



# **KOBELCO**

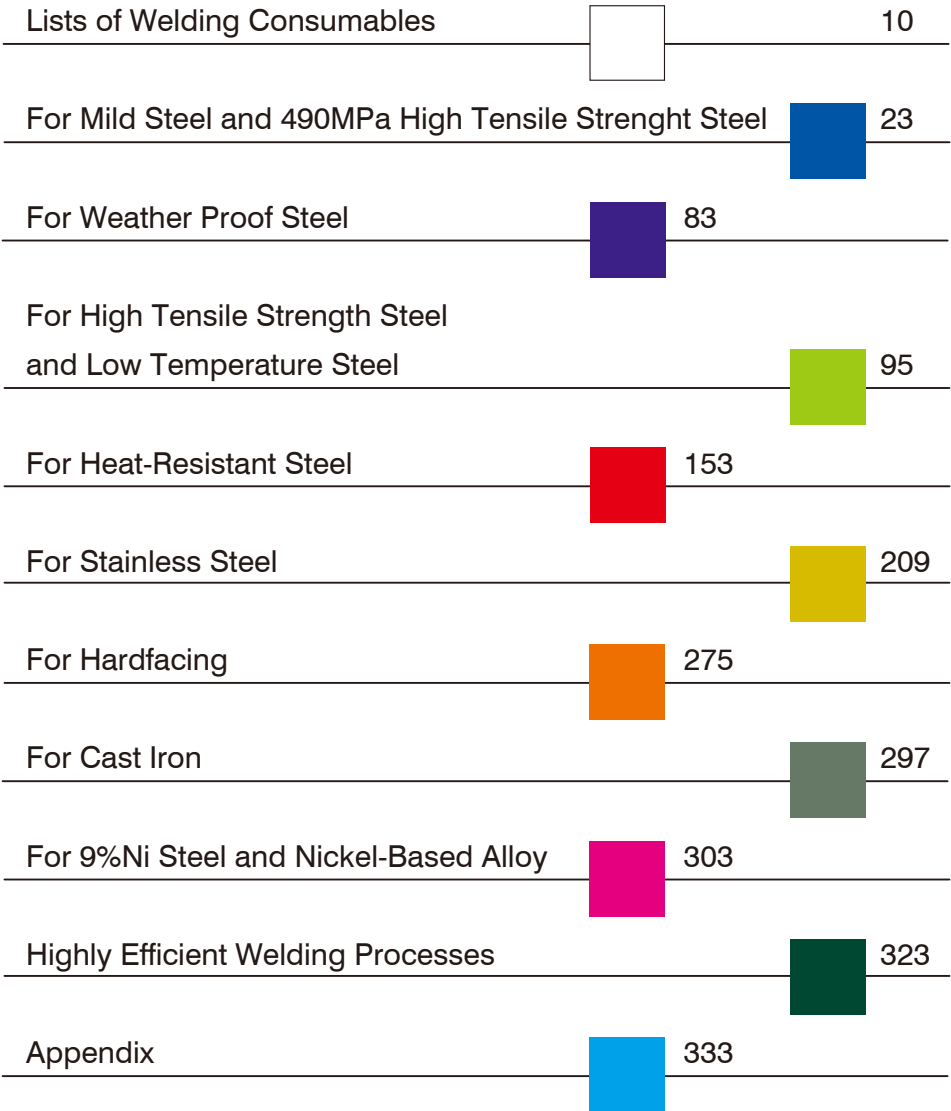
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## **WELDING HANDBOOK**

**KOBE STEEL, LTD.**  
**WELDING BUSINESS**



# Overall Index



• For your further information of welding consumable specifications, classifications, approvals and packages, please contact the nearest Kobelco office or sales representative.

# Notification

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We, Welding Business of Kobe Steel, Ltd., thank you very much for your continuous patronage of our products and services. We have changed the designation system of welding consumable as described in the following from April 2008. However, the technical design of the products is not changed.

<b>New group brand names and the corresponding products</b>
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All KOBELCO welding consumables are designated with “Trade Designation” and are grouped into the following three new groups on the basis of the characteristics of individual products as detailed below.

(1) **FAMILIARC™** (Famili-Arc)  
A coined word produced by combining “Familiar” and “Arc.”  
Welding consumables grouped into this group are used for general welded structures made of mild steels and high tensile strength steels that have the tensile strength of less than 590 MPa.

(2) **TRUSTARC™** (Trust-Arc)  
A coined word produced by combining “Trust” and “Arc.”  
Welding consumables grouped into this group are used for such steels that require highly credible qualities as high tensile strength steels with the tensile strength of 570 MPa and higher, low temperature steels, and heat-resistant low-alloy steels.

(3) **PREMIARC™** (Premi-Arc)  
A coined word produced by combining “Premium” and “Arc.”  
Welding consumables grouped into this group are used for high-alloy steels, stainless steels, and nonferrous metals.

The new group brand name (referred to as “Trademark” hereinafter) is put on the head of an individual trade designation. The trade designations are made by modifying the traditional brand names in accordance with the new designation system in which the position of hyphen is reviewed so that a hyphen comes after one letter or two letters. That is, the new brand name consists of “Trademark” and “Product name” as shown in the following. We are determined to control all the trade designations so that they can clearly be identified.

Examples of new and old brand names

Old brand name	New brand name
(1) B-10	<b>FAMILIARC™</b> B-10
(2) MG-50	<b>FAMILIARC™</b> MG-50
(3) TGS-50	<b>FAMILIARC™</b> TG-S50
(4) MGS-50	<b>FAMILIARC™</b> MG-S50
(5) ZERODE-44	<b>FAMILIARC™</b> Z-44
(6) CMA-106N	<b>TRUSTARC™</b> CM-A106N
(7) DW-308	<b>PREMIARC™</b> DW-308

## The purpose of changing the designation system

In recent years, we have found some other companies' products that have the same brand names as ours and false certificates that misrepresent our company's certificates in Japan and the Asian countries.

In order to cope with this problem, we have taken legal actions against the impostors that could be verified and have required them to change their product names. However, it is difficult in the traditional product designation system to protect all of our products from imitation. Hence, we have established the new designation system of welding consumable to ensure the trademark right in main countries and to make our products identifiable more clearly, in which the particular group brand name, "Trademark," is put on the head of an individual "Product name."

The new designation system is not only to prevent counterfeit products in Japan and overseas countries, but also to prevent our customers and users from suffering such a trouble in terms of our products.

This modification may cause customers and users to modify their relevant documents. We sincerely hope for your understanding of the abovementioned situation and for your cooperation with us.

## **Introduction to our Home page**

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search words: kobelco, welding handbook

or

<http://www.kobelco.co.jp/english/welding>

# Foreword

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Note the following preliminary information on use of this welding handbook.

## **1. Standards for welding consumables are abbreviated as follows**

- AWS : American Welding Society's Standard
- EN : European Norm
- ASME : American Society of Mechanical Engineers' Standard

## **2. Classifications for welding consumables are used in accordance with the following rules**

Welding consumables are classified in accordance with basically the mechanical and/or chemical requirements of the standards, excluding such requirements as size, length, marking and identification manners. For details please contact the nearest Kobelco office or sales representative.

## **3. The test conditions of mechanical properties and hardness are as follows**

- (1) Unless otherwise specified, impact values are obtained with Charpy 2mm-V notch specimens.
- (2) Unless otherwise specified, tension test and hardness test are carried out at room temperature.
- (3) Unless otherwise specified, tension test and hardness test are carried out in the as-welded condition.
- (4) The gauge length of tensile specimens is  $4 \times D$  (where D is the diameter) for testing at room temperature.
- (5) Unless otherwise specified, postweld heat treatment is followed by furnace cooling.
- (6) Unless otherwise specified, the testing method is as per AWS standard.
- (7) All mechanical and chemical data are given separately as "Example" (one of the manufacturer's laboratory test data) and "Guaranty" (the guaranty value as per AWS standard). Tensile strength and 0.2% offset strength are rounded as SI unit.

## **4. The weight per piece of covered electrode shows an approximate weight**

# Abbreviations and marks with definitions


This welding handbook uses the following abbreviations and marks if necessary.

Abbrev. and mark	Definition	Abbrev. and mark	Definition
AC	Alternating current or Air cooling	NL	Number of layer
A	Ampere	NR	Not required
AP	All positions	OD	Outer diameter
AW	As-welded	OQ	Oil quenching
Bal	Balance	OS	Offset strength
CR	Cooling rate	OSW	One-side welding
DBE	Distance between electrodes	Pol	Polarity
DC	Direct current	Pre. H	Preheat
DC-EN	DC, electrode negative	PT	Plate thickness
DC-EP	DC, electrode positive	PWHT	Postweld heat treatment
Dia.	Diameter	RA	Reduction of area
EGW	Electrode gas arc welding	RC	Redrying conditions
EI	Elongation	RG	Root gap
Ext	Extension of wire	RT	Room temperature
F	Flat position	SAW	Submerged arc welding
FC	Furnace cooling	SG	Shielding gas
FCW	Flux-cored wire	SMAW	Shielded metal arc welding
FCAW	Flux Cored Arc Welding	SR	Stress relief
GD	Groove design	SW	Solid wire
GMAW	Gas Metal Arc Welding	(T)	Trailing electrode
GS	Groove size	TIG	Tungsten inert gas
GTAW	Gas Tungsten Arc Welding	TS	Tensile strength
H	Horizontal position	Temp	Test temperature
HAZ	Heat-affected zone	V	Voltage
HF	Horizontal fillet	VD	Vertical-down position
HI	Heat input	VU	Vertical-up position
HT	High tensile	WP	Welding position
HR	Heat Resistant	WQ	Water quenching
Hv	Hardness (Vickers)	YP	Yield point
I PT	Interpass temperature	≅	Maximum
IV	Impact value	≅	Minimum
L	Length	[F]	FAMILIARC™
(L)	Leading electrode	[T]	TRUSTARC™
MS	Mild steel	[P]	PREMIARC™
NE	Number of electrode		



# Warning and Caution in Welding

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Pay your attention to the following warnings and cautions for your safety and health during welding and related operations

 <b>WARNING</b>	<b>Be sure to follow safety practices stated in the following in order to protect welders, operators and accompanied workers from a serious accident resulting in injury or death.</b>
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- Be sure to follow safety practices stated in the following when you use welding consumables.
- Be sure to follow safety practices stated in the instruction manual of welding equipment when you use it.

 <b>WARNING</b> 	<b>Electric shock can kill.</b>
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- Do not touch live electrical parts (A covered electrode held with an electrode holder and a welding wire are electrically live).
- Wear dry, insulated gloves. Do not wear torn or wet gloves. Use an electric shock preventing device (e.g., open-circuit-voltage-reducing device) when welders or operators work in confined or high-level spaces. Use also a lifeline when welders or operators conduct welding at a high-level space.
- Follow safety practices stated in the instruction manual of welding machines before use. Do not use a welding machine the case or cover of which is removed. Welding cables must have an adequate size for the capacity expected. Welding cables must be kept in an appropriate condition and a damaged cable must be repaired or replaced with new one.





## CAUTION



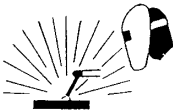
**Fumes and gases generated during welding are dangerous to your health.**

**Welding in confined spaces is dangerous because it can be a cause to suffocation by oxygen deficient.**

- Keep your head out of the source of fumes or gases to prevent you from directly breathing high density fumes or gases.
- Use local exhaust ventilation, or wear respirators in order to prevent you from breathing fumes and toxic gases which cause toxication, poor health and suffocation by oxygen deficient.
- Use general ventilation during welding in a workshop. Particularly during welding in confined spaces, be sure to use adequate ventilation or respirators, and welding should be done at the presence of a trained supervisor.
- Do not conduct welding at where degreasing, solvent cleaning, spraying, or painting operations are carried out nearby. Welding work accompanied by these operations may cause generation of harmful gases.
- Use adequate ventilation or respirators with special attention during welding plated and coated steels.
- Use respirators, eye safety glasses and safety leather gloves when using welding fluxes in order to prevent you from flux dust.



## CAUTION



**Arc rays can injure eyes and burn skin.**

- Wear hand shields with an adequate shade grade during welding operations and supervising the welding work. Select the correct shade grade for filter lenses and filter plates suitable for exact welding work by referring the standard JIS T81 41.
- Wear suitable protectors for protecting you from an arc ray; e.g., safety leather glove for welding, long sleeve shirt, foot cover, leather apron.
- Use, at need, shade curtains for welding by surrounding the welding areas in order to prevent accompanied workers from arc rays.



## CAUTION



**Fire and explosion can take place.**

- Never conduct welding at areas adjacent to highly inflammable materials. Remove combustibles so that spatters cannot ignite them. If combustibles cannot be removed, cover them with a noninflammable material.
- Do not weld vessels or pipes which contain combustibles or being sealed.
- Do not put a hot weldment close to combustibles right after welding finished.
- When welding ceilings, floors, walls, remove combustibles put at the other side of them.
- Any part of a welding wire, with exception of the portion appropriately extended from the tip of the torch, must be free from touching the electrical circuit of the base metal side.
- Fasten cable joints and seal them with an insulation tape. The cable of the base metal side should be connected as close as possible to the welding portion of the work.
- Prepare fire-extinguishing equipment at where welding is carried out, in order to cope with a possible accident.



## CAUTION



**Flying spatter and slag can injure eyes and cause skin burns.**

**High temperature heat of welding can cause skin burns.**

- Wear safety glasses, safety leather gloves for welding, long sleeve shirts, foot covers, leather aprons, etc.
- Do not touch weldments while they are hot.



## CAUTION



The tip of a welding wire and filler wire can injure eyes, faces, etc.

- When take off the tip of a wire fastened in the spool, be sure to hold the tip of the wire.
- When check the wire feeding condition, do not direct the welding touch to your face.



## CAUTION



Falling down or dropping welding consumables can injure you.

- Wear safety shoes and pay your attention not to drop welding consumables on your body when carrying and handling them. Keep yourself in a correct posture not to cause a crick in your back while handling them.
- Follow the handling instructions shown on the surface of the pail pack wire packages when handle them.
- Pile up welding consumables in a correct way so as not to cause falling or dropping while they are stored or carried.

# Lists of Welding Consumables

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
<b>For Mild Steel and 490MPa High Tensile Strength Steel</b>						
SMAW	<b>KOBE-6010</b>	A5.1 E6010	ISO 2560-A-E 35 0 C	3	1	38
	<b>B-33</b>	A5.1 E6013	-	2	1	44
	<b>RB-26</b>	A5.1 E6013	ISO 2560-A-E 35 0 R	2	1	33
	<b>Z-44</b>	A5.1 E6013	-	2	1	44
	<b>B-10</b>	A5.1 E6019	-	2	1	44
	<b>B-14</b>	A5.1 E6019	ISO 2560-A-E 35 2 RA	2	1	32
	<b>B-17</b>	A5.1 E6019	-	2	1	44
	<b>LB-26</b>	A5.1 E7016	-	4	1	46
	<b>LB-47</b>	A5.1 E7016	-	4	1	26
	<b>LB-52</b>	A5.1 E7016	ISO 2560-A-E 42 3 B	4	1	34
	<b>LB-52U</b>	A5.1 E7016	ISO 2560-A-E 42 2 B	4	1	35
	<b>LB-M52</b>	A5.1 E7016	-	4	1	26
	<b>LB-52A</b>	A5.1 E7016	-	4	1	46
	<b>LB-57</b>	A5.1 E7016	-	4	-	46
	<b>LT-B52A</b>	A5.1 E7018	-	4	1	48
	<b>LB-52-18</b>	A5.1 E7018	ISO 2560-A-E 42 3 B	4	1	36
	<b>KOBE-7024</b>	A5.1 E7024	ISO 2560-A-E 42 0 RR	1	1	37
	<b>LB-52T</b>	A5.1 E7048	-	4	1	46
	<b>LB-78VS</b>	A5.1 E7048	ISO 2560-A-E 42 2 B	4	1	41
	<b>KOBE-7010S</b>	A5.5 E7010-P1	ISO 2560-A-E 42 0 C	3	-	39
<b>LB-76</b>	A5.5 E7016-G	-	4	1	46	
<b>KOBE-8010S</b>	A5.5 E8010-P1	ISO 2560-A-E 36 0 Z C	3	-	40	
<b>LB-88VS</b>	A5.5 E8018-G	ISO 2560-A-E 46 2 Z B	4	-	42	
<b>LB-98VS</b>	A5.5 E9018-G	ISO 2560-A-E 50 2 Z B	4	-	43	
<b>LT-B50</b>	-	-	-	1	48	
FCAW	<b>MX-100T</b>	A5.18 E70C-6C/6M	ISO 17632-A - T 42 2 M C/M 1 H5	6	1	57
	<b>MX-A100</b>	A5.18 E70C-6M	ISO 17632-A - T 42 4 M M 3 H5	6	1	56
	<b>DW-200</b>	A5.20 E70T-1C	-	6	1	58
	<b>MX-100</b>	A5.20 E70T-1C	-	6	1	60
	<b>MX-200</b>	A5.20 E70T-1C	ISO 17632-A - T 42 0 R C 3 H5	6	1	54

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
FCAW	<b>MX-200E</b>	A5.20 E70T-9C	ISO 17632-A - T 42 3 R C 3 H5	6	1	55
	<b>MX-200H</b>	A5.20 E70T-1C	-	6	1	60
	<b>MX-A200</b>	A5.20 E70T-1M	-	6	1	60
	<b>DW-100</b>	A5.20 E71T-1C	ISO 17632-A - T 42 0 P C 1 H10	6	1	50
	<b>DW-100E</b>	A5.20 E71T-9C	ISO 17632-A - T 42 2 P C 1 H10	6	1	51
	<b>DW-100V</b>	A5.20 E71T-1C	-	6	1	58
	<b>DW-50</b>	A5.20 E71T-1C/1M, -9C/9M	ISO 17632-A - T 42 2 P C/M 1 H5	6	1	53
	<b>DW-A50</b>	A5.20 E71T-1M	ISO 17632-A - T 42 2 P M 1 H5	6	1	52
	<b>DW-A51B</b>	A5.20 E71T-5M-J	-	6	1	58
GMAW	<b>MIX-50</b>	A5.18 ER70S-3	-	6	1	64
	<b>MG-51T</b>	A5.18 ER70S-6	-	6	1	63
	<b>MIX-50S</b>	A5.18 ER70S-G	-	6	1	66
	<b>MG-50</b>	A5.18 ER70S-G	-	6	1	62
	<b>MG-S50</b>	A5.18 ER70S-G	-	6	1	66
	<b>SE-A50</b>	A5.18 ER70S-G	-			64
	<b>MIX-1TS</b>	-	-			64
	<b>MG-50T</b>	-	-	-	1	64
GTAW	<b>NO65G</b>	A5.18 ER70S-2	-	6	1	70
	<b>TG-S51T</b>	A5.18 ER70S-6	-	6	1	69
	<b>TG-S50</b>	A5.18 ER70S-G	-	6	1	68
SAW	<b>MF-53/US-36</b>	A5.17 F7A0-EH14	-	6	-	78
	<b>G-50/US-36</b>	A5.17 F7A2-EH14	-	6	-	72
	<b>G-60/US-36</b>	A5.17 F7A2-EH14	-	6	-	73
	<b>G-80/US-36</b>	A5.17 F7A2-EH14, F6P2-EH14	-	6	-	78
	<b>PF-H55E/US-36</b>	A5.17 F7A4-EH14	-	6	1	80
	<b>MF-300/US-36</b>	A5.17 F7A6-EH14, F7P6-EH14	-	6	-	76
	<b>MF-38/US-36</b>	A5.17 F7A6-EH14, F7P6-EH14	-	6	-	74
<b>For Weather Proof Steel</b>						
SMAW	<b>LB-W52</b>	A5.5 E7016-G	-	4	-	86
	<b>LB-W52B</b>	A5.5 E7016-G	-	4	-	86

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
SMAW	<b>LB-W588</b>	A5.5 E8016-C3	-	4	-	86
	<b>LB-W62G</b>	A5.5 E8018-W2	-	4	-	86
FCAW	<b>DW-588</b>	A5.29 E81T1-W2C	-	6	-	88
	<b>DW-50W</b>	-	-	-	-	88
GMAW	<b>MG-W50TB</b>	A5.28 ER80S-G	-	6	-	90
SAW	<b>MF-53/US-W52B</b>	A5.23 F7A0-EG-G	-	6	-	92
	<b>MF-38/US-W52B</b>	A5.23 F7A2-EG-G	-	6	-	92
<b>For High Tensile Steel and Low Temperature Steel</b>						
SMAW	<b>LB-7018-1</b>	A5.1 E7018-1	ISO 2560-A-E 42 4 B	4	1	102
	<b>NB-3J</b>	A5.5 E7016-C2L	-	4	10	114
	<b>LB-52NS</b>	A5.5 E7016-G	ISO 2560-A-E 42 6 Z B	4	-	107
	<b>LB-62L</b>	A5.5 E8016-C1	-	4	10	109
	<b>LB-65L</b>	A5.5 E8016-C1	-	4	10	114
	<b>NB-1SJ</b>	A5.5 E8016-G	-	4	10	108
	<b>LB-62</b>	A5.5 E9016-G	ISO 2560-A-E 50 3 Z B	4	-	104
	<b>LB-62U</b>	A5.5 E9016-G	-	4	-	106
	<b>LB-62UL</b>	A5.5 E9016-G	ISO 2560-A-E 50 3 Z B	4	-	105
	<b>LB-67L</b>	A5.5 E9016-G	-	4	10	110
	<b>LB-62D</b>	A5.5 E9018-G	-	4	-	114
	<b>LB-106</b>	A5.5 E10016-G	-	4	-	114
	<b>LB-70L</b>	A5.5 E10016-G	-	4	-	111
	<b>LB-116</b>	A5.5 E11016-G	-	4	12	114
	FCAW	<b>LB-80UL</b>	A5.5 E11016-G	-	4	12
<b>LB-88LT</b>		A5.5 E11016-G	-	4	12	113
<b>LB-80L</b>		A5.5 E11018-G H4	-	4	-	112
<b>MX-55LF</b>		A5.20 E70T-9C-J	-	6	-	130
<b>DW-A55ESR</b>		A5.20 E71T-12M-J	-	6	1	130
<b>DW-55E</b>		A5.20 E71T-9C-J	ISO 17632-A - T 42 4 P C 1 H5	6	-	116
<b>DW-A55E</b>		A5.20 E71T-9M-J	ISO 17632-A - T 42 4 P M 1 H5	6	1	117
<b>MX-A55T</b>		A5.28 E80C-G	-	6	10	130
<b>MX-A55Ni1</b>	A5.28 E80C-G	ISO 17632-A - T46 6 Mn1Ni M M 3 H5	6	-	127	
<b>MX-A80L</b>	A5.28 E110C-G H4	ISO 18276 T69 6 Mn2.5Ni M M 3 H5	6	-	128	

