90	(18)	(23) (24)
LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR	860, 880M, 882/LA-71 (14) (14)	LA75 LA75, LA100 LA75, LA100		(24) 91K2-H, (24) 91K2-H
LH-90 MR, Jet-LH 8018-B2 MR Jet-LH 9018-B3 MR	MIL800-H, 880M, 882/LA92, (26) MIL800-H, 880M, 882/LA93			
Excalibur 7018-1, LH-75 MR LH-8018-C1 MR, Excalibur 8018-C1 MR LH-8018-C1 MR, Excalibur 8018-C1 MR LH-110M MR	880MLA75 880M/LAC-Ni2 880M/LA75 (12)	LA75 LA75 LA100, MC1100	(19)	81K2-H 81K2-H
Excalibur 7018-1, 7018-1, LH-78 MR Excalibur 7018-1, 7018-1, LH-78 MR	(10), (11) (10), (11)	(16) (16)	(18) (18)	(23) (23)
(1) Excalibur 7018-1, LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11) 880M/L56 (14)	(16) LA75 LA75	(18) (19)	(23) 81K2-H (24)
(2) (2) (2) (3), (6) (3) (3), (6) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) (10), (11) (10), (11) (10), (11), (15) (10), (11) (10), (11), (15) (14) (13)	(16) (16) (16) (16), LA75 (16) (16), LA75 LA75 LA100	(17) (17) (17) (17) (17) (17) (19) 91K2-H	(23) (23) (23) (23), (25) (23) (23), (25) (24)
LH-110M MR	(12) (12)	LA100 MC1100	91K2-H	
Excalibur 7018-1	8500/L-S3	LA75	(19)	(24)

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A812	High-Strength, Low-Alloy Sheet, Pressure Vessels Specification was discontinued 1997	65 80	85-110 100-125	65 min 80 min
A822	Steel Tubing, Hydraulic Service, 1/8-3 Dia.		45 min	25 min
A832	Pressure Vessel, Cr-Mo-V-Ti-B	Grade 21V (3% Cr, 1% Mo, 0.25% V Ti-B) Grade 22V (2.25% Cr, 1% Mo, 0.25% V)	85-110 85-110	60 min 60 min
A841	Pressure Vessel Plates, TMCP	Class 1, up to and including 2.5 in. & >2.5 in. Class 2, up to and including 2.5 in. & >2.5 in.	70-90 & 65-85 80-100 & 75-95	50 min & 45 min 60 min & 55 min
A847	Low Alloy Tubing with Improved Atmospheric Corrosion		70 min	50 min
A850	Steel Bars, C-Mn	Class 1 Class 2	70-99 70-99	50 min 50 min
A852	Quenched & Tempered Low Alloy Structural Plate		90-110	70 min
A858	Heat Treated Fittings for Low-Temp. & Corrosive Service, Max 0.60% Ni, 0.30% Cr, 0.35% Cu	CVN Req - 20 ft-lbs @ -50° F	70-95	36 min
A859	Steel Forgings, Age Harden Ni-Cu-Cr-Mo-Cb	Class 1 Class 2	65-85 75-95	55 min 65 min
A860	High-Strength Fittings CVN Req't - 30 ft-lbs @ -50°F Max. Ni 1.0%, Stress Relieved 1 hour @ 1150°F	WPHY 42 WPHY 46 WPHY 52 WPHY 60 WPHY 65 WPHY 70	60-85 63-88 66-91 75-100 77-102 80-105	42 min 46 min 52 min 60 min 65 min 70 min
A871	High-Strength, Low-Alloy, Structural, with Atmospheric Corrosion Resistance	60 65	75 min 80 min	60 min 65 min
A873	Steel Sheet Pressure Vessels, 2.25% Cr-1% Mo for use @ elevated teperatures Discontinued in 1997	Class 1 Class 2 Class 3 Class 4 Class 5	60-85 75-100 85-110 95-120 130-160	30 min 45 min 60 min 75 min 100 min
A907	Sheet & Strip, Hot-Rolled, Structural Quality (Discontinued 6/01, replaced with A1018)	30, 33, 36, & 40	49, 52, 53, & 55 min	30, 33, 36, & 40 min
A913	High-Strength Low Alloy Shapes of Structural Quality, Produced by Quenching & Self-Tempering Process	50 60 65 70	65 min 75 min 80 min 90 min	50 min 60 min 65 min 70 min
A935	Steel, Sheet & Strip, High Strength Low - Alloy Columbium or Vanadium or Both (Discontinued 6/01, replaced with A1018)	45 50, 55, & 60 65 70	60 min 65 & 70 min 80 min 85 min	45 min 50 & 55 min 65 min 70 min
A936	High Strength, Low-Alloy Sheet & Strip, Heavy Thickness Coils (Discontinued 6/01, replaced with A1018)	50 60 70 80	60 min 70 min 80 min 90 min	50 min 60 min 70 min 80 min
A945	High Strength, Low-Alloy Structural Plate w/Low Carbon & Restricted Sulfur for Improved Weldability	50 65	70-90 78-100	50 min 65 min
A984	Steel Line Pipe, black, Plain-End, Electric-Resistance-Welded	35 45 55 65 80	60 min 65 min 70 min 75 min 90 min	35-70 45-72 55-80 65-85 80-97