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
FCAW	<b>DW-50LSR</b>	A5.29 E71T1-GC	-	6	-	118
	<b>DW-55L</b>	A5.29 E81T1-K2C	ISO 17632-A - T 46 6 1.5Ni P C 1 H5	6	10	120
	<b>DW-55LSR</b>	A5.29 E81T1-K2C	ISO 17632-A - T 46 6 1.5Ni P C 1 H5	6	10	122
	<b>DW-62L</b>	A5.29 E91T1-Ni2C-J	ISO 17632-A - T 50 6 Z P C 2 H5	6	10	124
	<b>DW-A55L</b>	A5.29 E81T1-K2M	ISO 17632-A - T 46 6 1.5Ni P M 1 H5	6	10	121
	<b>DW-A55LSR</b>	A5.29 E81T1-Ni1M	ISO 17632-A - T 46 6 Z P M 1 H5	6	10	123
	<b>DW-A62L</b>	A5.29 E91T1-GM	ISO 17632-A - T 50 6 Z P M 2 H5	6	10	125
	<b>DW-A65L</b>	A5.29 E91T1-K2M-J	ISO 18276-A- T55 4 Z P M 2 H5	6	10	126
	<b>DW-A81Ni1</b>	A5.29 E81T1-Ni1M-J	ISO 17632-A - T 46 6 1Ni P M 2 H5	6	10	119
GMAW	<b>MG-S50LT</b>	A5.18 ER70S-G	-	6	-	136
	<b>MG-S1N</b>	A5.28 ER70S-G	-	6	10	136
	<b>MG-S3N</b>	A5.28 ER70S-G	-	6	-	136
	<b>MG-60</b>	A5.28 ER80S-G	-	6	-	132
	<b>MG-T1NS</b>	A5.28 ER80S-G	-	6	10	97
	<b>MG-S63B</b>	A5.28 ER90S-G	-	6	-	132
	<b>MG-70</b>	A5.28 ER100S-G	-	6	-	132
	<b>MG-S70</b>	A5.28 ER100S-G	-	6	12	132
	<b>MG-80</b>	A5.28 ER110S-G	-	-	-	134
	<b>MG-S80</b>	A5.28 ER110S-G	-	6	-	134
	<b>MG-S88A</b>	A5.28 ER120S-G	-	6	-	134
GTAW	<b>TG-S1N</b>	A5.28 ER70S-G	-	6	-	140
	<b>TG-S3N</b>	A5.28 ER70S-G	-	6	10	140
	<b>TG-S60A</b>	A5.28 ER80S-G	-	6	-	138
	<b>TG-S62</b>	A5.28 ER80S-G	-	6	2	138
	<b>TG-S80AM</b>	A5.28 ER110S-G	-	6	-	138
SAW	<b>MF-38/US-49A</b>	A5.17 F7A6-EH14 F7P6-EH14	-	6	-	150
	<b>PF-H55S/US-49A</b>	A5.17 F7A6-EH14 F7P6-EH14	-	6	1	96
	<b>PF-H55LT/US-36</b>	A5.17 F7A8-EH14 F7P8-EH14	-	6	1	148

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
SAW	<b>PF-H55AS/US-36J</b>	A5.17 F7A8-EH14 F7P8-EH14	-	6	1	149
	<b>PF-H203/US-203E</b>	A5.23 7P15-ENi3-Ni3	-	6	10	150
	<b>MF-38/US-A4</b>	A5.23 F8A4-EA4-A4, F8P4-EA4-A4	-	6	2	144
	<b>MF-38/US-49</b>	A5.23 F8A4-EG-A4, F8P6-EG-A4	-	6	-	142
	<b>MF-38/US-40</b>	A5.23 F9A6-EA3-A3, F8P6-EA3-A3	-	6	-	145
	<b>PF-H80AS/US-80LT</b>	A5.23 F11A10-EG-G	-	6	-	147
	<b>PF-H80AK/US-80BN</b>	A5.23 F11A4-EG-G	-	6	-	150
	<b>PF-H80AK/US-80LT</b>	A5.23 F12A10-EG-G	-	6	-	146
<b>For Heat-Resistant Steel</b>						
SMAW	<b>BL-96</b>	A5.5 E9016-G	-	4	-	172
	<b>CM-B95</b>	A5.5 E7015-B2L	-	4	3	170
	<b>CM-A76</b>	A5.5 E7016-A1	-	4	2	170
	<b>CM-B83</b>	A5.5 E8013-G	-	2	3	154
	<b>CM-B105</b>	A5.5 E8015-B3L	-	4	4	170
	<b>CM-A96</b>	A5.5 E8016-B2	-	4	3	160
	<b>CM-A96MB</b>	A5.5 E8016-B2	-	4	3	161
	<b>CM-A96MBD</b>	A5.5 E8016-B2	-	4	3	161
	<b>CM-5</b>	A5.5 E8016-B6	-	4	4	172
	<b>CM-9</b>	A5.5 E8016-B8	-	4	5	166
	<b>CM-B98</b>	A5.5 E8018-B2	-	4	3	170
	<b>CM-A106</b>	A5.5 E9016-B3	-	4	4	162
	<b>CM-A106N</b>	A5.5 E9016-B3	-	4	4	163
	<b>CM-A106ND</b>	A5.5 E9016-B3	-	4	4	163
	<b>CM-95B9</b>	A5.5 E9015-B9	-	4	5	168
	<b>CM-96B9</b>	A5.5 E9016-B9	-	4	5	168
	<b>CM-9Cb</b>	A5.5 E9016-G	-	4	-	167
	<b>CM-B108</b>	A5.5 E9018-B3	-	4	4	170
	<b>CM-2CW</b>	-	-	4	-	172
	<b>CM-A106H</b>	-	-	-	4	164
<b>CM-A106HD</b>	-	-	-	4	165	
<b>CR-12S</b>	-	-	-	-	169	
GMAW	<b>MG-S5CM</b>	A5.28 ER80S-B6	-	6	4	176



Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
GMAW	<b>MG-S9CM</b>	A5.28 ER80S-B8	-	6	5	176
	<b>MG-S56</b>	A5.28 ER80S-G	-	6	-	174
	<b>MG-S1CM</b>	A5.28 ER80S-G	-	6	3	174
	<b>MG-SM</b>	A5.28 ER80S-G	-	6	2	174
	<b>MG-S9Cb</b>	A5.28 ER90S-G	-	6	-	176
	<b>MG-S2CM</b>	A5.28 ER90S-G	-	6	4	174
	<b>MG-S2CW</b>	A5.28 ER90S-G	-	6	-	176
	<b>MG-CM</b>	A5.28 ER80S-G	-	6	3	155
	<b>MG-S2CMS</b>	A5.28 ER90S-G	-	6	4	174
	<b>MG-S12CRS</b>	-	-	-	-	176
GTAW	<b>TG-S70SA1</b>	A5.28 ER70S-A1	-			188
	<b>TG-S5CM</b>	A5.28 ER80S-B6	-	6	4	188
	<b>TG-S9CM</b>	A5.28 ER80S-B8	-	6	5	185
	<b>TG-S1CML</b>	A5.28 ER80S-G	-	6	3	179
	<b>TG-S2CML</b>	A5.28 ER80S-G	-	6	4	182
	<b>TG-S56</b>	A5.28 ER80S-G	-	6	11	188
	<b>TG-S63S</b>	A5.28 ER90S-G	-	6	12	188
	<b>TG-S1CM</b>	A5.28 ER80S-G	-	6	3	178
	<b>TG-SM</b>	A5.28 ER80S-G	-	6	2	188
	<b>TG-S80B2</b>	A5.28 ER80S-B2	-	6	3	180
	<b>TG-S90B3</b>	A5.28 ER90S-B3	-	6	4	183
	<b>TG-S90B9</b>	A5.28 ER90S-B9	-	6	5	187
	<b>TG-S2CM</b>	A5.28 ER90S-G	-	6	4	181
	<b>TG-S9Cb</b>	A5.28 ER90S-G	-	6	5	186
	<b>TG-S12CRS</b>	-	-	-	-	188
	<b>TG-S2CMH</b>	-	-	-	4	184
	<b>TG-S2CW</b>	-	-	6	-	188
<b>TG-SCM</b>	-	-	-	3	155	
SAW	<b>PF-200S/US-502</b>	A5.23 F7P2-EG-B6	-	6	4	204
	<b>PF-200/US-511N</b>	A5.23 F8P2-EG-B2	-	6	3	194
	<b>PF-200D/US-511ND</b>	A5.23 F8P2-EG-B2	-	6	3	195
	<b>MF-38/US-A4</b>	A5.23 F8P4-EA4-A4 F8A4-EA4-A4	-	6	2	192
	<b>MF-38/US-49</b>	A5.23 F8P6-EG-A4 F8A4-EG-A4	-	6	-	190

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
SAW	<b>MF-38/US-40</b>	A5.23 F8P6-EA3-A3 F9A6-EA3-A3	-	6	-	193
	<b>PF-200/US-521S</b>	A5.23 F9P2-EG-B3	-	6	4	196
	<b>PF-200D/US-521S</b>	A5.23 F9P2-EG-B3	-	6	4	197
	<b>MF-27/US-56B</b>	A5.23 F9P4-EG-G	-	6	-	202
	<b>PF-200/US-56B</b>	A5.23 F9P4-EG-G	-	6	-	202
	<b>PF-90B9/US-90B9</b>	A5.23 F9PZ-EB9-B9	-	6	-	201
	<b>PF-200S/US-9Cb</b>	A5.23 F10PZ-EG-G	-	6	-	200
	<b>PF-500/US-521H</b>	-	-	-	4	198
	<b>PF-500D/US-521HD</b>	-	-	-	4	199
	<b>MF-29A/US-2CW</b>	-	-	-	-	204
	<b>PF-200S/US-12CRSD</b>	-	-	-	-	206
<b>For Stainless Steel</b>						
SMAW	<b>NC-38</b>	A5.4 E308-16	-	5	8	218
	<b>NC-38H</b>	A5.4 E308H-16	-	5	8	220
	<b>NC-38LT</b>	A5.4 E308L-16	-	5	8	228
	<b>NC-38L</b>	A5.4 E308L-16	-	5	8	219
	<b>NC-39</b>	A5.4 E309-16	-	5	8	221
	<b>NC-39L</b>	A5.4 E309L-16	-	5	8	222
	<b>NC-39MoL</b>	A5.4 E309LMo-16	-	5	8	223
	<b>NC-30</b>	A5.4 E310-16	-	5	9	210
	<b>NC-32</b>	A5.4 E312-16	-	5	-	210
	<b>NC-36</b>	A5.4 E316-16	-	5	8	224
	<b>NC-36L</b>	A5.4 E316L-16	-	5	8	225
	<b>NC-36LT</b>	A5.4 E316L-16	-	5	8	228
	<b>NC-317L</b>	A5.4 E317L-16	-	5	8	228
	<b>NC-37</b>	A5.4 E347-16	-	5	8	230
	<b>NC-37L</b>	A5.4 E347-16	-	5	8	230
	<b>CR-40Cb</b>	A5.4 E409Nb-16	-	-	7	226
	<b>CR-40</b>	A5.4 E410-16	-	4	6	226
	<b>CR-43</b>	A5.4 E430-16	-	4	7	227
	<b>CR-43Cb</b>	A5.4 E430Nb-16	-	-	7	227
	<b>NC-2209</b>	A5.4 E2209-16	-	-	-	232
<b>NC-2594</b>	A5.4 E2594-16	-	-	-	232	
<b>CR-43CbS</b>	-	-	-	7	227	

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
SMAW	<b>NC-316MF</b>	-	-	-	-	230
	<b>NC-329M</b>	-	-	-	8	232
FCAW	<b>DW-308H</b>	A5.22 E308HT1-1/4	-	6	8	248
	<b>DW-308L</b>	A5.22 E308LT0-1/4	ISO 17633-A-T 19 9 L R C/M 3	6	8	235
	<b>DW-308LT</b>	A5.22 E308LT0-1/4	-	6	8	252
	<b>DW-308LH</b>	A5.22 E308LT1-1/4	-	6	8	248
	<b>DW-308LP</b>	A5.22 E308LT1-1/4	ISO 17633-A-T 19 9 L P C/M 1	6	8	236
	<b>DW-308</b>	A5.22 E308T0-1/4	ISO 17633-A-T Z 19 9 R C/M 3	6	8	234
	<b>DW-309MoL</b>	A5.22 E309LMoT0-1/4	ISO 17633-A-T 23 12 2 L R C/M 3	6	8	240
	<b>DW-309MoLP</b>	A5.22 E309LMoT1-1/4	ISO 17633-A-T 23 12 2 L R C/M 1	6	8	241
	<b>DW-309L</b>	A5.22 E309LT0-1/4	ISO 17633-A-T 23 12 L R C/M 3	6	8	238
	<b>DW-309LP</b>	A5.22 E309LT1-1/4	ISO 17633-A-T 23 12 L P C/M 1	6	8	239
	<b>DW-309</b>	A5.22 E309T0-1/4	ISO 17633-A-T Z 23 12 R C/M 3	6	8	237
	<b>DW-309LH</b>	A5.22 E309LT1-1/4	-	6	8	248
	<b>DW-310</b>	A5.22 E310T0-1/4	-	6	9	252
	<b>DW-312</b>	A5.22 E312T0-1	-	6	-	252
	<b>DW-316L</b>	A5.22 E316LT0-1/4	ISO 17633-A-T Z 19 12 3 R C/M 3	6	8	243
	<b>DW-316LT</b>	A5.22 E316LT1-1/4	-	6	8	254
	<b>DW-316LH</b>	A5.22 E316LT1-1/4	-	6	8	250
	<b>DW-316LP</b>	A5.22 E316LT1-1/4	ISO 17633-A-T 19 12 3 L P C/M 1	6	8	244
	<b>DW-316</b>	A5.22 E316T0-1/4	ISO 17633-A-T Z 19 12 2 R C/M 3	6	8	242
	<b>DW-316H</b>	A5.22 E316T1-1/4	-	6	8	250
	<b>DW-317L</b>	A5.22 E317LT0-1/4	-	6	8	254
	<b>DW-317LP</b>	A5.22 E317LT1-1/4	-			256
	<b>DW-317LH</b>	A5.22 E317LT1-1/4				256
<b>DW-347</b>	A5.22 E347T0-1/4	-	6	8	254	
<b>DW-347H</b>	A5.22 E347T1-1/4	-	6	8	250	

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
FCAW	DW-329A	A5.22 E2209T0-1/4	ISO 17633-A-T 22 9 3 N L R C/M 3	6	8	245
	DW-329AP	A5.22 E2209T1-1/4	ISO 17633-A-T 22 9 3 N L P C/M 1	6	8	246
	DW-2209	A5.22 E2209T1-1/4	-	-	-	258
	DW-2594	A5.22 E2594T1-1/4	-	-	-	258
	TG-X308L	A5.22 R308LT1-5	-	-	8	264
	TG-X309L	A5.22 R309LT1-5	-	-	8	265
	TG-X316L	A5.22 R316LT1-5	-	-	8	266
	TG-X347	A5.22 R347T1-5	-	-	8	267
	DW-410Cb	-	-	-	7	211
	DW-430CbS	-	-	-	7	211
	DW-2101	-	-	-	-	258
	MX-A135N	-	-	-	-	260
	MX-A410NM	-	-	-	-	260
	MX-A430M	-	-	-	7	260
GMAW	MG-S308	A5.9 ER308	-	6	8	262
	MG-S308LS	A5.9 ER308LSi	-	6	8	262
	MG-S309	A5.9 ER309	-	6	8	262
	MG-S309LS	A5.9 ER309LSi	-	6	8	262
	MG-S316LS	A5.9 ER316LSi	-	6	8	262
	MG-S347S	A5.9 ER347Si	-	6	8	211
	MG-S430M	-	-	-	-	211
GTAW	TG-S308	A5.9 ER308	-	6	8	268
	TG-S308L	A5.9 ER308L	-	6	8	268
	TG-S309	A5.9 ER309	-	6	8	268
	TG-S309L	A5.9 ER309L	-	6	8	268
	TG-S309MoL	A5.9 ER309LMo	-	-	8	268
	TG-S310	A5.9 ER310	-	6	9	270
	TG-S316	A5.9 ER316	-	6	8	268
	TG-S316L	A5.9 ER316L	-	6	8	270
	TG-S317L	A5.9 ER317L	-	6	8	270
	TG-S347	A5.9 ER347	-	6	8	270
	TG-S410	A5.9 ER410	-	6	6	272
	TG-S2209	A5.9 ER2209	-	-	-	272
	TG-S2594	A5.9 ER2594	-	-	-	272

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
GTAW	TG-S310MF	-	-	-	-	270
	TG-S329M	-	-	-	-	272
	TG-S410Cb	-	-	-	7	272
	NO4051	-	-	-	-	270
SAW	PF-S1/US-308	A5.9 ER308	-	6	8	211
	PF-S1/US-308L	A5.9 ER308L	-	6	8	211
	PF-S1/US-309	A5.9 ER309	-	6	8	211
	PF-S1/US-309L	A5.9 ER309L	-	6	8	211
	PF-S1M/US-316	A5.9 ER316	-	6	8	211
	PF-S1M/US-316L	A5.9 ER316L	-	6	8	211
	PF-S1/US-317L	A5.9 ER317L	-	6	8	211
	PF-S1/US-347	A5.9 ER347	-	6	8	211
	PF-S4M/US-410	-	-	-	7	211
<b>For Hardfacing</b>						
SMAW	HF-240	-	-	-	-	280
	HF-260	-	-	-	-	280
	HF-330	-	-	-	-	280
	HF-350	-	-	-	-	280
	HF-450	-	-	-	-	282
	HF-500	-	-	-	-	282
	HF-600	-	-	-	-	282
	HF-650	-	-	-	-	282
	HF-700	-	-	-	-	284
	HF-800K	-	-	-	-	284
	HF-950	-	-	-	-	284
	HF-11	-	-	-	-	286
	HF-12	-	-	-	-	286
	HF-13	-	-	-	-	286
	HF-16	-	-	-	-	286
HF-30	-	-	-	-	286	
FCAW	DW-H250	-	-	-	-	288
	DW-H350	-	-	-	-	288
	DW-H450	-	-	-	-	288
	DW-H600	-	-	-	-	288
	DW-H700	-	-	-	-	288

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
FCAW	DW-H800	-	-	-	-	288
	DW-H11	-	-	-	-	290
	DW-H16	-	-	-	-	290
	DW-H30	-	-	-	-	290
	DW-H30MV	-	-	-	-	290
SAW	G-50/US-H250N	-	-	-	-	292
	G-50/US-H350N	-	-	-	-	292
	G-50/US-H400N	-	-	-	-	292
	G-50/US-H450N	-	-	-	-	292
	G-50/US-H500N	-	-	-	-	294
	MF-30/US-H550N	-	-	-	-	294
	MF-30/US-H600N	-	-	-	-	294
<b>For Cast Iron</b>						
SMAW	CI-A1	A5.15 ENi-CI	-	-	-	300
	CI-A2	A5.15 ENiFe-CI	-	-	-	300
	CI-A3	A5.15 Est	-	-	-	300
<b>For Nickel-Based Alloy</b>						
SMAW	NI-C70A	A5.11 ENiCrFe-1	-	43	-	310
	NI-C703D	A5.11 ENiCrFe-3	-	43	-	310
	NI-C70S	A5.11 ENiCrFe-9	-	43	-	308
	NI-C1S	A5.11 ENiMo-8	-	44	-	308
	NI-C625	-	-	-	-	310
	ME-L34	-	-	-	-	310
FCAW	DW-N82	A5.34 ENiCr3T0-4	-	-	-	312
	DW-N625	A5.34 ENiCrMo3T1-4	-	-	-	314
	DW-NC276	A5.34 ENiCrMo4T0-4	-	-	-	314
	DW-N70S	-	-	-	-	312
GMAW	MG-S70NCb	A5.14 ERNiCr-3	-	43	-	316
GTAW	TG-S70NCb	A5.14 ERNiCr-3	-	43	-	318
	TG-SN625	A5.14 ERNiCrMo-3	-	43	-	318
	TG-S709S	A5.14 ERNiMo-8	-	44	-	318
SAW	PF-N3/US-709S	A5.14 ERNiMo-8	-	44	-	320
	PF-N4/US-709S	A5.14 ERNiMo-8	-	44	-	320

Welding Process	Product names	ASME / AWS	EN	ASME		Page
				F No.	A No.	
<b>Highly Efficient Welding Processes</b>						
FCB™	PF-I50/US-43/ PF-I50R (MF-1R)	-	-	-	-	324
	PF-I55E/US-36/ PF-I50R (MF-1R)	-	-	-	-	324
FA-B	MF-38/US-36/ RR-2/FA-B1	-	-	-	-	326
FA-B	MF-38/US-49/ RR-2/FA-B1	-	-	-	-	326
	PF-I52E/US-36/ RR-2/FA-B1	-	-	-	-	326
EGW	DW-S43G	A5.26 EG70T-2	-	6	-	328
	DW-S1LG	-	-	-	-	328
	DW-S60G	-	-	-	-	328
EAW	LB-116	A5.5 E11016-G	-	4	12	330
	LB-80EM	-	-	-	-	330





**For Mild Steel and 490MPa High Tensile Strength Steel**

## **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Flux Cored Arc Welding (FCAW)**

**Gas Metal Arc Welding (GMAW)**

**Gas Tungsten Arc Welding (GTAW)**

**Submerged Arc Welding (SAW)**

## For Mild Steel and 490MPa High Tensile Strength Steel

### A guide for selecting the type of welding consumable <sup>(1)</sup>

Type of covering and AWS classification		High titania	Low hydrogen	Ilmenite <sup>(2)</sup>	High cellulose	Lime titania <sup>(3)</sup>	Iron-powder iron-oxide	Iron-powder titania
		E6013	E7016	E6019	E6010	E6013	E6027	E7024
<b>Weldability</b>								
▪ Crack resistant		△	⊙	○	○	○	△	△
▪ X-ray soundness		△	⊙	○	△	○	△	△
▪ Impact value		△	⊙	○	○	○	△	△
<b>Usability</b>								
▪ Suitability for particular welding positions	F	⊙	○	⊙	△	⊙	-	-
	F, HF	⊙	○	⊙	△	⊙	⊙	⊙
	VU	△	⊙	⊙	○	⊙	-	-
	VD	○	-(4)	-	⊙	△	-	-
	OH	△	⊙	⊙	○	⊙	-	-
▪ Bead appearance	F	⊙	△	○	△	⊙	-	-
	F, HF	⊙	△	○	△	⊙	⊙	⊙
	V, OH	⊙	⊙	○	○	⊙	-	-
▪ Penetration		△	○	⊙	⊙	○	△	△
▪ Spatter		⊙	○	○	△	○	○	○
▪ Slag removal		⊙	△	○	○	○	⊙	⊙
▪ Travel speed		○	△	○	△	⊙	⊙	⊙
▪ Suitability for thin metal		⊙	△	○	△	⊙	○	○

Note (1) ⊙: Excellent, ○: Good, △: Fair

F: Flat butt welding, F, HF: Flat and horizontal fillet welding, VU: Vertical-up welding, VD: Vertical-down welding, OH: Overhead welding, V, OH: Vertical and overhead welding

(2) The ilmenite type corresponds to the iron-oxide titania potassium type per the AWS standard.