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
Excalibur 9018-M MR LH-110M MR		LA75 LA100, MC1100		81K2-H
(2), (4)		(16)		
Jet-LH 9018-B3 MR Jet-LH 9018-B3 MR	MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93			
(1) LH-8018-C3, Excalibur 8018-C3	(10), (11) 860, 960/LA75	(16) LA75	(18)	(23) 81Ni1-H
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR	(10), (11)	(16)	(18)	(23)
(1) (1)	(10) (10)	(16) (16)	(18) (18)	(23) (23)
Excalibur 9018-M MR	MIL800-HPNi/LA85, (31)	MC1100		91K2-H
Excalibur 7018, 7018-1, LH-78, LH-8018-C3 MR, Excalibur 8018-C3 MR	880M/L56	LA75	NR-207	81K2-H
LH-8018-C1 MR, Excalibur 8018-C1 MR LH-8018-C1 MR, Excalibur 8018-C1 MR	880M/LA75 880M/LA75	LA75 LA75		
Excalibur 7018-1 Excalibur 7018-1 Excalibur 7018-1	8500/LS3 8500/LS3 8500/LS3 8500/LA85 8500/LA85			
LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR	860, 960/LA75 860, 960/LA75	LA75 LA75		81Ni1-H 81Ni1-H
Jet-LH 9018-B3L Jet-LH 9018-B3L Jet-LH 9018-B3L	MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93 MIL800-H, 880M, 882/LA93			
(2)	(10), (11)	(16)	(17)	(23)
LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	761/L61, 860, 960/L50 960/LA75 960/LA75 880M/LA100	LA75 LA75 LA75	(18) NR-311 Ni	(23) (24) (24) (24)
(2) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) (10), (11) (14) (14)	(16) (16) LA90 LA90	(17) (17)	(23) (23) (24) (24)
(2) (3) LH-8018-C3 MR, Excalibur 8018-C3 MR		(16) (16) LA75 LA90, MC900	(17) (17)	(23) (23) (24) 91K2-H
Excalibur 7018-1 LH-8018-C3 MR, Excalibur 8018-C3 MR	8500/L-S3, LA85 8500/L-S3, LA85	LA75 LA75	NR-203MP	(24) 81K2-H
(2), (4) Pipeliner 6P+, Pipeliner 8P+, FW 5P+, SA HYP+, SA70+, SA 80 SA 70+, SA 80, SA HYP+, LH-D80, LH-D90, Pipeliner 8P+ SA 70+, SA 80, LH-D80, LH-D90, Pipeliner 8P+ SA 90 (28), LH-D90	860/L60, L61 860/L60, L61 860/L60, L61 860/L60, L61 880M/LA90	(16) (16) L56 L56 LA90	(21) (21) (21) (21)	(23) (23) (24) (24) 91K2-H