(3) The lime titania type is not specified by the AWS standard, but exact products fall in the range of AWS E6013.

(4) Some low-hydrogen electrodes classified as E7048 are suitable exclusively for vertical-down welding.

### **Tips for better welding results**

---

- (1) Slag and fumes on tack weld beads absorb moisture; therefore, they must be removed right after tack welding to prevent adverse effects on the subsequent main welding.
- (2) When wind velocity is more than 3m/sec in field welding, use a wind screen, or nitrogen in the wind decreases impact value and X-ray soundness of the weld.
- (3) In welding medium and heavy thick mild steels by using non-low-hydrogen electrodes, keep the work at appropriate preheat and interpass temperature to remove diffusible hydrogen and thereby prevent cracking in the weld.
- (4) In order to get better impact values, it is effective to lay each weld layer as thin as possible.
- (5) Many covered electrodes can be used with both AC and DC power sources. Low-hydrogen type electrodes, however, should be tested on mechanical properties beforehand, because DC current causes a little lower strength of the weld metal.
- (6) Low-hydrogen type electrodes are more suitable for surface finishing and repair welding of gas shielded metal arc and self-shielded metal arc welded deposits in order to prevent pits and blowholes.

### **How to keep covered electrodes in good condition**

---

- (1) Store covered electrodes in a warehouse where the humidity is low.
- (2) Low-hydrogen type electrodes should be stored in an oven (100-150°C) placed near the welding area after re-drying was finished so that welders can take out the electrodes little by little. This manner is good for preventing the electrodes from moisture pick up and thereby decrease the diffusible hydrogen content of the weld metal.
- (3) A change of the color of the flux coating to become darker, much more spatter, stronger arc, and irregular slag-covering are signs that the electrodes picked up moisture excessively. In such a case, re-drying is effective even for non-low-hydrogen electrodes to improve usability and X-ray soundness. But excessive drying for long hours at high temperatures deteriorates X-ray soundness of the weld metal.
- (4) Welders should bring an appropriate amount of electrodes for half-a-day use at sites in order to prevent electrodes from excessive moisture pick up.

## For Mild Steel and 490MPa High Tensile Strength Steel

A guide for selecting filler metals for API grade pipes and comparison of welding procedures <sup>(1)</sup>

API 5L pipe grade	Welding pass	With high cellulose electrodes	With low hydrogen electrodes		
		Downhill welding process	Uphill welding process	Downhill welding process	
				With only low hydrogen electrodes	With a combination of high cellulose and low hydrogen electrodes
A25 A, B X42 X46 X52	Root	KOBE-6010 KOBE-7010S	LB-52U	LB-78VS	KOBE-6010 KOBE-7010S
	Hot		LB-47 LB-52 LB-M52 LB-52-18		
	Filler and cap		LB-78VS		
X56	Root	KOBE-6010 KOBE-7010S	LB-52U	LB-78VS	KOBE-6010 KOBE-7010S
	Hot		LB-52 LB-M52 LB-52-18		
	Filler and cap		LB-78VS		
X60	Root	KOBE-6010 KOBE-7010S	LB-52U	LB-78VS LB-88VS	KOBE-6010 KOBE-7010S
	Hot		LB-52 LB-M52 LB-52-18		
	Filler and cap		LB-78VS LB-88VS		
X65	Root	KOBE-7010S KOBE-8010S	LB-52U	LB-88VS	KOBE-7010S KOBE-8010S
	Hot		LB-57 LB-62 LB-62D		
	Filler and cap		LB-88VS		
X70	Root	KOBE-7010S KOBE-8010S	LB-62U	LB-88VS	KOBE-7010S KOBE-8010S
	Hot		LB-62 LB-62D		
	Filler and cap		LB-88VS		
X80	Root	-	LB-62U	LB-98VS	KOBE-7010S KOBE-8010S
	Hot		LB-65D		
	Filler and cap		LB-98VS		
<b>Weldability</b>					
▪ Stability of root pass		○	◎	△	○
▪ Weld soundness		○	◎	○	○
▪ Crack resistance		△	◎	◎	○
<b>Welding efficiency</b>		◎	△	○	◎
<b>Groove size tolerance</b>		○	◎	△	○

Note (1) ◎: Excellent, ○: Fair, △: Inferior

## Tips for better welding results

### 1) Sizes and tolerances of welding grooves

In one-side butt welding of pipes, it is important to make sound root pass welds without incomplete joint penetration and other discontinuities. For this, it is essential to prepare welding grooves suitable for individual welding procedures. Refer to the recommended sizes and tolerances of the grooves shown in the table below.

Welding consumable	Welding process	Recommendation and tolerance	Groove angle (deg.)	Root face (mm)	Root gap (mm)	Misalignment (mm)
High cellulose electrodes	Downhill welding	Recommendation	60-70	1.2-2.4 (1.2-2.0)	1.2-2.0	≤0.8
		Tolerance	50-75	0.8-2.4	0.8-2.4	≤1.6
Low hydrogen electrodes	Uphill welding	Recommendation	60-80 (70-80)	0.4-2.0	2.0-3.2 (2.0-2.6)	≤1.6 (≤0.8)
		Tolerance	55-90	0.4-2.4	1.6-3.6	≤2.0
	Downhill welding	Recommendation	60-80	1.2-2.0	2.6-3.4 (2.6-3.2)	≤0.6
		Tolerance	55-90	1.0-2.0	2.5-3.5	≤1.0

Note: Recommended ranges in parentheses are suitable for small diameter tubes with an approximate thickness of 7mm or less.

### 2) How to proceed root pass welding

- (1) Downhill welding should be started at the 11 to 1 o'clock position of a pipe, whereas uphill welding should be started at the 5 to 7 o'clock position in common procedures. However, welding should be started at where there is a narrower root opening.
- (2) It is recommended to strike an arc on the groove face and transfer the arc to the root of the groove, maintaining the arc in stable condition.
- (3) Joint penetration can be adjusted by controlling the shape of a keyhole molten crater by adjusting welding current, electrode holding angle, the extent of sticking an electrode into the root opening, and weaving width. Control the penetration more strictly particularly at the 12 o'clock position where reverse side bead extrusion tends to be excessive and the 6 o'clock position that tends to cause a concave reverse side beads.
- (4) Before joining beads particularly with low hydrogen electrodes, the end of the preceding bead should be tapered by grinding.
- (5) After the completion of root pass welding, remove slag and unacceptable portion of beads, and shape the beads along the entire circumference of the pipe by grinding. Particularly, where the weld surfaces contain deep undercut, the shaping should be conducted more carefully.

## For Mild Steel and 490MPa High Tensile Strength Steel

### Types and features of flux-cored wires

There are two types of flux cored wires: DW series rutile type and MX series metal type. Both DW and MX series include a variety of wires that use either CO<sub>2</sub> or Ar-CO<sub>2</sub> admixture shielding gas. The following paragraphs describe essential characteristics of both types of flux-cored wires to provide users with a useful guide.

DW series:

DW series is the most popular type of flux-cored wire, most of which contains rutile flux. This series offers excellent weldability with good arc stability and very low spatter generation. With CO<sub>2</sub> or Ar-CO<sub>2</sub> admixture shielding gas, DW wires show good slag removability and smooth, glossy bead appearance. Because of high deposition rates, highly efficient welding can be conducted. DW series includes those suitable for out-of-position welding and those suitable for horizontal fillet welding for a variety of applications.

MX series:

MX series is metal type flux-cored wire. Due to high deposition rates, highly efficient welding can be conducted. MX wires offer excellent weldability with good arc stability and low spatter generation. With some wires, the amount of slag is as little as in gas metal arc welding with solid wires; therefore, multi-pass welding can continuously be conducted without removing the slag on each pass. A variety of MX wires are available to cover wide applications of thin plate, medium and thick plate, and primer-coated plates.

Deposition rate:

Compared at the same welding current, the deposition rates of flux-cored wires are higher by 50 - 60% relative to stick electrodes and 10 - 20% higher than solid wires. Spatter generation in use of flux-cored wires is much lower than in use of solid wires.

### Tips for better welding results

In addition to the tips for gas metal arc welding with solid wires, the following tips especially for flux-cored wires are essential to use the excellent features of the wires.

- (1) Because the wire is softer than solid wire, do not excessively tighten the pressure roller of the wire feeder so as not to cause the deformation of the wire.
- (2) In flat butt welding, backhand technique is better for stable penetration. In horizontal and overhead fillet welding, forehand technique is better for flat bead appearance.
- (3) In vertical down fillet welding, the first layer run should be straight and keep the welding speed faster to avoid slag inclusions and to get better penetration. For the 2nd and subsequent layers, remove the slag of preceding beads and avoid weaving.
- (4) In one-side welding, welding parameter should carefully be selected to prevent welding defects such as hot cracking.
- (5) In horizontal fillet welding of primer-coated plates, porosity defects such as pit and gas hole are apt to occur; therefore, the selection of proper wires and welding parameters suitable for welding primer-coated plates are essential. Figure 1 shows the relationship between welding speed and the number of leg pits occurred in the weld metal. Figure 2 shows proper welding speeds related to fillet leg lengths.

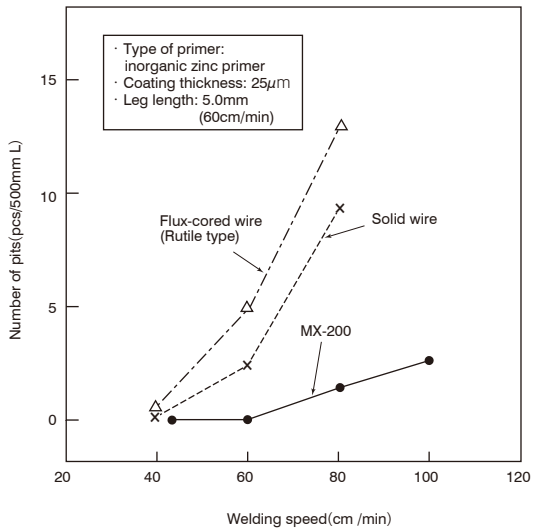


Fig.1 Porosity resistance to primer

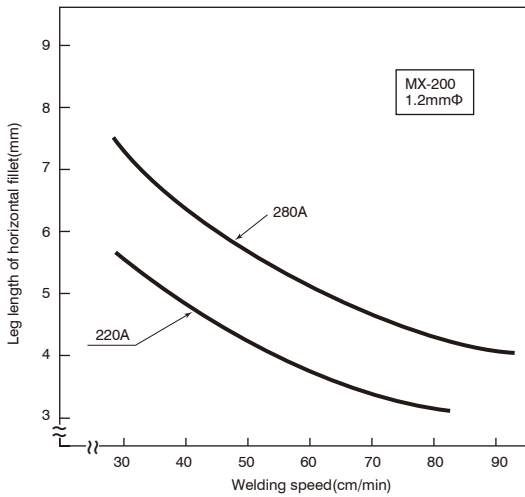


Fig.2 Horizontal fillet leg length vs. welding speed

## **For Mild Steel and 490MPa High Tensile Strength Steel**

### **Tips for better welding results in GMAW**

- (1) Use a CO<sub>2</sub> shielding gas corresponding to ANSI/AWS A5.32/A5.32M SG-C or an equivalent CO<sub>2</sub> gas purified for welding.
- (2) Control the mixing ratio of Ar and CO<sub>2</sub> in an Ar-CO<sub>2</sub> admixture shielding gas because fluctuation of the mixing ratio affects the usability of a solid wire.
- (3) Adjust the shielding gas flow rate in the 20 to 25 l/min range.
- (4) Use a wind screen in welding in a windy area because a strong wind causes blowholes.
- (5) Use a proper ventilation system at where general ventilation is inadequate.
- (6) Keep the tip-to-work distance at around 15 mm with welding currents less than 250A and at around 20 to 25 mm with welding currents over 250A.
- (7) The use of an excessively low arc voltage may generate a large sound in spray arc welding with an Ar-CO<sub>2</sub> shielding gas. In such a case increase the arc voltage to prevent blowholes.
- (8) Torch angle, welding speed, wire diameter, and welding current markedly affect bead appearance and penetration; therefore, adjust such welding parameters according to the application.

### **Tips for better welding results in GTAW**

- (1) Welding power source:  
Use the DC-EN connection with the constant current or drooping characteristic DC power source in general applications.
- (2) Shielding gas:  
Use an argon gas with a high purity equivalent to that of JIS K1105, in order to prevent pits and blowholes in the weld metal and decrease consumption of the tip of a tungsten electrode. When the length of the Ar gas piping is long, use metal pipes or Teflon tubes to prevent porosity in the weld metal, because moisture can permeates into the Ar gas through the wall of a rubber hose and thereby causes porosity. Adjust the shielding gas flow rate in the 12-18 l/min range.
- (3) Tungsten electrode:  
A 1-2% thoriated tungsten electrode is suitable. The tip of the tungsten electrode must be kept sharp in order to maintain the arc stable.
- (4) Tungsten electrode extension length and arc length:  
In order to keep the shielding of molten weld pool in good condition, the extension of a tungsten electrode from shielding nozzle should be approx. 5 mm. Maintain the arc length at 1-3 mm. The use of an excessively long arc length can deteriorate the shielding effect and causes undercut.
- (5) Cleaning of welding groove:  
Because the quality of gas tungsten arc welds is markedly affected by dirt on groove surfaces, scale, rust, water and oil must be removed before welding because they can cause pits, blowholes and unstable arcs.
- (6) Wind protection and ventilation:  
Use a wind screen in a windy site to maintain the shielding gas in good condition. Use an appropriate ventilation system where welding is carried out in a confined area to prevent welders from oxygen deficiency.



### **Tips for better welding results in SAW**

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(1) Accuracy of groove sizes:

The accuracy of root gap and groove angle affects the quality of welds much more than with other welding processes; where the accuracy is poor, burn-through, lack of penetration, excessive or insufficient reinforcement can occur.

(2) Surface of groove:

Rust and oil in the groove shall be removed before welding to prevent pits and blowholes.

(3) Distribution and circulation of flux:

Where a flux is supplied excessively on the base plate, the bead appearance becomes irregular particularly in use of melted fluxes. In case where a flux is used repetitively by means of a circulation system, the flux can be contaminated with scale and dust and its grain size distribution can be varied; therefore, add new flux occasionally to maintain good performances of the flux.

(4) Grain size of flux:

Several grain sizes are available for a certain melted flux. The most proper size depends on welding currents to be used. The use of high currents with a coarse grain size flux can deteriorates bead appearance; in contrast, the use of low currents with a fine grain size flux can cause pock marks because of poor degassing.

(5) Welding condition and penetration:

Submerged arc welding can use a wide range of parameters such as wire diameter, welding current, arc voltage and welding speed; however, erroneous setting of the parameter causes burn-through, and insufficient or excessive penetration and reinforcement. The bead shape can be affected by the travel angle of a wire; that is, where the wire is leaned to the direction of welding (backhand welding), the bead shape becomes narrower with comparatively deep penetration. In contrast, where the wire is leaned to the opposite direction of welding (forehand welding), the bead shape becomes wider with shallower penetration.

## Covered electrode

**Classification:** ASME / AWS A5.1 E6019  
EN ISO 2560-A-E 35 2 RA

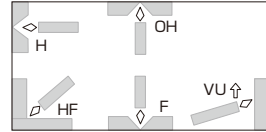
**Features:** ▪ Suitable for butt and fillet welding of thin and medium-thick plates (up to 20mm)  
▪ Excellent usability

**Type of covering:** Ilmenite

**Redrying conditions:** 70~100°Cx0.5~1h

**Identification color:** 1st Pale brown, 2nd -

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.10	0.10	0.43	0.015	0.007
Guaranty	0.05~0.13	0.05~0.25	0.25~0.65	≤0.030	≤0.025

## Mechanical properties of all-weld metal as per AWS

	YP (MPa)	TS (MPa)	EI (%)	IV (J)
Example	410	460	32	-18°C: 82
Guaranty	≥330	≥410	≥22	-18°C ≥27

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~90A	85~140A	130~190A	180~260A	240~310A
VU, OH	45~75A	60~120A	100~160A	135~210A	-

## Polarity

Example	AC
Guaranty	AC, DC-EP, DC-EN

## Approvals

ABS	LR	DNV	BV	NK	Others
3	3m	3	3	KMW3	CR: 3 GL: 3

## Packages

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
2.6	350	5	20	20
3.2	400	5	20	35
4.0	450	5	20	62
5.0	450	5	20	94
6.0	450	5	20	141

**Covered electrode**

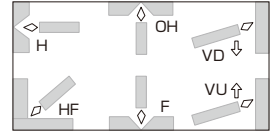
**Classification:** ASME / AWS A 5.1 E6013  
EN ISO 2560-A-E 35 0 R

**Features:** ▪ Suitable for butt and fillet welding of thin plates  
▪ Excellent usability in all positions including vertical downward

**Type of covering:** High titania

**Redrying Conditions:** 70~100°Cx0.5~1h

**Identification color:** 1st Black, 2nd -

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S
Example	0.08	0.30	0.37	0.012	0.010
Guaranty	0.05~0.12	0.15~0.45	0.25~0.65	≤0.030	≤0.025

**Mechanical properties of all-weld metal as per AWS**

	YP (MPa)	TS (MPa)	EI (%)
Example	450	510	25
Guaranty	≥330	≥410	≥17

**Recommended welding parameters**

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H, VD	30~65A	45~95A	60~125A	105~170A	150~220A
VU, OH	30~65A	45~95A	60~125A	100~150A	125~190A

**Polarity**

Example	AC
Guaranty	AC, DC-EP, DC-EN

**Approvals**

ABS	LR	NK
2	2m	KMW2

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.0	300	2	20	10
2.6	350	5	20	19
3.2	350	5	20	29
4.0	400	5	20	53
5.0	400	5	20	81

## Covered electrode

**Classification:** ASME / AWS A5.1 E7016  
EN ISO 2560-A-E 42 3 B

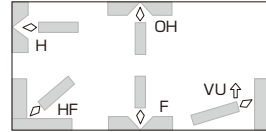
**Features:** • Suitable for butt and fillet welding of heavy structures  
• Excellent mechanical properties

**Type of covering:** Low hydrogen

**Redrying Conditions:** 300~350°Cx0.5~1h

**Identification color:** 1st Blue white, 2nd White

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.08	0.60	0.94	0.011	0.006
Guaranty	0.05~0.10	≤0.75	≤1.60	≤0.020	≤0.020

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	500	570	32	-29°C: 120	AW
	420	520	33	-29°C: 150	620x1
Guaranty	≥400	≥480	≥22	-29°C≥27	AW
	≥350	≥460	≥25	-29°C≥27	620±15x1

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	90~130A	130~180A	180~240A	210~310A
VU, OH	50~80A	80~120A	110~170A	150~200A	-

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Approvals

ABS	LR	DNV	BV	NK	GL
3H10, 3Y, 3Y400	3Ym H15	3YH10	3H, 3YHH	KMW53Y40H10	3YH15

## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	350	5	20	20
3.2	350	5	20	31
4.0	400	5	20	54
5.0	450	5	20	97
6.0	450	5	20	137

**Covered electrode**

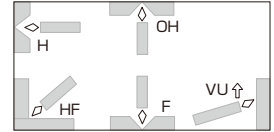
**Classification:** ASME / AWS A5.1 E7016  
EN ISO 2560-A-E 42 2 B

**Features:** • Suitable for one side welding of pipes  
• Extremely good arc stability in one side welding with relatively low current

**Type of covering:** Low hydrogen

**Redrying Conditions:** 300~350°Cx0.5~1h

**Identification color:** 1st Blue white, 2nd Pink

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S
Example	0.08	0.64	0.86	0.012	0.008
Guaranty	0.05~0.10	≤0.75	≤1.60	≤0.020	≤0.020

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	480	560	31	-29°C: 80
Guaranty	≥400	≥480	≥22	-29°C ≥27

**Recommended welding parameters**

Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	60~90A	90~130A	130~180A	180~240A
VU, OH	50~80A	80~120A	110~170A	150~200A
Root pass	30~80A	60~110A	90~140A	130~180A

Root pass: DC-EN is also suitable.

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS	LR	DNV	BV	NK	CCS
3H10, 3Y	3Ym H15	3YH10	3, 3YHH	KMW53H10	3YH10

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	350	5	20	20
3.2	400	5	20	35
4.0	400	5	20	53
5.0	400	5	20	82

## Covered electrode

**Classification:** ASME / AWS A5.1 E7018  
EN ISO 2560-A-E 42 3 B

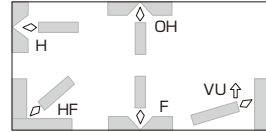
**Features:** • Suitable for butt and fillet welding of heavy structure  
• Good performance by DC-EP current

**Type of covering:** Iron powder low hydrogen

**Redrying Conditions:** 300~350°Cx0.5~1h

**Identification color:** 1st Blue white, 2nd Blue

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.07	0.59	0.97	0.013	0.007
Guaranty	0.05~0.10	≤0.75	≤1.60	≤0.020	≤0.020

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	500	560	31	-29°C:110	AW
	420	520	32	-29°C:140	620x1
Guaranty	≥400	≥480	≥22	-29°C≥27	AW
	≥350	≥460	≥25	-29°C≥27	620±15x1

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	65~95A	90~130A	130~190A	190~250A
VU, OH	60~90A	80~120A	110~170A	165~210A

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Approvals

ABS	LR	DNV	NK
3Y H10	3Ym H15	3YH10	KMW53H10

## Packages

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
2.6	350	5	20	24
3.2	400	5	20	41
4.0	450	5	20	69
5.0	450	5	20	106

**Covered electrode**

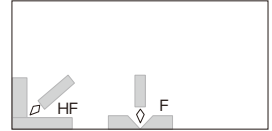
**Classification:** ASME / AWS A5.1 E7024  
EN ISO 2560-A-E 42 0 RR

**Features:** • Suitable for flat and horizontal fillet welding  
• Good welding usability in manual and gravity welding

**Type of covering:** Iron powder titania

**Redrying Conditions:** 70~100°Cx0.5~1h

**Identification color:** 1st -, 2nd -

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.09	0.35	0.63	0.017	0.008
Guaranty	≤0.15	≤0.90	≤1.25	≤0.030	≤0.030

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>
Example	470	540	27	0°C: 55
Guaranty	≥400	≥490	≥17	-

**Recommended welding parameters**

	3.2mm	4.0mm	5.0mm
Dia.	3.2mm	4.0mm	5.0mm
F, HF	120~150A	170~210A	220~260A

**Polarity**

Example	DC-EP
Guaranty	DC-EP, AC, DC-EN

**Packages**

<b>Dia. (mm)</b>	<b>Length (mm)</b>	<b>Weight per pack(kg)</b>	<b>Weight per carton(kg)</b>	<b>Weight per piece(g)</b>
3.2	400	5	20	57
4.0	450	5	20	101
5.0	450	5	20	147

## Covered electrode for pipe welding (up to API-X52)

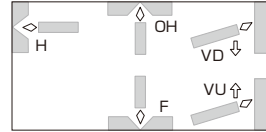
**Classification:** ASME / AWS A5.1 E6010  
EN ISO 2560-A-E 35 0 C

**Features:** • Suitable for butt welding of pipes  
• Excellent usability in vertical downward welding

**Type of covering:** High cellulose

**Identification color:** 1st Yellowish green, 2nd -

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.12	0.15	0.51	0.009	0.008
Guaranty	0.05~0.20	≤0.40	0.30~0.80	≤0.030	≤0.025

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	430	510	27	-29°C: 63
Guaranty	≥330	≥410	≥22	-29°C ≥27

## Recommended welding parameters

	2.4mm	3.2mm	4.0mm	4.8mm
F, H	40~75A	70~130A	90~180A	140~225A
VD	40~75A	70~130A	90~180A	140~225A
VU, OH	40~75A	70~130A	90~180A	140~225A

## Polarity

Example	DC-EP
Guaranty	DC-EP

## Packages

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
2.4	300	2	20	13
3.2	350	5	20	27
4.0	350	5	20	40
4.8	350	5	20	58



# KOBE-7010S

Covered electrode for pipe welding (up to API-X52 to X60)

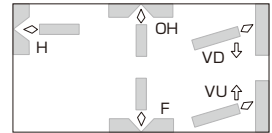
**Classification:** ASME / AWS A5.5 E7010-P1  
EN ISO 2560-A-E 42 0 C

**Features:** • Suitable for butt welding of pipes  
• Excellent usability in vertical downward welding

**Type of covering:** High cellulose

**Identification color:** 1st Brown, 2nd Black

**Welding Positions:**



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.14	0.10	1.01	0.012	0.007
Guaranty	≤0.20	≤0.60	≤1.20	≤0.03	≤0.03

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	470	570	30	-29°C: 61
Guaranty	≥410	≥480	≥22	-29°C ≥27

## Recommended welding parameters

	2.4mm	3.2mm	4.0mm	4.8mm
Dia.	2.4mm	3.2mm	4.0mm	4.8mm
F, H	40~70A	60~120A	90~170A	130~210A
VD	40~70A	70~120A	100~170A	150~210A
VU, OH	40~70A	60~120A	80~160A	120~200A

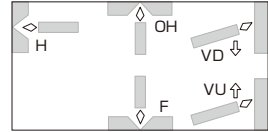
## Polarity

Example	DC-EP
Guaranty	DC-EP

## Packages

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
2.4	300	2	20	13
3.2	350	5	20	26
4.0	350	5	20	40
4.8	350	5	20	58

# KOBE-8010S

**FAMILIARC™****Covered electrode for pipe welding (up to API-X60 to X70)****Classification:** ASME / AWS A5.5 E8010-P1  
EN ISO 2560-A-E 36 0 Z C**Features:** • Suitable for butt welding of pipes  
• Excellent usability in vertical downward welding**Type of covering:** High cellulose**Identification color:** 1st Blue white, 2nd -**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Mo
Example	0.15	0.12	1.05	0.012	0.006	0.27
Guaranty	≤0.20	≤0.60	≤1.20	≤0.03	≤0.03	≤0.50

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	520	620	28	-29°C: 54
Guaranty	≥460	≥550	≥19	-29°C ≥27

**Recommended welding parameters**

	3.2mm	4.0mm	4.8mm
Dia.	3.2mm	4.0mm	4.8mm
F, H	60~120A	90~170A	130~210A
VD	70~120A	100~170A	150~210A
VU, OH	60~120A	80~160A	120~200A

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
3.2	350	5	20	26
4.0	350	5	20	40
4.8	350	5	20	58

**Covered electrode for pipe welding (up to API-X60)**

**Classification:** ASME / AWS A5.1 E7048  
EN ISO 2560-A-E 42 2 B

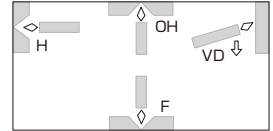
**Features:**

- Suitable for butt welding of pipes
- Excellent usability in vertical downward welding
- Good mechanical properties

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st Orange, 2nd Black

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S
Example	0.06	0.56	1.18	0.012	0.005
Guaranty	0.05~0.10	≤0.90	≤1.60	≤0.020	≤0.020

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	490	580	30	-29°C:100
Guaranty	≥400	≥480	≥22	-29°C ≥27

**Recommended welding parameters**

	3.2mm	4.0mm
Dia.	3.2mm	4.0mm
F, VD, H	80~140A	130~210A
OH	80~120A	110~160A

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
3.2	350	5	20	33
4.0	400	5	20	56

**Covered electrode for pipe welding (API-X60 to X70)**

**Classification:** ASME / AWS A5.5 E8018-G  
EN ISO 2560-A-E 46 2 Z B

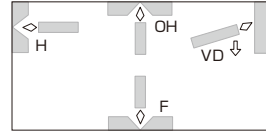
**Features:**

- Suitable for butt welding of pipes
- Excellent usability in vertical downward welding
- Good mechanical properties

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st Yellowish green, 2nd Yellowish green

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo
Example	0.06	0.55	1.20	0.012	0.006	0.53	0.12
Guaranty	0.05~0.10	0.30~0.75	1.00~1.40	≤0.020	≤0.020	0.40~0.80	≤0.30

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	510	620	30	-18°C: 120
Guaranty	≥460	≥550	≥19	-

**Recommended welding parameters**

	3.2mm	4.0mm	4.5mm
F, VD, H	80~140A	130~200A	160~250A
OH	80~120A	110~160A	130~190A

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
3.2	350	5	20	31
4.0	400	5	20	56
4.5	400	5	20	68

**Covered electrode for pipe welding (API-X80)**

**Classification:** ASME / AWS A5.5 E9018-G  
EN ISO 2560-A-E 50 2 Z B

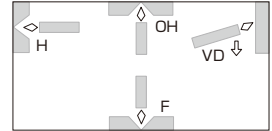
**Features:**

- Suitable for butt welding of pipes
- Excellent usability in vertical downward welding
- Good mechanical properties

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st Blue, 2nd Silver

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo
Example	0.06	0.61	1.27	0.013	0.004	1.17	0.18
Guaranty	0.05~0.10	0.30~0.75	1.00~1.50	≤0.020	≤0.020	0.90~1.40	0.10~0.40

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	560	660	30	-18°C: 130
Guaranty	≥530	≥620	≥17	-

**Recommended welding parameters**

	3.2mm	4.0mm	4.5mm
F, VD, H	80~140A	130~200A	160~250A
OH	80~120A	110~160A	130~190A

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weigh per carton(kg)	Weight per piece(g)
3.2	350	5	20	31
4.0	400	5	20	56
4.5	400	5	20	67

## Covered Electrodes for Mild Steel

Product names	ASME AWS class.	Type of covering	Pol.	Features	WP	
<b>B-10</b>	A5.1 E6019	Ilmenite	AC DC-EP DC-EN	<ul style="list-style-type: none"> <li>• Suitable for butt and fillet welding of thin and thick plates (up to 20mm)</li> <li>• Better usability</li> <li>• RC: 70~100°Cx0.5~1h</li> </ul>	F	Ex
					HF	Gt
<b>B-17</b>	A5.1 E6019	Ilmenite	AC DC-EP DC-EN	<ul style="list-style-type: none"> <li>• Suitable for butt and fillet welding of thin and thick plate (up to 20mm)</li> <li>• Good mechanical properties</li> <li>• RC: 70~100°Cx0.5~1h</li> </ul>	F	Ex
					HF	Gt
<b>Z-44</b>	A5.1 E6013	Lime titania	AC DC-EP DC-EN	<ul style="list-style-type: none"> <li>• Typical lime titania type electrode</li> <li>• RC: 70~100°Cx0.5~1h</li> </ul>	F	Ex
					HF	Gt
<b>B-33</b>	A5.1 E6013	High titania	AC DC-EP DC-EN	<ul style="list-style-type: none"> <li>• Excellent usability in the flat and horizontal positions</li> <li>• RC: 70~100°Cx0.5~1h</li> </ul>	F	Ex
					HF	Gt
					H	
					VU	
					OH	

Note: Welding tests are as per AWS. Ex: Example (polarity: AC);

### Approvals

**B-17** ABS, LR, DNV, BV, NK, GL, CR

**Z-44** ABS, LR, DNV, NK

### Identification color

Product names	1st	2nd
<b>B-10</b>	Green	-
<b>B-17</b>	Yellow	-
<b>Z-44</b>	Silver gray	Blue white
<b>B-33</b>	Pink	-

Chemical composition of all-weld metal (%)					Mechanical properties of all-weld metal				
C	Si	Mn	P	S		YP (MPa)	TS (MPa)	EI (%)	IV (J)
0.10	0.09	0.39	0.016	0.008	Ex	400	450	30	-18°C: 68
0.05~ 0.13	0.05~ 0.25	0.25~ 0.65	≤0.030	≤0.025	Gt	≥330	≥410	≥22	-18°C ≥27
0.09	0.08	0.60	0.012	0.006	Ex	420	470	31	-18°C: 80
0.05~ 0.13	0.05~ 0.25	0.50~ 0.90	≤0.030	≤0.025	Gt	≥330	≥410	≥22	-18°C ≥27
0.08	0.14	0.34	0.014	0.009	Ex	410	460	32	0°C: 110
≤0.12	0.05~ 0.45	0.20~ 0.60	≤0.030	≤0.025	Gt	≥330	≥410	≥17	-
0.08	0.30	0.33	0.013	0.009	Ex	430	480	25	-
0.05~ 0.12	0.20~ 0.50	0.10~ 0.65	≤0.030	≤0.025	Gt	≥330	≥410	≥17	-

Gt: Guaranty (polarity: as specified above)

## Diameter and Length (mm)

Dia.	2.0	2.6	3.2	4.0	5.0	6.0
<b>B-10</b>	-	350	350	400	400	450
<b>B-17</b>	-	350	350	400	400	450
<b>Z-44</b>	300	350	350	450	450	450
<b>B-33</b>	300	350	350	400	400	450

## Covered Electrodes for 490MPa High Tensile Strength Steel

Product names	ASME AWS class.	Type of covering	Pol.	Features	WP	Chemical		
						C	Si	
LB-26	A5.1 E7016	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Low hydrogen type containing iron powder</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F HF H VU OH	Ex	0.08	0.50
					Gt	0.05~0.10	≤0.75	
LB-52A	A5.1 E7016	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Better impact value</li> <li>RC: 350~400°Cx1h</li> </ul>	F HF H VU OH	Ex	0.08	0.57
					Gt	0.05~0.10	≤0.75	
LB-52T	A5.1 E7048	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Low hydrogen type for tack welding</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F HF H VU VD OH	Ex	0.08	0.47
					Gt	0.05~0.10	≤0.90	
LB-57	A5.1 E7016	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding of 520MPa high tensile steel</li> <li>RC: 350~400°Cx1h</li> </ul>	F HF H VU OH	Ex	0.08	0.64
					Gt	0.05~0.10	≤0.75	
LB-76	A5.5 E7016-G	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding of 520MPa high tensile steel</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F HF H VU OH	Ex	0.08	0.58
					Gt	0.05~0.10	0.30~0.75	

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Approvals

LB-26	ABS, LR, DNV, BV, NK, CR
LB-52A	NK
LB-52T	ABS, LR, DNV, BV, NK, CR

### Identification color

Product names	1st	2nd
LB-26	Blue white	-
LB-52A	Red	White
LB-52T	Red	-
LB-57	Blue	Brown
LB-76	Blue white	Green



composition of all-weld metal (%)				Mechanical properties of all-weld metal					
Mn	P	S	Mo		YP (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
0.97	0.013	0.007	-	Ex	480	550	33	-29°C:100	AW
					410	500	34	-29°C:130	620×1
≤1.60	≤0.020	≤0.020	-	Gt	≥400	≥480	≥22	-29°C≥27	AW
					≥340	≥450	≥25	-29°C≥27	620±15x1
1.12	0.012	0.005	-	Ex	500	580	31	-29°C:120	AW
					430	530	33	-29°C:150	620×1
≤1.60	≤0.020	≤0.020	-	Gt	≥400	≥480	≥22	-29°C≥27	AW
					≥370	≥480	≥25	-29°C≥27	620±15x1
1.06	0.012	0.007	-	Ex	450	540	32	-29°C:110	AW
≤1.60	≤0.020	≤0.020	-	Gt	≥400	≥480	≥22	-29°C≥27	AW
0.85	0.011	0.006	0.17	Ex	530	610	31	-29°C:100	AW
					470	540	32	-29°C:130	620x10
≤1.60	≤0.020	≤0.020	≤0.30	Gt	≥400	≥480	≥22	-29°C≥27	AW
					≥400	≥500	≥25	-29°C≥27	620±15x10
1.30	0.013	0.007	-	Ex	510	600	29	-29°C:110	AW
1.00~ 1.50	≤0.020	≤0.020	-	Gt	≥390	≥480	≥25	-	AW

Gt: Guaranty (polarity: as specified above)

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0	6.0
<b>LB-26</b>	350	350	400	450	450
<b>LB-52A</b>	-	350	400	450	450
<b>LB-52T</b>	-	350	400	450	-
<b>LB-57</b>	350	350	400	450	450
<b>LB-76</b>	-	350	400	450	450

## Covered Electrodes for 490MPa High Tensile Strength Steel

Product names	ASME AWS class.	Type of covering	Pol.	Features	WP	Chemical C	
						Ex	0.07
LT-B50	-	Lime titania	AC DC-EP DC-EN	<ul style="list-style-type: none"> <li>Suitable for flat and horizontal fillet welding</li> <li>RC: 70~100°Cx0.5~1h</li> </ul>	F HF	Ex	0.07
						Gt	≤0.10
LT-B52A	A5.1 E7018	Low hydro- gen	AC DC-EP	<ul style="list-style-type: none"> <li>Suitable for flat and horizontal fillet welding</li> <li>Iron powder low hydrogen type</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F HF	Ex	0.07
						Gt	≤0.11

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Approvals

LT-B50	ABS, LR, DNV, BV, NK, CR, GL
LT-B52A	ABS, LR, DNV, BV, NK

### Identification color

Product names	1st	2nd
LT-B50	Purple	Orange
LT-B52A	Silver	Orange

composition of all-weld metal (%)				Mechanical properties of all-weld metal				
Si	Mn	P	S		YP (MPa)	TS (MPa)	EI (%)	IV (J)
0.39	0.94	0.017	0.009	Ex	480	530	29	0°C: 74
0.10~ 0.70	0.60~ 1.25	≤0.030	≤0.025	Gt	≥390	≥490	≥20	0°C≥47
0.35	1.03	0.014	0.008	Ex	480	550	30	-29°C: 75
≤0.75	≤1.60	≤0.025	≤0.025	Gt	≥400	≥480	≥22	-29°C≥27

Gt: Guaranty (polarity: as specified above)

## Diameter and length (mm)

Dia.	4.0	4.5	5.0	5.5	6.0	6.4	7.0	8.0
	450	450	450	450	450	450	450	450
<b>LT-B50</b>	-	550	550	550	550	550	550	550
	-	700	700	700	700	700	700	700
	450	-	550	-	550	550	550	450
<b>LT-B52A</b>	-	-	700	-	700	700	700	550
	-	-	-	-	-	-	-	700

## Flux cored wire

**Classification:** ASME / AWS A5.20 E71T-1C  
EN ISO 17632-A - T 42 0 P C 1 H10

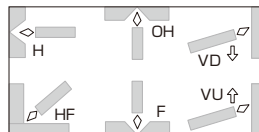
**Features:** • Soft and stable arc, less fume and spattering, smooth bead appearance, and good slag removal

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.05	0.45	1.35	0.013	0.009
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	510	570	30	-18°C: 85
Guaranty	≥400	≥490	≥22	-18°C ≥27

## Recommended welding parameters

	1.2mm	1.4mm	1.6mm
Dia.	1.2mm	1.4mm	1.6mm
F, HF	120~300A	160~350A	200~400A
H	120~280A	160~320A	200~350A
VU, OH	120~260A	160~270A	200~280A
VD	200~300A	220~300A	250~300A

## Approvals

ABS	LR	DNV	BV	NK	Others
2YSA, 2Y400SA, H10	2YS, 2YM H10	II YMS(H10)	SA2M, SA2YM, SA2Y40M HH	KSW52Y40G(C)H10	CR: 2YS-HH GL: 2Y40H10S KR: 2YSG(C) CCS: 2SH10, 2YSH10

## Packages

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5	1.4	Spool	15	1.6	Spool	15
	Spool	15		Spool	20		Spool	20
	Spool	20		Pack	250		Pack	350
	Pack	250		Pack	350			

**DW-100E****Flux cored wire**

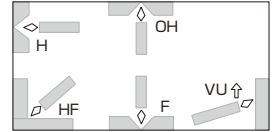
**Classification:** ASME / AWS A5.20 E71T-9C  
EN ISO 17632-A - T 42 2 P C 1 H10

**Features:** • Excellent impact value at low temperatures down to -29°C

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS (shielding gas: CO<sub>2</sub>)**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>
Example	0.05	0.43	1.28	0.013	0.008	0.38
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	≤0.50

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>
Example	510	570	29	-29°C: 100
Guaranty	≥400	≥480	≥22	-29°C ≥27

**Recommended welding parameters**

	1.2mm	1.4mm
Dia.	1.2mm	1.4mm
F	120~300A	150~400A
HF	120~300A	150~350A
H	120~280A	150~320A
VU, OH	120~250A	150~250A

**Approvals**

<b>ABS</b>	<b>LR</b>	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
3YSA, 3Y400SA, H10	3YS, H10	III YMS	SA3, 3YM	KSW53G	GL: 3YS CCS: 3YSH10

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>
1.2	Spool	12.5	1.4	Spool	15
	Spool	15			

## Flux cored wire

**Classification:** ASME / AWS A5.20 E71T-1M

EN ISO 17632-A - T 42 2 P M 1 H5

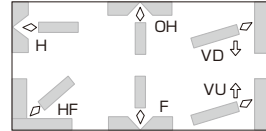
**Features:** • Excellent usability with soft and stable arc, less fume and spattering, good bead appearance and smooth slag removal

**Type of flux:** Rutile

**Shielding gas:** Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.05	0.48	1.22	0.013	0.009
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	510	570	30	-18°C: 110
Guaranty	≥400	≥490	≥22	-18°C ≥27

## Recommended welding parameters

	1.2mm	1.6mm		1.2mm	1.6mm
Dia.	1.2mm	1.6mm	Dia.	1.2mm	1.6mm
F	120~300A	180~450A	VU, OH	120~260A	180~280A
HF	120~300A	180~400A	VD	200~300A	250~300A
H	120~280A	180~350A			

## Approvals

ABS	LR	DNV	BV	NK	GL
3YSA, H5	3YS, H5	III YMS(H5), MG	SA3YM HHH	KSW52G(M2)H5	3YH5S

## Packages

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.1	Spool	15	1.2	Spool	15	1.6	Spool	15
	Spool	20		Spool	20			

# DW-50

**Flux cored wire**

**Classification:** ASME / AWS A5.20 E71T-1C/1M, -9C/9M  
 EN ISO 17632-A - T 42 2 P C/M 1 H5

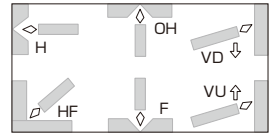
**Features:** • Excellent usability with soft and stable arc, less fume and spattering, good bead appearance and smooth slag removal

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:**



**Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S
Example	0.04	0.67	1.29	0.011	0.008
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	510	582	27	-29°C: 71
Guaranty	≥400	≥490	≥22	-29°C ≥27

**Recommended welding parameters**

	1.2mm	1.6mm
Dia.	1.2mm	1.6mm
F, HF, H	120~250A	180~340A
VU, OH	120~250A	180~280A
VD	200~250A	250~300A

**Approvals**

ABS	LR	DNV	NK	Others
3YSA, H5	3YS, H5	III YMS(H5)	KSW53G(C)H5	GL: 3YH5S CWB

**Packages**

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.1	Spool	5	1.2	Spool	15	1.6	Spool	15
	Spool	12.7					Spool	20
	Spool	20					Pack	250
	Pack	250						

## Flux cored wire

**Classification:** ASME / AWS A5.20 E70T-1C  
EN ISO 17632-A - T 42 0 R C 3 H5

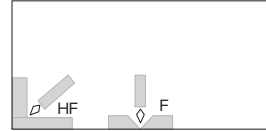
**Features:** • Excellent porosity resistibility to inorganic zinc primer

**Type of flux:** Metal

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.06	0.50	1.40	0.013	0.009
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	530	590	29	-18°C: 55
Guaranty	≥400	≥490	≥22	-18°C ≥27

## Recommended welding parameters

	1.2mm	1.4mm	1.6mm
Dia.			
F	150~300A	170~400A	200~450A
HF	180~300A	200~350A	270~400A

## Approvals

ABS	LR	DNV	BV	NK	Others
2YSA, 2Y400SA, H5	2YS, H5	II YMS(H5)	SA2YM HHH	KSW52Y40G(C)H5	CR: 2YS-HH GL: 3YH5S KR: 2YSG(C)H10 CCS: 2YSH5

## Packages

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.2	Spool	15	1.4	Spool	15	1.6	Spool	20
	Spool	20		Spool	20		Pack	350
	Pack	250		Pack	250			



# MX-200E

## Flux cored wire

**Classification:** ASME / AWS A5.20 E70T-9C

EN ISO 17632-A - T 42 3 R C 3 H5

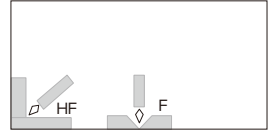
- Features:**
- Excellent porosity resistibility to inorganic zinc primer
  - Excellent impact value at low temperatures down to -29°C

**Type of flux:** Metal

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.05	0.63	1.57	0.008	0.007
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	540	600	30	-29°C: 70
Guaranty	≥400	≥490	≥22	-29°C ≥27

## Recommended welding parameters

	1.2mm	1.4mm
Dia.	1.2mm	1.4mm
F	150~300A	170~400A
HF	180~300A	200~350A

## Approvals

ABS	LR	DNV	BV	NK	GL
4Y400SA, H5	4Y40S(H5)	IVY40MS(H5)	SA4Y40M H5	KSW54Y40G(C)H5	4Y40H5S

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	15
	Spool	20
	Pack	250

## Flux cored wire

**Classification:** ASME / AWS A5.18 E70C-6M

EN ISO 17632-A - T 42 4 M M 3 H5

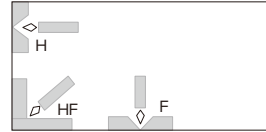
**Features:** • Better arc stability and wider optimum current range for spray transfer arc with less spattering than solid wire