Filler Metals Selection Guide

ASTM Number	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
A992	Steel for Structural Shapes for use in Building Framing		65 min	50-65
A996	Rail-Steel & Axle-Steel for Concrete Reinforcement	40 50 60	70 min 80 min 90 min	40 min 50 min 60 min
A1008	Steel, Sheet, Cold-Rolled, Structural, High Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability.	CS, (Types A, B, & C), DS, (Types A & B), DDS, EDDS SS, Grades 25, 30, 33, & 40 SS, Grade 80 HSLAS, Grade 45 Class 1 & 2 HSLAS, Grade 50 Class 1 & 2 HSLAS, Grade 55 Class 1 & 2 HSLAS, Grade 60 Class 1 & 2 HSLAS, Grade 65 Class 1 & 2 HSLAS, Grade 70 Class 1 & 2 HSLAS-F Grade 50 HSLAS-F Grade 60 HSLAS-F Grade 70 HSLAS-F Grade 80	--- --- 42, 45, 48, & 52 min 82 min 60 & 55 65 & 60 70 & 65 min 75 & 70 min 80 & 75 min 85 & 80 60 min 70 min 80 min 90 min	20-40, 22-35, 17-29, 15-25 25, 30, 33, & 40 min 80 min 45 min 50 & 55 50 & 55 60 & 65 60 & 65 70 min 50 min 60 min 70 min 80 min
A1011	Steel, Sheet, Hot-Rolled, Structural, High Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability.	CS, (Types A, B, & C), DS, types (A & B) SS, Grades 25, 30, 33, & 40 SS, Grade 80 HSLAS, Grade 45 Class 1 & 2 HSLAS, Grade 50 Class 1 & 2 HSLAS, Grade 55 Class 1 & 2 HSLAS, Grade 60 Class 1 & 2 HSLAS, Grade 65 Class 1 & 2 HSLAS, Grade 70 Class 1 & 2 HSLAS-F Grade 50 HSLAS-F Grade 60 HSLAS-F Grade 70 HSLAS-F Grade 80	--- 42, 45, 48, & 52 min 82 min 60 & 55 min 65 & 60 min 70 & 65 min 75 & 70 min 80 & 75 min 85 & 80 min 60 min 70 min 80 min 90 min	20-40, 22-35, 17-29, 15-25 25, 30, 33, & 40 min 80 min 45 min 50 & 55 min 50 & 55 min 60 & 65 min 60 & 65 min 70 min 50 min 60 min 70 min 80 min
A1018	Steel, Sheet, Hot-Rolled, Structural, High Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability.	SS, Grades 25, 30, 33, & 40 SS, Grade 80 HSLAS, Grade 45 Class 1 & 2 HSLAS, Grade 50 Class 1 & 2 HSLAS, Grade 55 Class 1 & 2 HSLAS, Grade 60 Class 1 & 2 HSLAS, Grade 65 Class 1 & 2 HSLAS, Grade 70 Class 1 & 2 HSLAS-F Grade 50 HSLAS-F Grade 60 HSLAS-F Grade 70 HSLAS-F Grade 80	42, 45, 48, & 52 min 82 min 60 & 55 65 & 60 70 & 65 75 & 70 80 & 75 85 & 80 60min 70 min 80 min 90 min	25, 30, 33, & 40 min 80 min 45 min 50 & 55 50 & 55 60 & 65 60 & 65 70 min 50 min 60 min 70min 80 min

** For gas-shielded processes (GMAW & FCAW-G), the type of gas shielding used will affect the electrode operability characteristics and mechanical properties. All suggestions listed in this guide are based on the resultant mechanical properties when the electrode is used with the shielding gas required for AWS classification. Changes in shielding gas may make the suggestions inappropriate, or create new options. Selecting the correct shielding gas is beyond the scope of this document.