**Type of flux:** Metal

**Shielding gas:** Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.05	0.63	1.58	0.017	0.011
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	450	550	33	-40°C: 71
Guaranty	≥400	≥483	≥22	-40°C ≥27

## Recommended welding parameters

Dia.	1.2mm	1.4mm	1.6mm
F	150~350A	200~450A	250~500A
HF, H	150~300A	200~400A	250~450A

## Approvals

LR	DNV	BV	GL
4YS, H5	IVYMS(H5)	SA4YM HHH	4YH5S

## Packages

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.2	Spool	15	1.4	Spool	15	1.6	Spool	15
	Spool	20		Spool	20		Spool	20
	Pack	200		Pack	250		Pack	250

**Flux cored wire**

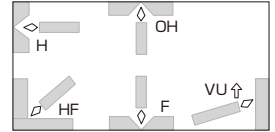
**Classification:** ASME / AWS A5.18 E70C-6C/6M  
EN ISO 17632-A - T 42 2 M C/M 1 H5

**Features:** • Suitable for thin plates (e.g., 0.8mm)  
• Excellent arc stability in low current range (50~180A)  
for short circuiting welding

**Type of flux:** Metal

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S
Example	0.08	0.49	1.53	0.013	0.015
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	480	560	31	-29°C: 62
Guaranty	≥400	≥490	≥22	-29°C ≥27

**Recommended welding parameters**

	1.2mm	1.4mm
Dia.	1.2mm	1.4mm
F, HF, H	50~300A	80~400A
VU, OH	50~180A	70~180A

**Approvals**

ABS	LR	DNV	BV	Others
3YSA, H5	3YS, H5	III YMS(H5)	SA3YM HHH	CR: 3YS-HH GL: 3YH5S

**Packages**

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.2	Spool	20	1.4	Spool	20
	Pack	250		Pack	250

## Flux cored Wires for 490MPa High Tensile Strength Steel

Product names	ASME AWS class.	Type of cored flux	SG	Pol.	Features	WP
DW-100V	A5.20 E71T-1C	Rutile	CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>▪ Suitable for butt and fillet welding in all positions including vertical downward</li> <li>▪ Excellent performance especially in vertical upward</li> </ul>	F HF H VD VU OH
						Ex
DW-200	A5.20 E70T-1C	Rutile	CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>▪ Suitable for flat and horizontal fillet welding</li> <li>▪ A large leg length of about 9mm in horizontal fillet</li> </ul>	F HF
						Ex
DW-A51B	A5.20 E71T-5M-J	Basic	Ar- CO <sub>2</sub>	DC-EN	<ul style="list-style-type: none"> <li>▪ Suitable for butt and fillet welding in all positions</li> </ul>	F HF H VU OH
						Ex
						Gt

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

DW-100V	ABS, LR, DNV, BV, NK, GL
DW-200	ABS, LR, DNV, BV, NK
DW-A51B	LR, DNV, BV, GL

Chemical composition of all-weld metal (%)					Mechanical properties of all-weld metal				
C	Si	Mn	P	S		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
0.05	0.60	1.35	0.010	0.009	Ex	490	580	30	-18°C: 50
≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	Gt	≥400	≥490	≥22	-18°C≥27
0.06	0.48	1.50	0.012	0.010	Ex	490	560	28	-18°C: 60
≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	Gt	≥400	≥490	≥22	-18°C≥27
0.07	0.45	1.40	0.014	0.009	Ex	480	570	30	-40°C: 95
≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	Gt	≥400	≥480	≥22	-40°C≥27

## Diameter (mm)

<b>DW-100V</b>	1.2, 1.4
<b>DW-200</b>	1.2, 1.4
<b>DW-A51B</b>	1.2, 1.6

## Metal Type Flux Cored Wires

Product names	ASME AWS class.	Type of cored flux	SG	Pol.	Features	WP	
<b>MX-100</b>	A5.20 E70T-1C	Metal	CO <sub>2</sub>	DC-EP	▪ Suitable for butt and fillet welding	F HF H	Ex Gt
<b>MX-200H</b>	A5.20 E70T-1C	Metal	CO <sub>2</sub>	DC-EP	▪ Suitable for horizontal fillet welding by high speed tandem method (150cm/min) ▪ Excellent porosity resistibility to inorganic zinc primer	F HF	Ex Gt
<b>MX-A200</b>	A5.20 E70T-1M	Metal	Ar- CO <sub>2</sub>	DC-EP	▪ Suitable for flat and horizontal fillet welding ▪ Excellent porosity resistibility to inorganic zinc primer	F HF	Ex Gt

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

<b>MX-100</b>	ABS, LR, DNV, BV, NK, CR, GL
<b>MX-200H</b>	ABS, LR, DNV, BV, NK, CR, KR, CCS

Chemical composition of all-weld metal (%)					Mechanical properties of all-weld metal				
C	Si	Mn	P	S		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
0.06	0.62	1.35	0.014	0.011	Ex	510	580	30	-18°C: 50
≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	Gt	≥400	≥490	≥22	-18°C≥27
0.06	0.55	1.55	0.015	0.008	Ex	500	600	27	-18°C: 90
≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	Gt	≥400	≥490	≥22	-18°C≥27
0.05	0.56	1.52	0.010	0.009	Ex	520	590	29	-18°C: 67
≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	Gt	≥400	≥490	≥22	-18°C≥27

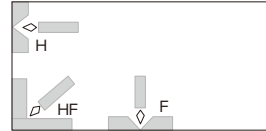
## Diameter (mm)

<b>MX-100</b>	1.2, 1.4, 1.6, 2.0
<b>MX-200H</b>	1.4, 1.6
<b>MX-A200</b>	1.1, 1.3, 1.6

## Solid wire

**Classification:** ASME / AWS A5.18 ER70S-G  
**Features:** • Higher currents are recommended  
**Shielding gas:** CO<sub>2</sub>  
**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Cu	Al	Ti+Zr
Example	0.04	0.73	1.64	0.010	0.010	0.23	0.01	0.22
Guaranty	≤0.15	0.55~ 1.10	1.40~ 1.90	≤0.030	≤0.030	≤0.50	≤0.10	≤0.30

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	490	570	30	-18°C: 100	AW
	420	530	34	-18°C: 110	625x1
Guaranty	≥400	≥480	≥22	0°C ≥47	AW

## Recommended welding parameters

	1.0mm	1.2mm	1.4mm	1.6mm
Dia.	1.0mm	1.2mm	1.4mm	1.6mm
F, HF	50~220A	100~350A	150~450A	200~550A
H	50~200A	100~300A	150~350A	200~400A

## Approvals

ABS	LR	DNV	BV	NK	Others
3SA, 3YSA	3YS, H15	III YMS	SA3M, SA3YM	KSW53G(C)	CR: 3YS GL: 3YS KR: 3YSG(C)

## Packages

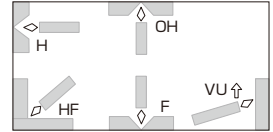
Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.0	Spool	20	1.4	Spool	15
1.2	Spool	10		Spool	20
	Spool	15		Pack	250
	Spool	20		Pack	400
	Pack	300	1.6	Spool	20
				Pack	400



**Solid wire****Classification:** ASME / AWS A5.18 ER70S-6

**Features:**

- Higher currents can be applied in vertical and overhead positions
- Suitable for pipe welding in all positions

**Shielding gas:** CO<sub>2</sub>**Polarity:** DC-EP**Welding Positions:****Chemical composition of wire (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>
Example	0.10	0.88	1.56	0.011	0.012	0.24
Guaranty	0.06~ 0.15	0.80~ 1.10	1.40~ 1.85	≤0.025	≤0.030	≤0.50

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>Shielding gas</b>
Example	470	560	32	-29°C: 70	CO <sub>2</sub>
	520	600	31	-29°C: 90	80%Ar-20%CO <sub>2</sub>
Guaranty	≥400	≥480	≥22	-29°C ≥27	CO <sub>2</sub>

**Recommended welding parameters**

	0.9mm	1.0mm	1.2mm
F, HF	50~200A	50~220A	80~350A
H	50~180A	50~200A	80~300A
VU	50~140A	50~140A	50~160A
OH	50~120A	50~120A	50~140A

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>
0.9	Spool	20	1.2	Spool	20
1.0	Spool	20		Pack	300
	Pack	250			

## Solid Wires

Product names	ASME AWS Class	SG	Pol.	Features	WP	Chemical		
						C	Si	
SE-A50	A5.18 ER70S -G	80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Smooth wire feeding, Smooth arc start and stable arc with little spatter generation</li> <li>The special surface treatment that eliminates the need for Cu coating</li> </ul>	F VU OH	Ex	0.06	0.62
						Gt	≤0.15	0.40~ 1.00
MG-50T	-	CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding in all positions</li> <li>Suitable for lower currents</li> </ul>	F HF H VU OH	Ex	0.06	0.75
						Gt	≤0.15	0.55~ 1.10
MIX-50	A5.18 ER70S -3	80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding in all positions</li> <li>Suitable for lower currents</li> </ul>	F HF H VU OH	Ex	0.10	0.55
						Gt	0.06~ 0.15	0.45~ 0.70
MIX-1TS	-	80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Pulsed MAG with MIX-1TS offers better bead appearance on a galvanized steel plate</li> </ul>		Ex	0.08	0.60
						Gt	≤0.15	0.40~ 1.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

SE-A50	NK
MG-50T	ABS, LR, DNV, BV, NK, CR, KR
MIX-50	ABS, NK

composition of wire (%)				Mechanical properties of all-weld metal					PWHT (°C×h) & SG
Mn	P	S	Cu	YP (MPa)	TS (MPa)	EI (%)	IV (J)		
1.27	0.010	0.015	0.10	Ex	460	559	30	-20°C: 120	AW
0.90~ 1.60	≦0.030	≦0.030	≦0.50	Gt	≧400	≧490	≧18	-20°C ≧27	AW
1.34	0.011	0.011	0.24	Ex	460	540	31	-18°C: 100	AW
					360	490	34	-18°C: 110	625x2
1.25~ 1.90	≦0.030	≦0.030	≦0.50	Gt	≧390	490~ 670	≧18 (5D)	0°C ≧27	AW
1.11	0.012	0.011	0.24	Ex	440	540	32	-18°C: 170	AW
0.90~ 1.40	≦0.025	≦0.030	≦0.50	Gt	≧400	≧480	≧22	-18°C ≧27	AW
1.01	0.010	0.006	0.24	Ex	440	540	30	-20°C ≧150	AW
0.90~ 1.60	≦0.030	≦0.030	≦0.50	Gt	≧390	≧490	≧18	-20°C ≧27	AW

## Diameter (mm)

<b>SE-A50</b>	0.9, 1.0, 1.2	<b>MIX-50</b>	0.9, 1.0, 1.2
<b>MG-50T</b>	0.8, 0.9, 1.0, 1.2, 1.6	<b>MIX-1TS</b>	1.2

## Solid Wires

Product names	ASME AWS Class	SG	Pol.	Features	WP	Chemical		
						C	Si	
MIX-50S	A5.18 ER70S -G	80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding in all positions</li> <li>Suitable for higher currents</li> </ul>	F HF H VU OH	Ex	0.07	0.57
						Gt	≤0.15	0.40- 1.00
MG-S50	A5.18 ER70S -G	Ar- 5~20% CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding in all positions</li> </ul>	F HF H VU OH	Ex	0.11	0.72
		Ar- 2~5%O <sub>2</sub>				Gt	≤0.12	0.50- 1.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

MIX-50S      ABS, LR, DNV, BV, NK, GL

composition of wire (%)				Mechanical properties of all-weld metal					
Mn	P	S	Cu		YP (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h) & SG
1.17	0.010	0.013	0.24	Ex	470	550	32	-18°C: 170	AW
1.00- 1.60	≤0.030	≤0.030	≤0.50	Gt	≥400	≥480	≥22	-18°C ≥27	AW
				Ex	450	570	28	-29°C: 180	AW 80%Ar-20%CO <sub>2</sub>
					370	520	32	-29°C: 190	620x1 80%Ar-20%CO <sub>2</sub>
1.41	0.010	0.011	0.24	Gt	≥400	≥480	≥22	-29°C ≥27	AW
				Ex	490	590	33	-29°C: 180	AW 98%Ar-2%O <sub>2</sub>
					400	540	33	-29°C: 200	620x1 98%Ar-2%O <sub>2</sub>
1.20- 1.60	≤0.025	≤0.025	≤0.50	Gt	≥400	≥480	≥22	-29°C ≥27	AW

## Diameter (mm)

**MIX-50S** 0.9, 1.0, 1.2, 1.4, 1.6

**MG-S50** 0.9, 1.0, 1.2, 1.4, 1.6

**TIG welding rod and wire****Classification:** ASME / AWS A5.18 ER70S-G**Features:**

- Good impact value at low temperatures
- Most widely used in Japan

**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Yellow**Chemical composition of rod and wire (%) as per AWS**

	C	Si	Mn	P	S	Cu	Al	Ti	Zr
Example	0.10	0.74	1.40	0.009	0.010	0.24	0.01	0.01	0.01
Guaranty	≤0.12	≤0.95	1.00~1.50	≤0.025	≤0.025	≤0.50	≤0.15	≤0.15	≤0.12

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	480	580	33	-29°C: 180	AW
	380	500	36	-29°C: 230	625x8
Guaranty	≥400	≥480	≥22	-29°C≥27	AW

**Approvals**

ABS	LR	DNV	BV	NK	CCS
3, 3Y, MG	3Ym(H15)	III YM	SA3YM	KSW53G(I)	3, 3YSM

**Packages**

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Spool	10	-	-
	Spool	20	-	-
	Tube	5	1,000	9
1.6	Spool	10	-	-
	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire****Classification:** ASME / AWS A5.18 ER70S-6**Features:** • Its tensile strength after long time PWHT is high enough for 490MPa**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Black**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>	<b>Al</b>	<b>Ti</b>	<b>Zr</b>
Example	0.10	0.89	1.56	0.010	0.011	0.23	0.01	0.01	0.01
Guaranty	0.07~ 0.15	0.80~ 1.00	1.40~ 1.85	≤0.025	≤0.025	≤0.50	≤0.15	≤0.15	≤0.12

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	510	610	32	-29°C: 210	AW
	420	550	35	-29°C: 160	625x24
Guaranty	≥400	≥480	≥22	-29°C≥27	AW

**Approvals**

Others

TÜV

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Spool	10	-	-
1.6	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

## TIG welding rod and wire

**Classification:** ASME / AWS A5.18 ER70S-2**Features:** • Suitable for root pass welding of pipes**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** 1st Blue white, 2nd -

## Chemical composition of rod and wire (%) as per AWS

	C	Si	Mn	P	S	Cu	Al	Ti	Zr
Example	0.04	0.54	1.25	0.007	0.014	0.25	0.07	0.08	0.04
Guaranty	≤0.07	0.40~ 0.70	0.90~ 1.40	≤0.025	≤0.030	≤0.50	0.05~ 0.15	0.05~ 0.15	0.02~ 0.12

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	560	620	28	-29°C: 200	AW
	520	600	30	-29°C: 160	625x8
Guaranty	≥400	≥480	≥22	-29°C≥27	AW

## Packages

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
0.9	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Tube	5	1,000	9
1.6	Spool	20	-	-
	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63





**SAW flux and wire combination****Classification:** ASME / AWS A5.17 F7A2-EH14**Features:** • Suitable for butt and fillet welding of thin plates at high speeds

• DC-EP (CP type power source) is better for sheet metal of 4mm or thinner

**Type of flux:** Fused**Redrying conditions of flux:** 150~350°Cx1h**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>
Example	0.12	0.03	1.95	0.013	0.005	0.11
Guaranty	0.10~0.20	≤0.10	1.70~2.20	≤0.030	≤0.030	≤0.35

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.06	0.44	1.83	0.012	0.004

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°Cxh)</b>
Example	440	540	29	-29°C: 40	AW
Guaranty	≥400	480~660	≥22	-29°C≥27	AW

**Polarity**

Example	AC
Guaranty	AC

**Packages**

Wire			Flux		
<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	10,20	8x48	Can	25
2.0	Spool	10,20	12x65	Can	25
2.4	Coil	25,76	12x150	Can	25
	Spool	10			
	Pack	300			
3.2	Coil	25,76			
	Pack	300			
4.0	Coil	25,75,150			
	Pack	300			
4.8	Coil	25,75,150			
6.4	Coil	25,78,159			

**SAW flux and wire combination****Classification:** ASME / AWS A5.17 F7A2-EH14**Features:** • Suitable for butt and fillet welding of thin or medium plate at high speeds**Type of flux:** Fused**Redrying conditions of flux:** 150~350°Cx1h**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>
Example	0.12	0.03	1.95	0.013	0.005	0.11
Guaranty	0.10~0.20	≤0.10	1.70~2.20	≤0.030	≤0.030	≤0.35

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.07	0.34	1.70	0.017	0.004

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C/h)</b>
Example	460	560	27	-29°C: 40	AW
Guaranty	≥400	480~660	≥22	-29°C≥27	AW

**Polarity**

Example	AC
Guaranty	AC

**Approvals**

	<b>ABS</b>	<b>LR</b>	<b>DNV</b>	<b>BV</b>	<b>NK</b>
Single	1T	1T	IT	A1T	KAW1TM

**Packages**

Wire			Flux		
<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	10,20	12x65	Can	25
2.0	Spool	10,20	12x150	Can	25
2.4	Coil	25,76			
	Spool	10			
	Pack	300			
3.2	Coil	25,76			
	Pack	300			
4.0	Coil	25,75,150			
	Pack	300			
4.8	Coil	25,75,150			
6.4	Coil	25,78,159			

# MF-38/US-36

**FAMILIARC™****SAW flux and wire combination****Classification:** ASME / AWS A5.17 F7A6-EH14  
F7P6-EH14**Features:** • Suitable for butt and flat fillet welding of medium or heavy thick plate  
• Excellent mechanical properties of weld metal by multi-pass welding**Type of flux:** Fused**Redrying conditions of flux:** 150~350°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Cu
Example	0.12	0.03	1.95	0.013	0.005	0.11
Guaranty	0.10~0.20	≤0.10	1.70~2.20	≤0.030	≤0.030	≤0.35

**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S
Example	0.09	0.32	1.63	0.018	0.011

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	490	570	30	-51°C: 59	AW
	420	530	31	-51°C: 64	620x1
Guaranty	≥400	480~660	≥22	-51°C≥27	AW
	≥400	480~660	≥22	-51°C≥27	620±15x1

**Polarity**

Example	AC
Guaranty	AC

**Approvals**

	ABS	LR	DNV	BV	NK	Others
Single	2T, 2YT 3M, 3YM	2T, 2YT 3YM	II YT III YM	A2, 2YT A3, 3YM	KAW52T KAW53M	CR: 2YT,3YM GL: 2YT,3YM KR: 2YT,3YM

## Packages

### Wire

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	10,20
2.0	Spool	10,20
2.4	Coil	25,76
	Spool	10
	Pack	300
3.2	Coil	25,76
	Pack	300
4.0	Coil	25,75,150
	Pack	300
4.8	Coil	25,75,150
6.4	Coil	25,78,159

### Flux

<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
12x65	Can	25
20x200	Can	25
20xD	Can	25

**SAW flux and wire combination**

**Classification:** ASME / AWS A5.17 F7A6-EH14  
F7P6-EH14

**Features:** • Suitable for butt and flat fillet welding of medium or heavy thick plate  
• Excellent slag removal and good mechanical properties

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>
Example	0.12	0.03	1.95	0.013	0.005	0.11
Guaranty	0.10~0.20	≤0.10	1.70~2.20	≤0.030	≤0.030	≤0.35

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.09	0.23	1.62	0.014	0.007

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°Cxh)</b>
Example	470	570	30	-51°C: 90	AW
	410	520	31	-51°C: 82	620x1
Guaranty	≥400	480~660	≥22	-51°C≥27	AW
	≥400	480~660	≥22	-51°C≥27	620±15x1

**Polarity**

Example	AC
Guaranty	AC

## Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
1.6	Spool	10,20	20x200	Can	25
2.0	Spool	10,20			
2.4	Coil	25,76			
	Spool	10			
3.2	Pack	300			
	Coil	25,76			
4.0	Pack	300			
	Coil	25,75,150			
4.8	Pack	300			
	Coil	25,75,150			
6.4	Coil	25,78,159			

## SAW Flux and Wire Combinations

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical C
<b>G-80/ US-36</b>	A5.17 F7A2-EH14 F6P2-EH14	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for butt and flat fillet welding of medium or heavy thick plate</li> <li>▪ Good Mechanical properties in multi-pass welding</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Wire-Ex 0.12
					Wire-Gt 0.10~0.20
					Weld-Ex 0.09
<b>MF-53/ US-36</b>	A5.17 F7A0-EH14	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for fillet welding for both single and multiple electrodes procedures</li> <li>▪ Excellent bead appearance and slag removal</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Wire-Ex 0.12
					Wire-Gt 0.10~0.20
					Weld-Ex 0.05

Note: Welding tests are as per AWS. Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)

### Approvals

<b>G-80/US-36</b>	ABS, LR, DNV, BV, NK, KR
<b>MF-53/US-36</b>	ABS, LR, DNV, NK



composition (%)				Mechanical properties of weld metal					
Si	Mn	P	S		0.2%OS (MPa)	TS (MPa)	EI (%)	IV(J)	PWHT (°C/h)
0.03	1.95	0.013	0.005	Ex	410	520	29	-29°C: 43	AW
≤0.10	1.70~ 2.20	≤0.030	≤0.030		360	500	35	-29°C: 82	620 x1
0.46	1.41	0.018	0.011	Gt	≥400	480~ 660	≥22	-29°C ≥27	AW
					≥330	410~ 550	≥22	-29°C ≥27	620±15 x1
0.03	1.95	0.013	0.005	Ex	430	510	29	-18°C: 40	AW
≤0.10	1.70~ 2.20	≤0.030	≤0.030						
0.67	1.61	0.016	0.009	Gt	≥400	480~ 660	≥22	-18°C ≥27	AW

Weld-Ex: Example of weld metal

## Diameter of wire (mm)

**US-36** 1.6, 2.0, 2.4, 3.2, 4.0, 4.8, 6.4

## Mesh size of flux

**G-80** 12x65, 12x200, 20x200, 32x200, 20xD

**MF-53** 8x48

## SAW Flux and Wire Combinations

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical		
					C	Si	
PF-H55E/ US-36	A5.17 F7A4 -EH14	Bonded	AC	<ul style="list-style-type: none"> <li>▪ Suitable for single-pass-on-both-sides or multi-layer butt welding</li> <li>▪ Good bead appearance and excellent impact value</li> <li>▪ RC: 200~300°Cx1h</li> </ul>	Wire-Ex	0.12	0.03
					Wire-Gt	0.10~ 0.20	≤0.10
					Weld-Ex	0.09	0.21

Note: Welding tests are as per AWS. Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)

### Approvals

PF-H55E/US-36      ABS, LR, DNV, BV, NK, GL, CR

composition (%)				Mechanical properties of weld metal					
Mn	P	S	Mo		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT
1.95	0.013	0.005	-						
				Ex	460	530	32	-40°C: 118	AW
1.70~ 2.20	≤0.030	≤0.030	-						
1.23	0.015	0.007	-	Gt	≥400	480~ 660	≥22	-40°C ≥27	AW

Weld-Ex: Example of weld metal

### Diameter of wire (mm)

**US-36** 1.6, 2.0, 2.4, 3.2, 4.0, 4.8, 6.4

### Mesh size of flux

**PF-H55E** 10x48



**For Weather Proof Steel**

## **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Flux Cored Arc Welding (FCAW)**

**Gas Metal Arc Welding (GMAW)**

**Submerged Arc Welding (SAW)**

## For Weather Proof Steel

### A guide for selecting welding consumables

Table 1 shows suitable welding consumables for shielded metal arc welding (SMAW), flux cored arc welding (FCAW), gas metal arc welding (GMAW), and submerged arc welding (SAW) of weather proof steels.