Filler Metals Selection Guide

SMAW	SAW	GMAW**	FCAW-S	FCAW-G**
(1)	(10), (11)	(16)	(17)	(23)
(1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR		(16) LA75 LA90	(18)	(23) (24) 91K2-H
(2)	(10), (11)	(16)	(17)	(23)
(2) Excalibur 9018-M MR	(10), (11) 880M, 8500/LA90	(16) LA90	(17)	(23) 91K2-H
(2) (1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR (2) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) (10), (11) (10), (11) 8500/L-S3, LA85 8500/L-S3, LA85 8500/L-S3, LA85 (10), (11) (10), (11) 8500/L-S3, LA85 880M, 8500/LA90	(16) (16) (16) LA75 LA75 LA75 (16) (16) LA75 LA90	(17) (17) (17) (17) (17)	(23) (23) (23) 81K2-H 81K2-H 81K2-H (23) (23) 81K2-H 91K2-H
(2)	(10), (11)	(16)	(17)	(23)
(2) Excalibur 9018-M MR (2) (1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR (2) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) 880M, 8500/LA90 (10), (11) (10), (11) (10), (11) 8500/L-S3, LA85 8500/L-S3, LA85 8500/L-S3, LA85 (10), (11) (10), (11) 8500/L-S3, LA85 880M, 8500/LA90	(16) LA90 (16) (16) (16) LA75 LA75 LA75 (16) (16) LA75 LA90	(17) (17) (17) (17) (17)	(23) 91K2-H (23) (23) (23) 81K2-H 81K2-H 81K2-H (23) (23) 81K2-H 91K2-H
(2) Excalibur 9018-M MR (2) (1) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR LH-8018-C3 MR, Excalibur 8018-C3 MR (2) (1) LH-8018-C3 MR, Excalibur 8018-C3 MR Excalibur 9018-M MR	(10), (11) 880M, 8500/LA90 (10), (11) (10), (11) (10), (11) 8500, 8500-H2/L-S3, LA85 8500, 8500-H2/L-S3, LA85 8500, 8500-H2/L-S3 LA85 (10), (11) (10), (11) 8500, 8500-H2/L-S3, LA85 880M, 8500/LA90	(16) LA90 (16) (16) (16) LA75 LA75 LA75 (16) (16) LA75 LA90	(17) (17) (17) (17) (17)	(23) 91K2-H (23) (23) (23) 81K2-H 81K2-H 81K2-H (23) (23) 81K2-H 91K2-H

Filler Metals Selection Guide » American Petroleum Institute

API Spec.	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
2H	C-Mn Steel Plate for Offshore Platform	42 (CVN Requirement 25 ft-lbs @ -40°F)	62-82	42 min
		50, </=2.5 (CVN Requirement 30 ft-lbs @ -40°F)	70-90	50 min
		50, >2.5 (CVN Requirement 30 ft-lbs @ -40°F)	70-90	47 min
2W	Steel Plates for Offshore Structures, Produced by Thermo-Mechanical Control Processing (TMCP)	42 (CVN Requirement 25 ft-lbs @ -40°F)	62 min	42-67
		50 (CVN Requirement 30 ft-lbs @ -40°F)	65 min	50-75
		50T (CVN Requirement 30 ft-lbs @ -40°F)	70 min	50-80
		60 (CVN Requirement 35 ft-lbs @ -40°F)	75 min	60-90
2Y	Steel Plates, Quenched & Tempered, for Offshore Structures	42 (CVN Requirement 25 ft-lbs @ -40°F)	62 min	42-67
		50 (CVN Requirement 30 ft-lbs @ -40°F)	65 min	50-75
		50T (CVN Requirement 30 ft-lbs @ -40°F)	70 min	50-80
		60 (CVN Requirement 35 ft-lbs @ -40°F)	75 min	60-90

Product Specification Levels (PSL) were added to the specification January 2000. PSL2 has mandatory requirements for carbon equivalent, notch toughness, maximum yield strength, and maximum tensile strength.

SMAW	SAW***		GMAW**	FCAW-S	FCAW-G**
	Double-Ending	Longitudinal & Spiral Seam*			
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61 LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61 LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61 LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
LH-8018-C3 MR	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75		(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
Excalibur 7018-1	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75	(19)	(24)
LH-8018-C3 MR	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	880M/L50, L-S3, LA85, 960/L50, L61, LA85, 882, 8500, 860/L50, L-S3, L61, LA85	LA75		(24)

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API Spec.	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
5L	Welded Steel Line Pipe	Product Specification Level (PSL) 1		
		A25	45 min	25 min
		A	48 min	30 min
		B	60 min	35 min
		X42	60 min	42 min
		X46	63 min	46 min
		X52	66 min	52 min
		X56	71 min	56 min
		X60	75 min	60 min
		X65	77 min	65 min
		X70	82 min	70 mn

Product Specification Levels (PSL) were added to the specification January 2000. PSL2 has mandatory requirements for carbon equivalent, notch toughness, maximum yield strength, and maximum tensile strength.