Table 1 Welding consumables for weather proof steel <sup>(1)</sup>

Steel grade	ASTM	JIS G3114	ASTM
		A709 Gr.36	SMA400P SMA400W SMA490P SMA490W
SMAW	<b>LB-W52B</b>		<b>LB-W588</b> <b>LB-W62G</b>
FCAW	<b>DW-50W</b>		<b>DW-588</b>
GMAW	<b>MG-W50TB</b>		-
SAW	<b>MF-38/US-W52B</b> <b>MF-53/US-W52B (HF)</b>		-

Note (1) F, H, and HF designate suitable welding position.

## Tips for better welding results

In addition to the tips for mild steel and 490MPa high tensile strength steel, the following notes should be taken into consideration in welding weather proof steels.

- (1) Remove rust and dirt from welding grooves to prevent pits and blowholes in the weld metal.
- (2) Use an appropriate welding procedure taking into account the requirements for the mechanical properties of the weldment, because heat input, interpass temperature and plate thickness affect the cooling rate of welds and, where the cooling rate is excessively low, the tensile strength and notch toughness of the weld decrease.
- (3) Use appropriate preheating according to the type of base metal and the thickness of the work to prevent cold cracking in the weld. Table 2 shows the minimum preheat temperatures used in general applications.

Table 2 Minimum preheat temperatures (°C) for general uses for several steel grades and thicknesses

Steel grade (See Table 1)	Type of welding joint	Welding process	Plate thickness (mm)		
			25 max	Over 25 Up to 38	Over 38 Up to 50
A709 Gr.36 SMA400P SMA400W	Groove Fillet	SMAW	-	50	100
		FCAW, GMAW, SAW	-	-	50
A588 A709 Gr.50W A242 SMA490P SMA490W	Groove Fillet	SMAW	50	100	100
		FCAW, GMAW, SAW	-	-	50

- (4) For welding a high-phosphorous weather proof steel (e.g., A242), use lower welding currents and slower welding speeds to prevent hot cracking.

## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical		
						C	Si	
LB-W52	A5.5 E7016 -G	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding of weather proof steel (with painting)</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F HF H VU OH	Ex	0.07	0.48
			DC-EP			Gt	≤0.12	≤0.90
LB-W52B	A5.5 E7016 -G	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding of weather proof steel (without painting)</li> <li>RC: 350~400°C x1h</li> </ul>	F HF H VU OH	Ex	0.05	0.54
			DC-EP			Gt	≤0.12	≤0.90
LB-W588	A5.5 E8016 -C3	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding of ASTM A588 and A242 steel</li> <li>RC: 350~400°C x1h</li> </ul>	F HF H VU OH	Ex	0.07	0.57
			DC-EP			Gt	≤0.12	≤0.80
LB-W62G	A5.5 E8018 -W2	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for butt and fillet welding of 570MPa class weather proof steel</li> <li>Applicable for ASTM A588 and A242 steel</li> <li>RC: 350~400°C x1h</li> </ul>	F HF H VU OH	Ex	0.07	0.58
			DC-EP			Gt	≤0.12	0.35~0.80

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Identification color

Product names	1st	2nd
LB-W52	Blue	Pink
LB-W52B	Green	Red
LB-W588	White	Silver gray
LB-W62G	Silver gray	Silver gray



composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Mn	P	S	Cu	Ni	Cr		0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
0.82	0.010	0.005	0.31	0.33	-	Ex	490	550	31	-29°C: 130
0.30~ 1.40	≦0.040	≦0.030	0.20~ 0.60	0.25~ 0.70	-	Gt	≧390	≧480	≧25	-
0.63	0.010	0.004	0.38	0.20	0.59	Ex	480	570	29	-29°C: 140
0.30~ 1.40	≦0.040	≦0.030	0.30~ 0.70	0.05~ 0.70	0.45~ 0.75	Gt	≧390	≧480	≧25	-
1.10	0.010	0.007	-	1.06	-	Ex	520	600	30	-40°C: 120
0.40~ 1.25	≦0.03	≦0.03	-	0.80~ 1.10	-	Gt	470~ 550	≧550	≧24	-40°C ≧27
1.02	0.009	0.004	0.35	0.49	0.57	Ex	540	640	29	-18°C: 160
0.50~ 1.30	≦0.03	≦0.03	0.30~ 0.75	0.40~ 0.80	0.45~ 0.70	Gt	≧460	≧550	≧19	-18°C ≧27

Gt: Guaranty (polarity: as specified above)

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0
<b>LB-W52</b>	350	350	400	450
<b>LB-W52B</b>	-	350	400	450
<b>LB-W588</b>	300	350	400	400
<b>LB-W62G</b>	350	350	400	450

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical		
							C	Si	
DW-50W	-	Rutile	CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>▪ Suitable for butt and fillet welding in all positions</li> <li>▪ Applicable for weather proof steel which is used normally without painting</li> </ul>	F	Ex	0.06	0.35
						HF H VU OH			
DW-588	A5.29 E81T1 -W2C	Rutile	CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>▪ Suitable for butt and fillet welding in all positions</li> <li>▪ Applicable for A588 steel which is used normally without painting</li> </ul>	F	Ex	0.04	0.55
						HF H VU OH			

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Mn	P	S	Cu	Cr	Ni		0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
1.06	0.013	0.008	0.39	0.54	0.38	Ex	510	590	27	0°C: 140
0.50~ 1.60	≤0.03	≤0.03	0.30~ 0.60	0.45~ 0.75	0.05~ 0.70	Gt	≥390	≥490	≥20	0°C ≥47
1.14	0.012	0.010	0.41	0.52	0.48	Ex	550	620	27	-29°C: 60
0.50~ 1.30	≤0.03	≤0.03	0.30~ 0.75	0.45~ 0.70	0.40~ 0.80	Gt	≥470	550~ 690	≥19	-29°C ≥27

## Diameter (mm)

DW-50W	1.2, 1.4, 1.6
DW-588	1.2

## Solid wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical			
						C	Si	Mn	
MG-W50TB	A5.28 ER80S -G	CO <sub>2</sub> 80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>▪ Applicable for weatherproof steel which is used normally without painting</li> <li>▪ Lower currents are suitable</li> </ul>	F HF H VU OH	Ex	0.03	0.77	1.39
						Gt	≤0.15	0.30~ 1.20	0.70~ 1.80

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of wire (%)					Mechanical properties of all-weld metal					
P	S	Cr	Ni	Cu		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG
0.012	0.010	0.61	0.19	0.45	Ex	450	560	30	0°C: 110	CO <sub>2</sub>
						480	580	29	-18°C: 120	80%Ar- 20%CO <sub>2</sub>
≦0.030	≦0.030	0.50~ 0.80	0.05~ 0.70	0.30~ 0.60	Gt	≧400	≧550	≧19	0°C ≧47	CO <sub>2</sub>
						≧400	≧550	≧19	-18°C ≧27	80%Ar- 20%CO <sub>2</sub>

## Diameter (mm)

**MG-W50TB** 1.0, 1.2

## SAW Flux and Wire Combinations

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical		
					C	Si	
<b>MF-38/ US-W52B</b>	A5.23 F7A2 -EG-G	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for butt and flat fillet welding (without painting)</li> <li>▪ Good impact value</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Wire-Ex	0.10	0.03
					Wire-Gt	≤0.15	≤0.10
					Weld-Ex	0.05	0.32
<b>MF-53/ US-W52B</b>	A5.23 F7A0 -EG-G	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for fillet welding (without painting)</li> <li>▪ Excellent bead appearance and good slag removal</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Wire-Ex	0.10	0.03
					Wire-Gt	≤0.15	≤0.10
					Weld-Ex	0.05	0.58

Note: Welding tests are as per AWS. Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)

composition (%)						Mechanical properties of weld metal				
Mn	P	S	Cu	Cr	Ni	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	
1.51	0.010	0.008	0.36	0.62	0.14	Ex	490	590	25	-29°C: 76
1.20~ 1.80	≤0.025	≤0.025	0.30~ 0.55	0.50~ 0.80	0.10~ 0.25					
1.48	0.017	0.005	0.35	0.51	0.14	Gt	≥400	480~ 660	≥22	-29°C ≥27
1.51	0.010	0.008	0.36	0.62	0.14	Ex	430	530	23	-18°C: 35
1.20~ 1.80	≤0.025	≤0.025	0.30~ 0.55	0.50~ 0.80	0.10~ 0.25					
1.35	0.009	0.007	0.36	0.59	0.18	Gt	≥400	480~ 660	≥22	-18°C ≥27

Weld-Ex: Example of weld metal

### Diameter of wire (mm)

**US-W52B** 1.6, 2.0, 2.4, 3.2, 4.0, 4.8

### Mesh size of flux

**MF-38** 12x65, 20x200, 20xD

**MF-53** 8x48





**For High Tensile Strength Steel and Low Temperature Steel**

## **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Flux Cored Arc Welding (FCAW)**

**Gas Metal Arc Welding (GMAW)**

**Gas Tungsten Arc Welding (GTAW)**

**Submerged Arc Welding (SAW)**

## For High Tensile Strength Steel and Low Temperature Steel

### A guide for selecting welding consumables <sup>(1)</sup>

TS	≥490MPa	≥520MPa	≥550MPa
YS	≥350MPa	≥400MPa	≥420MPa
IV	≥35J	≥40J	≥42J

#### SMAW

-20°C	<b>LB-52</b> (AC, DC-EP, SR) <b>LB-52A</b> (AC, DC-EP, SR)	<b>LB-57</b> (AC, DC-EP, SR)	<b>LB-62UL</b> (AC, DC-EP, SR) <b>LB-62</b> (AC, DC-EP, SR)
-40°C	<b>LB-7018-1</b> (DC-EP)	<b>NB-1SJ</b> (AC, DC-EP, SR) <b>LB-52NS</b> (AC)	<b>NB-1SJ</b> (AC, SR) <b>LB-62L</b> (AC, DC-EP, SR)
-60°C	<b>NB-1SJ</b> (AC, DC-EP, SR) <b>LB-52NS</b> (AC, DC-EP, SR)		

#### FCAW, GMAW <sup>(2)</sup>

-20°C	<b>DW-100E</b> (100%CO <sub>2</sub> ) <b>MG-S50</b> (Ar-20%CO <sub>2</sub> , SR)	<b>DW-55L</b> (100%CO <sub>2</sub> ) <b>DW-A81Ni1</b> (Ar-20%CO <sub>2</sub> ) <b>MG-T1NS</b> (Ar-20%CO <sub>2</sub> )	
-30°C	<b>DW-55E</b> (100%CO <sub>2</sub> ) <b>DW-A55E</b> (Ar-20%CO <sub>2</sub> )		
-40°C	<b>DW-A55ESR</b> (Ar-20%CO <sub>2</sub> , SR)		
-50°C	<b>DW-50LSR</b> (100%CO <sub>2</sub> , SR)	<b>DW-55LSR</b> (100%CO <sub>2</sub> , SR) <b>DW-A55L</b> (Ar-20%CO <sub>2</sub> ) <b>DW-A55LSR</b> (Ar-20%CO <sub>2</sub> , SR)	<b>DW-A81Ni1</b> (Ar-20%CO <sub>2</sub> )
-60°C	<b>DW-55L</b> (100%CO <sub>2</sub> ) <b>DW-A55L</b> (Ar-20%CO <sub>2</sub> ) <b>MG-S50LT</b> (Ar-20%CO <sub>2</sub> , SR) <b>MX-A55Ni1</b> (Ar-20%CO <sub>2</sub> )	<b>DW-55LSR</b> (100%CO <sub>2</sub> , SR) <b>DW-A55L</b> (Ar-20%CO <sub>2</sub> ) <b>DW-A55LSR</b> (Ar-20%CO <sub>2</sub> , SR) <b>MG-S50LT</b> (Ar-20%CO <sub>2</sub> ) <b>MX-A55Ni1</b> (Ar-20%CO <sub>2</sub> )	<b>DW-55LSR</b> (100%CO <sub>2</sub> ) <b>DW-A55L</b> (Ar-20%CO <sub>2</sub> ) <b>DW-A55LSR</b> (Ar-20%CO <sub>2</sub> ) <b>MX-A55Ni1</b> (Ar-20%CO <sub>2</sub> )

#### GTAW <sup>(3)</sup>

-20°C	<b>TG-S50</b> (SR) <b>TG-S51T</b> (SR)	<b>TG-S62</b> (SR) <b>TG-S60A</b> (SR)	<b>TG-S62</b> (SR) <b>TG-S60A</b> (SR)
-30°C			
-40°C	<b>TG-S1MT</b>	<b>TG-S60A</b> (SR)	<b>TG-S60A</b> (SR)
-60°C	<b>TG-S1N</b>		

#### SAW

-20°C	<b>MF-38/US-36</b> (AC, SR)	<b>MF-38/US-49A</b> (AC, SR)	
-40°C	<b>PF-H55AS/US-36J</b> (DC-EP, SR) <b>PF-H55LT/US-36</b> (AC, SR)	<b>PF-H55S/US-49A</b> (AC, SR)	<b>PF-H55S/US-49A</b> (AC, SR) <b>PF-H80AK/US-56B</b> (DC-EP)
-60°C		<b>PF-H55AS/US-36J</b> (DC-EP) <b>PF-H55LT/US-36</b> (AC) <b>PF-H55LT/US-36J</b> (AC, SR)	<b>PF-H55LT/US-36J</b> (AC)

Note (1) Welding consumables shown with SR are suitable for the as-welded and PWHT conditions.

(2) DW-XXX and DW-AXXX are flux-cored wires. MG-SXXX and MG-TXXX are solid wires.

	$\geq 610\text{MPa}$ $\geq 500\text{MPa}$ $\geq 50\text{J}$	$\geq 670\text{MPa}$ $\geq 550\text{MPa}$ $\geq 55\text{J}$	$\geq 770\text{MPa}$ $\geq 690\text{MPa}$ $\geq 69\text{J}$
	<b>LB-62UL</b> (AC, DC-EP, SR) <b>LB-62</b> (AC, DC-EP, SR)	<b>LB-106</b> (AC, DC-EP)	<b>LB-80UL</b> (AC) <b>LB-116</b> (AC)
	<b>LB-65L</b> (DC-EP, SR) <b>LB-62L</b> (AC, SR) <b>LB-67L</b> (DC-EP, SR)	<b>LB-70L</b> (DC-EP) <b>LB-Y75</b> (AC)	<b>LB-80L</b> (DC-EP) <b>LB-88LT</b> (AC)
	<b>DW-A65L</b> (Ar-20%CO <sub>2</sub> ) <b>MG-T1NS</b> (Ar-20%CO <sub>2</sub> )	<b>MG-S70</b> (Ar-20%CO <sub>2</sub> )	<b>MG-S80</b> (Ar-20%CO <sub>2</sub> )
	<b>DW-62L</b> (100% CO <sub>2</sub> ) <b>DW-A62L</b> (Ar-20%CO <sub>2</sub> ) <b>MG-S62L</b> (Ar-20%CO <sub>2</sub> )	-	<b>MG-S88A</b> (Ar-20%CO <sub>2</sub> ) <b>MX-A80L</b> (Ar-20%CO <sub>2</sub> )
	<b>TG-S62</b> (SR) <b>TG-S60A</b> (SR)	<b>TG-S80AM</b> (SR)	
	<b>TG-S60A</b> (SR)		
	<b>MF-38/US-40</b> (AC)	<b>PF-H80AK/US-255</b> (AC)	<b>PF-H80AS/US-80LT</b> (DC-EP) <b>PF-H80AK/US-80LT</b> (AC)
	<b>PF-H55S/US-40</b> (AC) <b>PF-H80AK/US-56B</b> (AC, DC-EP)		
	<b>PF-H80AK/US-56B</b> (AC) <b>PF-H55S/US-2N</b> (AC, SR)		

(3) In one-side welding, back shielding is recommended.

(4) To prevent cold cracks or to assure mechanical properties of weld metals, preheating and interpass temperatures must be controlled as per an appropriate welding procedure spec.

## **For High Tensile Strength Steel and Low Temperature Steel**

### **Tips for better welding results**

#### **Common to individual welding processes**

- (1) Use an appropriate welding procedure taking into account the requirements for the mechanical properties of the weldment, because heat input, Interpass temperature and plate thickness affect the cooling rate of welds and, where the cooling rate is excessively low, the tensile strength and notch toughness of the weld decrease.
- (2) Use appropriate preheat and Interpass temperatures to prevent cold cracking assisted by the diffusible hydrogen in welds. Suitable preheat and Interpass temperatures vary depending upon welding process, plate thickness, and kind of steel plate. In general, higher tensile strength steels need higher preheat and interpass temperatures.
- (3) Select appropriate welding consumables and welding conditions carefully particularly in cases where the weld metal dilution by the base metal is large, because the chemical composition of the weld metal can markedly be affected by the base metal chemical composition and thereby the properties of the weld metal can be varied.
- (4) Confirm the applicability of postweld heat treatment for welding consumables before use, because some welding consumables can provide good notch toughness only in the as-welded condition and some welding consumables can provide sufficient notch toughness in the postweld heat treated conditions.
- (5) Confirm the suitable electric current characteristics for welding consumables before use, because each welding consumable is designed to provide the highest performances with specific type of electric current (AC, DC, or both) and polarity (DC-EP, DC-EN, or both). Therefore, when a welding consumable designed for AC is used in DC or in opposite case, there are possibilities to deteriorate the properties of the weld metal and usability.
- (6) Some welding consumable can be used by both AC and DC-EP; however, the use of DC-EP causes a little decrease in strength of the weld metal.

#### **SMAW**

- (1) Low-hydrogen type electrodes should be stored in an oven (100-150°C) placed near the welding area after re-drying was finished. Take out minimize amounts of electrodes needed for a certain work from the oven. This manner is to keep the diffusible hydrogen content of the weld metal in a low level.
- (2) Use the backstep technique directly in the welding groove or strike an arc on a scrap plate before transferring the arc into the groove to prevent cracking.
- (3) Keep the arc length as short as possible to maintain good shielding by the coating flux decomposed gases during welding. The use of a long arc can cause a decrease of impact value of the weld metal caused by the nitrogen in the atmosphere and, where the arc length is excessive, blowholes can occur in the weld metal. Use a wind screen in windy areas.
- (4) Refer to the tips for Mild Steel and 490MPa High Tensile Strength Steel for other notes.

## **FCAW, GMAW, and GTAW**

- (1) Use suitable shielding gas for each welding wire because the composition of a shielding gas can affect the mechanical properties of the weld metal.
- (2) Use a wind screen in windy areas to maintain the shielding gas in good condition. Insufficient or irregular shielding gas can cause weld defects.
- (3) Refer to the tips for welding Mild Steel and 490MPa High Tensile Strength Steel for other notes.

## **SAW**

- (1) Remove rust, oil, grease, and water in the welding groove beforehand because such dirt can cause weld defects like pits and blowholes.
- (2) Select suitable steel plates and welding consumables carefully taking into account the dilution of weld metal by the base metal. Submerged arc welding characterizes deeper penetration and thus larger dilution; therefore, the properties of the weld metal can markedly be varied by the chemical composition of the base metal. Especially in the single-pass-on-both-side welding, the dilution ratio becomes as large as about 60% and thus the properties of the weld metal is considerably affected by the chemical composition of the base metal.
- (3) Refer to the tips for Mild Steel and 490MPa High Tensile Strength Steel for other notes.

### **How to prevent cold cracks in welding high tensile strength steels**

In order to prevent cold cracks in arc welding, preheat temperature is a key factor, which relates to the hardenability of the steel material, the amount of diffusible hydrogen in the weld metal, and the degree of restraint of the welding joint. Fig. 1 shows the relationship between preheat temperature and the Cracking Parameter ( $P_C$ ) which consists of the Cracking Parameter of Material ( $P_{CM}$ ), plate thickness ( $t$ ), and diffusible hydrogen ( $H$ ). This diagram was developed through the y-groove cracking test of high tensile strength steels having a variety of chemical compositions. It can be considered that  $P_{CM}$  relates to the hardenability of a steel material, and plate thickness relates to the degree of restraint of a welding joint. Hence,  $P_C$  can be a guide to estimating the preheat temperature needed for preventing a cold crack in arc welding of a particular steel material.

However, in the stricter sense, the following formula ( $P_W$ ) is more recommended to use for estimating the cooling time after welding that relates to preheat temperature, heat input, ambient temperature, and other factors to prevent a cold crack in arc welding of actual steel structures. The applicable ranges of individual parameters are given in Table 1.

$$P_W = P_{CM} + H/60 + R_F/400,000$$

where  $P_{CM}$  (%): the same as that contained in the  $P_C$  formula

$R_F$  (N/mm $\cdot$ mm): the degree of restraint of a welding joint

The degree of restraint (N/mm $\cdot$ mm) of a y-groove welding joint used for developing  $P_C$  is about 700 times the plate thickness (mm); if  $R_F$  is substituted by  $700 \times t$ ,  $P_W$  becomes almost the same as  $P_C$ .

For High Tensile Strength Steel and Low Temperature Steel

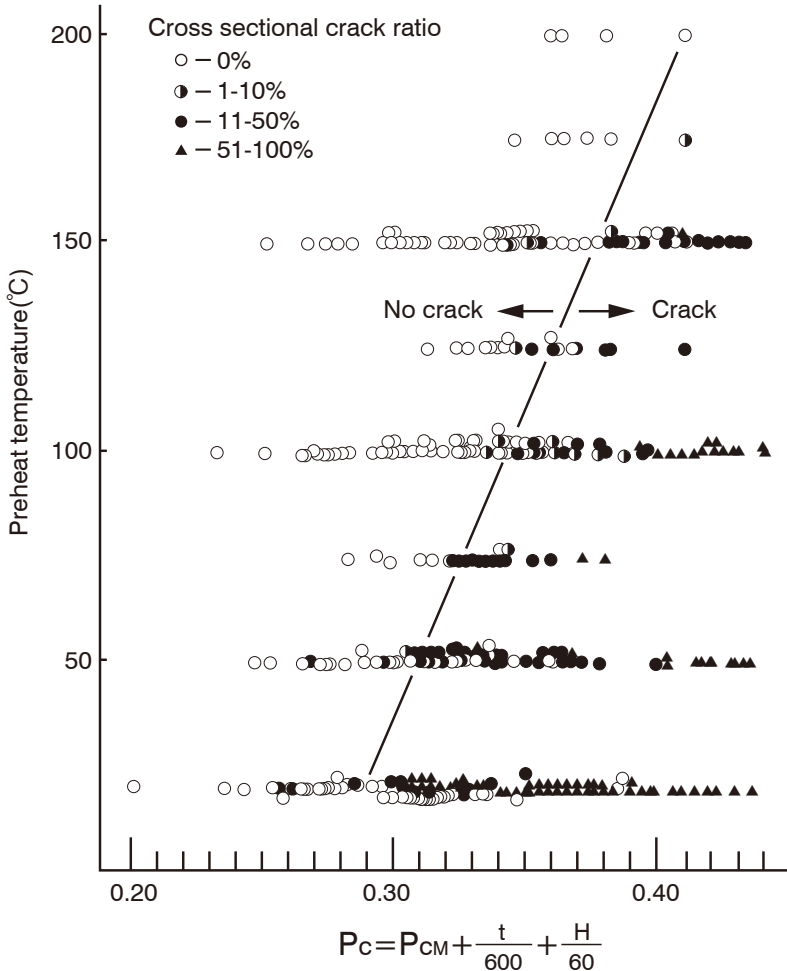


Fig. 1 Preheat temperature vs. cracking parameter (Plate thickness: 16~50 mm)  
 $P_{CM} = C + Si/30 + Mn/20 + Cu/20 + Ni/60 + Cr/20 + Mo/15 + V/10 + 5B$  (%)  
 t: Plate thickness (mm)  
 H: Content of diffusible hydrogen of deposited metal (Glycerine method) (ml/100 g)  
 $H$  (Glycerine method) = 0.79H (Gas chromatography method) - 1.73

Table 1 Applicable ranges of parameters for Pw formula

Chemical composition of steels (%)										
C	Si	Mn	Cu	Ni	Cr	Mo	V	Ti	Nb	B
0.07~ 0.22	0~ 0.60	0.40~ 1.40	0~ 0.50	0~ 1.20	0~ 1.20	0~ 0.70	0~ 0.12	0~ 0.05	0~ 0.04	0~ 0.005
Amount of diffusible hydrogen, H			Plate thickness, t			Degree of restraint, R <sub>F</sub>				
1.0~5.0 ml/100g			19~50 mm			5000~33000 N/mm·mm				

(References: WES 3001-1996 and JIS Z 3118-1992)

## Covered electrode

**Classification:** ASME / AWS A5.1 E7018-1  
EN ISO 2560-A-E 42 4 B

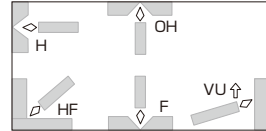
**Features:** • Suitable for low temperature service steel

**Type of covering:** Iron powder low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st Brown, 2nd White

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ti	B
Example	0.07	0.40	1.57	0.011	0.003	0.025	0.0035
Guaranty	≤0.15	≤0.75	≤1.60	≤0.035	≤0.035	-	-

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	490	580	31	-46°C: 135	AW
Guaranty	≥400	≥480	≥22	-46°C ≥27	AW

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	70~100A	90~130A	130~180A	180~240A
VU, OH	65~95A	80~120A	110~170A	-

## Polarity

Example	DC-EP
Guaranty	AC, DC-EP

## Approvals

ABS	LR
4Y400, H10	4Y40m H10



## Packages

<b>Dia. (mm)</b>	<b>Length (mm)</b>	<b>Weight per pack (kg)</b>	<b>Weight per carton (kg)</b>	<b>Weight per piece (g)</b>
2.6	350	5	20	23
3.2	350	5	20	35
4.0	400	5	20	61
	450	5	20	69
5.0	450	5	20	106

## Covered electrode

**Classification:** ASME / AWS A5.5 E9016-G  
EN ISO 2560-A-E 50 3 Z B

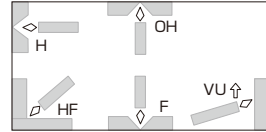
**Features:** • Suitable for butt and fillet welding  
• Typical covered electrode in this classification

**Type of covering:** Low hydrogen and moisture resistant

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st Blue white, 2nd Yellow

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo
Example	0.07	0.61	1.15	0.011	0.005	0.63	0.26
Guaranty	≤0.09	0.40~ 0.75	0.75~ 1.35	≤0.020	≤0.020	0.40~ 0.75	0.20~ 0.40

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	550	650	30	-18°C: 150
Guaranty	≥530	≥620	≥17	-

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	90~130A	130~180A	180~240A	250~310A
VU, OH	50~80A	80~115A	110~170A	150~200A	-

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Approvals

ABS	LR	DNV	BV	NK	CR
3YQ500 H10	3Ym H15	3YH10	3 HH, 3Y HH	KMW3Y50H10	MG

## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	17
3.2	350	5	20	30
4.0	400	5	20	55
5.0	400	5	20	85
6.0	450	5	20	140

**Covered electrode**

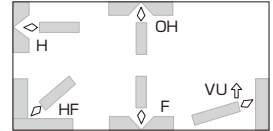
**Classification:** ASME / AWS A5.5 E9016-G  
EN ISO 2560-A-E 50 3 Z B

**Features:** • Excellent crack resistibility

**Type of covering:** Low hydrogen and moisture resistant

**Redrying Conditions:** 350~430°Cx1h

**Identification color:** 1st Brown, 2nd Silver

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo
Example	0.07	0.63	1.13	0.010	0.006	0.65	0.25
Guaranty	≤0.09	0.40~ 0.75	0.75~ 1.35	≤0.020	≤0.020	0.45~ 0.80	0.20~ 0.40

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	550	650	30	-18°C: 160
Guaranty	≥530	≥620	≥17	-

**Recommended welding parameters**

	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	90~130A	130~180A	180~240A	250~310A
VU, OH	80~115A	110~170A	150~200A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

CCS  
3Y50H10

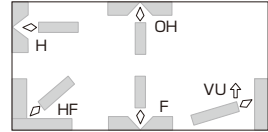
**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	85
6.0	450	5	20	140

**Covered electrode****Classification:** ASME / AWS A5.5 E9016-G

**Features:**

- Suitable for one-side welding of pipes
- Good arc stability with relatively low currents
- Excellent crack resistibility

**Type of covering:** Low hydrogen and moisture resistant**Redrying Conditions:** 350~400°Cx1h**Identification color:** 1st Blue, 2nd Yellow**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo
Example	0.08	0.64	1.03	0.010	0.004	0.59	0.24
Guaranty	≤0.09	0.40~ 0.75	0.70~ 1.20	≤0.020	≤0.020	0.45~ 0.80	0.20~ 0.40

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	560	650	26	-20°C: 88
Guaranty	≥530	≥620	≥17	-

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm
F, HF, H	60~90A	90~130A	130~180A
VU, OH	50~80A	80~115A	110~170A
Root pass	30~80A	60~110A	90~140A

**Polarity**

Example	DC-EP
Guaranty	DC-EP, AC (DC-EN is also suitable for root pass.)

**Approvals****ABS**

3YQ500 H10

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
2.6	350	5	20	20
3.2	350	5	20	30
4.0	400	5	20	53

**Covered electrode**

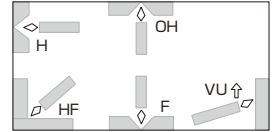
**Classification:** ASME / AWS A5.5 E7016-G  
EN ISO 2560-A-E 42 6 Z B

**Features:** • Good CTOD properties at temperatures down to -30°C  
• Better impact values at temperatures down to -60°C

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st White, 2nd Green

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Ti	B
Example	0.08	0.40	1.38	0.012	0.007	0.48	0.023	0.0021
Guaranty	≤0.10	0.30~ 0.90	1.00~ 1.60	≤0.020	≤0.020	0.30~ 0.70	0.005~ 0.035	0.0005~ 0.0045

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	490	580	29	-60°C: 130	AW
	470	570	31	-60°C: 120	620x1
Guaranty	≥390 ≥390	≥480 ≥480	≥25 ≥25	-60°C ≥27 -60°C ≥27	AW 620±15x1

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	90~130A	130~180A	180~240A	250~310A
VU, OH	50~80A	80~120A	110~170A	150~200A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS	LR	DNV	BV	NK
3Y, 4Y400 H10	5Y40m(H15)	5Y40H10, NV2-4(L), 4-4(L)	4Y40M HH(KV-60)	KMWL3H10, KMW54Y40

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
2.6	300	2	20	17
3.2	350	5	20	31
4.0	400	5	20	55
5.0	450	5	20	97
6.0	450	5	20	140

## Covered electrode

**Classification:** ASME / AWS A5.5 E8016-G

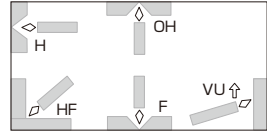
**Features:** • Good CTOD properties at temperatures down to -45°C  
• Good impact values at temperatures down to -80°C

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st White, 2nd Brown

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Ti	B
Example	0.08	0.31	1.32	0.007	0.004	1.33	0.020	0.0018
Guaranty	≤0.10	0.15~ 0.50	1.10~ 1.70	≤0.020	≤0.020	1.10~ 1.70	0.005~ 0.035	0.0005~ 0.0045

## Mechanical properties of all-weld metal as AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	520	610	29	-80°C: 127	AW
	490	580	29	-80°C: 130	620x1
Guaranty	≥460	≥550	≥19	-60°C≥27	AW
	≥460	≥550	≥19	-60°C≥27	620±15x1

## Recommended welding parameters

	3.2mm	4.0mm	5.0mm
F, HF, H	90~130A	130~180A	180~240A
VU, OH	80~120A	110~170A	150~200A

## Polarity

Example	AC
Guaranty	AC

## Approvals

LR	DNV	BV	NK
5Y40m(H15)	5YH10, NV2-4L, 4-4L	4Y40M HH, UP	KMW5Y42H10

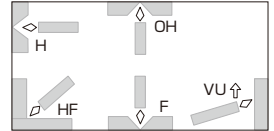
## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
3.2	350	5	20	31
4.0	400	5	20	55
5.0	450	5	20	97

**Covered electrode****Classification:** ASME / AWS A5.5 E8016-C1

**Features:**

- Good CTOD properties at temperatures down to -10°C
- Better impact values at temperatures down to -60°C
- AC is recommended for 570 to 610MPa class steel

**Redrying Conditions:** 350~400°Cx1h**Identification color:** 1st Blue, 2nd Orange**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo	Ti	B
Example	0.07	0.34	0.97	0.012	0.005	2.10	0.13	0.022	0.0016
Guaranty	≤0.10	≤0.60	≤1.20	≤0.03	≤0.03	2.00~2.75	-	-	-

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	540	650	27	-60°C: 130	AW
	530	640	28	-60°C: 120	608x1
Guaranty	≥460	≥550	≥19	-60°C≥27	AW
	≥460	≥550	≥19	-60°C≥27	605±15x1

**Recommended welding parameters**

	3.2mm	4.0mm	5.0mm
F, HF, H	90~130A	130~180A	180~240A
VU, OH	80~120A	100~170A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS
5YQ500 H10, MG

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton (kg)	Weight per piece (g)
3.2	350	5	20	31
4.0	400	5	20	55
5.0	450	5	20	97

## Covered electrode

**Classification:** ASME / AWS A5.5 E9016-G

**Features:**

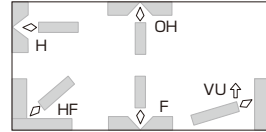
- Good CTOD properties at temperatures down to -20°C
- Better impact values at temperatures down to -60°C
- Excellent crack resistibility

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st White, 2nd Yellow

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo
Example	0.06	0.33	1.09	0.008	0.002	2.55	0.13
Guaranty	≤0.10	0.15~0.50	0.60~1.20	≤0.020	≤0.020	2.00~2.75	≤0.3

## Mechanical properties of all-weld metal as AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	560	660	29	-60°C: 130	AW
	560	640	28	-60°C: 112	620x1
Guaranty	≥530	≥620	≥17	-60°C≥27	AW
	≥490	≥590	≥16	-60°C≥27	620±15x1

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	70~100A	80~120A	120~170A	170~230A
VU, OH	65~95A	70~110A	90~160A	-

## Polarity

Example	DC-EP
Guaranty	DC-EP

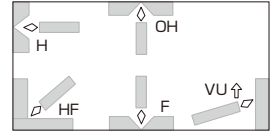
## Approvals

**ABS**  
5YQ500 H5

## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	31
4.0	400	5	20	55
5.0	450	5	20	97



**Covered electrode****Classification:** ASME / AWS A5.5 E10016-G**Features:** • Good impact values at temperatures down to -60°C  
• Excellent crack resistibility**Type of covering:** Low hydrogen**Redrying Conditions:** 350~430°Cx1h**Identification color:** 1st Green, 2nd Yellowish green**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr	Mo
Example	0.03	0.36	1.12	0.008	0.004	3.50	0.22	0.38
Guaranty	≤0.07	0.20~ 0.60	0.80~ 1.40	≤0.020	≤0.020	3.05~ 3.90	0.10~ 0.40	0.30~ 0.60

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	685	755	27	-60°C: 108
Guaranty	≥600	≥690	≥16	-60°C ≥27

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	70~100A	80~120A	120~170A	170~230A
VU, OH	65~95A	70~110A	90~160A	-

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Approvals**

ABS	DNV
4YQ620 H5	4Y62H5

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	87

## Covered electrode

**Classification:** ASME / AWS A5.5 E11018-G H4

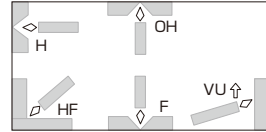
**Features:** • Good impact values at temperatures down to -60°C  
• Excellent crack resistibility

**Type of covering:** Low hydrogen

**Redrying Conditions:** 350~400°Cx1h

**Identification color:** 1st Brown, 2nd Brown

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo
Example	0.04	0.60	1.39	0.009	0.006	2.88	0.70
Guaranty	≤0.09	0.20~0.75	1.20~1.90	≤0.020	≤0.020	2.50~3.30	0.40~1.00

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	770	830	24	-60°C: 100
Guaranty	≥690	≥770	≥15	-60°C≥47

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	70~100A	80~120A	120~160A	170~210A
VU, OH	65~95A	70~110A	90~150A	-

## Polarity

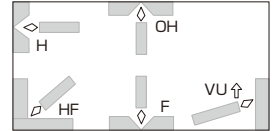
Example	DC-EP
Guaranty	DC-EP

## Approvals

<b>ABS</b>	<b>DNV</b>
5YQ690 H5	5Y69H5

## Packages

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	32
4.0	400	5	20	57
5.0	400	5	20	90

**Covered electrode****Classification:** ASME / AWS A5.5 E11016-G**Features:** • Good impact values at temperatures down to -80°C  
• Excellent crack resistibility**Type of covering:** Low hydrogen**Redrying Conditions:** 350~430°Cx1h**Identification color:** 1st Brown, 2nd Brown**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo
Example	0.04	0.58	1.81	0.012	0.006	2.62	0.73
Guaranty	≤0.09	0.40~0.75	1.40~2.00	≤0.020	≤0.020	2.10~2.80	0.50~0.80

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	750	840	20	-80°C: 63
Guaranty	≥670	≥760	≥15	-80°C ≥27

**Recommended welding parameters**

	3.2mm	4.0mm	5.0mm
F, HF, H	90~130A	130~180A	180~240A
VU, OH	80~115A	100~170A	-

**Polarity**

Example	AC
Guaranty	AC

**Approvals**

DNV
5Y69H5

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
3.2	350	5	20	30
4.0	400	5	20	54
5.0	400	5	20	87

# Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical			
						C	Si	Mn	
LB-62D	A5.5 E9018 -G	Low hydro- gen	DC- EP	▪ Suitable for 550 to 610MPa high tensile strength steel ▪ RC: 350~400°Cx1h	F HF H VU OH	Ex	0.06	0.61	1.28
						Gt	≤0.09	0.40~ 0.75	0.80~ 1.40
LB-65L	A5.5 E8016 -C1	Low hydro- gen	DC- EP	▪ Suitable for 610MPa high tensile strength steel ▪ RC: 350~400°Cx1h	F HF H VU OH	Ex	0.06	0.33	1.09
						Gt	≤0.10	≤0.60	≤1.20
LB-106	A5.5 E10016 -G	Low hydro- gen	AC	▪ Suitable for 690MPa high tensile strength steel ▪ RC: 350~400°Cx1h	F HF H VU OH	Ex	0.08	0.61	1.40
						Gt	≤0.09	0.40~ 0.75	1.20~ 1.70
LB-116	A5.5 E11016 -G	Low hydro- gen	AC	▪ Suitable for 780MPa high tensile strength steel ▪ RC: 350~400°Cx1h	F HF H VU OH	Ex	0.08	0.63	1.50
						Gt	≤0.09	0.40~ 0.75	1.20~ 1.70
LB-80UL	A5.5 E11016 -G	Low hydro- gen	AC	▪ Suitable for 780MPa high tensile strength steel ▪ Ultra low hydrogen type ▪ RC: 350~430°Cx1h	F HF H VU OH	Ex	0.08	0.52	1.50
						Gt	≤0.09	0.35~ 0.70	1.30~ 1.80
NB-3J	A5.5 E7016 -C2L	Low hydro- gen	AC	▪ Suitable for 3.5%Ni steel ▪ RC: 350~400°Cx1h	F HF H VU OH	Ex	0.04	0.26	0.66
						Gt	≤0.05	≤0.50	≤1.25

Note: Welding tests are as per AWS.

Ex: Example (polarity: AC, DC-EP for LB-62D), Gt: Guaranty (polarity: as specified above)

## Approvals

LB-106	ABS, NK, CR
LB-80UL	NK, CCS

## Identification color

Product names	1st	2nd	Product names	1st	2nd
LB-62D	Pink	Yellow	LB-116	Blue white	Red
LB-65L	White	Yellow	LB-80UL	Brown	Green
LB-106	Blue white	Purple	NB-3J	Yellow green	Silver gray

composition of all-weld metal (%)					Mechanical properties of all-weld metal					PWHT (°C/h)
P	S	Ni	Cr	Mo	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)		
0.011	0.005	0.57	-	0.25	Ex	570	660	29	-20°C: 170	AW
≤0.020	≤0.020	0.45~ 0.85	-	0.20~ 0.35	Gt	≥530	≥620	≥17	-20°C ≥27	AW
0.008	0.002	2.55	-	0.13	Ex	560	660	29	-60°C: 130	AW
≤0.03	≤0.03	2.00~ 2.75	-	-	Gt	≥460	≥550	≥19	-60°C ≥27	AW
0.010	0.005	1.50	0.22	0.19	Ex	660	760	25	-20°C: 110	AW
≤0.020	≤0.020	1.20~ 1.70	0.10~ 0.30	0.10~ 0.30	Gt	≥600	≥690	≥16	-20°C ≥27	AW
0.010	0.006	1.83	0.28	0.43	Ex	730	830	24	-20°C: 110	AW
≤0.020	≤0.020	1.50~ 2.10	0.20~ 0.40	0.35~ 0.55	Gt	≥670	≥760	≥15	-20°C ≥27	AW
0.009	0.006	1.90	0.28	0.43	Ex	710	820	25	-20°C: 110	AW
≤0.020	≤0.020	1.70~ 2.10	0.10~ 0.40	0.25~ 0.55	Gt	≥670	≥760	≥15	-20°C ≥27	AW
0.006	0.003	3.44	-	-	Ex	470	560	31	-85°C: 170	AW
						440	530	35	-100°C: 140	605 x1
≤0.03	≤0.03	3.00~ 3.75	-	-	Gt	≥390	≥480	≥25	-101°C ≥27	AW
						≥390	≥480	≥25	-101°C ≥27	605±15 x1

### Diameter and Length (mm)

	Dia.	2.6	3.2	4.0	5.0	Dia.	2.6	3.2	4.0	5.0
<b>LB-62D</b>	-		350	400	400	<b>LB-116</b>	300	350	400	400
<b>LB-65L</b>	-		-	400	-	<b>LB-80UL</b>	-	350	400	400
<b>LB-106</b>	-		350	400	400	<b>NB-3J</b>	-	350	400	-

# DW-55E



## Flux cored wire

**Classification:** ASME / AWS A5.20 E71T-9C-J  
EN ISO 17632-A - T 42 4 P C 1 H5

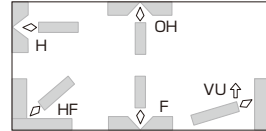
**Features:** • Excellent impact value at low temperatures down to -40°C

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.05	0.40	1.42	0.012	0.010	0.41
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	≤0.50

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	540	590	29	-40°C: 80
Guaranty	≥400	≥480	≥22	-40°C ≥27

## Recommended welding parameters

	1.2mm	1.4mm
Dia.	1.2mm	1.4mm
F	150~300A	150~400A
HF	150~300A	150~350A
H	150~280A	150~300A
VU, OH	150~250A	150~250A

## Approvals

ABS	LR	DNV	BV	NK	Others
3YSA, 3Y400SA, H5	3YS, 4Y40S, H5	III YMS(H5)	SA3, SA3YM HHH	KSW54Y40G(C)H5	CR: 3YS-HH L1YS-HH GL: 3YH5S

## Packages

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5	1.4	Spool	15
	Spool	15		Spool	20
	Spool	20			

# DW-A55E

## Flux cored wire

**Classification:** ASME / AWS A5.20 E71T-9M-J  
 EN ISO 17632-A - T 42 4 P M 1 H5

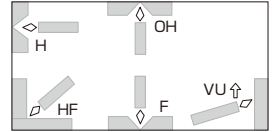
**Features:** • Excellent impact value at low temperatures down to -40°C

**Type of flux:** Rutile

**Shielding gas:** 80%Ar+20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.05	0.54	1.31	0.013	0.009	0.34
Guaranty	≤0.12	≤0.90	≤1.75	≤0.03	≤0.03	≤0.50

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	540	600	28	-40°C: 100
Guaranty	≥400	≥480	≥22	-40°C ≥27

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	LR	DNV	BV	GL
4Y400SA(H5)	4Y40S, H5	IVYMS(H5)	SA4Y40M HHH	3YH5S

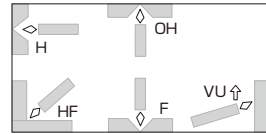
## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5
	Spool	15

## Flux cored wire

**Classification:** ASME / AWS A5.29 E71T1-GC**Features:** • Excellent impact value at low temperatures down to -60°C in the as-welded condition and down to -50°C in the PWHT condition**Type of flux:** Rutile**Shielding gas:** CO<sub>2</sub>**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.07	0.25	1.28	0.009	0.007	0.85
Guaranty	≤0.12	≤0.80	0.50~1.75	≤0.030	≤0.030	0.70~1.00

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	480	560	31	-60°C: 111	AW
	425	520	35	-60°C: 111	620×1
Guaranty	≥400	490~621	≥20	-60°C ≥27	AW

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	LR	DNV
5Y400SA, H5	5Y40S, H5	VY40MS(H5)

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5
	Spool	15
	Spool	20



# DW-A81Ni1



## Flux cored wire

**Classification:** ASME / AWS A5.29 E81T1-Ni1M-J  
EN ISO 17632-A - T 46 6 1Ni P M 2 H5

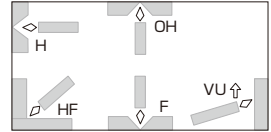
**Features:** • Excellent impact value at low temperatures down to -60°C  
• Meets the NACE MR0175 requirements for both chemistry and hardness. The nickel content is normally 1% max.