SMAW	SAW***		GMAW**	FCAW-S	FCAW-G**
	Double-Ending	Longitudinal & Spiral Seam*			
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5, FW 5P+, SA HYP+, SA 70+, Pipeliner 6P+, Pipeliner 8P+	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5P+, SAHYP+, SA 70+, SA 80+, 16P, Pipeliner 6P+,Pipeliner 8P+	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5P+, SAHYP+, SA 70+, SA 80, 16P, 18P, LH-D80, LH-D90. Pipeliner 6P+, Pipeliner 8P+	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5P+, SAHYP+, SA 70+, SA 80, 16P, 18P, LH-D80, LH-D90. Pipeliner 6P+, Pipeliner 8P+	860/L50, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L56	NR-207, -H	
SA70+, SA 80, 18P, LH-D80, LH-D90, Pipeliner 8P+	881/LA-71, LA75	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90		NR-207, -H	

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API Spec.	Description	Grades	Strength Requirements	
			Tensile (ksi)	Yield (psi)
5L	Welded Steel Line Pipe	Product Specification Level (PSL) 2 B	60-110	33-65
		X42	60-110	42-72
		X46	63-110	46-76
		X52	66-110	52-77
		X56	71-110	56-79
		X60	75-110	60-82
		X65	77-110	65-87
		X70	82-110	70-90
		X80	90-120	80 min

Product Specification Levels (PSL) were added to the specification January 2000. PSL2 has mandatory requirements for carbon equivalent, notch toughness, maximum yield strength, and maximum tensile strength.

* Welding on 2H, 2Y, and 2W grades is assumed to be multipass and longitudinal only. Welding on 5L grades is assumed to be single pass.

** For gas-shielded processes (GMAW & FCAW-G), the type of gas shielding used will affect the electrode operability characteristics and mechanical properties. All suggestions listed in this guide are based on the resultant mechanical properties when the electrode is used with the shielding gas required for AWS classification. Changes in shielding gas may make the suggestions inappropriate, or create new options. Selecting the correct shielding gas is beyond the scope of this document.

*** SAW recommendations are starting points only. Because of the varying requirements and the high dilution rates involved with pipe welding, all combinations should be tested on the pipe to be used to assure that all requirements are met.

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SMAW	SAW***		GMAW**	FCAW-S	FCAW-G**
	Double-Ending	Longitudinal & Spiral Seam*			
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
(2), (4)	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5, FW 5P+, SA HYP+, SA 70+, Pipeliner 6P+, Pipeliner 8P+	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5P+, SA HYP+, SA 70+, SA 80, 16P, Pipeliner 6P+, Pipeliner 8P+	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5P+, SA HYP+,SA 70+, SA 80, 16P, 18P, Pipeliner Lincoln LH-D80, Pipeliner Lincoln LH-D90, Pipeliner 6P+, Pipeliner 8P+	860/L60, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L50, L56	NR-207, -H	
FW 5P+, SA HYP+,SA 70+, SA 80, 16P, 18P, Pipeliner Lincoln LH-D80, Pipeliner Lincoln LH-D90, Pipeliner 6P+, Pipeliner 8P+	860/L50, L61	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90	L56	NR-207, -H	
SA 70+, SA 80, 18P, LH-D80, Pipeliner Lincoln LH-D90, Pipeliner 8P+	882/LA-71, LA75	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90		NR-207, -H	
SA 70+, SA 80 (Both Root Only), SA 90 (28), 18P, LH-D90	MIL800-H,880M/LA100	780/L61, 761, P223/L61, L70 997/L61, L70, LA81 995N/L70, LA81, LA90 995/L61, L70, LA81, LA90			

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THE LINCOLN ELECTRIC COMPANY
22801 Saint Clair Avenue ▪ Cleveland, OH ▪ 44117 ▪ U.S.A.
Phone: +1 216.481.8100 ▪ www.lincolnelectric.com