**Type of flux:** Rutile

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.05	0.32	1.26	0.006	0.006	0.95
Guaranty	≤0.12	≤0.80	≤1.50	≤0.030	≤0.030	0.80~1.10

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	520	580	29	-60°C: 142
Guaranty	≥470	550~690	≥19	-60°C ≥27

## Recommended welding parameters

Dia.	1.1~1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	LR	DNV	Others
5YQ420SA(H5) 4Y400SA(H5)	5Y42S, H5	VY42MS(H5)	CWB

## Packages

Dia. (mm)	Type	Weight (kg)
1.1	Spool	12.7
1.2	Spool	15

## Flux cored wire

**Classification:** ASME / AWS A5.29 E81T1-K2C  
EN ISO 17632-A - T 46 6 1.5Ni P C 1 H5

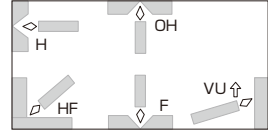
**Features:** • Excellent impact value at low temperatures  
down to -60°C

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.04	0.38	1.32	0.010	0.008	1.40
Guaranty	≤0.15	≤0.80	0.50~ 1.75	≤0.030	≤0.030	1.00~ 2.00

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	550	620	27	-60°C: 70
Guaranty	≥470	550~690	≥22	-60°C ≥27

## Recommended welding parameters

	1.2mm	1.4mm
Dia.		
F	150~300A	150~400A
HF	150~300A	150~350A
H	150~280A	150~300A
VU, OH	150~250A	150~250A

## Approvals

ABS	LR	DNV	BV	NK	Others
3YSA, 4Y400SA, MG	5Y40S, H15	VY40MS(H10), NV2-4L, 4-4L	SA5Y40M HH	KSWL3G(C), KSW54Y40G(C)	GL: 6Y40H15S KR: L 3SG(C)H10, 4Y40SG(C)H10 CCS: 5Y40SH10

## Packages

Dia. (mm)	Type	Weight (kg)	Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5	1.4	Spool	12.5
	Spool	15		Spool	15
	Spool	20			

# DW-A55L

## Flux cored wire

**Classification:** ASME / AWS A5.29 E81T1-K2M  
 EN ISO 17632-A - T 46 6 1.5Ni P M 1 H5

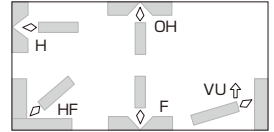
**Features:** • Excellent impact value at low temperatures down to -60°C

**Type of flux:** Rutile

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.06	0.30	1.15	0.009	0.007	1.41
Guaranty	≤0.15	≤0.80	0.50~1.75	≤0.030	≤0.030	1.00~2.00

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	560	630	27	-60°C: 94
Guaranty	≥470	550~690	≥22	-60°C ≥27

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	LR	DNV	BV
3YSA, MG	5Y46S, H5	VY46MS(H5), NV2-4, NV4-4	S5Y46 H5

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	15

## Flux cored wire

**Classification:** ASME / AWS A5.29 E81T1-K2C  
EN ISO 17632-A - T 46 6 1.5Ni P C 1 H5

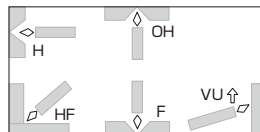
**Features:** • Excellent impact value at low temperatures down to -60°C in the as-welded and PWHT conditions

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.06	0.26	1.15	0.008	0.007	1.51
Guaranty	≤0.15	≤0.80	0.50~1.75	≤0.030	≤0.030	1.00~2.00

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	480	565	33	-60°C: 115	AW
	440	530	34	-60°C: 100	620X1
Guaranty	≥470	550~690	≥22	-60°C≥27	AW

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	LR	DNV	BV	NK
5YQ420SA(H5) 4Y400SA(H5)	5Y42S, 5Y42srS, MG, H10	VY42MS(H10), MG NV2-4L, 4-4L	SA4Y40M HH, UP	KSW5Y42G(C)H10, MG

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5
	Spool	15

# DW-A55LSR



**Flux cored wire**

**Classification:** ASME / AWS A5.29 E81T1-Ni1M  
 EN ISO 17632-A - T 46 6 Z P M 1 H5

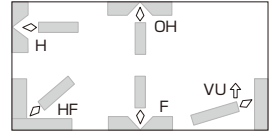
- Features:**
- Excellent impact value at low temperatures down to -60°C in the as-welded and PWHT conditions
  - Meets the NACE MR0175 requirements for both chemistry and hardness. The nickel content is normally 1% max.

**Type of flux:** Rutile

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:**



**Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni
Example	0.05	0.33	1.32	0.009	0.008	0.90
Guaranty	≤0.12	≤0.80	≤1.50	≤0.030	≤0.030	0.80~1.10

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	510	570	29	-60°C: 120	AW
	450	530	33	-60°C: 70	620x2
Guaranty	≥470	550~690	≥22	-60°C ≥27	AW

**Recommended welding parameters**

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

**Approvals**

ABS	LR	DNV
5YQ420SA(H5)	5Y42S(H5)	VY42MS(H5), NV2-4L, 4-4L

**Packages**

Dia. (mm)	Type	Weight (kg)
1.2	Spool	15

## Flux cored wire

**Classification:** ASME / AWS A5.29 E91T1-Ni2C-J  
EN ISO 17632-A - T 50 6 Z P C 2 H5

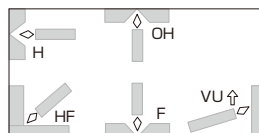
**Features:** • Excellent impact value at low temperatures down to -60°C  
• Excellent CTOD value at low temperatures down to -40°C

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub>

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.06	0.29	1.23	0.007	0.008	2.5
Guaranty	≤0.12	≤0.80	≤1.50	≤0.030	≤0.030	1.75~2.75

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	580	650	25	-60°C: 93	AW
Guaranty	≥540	620~760	≥17	-60°C≥27	AW

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	DNV
5YQ500SA H5	VY50MS(H5)

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5

# DW-A62L



## Flux cored wire

**Classification:** ASME / AWS A5.29 E91T1-GM  
EN ISO 17632-A - T 50 6 Z P M 2 H5

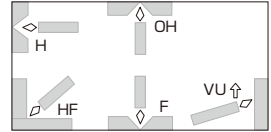
**Features:** • Excellent impact value at low temperatures down to -60°C  
• Excellent CTOD value at low temperatures down to -40°C

**Type of flux:** Rutile

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

### Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni
Example	0.07	0.32	1.33	0.007	0.011	2.1
Guaranty	≤0.12	≤0.80	≤1.50	≤0.030	≤0.030	1.75~2.75

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	560	640	27	-60°C: 82
Guaranty	≥540	620~760	≥17	-60°C ≥27

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Approvals

ABS	DNV
5YQ500 H5	VY50MS(H5)

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5

## Flux cored wire

**Classification:** ASME / AWS A5.29 E91T1-K2M-J  
EN ISO 18276-A-T55 4 Z P M 2 H5

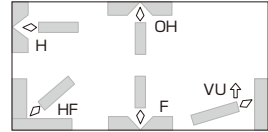
**Features:** • Excellent impact value at low temperatures down to -40°C

**Type of flux:** Rutile

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo
Example	0.05	0.32	1.18	0.009	0.008	1.78	0.11
Guaranty	≤0.15	≤0.80	0.50~1.75	≤0.030	≤0.030	1.00~2.00	≤0.35

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	600	660	25	-40°C: 80
Guaranty	≥540	620~760	≥17	-40°C ≥27

## Recommended welding parameters

Dia.	1.2mm
F, HF	150~300A
H	150~280A
VU, OH	150~250A

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	15



# MX-A55Ni1

**Flux cored wire**

**Classification:** ASME / AWS A5.28 E80C-G  
 EN ISO 17632-A - T46 6 Mn1Ni M M 3 H5

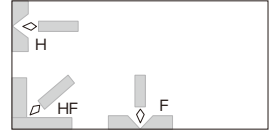
**Features:** • Excellent impact value at low temperatures down to -60°C

**Type of flux:** Metal

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:**



**Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni
Example	0.05	0.34	1.67	0.007	0.008	0.86
Guaranty	≤0.15	≤0.80	1.40~2.00	≤0.030	≤0.030	0.70~1.00

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	540	610	29	-60°C: 120
Guaranty	≥470	550~680	≥20	-60°C ≥47

**Recommended welding parameters**

Dia.	1.2mm
F, HF	150~300A
H	150~300A

**Packages**

Dia. (mm)	Type	Weight (kg)
1.2	Spool	15

## Flux cored wire

**Classification:** ASME / AWS A5.28 E110C-G H4

EN ISO 18276 T69 6 Mn2.5Ni M M 3 H5

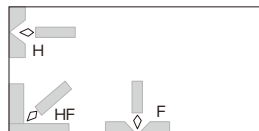
**Features:** • Excellent impact value at low temperatures down to -60°C

**Type of flux:** Metal

**Shielding gas:** 80%Ar-20%CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo
Example	0.06	0.48	1.87	0.008	0.010	2.37	0.09
Guaranty	0.03~0.10	≤0.90	1.1~2.0	≤0.020	≤0.020	2.1~3.0	≤0.1

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	720	800	24	-60°C: 120
Guaranty	≥690	770~940	≥17	-60°C≥47

## Recommended welding parameters

Dia.	1.1~1.2mm
F, HF	150~300A
H	150~300A

## Approvals

ABS	DNV	LR	GL
5YQ690SA(H5)	VY69MS(H5)	5Y69S, H5	6Y69H5S

## Packages

Dia. (mm)	Type	Weight (kg)
1.1	Spool	12.7
1.2	Spool	12.5



## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical C	
DW-A55ESR	A5.20 E71T -12M-J	Rutile	80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>▪ Suitable for butt and fillet welding in all positions</li> <li>▪ Excellent impact value at low temperatures down to -46°C in the as-welded and PWHT conditions</li> </ul>	F HF H VU OH	Ex	0.05
							Gt	≤0.12
MX-55LF	A5.20 E70T -9C-J	Metal	CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>▪ Suitable for flat and horizontal fillet welding</li> <li>▪ Excellent porosity resistibility to inorganic zinc primer</li> <li>▪ Excellent impact value at low temperatures down to -60°C</li> </ul>	F HF	Ex	0.05
							Gt	≤0.12
MX-A55T	A5.28 E80C -G	Metal	80%Ar- 20%CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>▪ Suitable for butt and fillet welding in all positions with a short circuit arc</li> <li>▪ Excellent impact value at low temperatures down to -60°C</li> </ul>	F HF H VU OH	Ex	0.05
							Gt	≤0.15

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

DW-A55ESR	ABS, CWB
MX-55LF	ABS, LR, DNV, BV, NK
MX-A55T	LR, DNV, BV

composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Si	Mn	P	S	Ni		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
0.50	1.40	0.013	0.007	0.40	Ex	500	580	30	-46°C: 100	AW
						470	560	31	-46°C: 60	620x3
≤0.90	≤1.60	≤0.03	≤0.03	≤0.50	Gt	≥400	480~ 620	≥22	-46°C ≥27	AW
0.44	1.42	0.012	0.007	0.34	Ex	540	590	29	-60°C: 58	-
≤0.80	≤1.75	≤0.03	≤0.03	≤0.50	Gt	≥400	≥490	≥22	-60°C ≥27	-
0.34	1.40	0.013	0.018	1.42	Ex	540	600	29	-60°C: 90	-
≤0.80	0.50~ 1.75	≤0.03	≤0.03	1.00~ 2.00	Gt	≥470	550~ 690	≥19	-60°C ≥27	-

## Diameter (mm)

<b>DW-A55ESR</b>	1.1, 1.2, 1.6
<b>MX-55LF</b>	1.2, 1.4, 1.6
<b>MX-A55T</b>	1.2, 1.4

## Solid Wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical			
						C	Si	Mn	
MG-60	A5.28 ER80S -G	CO <sub>2</sub>	DC- EP	▪ Suitable for flat, horizontal and horizontal fillet welding	F HF H	Ex	0.04	0.85	1.95
						Gt	≤0.12	0.60~ 1.00	1.65~ 2.15
MG-S63B	A5.28 ER90S -G	Ar- 5~25% CO <sub>2</sub>	DC- EP	▪ Suitable for 550 to 610MPa high tensile strength steel	F HF H VU OH	Ex	0.09	0.69	1.36
						Gt	≤0.12	0.40~ 0.90	1.00~ 1.50
MG-70	A5.28 ER100S -G	CO <sub>2</sub>	DC- EP	▪ Suitable for 690MPa high tensile strength steel	F HF H	Ex	0.08	0.78	2.00
						Gt	≤0.12	0.50~ 1.00	1.70~ 2.30
MG-S70	A5.28 ER100S -G	Ar- 5~25% CO <sub>2</sub>	DC- EP	▪ Suitable for 690MPa high tensile strength steel	F HF H VU OH	Ex	0.08	0.47	1.41
						Gt	≤0.11	0.30~ 0.80	0.90~ 1.60

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

## Approvals

MG-60 DNV, NK

composition of wire (%)						Mechanical properties of all-weld metal					
P	S	Ni	Cr	Mo	Cu		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°CX h) & SG
0.007	0.010	Al: 0.01	Ti+Zr: 0.20	0.32	0.23	Ex	590	670	28	-18°C: 90	AW
							570	660	29	-18°C: 80	620x5
≤0.025	≤0.025	Al: ≤0.10	Ti+Zr: ≤0.30	0.20~ 0.50	≤0.50	Gt	≥470	≥550	≥19	-5°C ≥47	AW
0.004	0.007	0.05	0.45	0.28	0.21	Ex	580	660	29	-18°C: 150	AW 80%Ar- 20%CO <sub>2</sub>
≤0.025	≤0.025	≤0.20	0.20~ 0.60	0.20~ 0.50	≤0.50	Gt	≥490	≥620	≥19	-5°C ≥47	AW 80%Ar- 20%CO <sub>2</sub>
0.008	0.007	1.05	0.03	0.64	0.23	Ex	610	720	26	-18°C: 90	AW
≤0.030	≤0.030	0.70~ 1.50	≤0.30	0.40~ 0.90	≤0.35	Gt	≥550	≥690	≥16	-18°C ≥27	AW
0.006	0.008	2.02	0.17	0.39	0.21	Ex	650	720	25	-40°C: 100	AW 80%Ar- 20%CO <sub>2</sub>
≤0.030	≤0.030	1.50~ 2.50	≤0.30	0.20~ 0.60	≤0.50	Gt	≥550	≥690	≥16	-40°C ≥27	AW 80%Ar- 20%CO <sub>2</sub>

### Diameter (mm)

<b>MG-60</b>	0.9, 1.2, 1.4, 1.6	<b>MG-70</b>	1.2, 1.6
<b>MG-S63B</b>	1.2, 1.6	<b>MG-S70</b>	1.2

## Solid wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical			
						C	Si	Mn	
MG-80	A5.28 ER110S -G	CO <sub>2</sub>	DC- EP	▪ Suitable for 780MPa high tensile strength steel	F HF H	Ex	0.08	0.67	1.88
						Gt	≤0.12	0.40~ 0.90	1.60~ 2.20
MG-S80	A5.28 ER110S -G	Ar- 5~25% CO <sub>2</sub>	DC- EP	▪ Suitable for 780MPa high tensile strength steel	F HF H VU OH	Ex	0.08	0.46	1.37
						Gt	≤0.12	0.30~ 0.60	1.10~ 1.60
MG-S88A	A5.28 ER120S -G	80%Ar- 20% CO <sub>2</sub>	DC- EP	▪ Suitable for 780MPa high tensile strength steel for low temperature service	F HF H VU OH	Ex	0.06	0.50	1.59
						Gt	≤0.09	0.30~ 0.70	1.30~ 1.70

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

## Approvals

MG-S80 ABS, DNV, NK, GL

MG-S88A ABS, DNV



composition of wire (%)						Mechanical properties of all-weld metal					
P	S	Ni	Cr	Mo	Cu		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT & SG
0.008	0.009	2.16	-	0.65	0.23	Ex	680	800	22	-18°C: 85	AW
≤0.030	≤0.030	1.80~ 2.60	-	0.40~ 0.90	≤0.35	Gt	≥590	≥760	≥15	-18°C ≥27	AW
0.007	0.002	2.64	0.19	0.50	0.22	Ex	770	850	20	-40°C: 80	AW 80%Ar- 20%CO <sub>2</sub>
≤0.030	≤0.030	2.40~ 3.00	0.10~ 0.40	0.30~ 0.70	≤0.35	Gt	≥665	≥760	≥15	-40°C ≥27	AW 80%Ar- 20%CO <sub>2</sub>
0.005	0.005	3.56	-	0.78	0.18	Ex	770	880	22	-80°C: 78	AW 80%Ar- 20%CO <sub>2</sub>
≤0.020	≤0.020	3.20~ 3.80	-	0.60~ 0.90	≤0.50	Gt	≥690	≥830	≥15	-60°C ≥27	AW 80%Ar- 20%CO <sub>2</sub>

## Diameter (mm)

<b>MG-80</b>	1.2, 1.6
<b>MG-S80</b>	1.2, 1.6
<b>MG-S88A</b>	1.2

## Solid wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical			
						C	Si	Mn	
MG-S50LT	A5.18 ER70S -G	80%Ar- 20% CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for 400 to 490 high tensile strength steel for low temperature service</li> <li>Ti-B type weld metal</li> </ul>	F HF H VU OH	Ex	0.09	0.39	1.91
						Gt	0.03~ 0.10	0.30~ 0.50	1.50~ 2.10
MG-S1N	A5.28 ER70S -G	Ar- 5~20% CO <sub>2</sub>	DC- EP	Suitable for low temperature steel	F HF H VU OH	Ex	0.04	0.43	1.30
						Gt	≤0.07	0.20~ 0.60	1.00~ 1.60
MG-S3N	A5.28 ER70S -G	Ar- 5~20% CO <sub>2</sub>	DC- EP	Suitable for 3.5% Ni steel	F HF H VU OH	Ex	0.03	0.26	1.18
						Gt	≤0.07	≤0.50	1.00~ 1.50

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

## Approvals

MG-S50LT ABS, LR, DNV, NK

composition of wire (%)					Mechanical properties of all-weld metal					
P	S	Ni	Others	Cu		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h) & SG
0.006	0.003	0.03	Ti: 0.08 B: 0.006	0.22	Ex	470	540	33	-60°C: 110	AW
						440	510	35	-60°C: 88	620x1
≤0.015	≤0.015	≤0.50	Ti: 0.04~ 0.12 B: 0.003~ 0.010	≤0.40	Gt	≥400	≥480	≥22	-60°C ≥27	AW
						≥400	≥480	≥22	-60°C ≥27	620±15x1
0.005	0.006	1.76	Mo: 0.21	0.21	Ex	410	520	32	-60°C: 140	620x1 80%Ar- 20%CO <sub>2</sub>
≤0.020	≤0.020	1.50~ 2.00	Mo ≤0.40	≤0.50	Gt	≥360	≥480	≥22	-60°C ≥27	620±15x1 80%Ar- 20%CO <sub>2</sub>
0.007	0.003	4.14	Mo: 0.22	0.22	Ex	470	570	32	-101°C: 130	620x1 95%Ar- 5%CO <sub>2</sub>
≤0.020	≤0.020	3.80~ 4.50	Mo ≤0.40	≤0.50	Gt	≥360	≥480	≥16	-105°C ≥27	620±15x1 95%Ar- 5%CO <sub>2</sub>

## Diameter (mm)

MG-S50LT	1.2, 1.6
MG-S1N	1.2, 1.6
MG-S3N	1.2, 1.6

## TIG Welding Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical				
					C	Si	Mn	P	
TG-S62	A5.28 ER80S -G	Ar	DC-EN	▪ Suitable for 550 to 590MPa high tensile strength steel	Ex	0.08	0.74	1.38	0.007
					Gt	≤0.10	0.30~0.85	1.15~1.65	≤0.020
TG-S60A	A5.28 ER80S -G	Ar	DC-EN	▪ Suitable for 550 to 610MPa high tensile strength steel	Ex	0.08	0.04	1.28	0.006
					Gt	≤0.12	≤0.20	1.00~1.60	≤0.025
TG-S80AM	A5.28 ER110S -G	Ar	DC-EN	▪ Suitable for 780MPa high tensile strength steel	Ex	0.09	0.11	1.24	0.006
					Gt	≤0.12	≤0.20	0.90~1.40	≤0.025

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Identification color

Product names	
TG-S62	White
TG-S60A	Orange
TG-S80AM	-

composition of rod and wire (%)					Mechanical properties of all-weld metal					
S	Ni	Mo	Others	Cu		YP (MPa)	TS (MPa)	EL (%)	IV (J)	PWHT (°C×h)
0.009	0.02	0.51	-	0.12	Ex	540	660	28	-20°C: 180	AW
						530	640	26	-20°C: 98	620 x1
≦0.020	≦0.60	0.25~ 0.65	-	≦0.50	Gt	≧420	≧550	≧18	-20°C ≧27	AW
						≧420	≧550	≧18	-20°C ≧27	620±15 x1
0.010	0.88	0.61	-	0.12	Ex	590	670	28	-60°C: 270	AW
						590	660	30	-60°C: 280	600 x1
≦0.025	0.60~ 1.20	0.30~ 0.65	-	≦0.50	Gt	≧420	≧550	≧18	-60°C ≧27	AW
						≧420	≧550	≧18	-60°C ≧27	600±15 x1
0.008	2.89	0.69	Cr: 0.36	0.21	Ex	760	880	23	-60°C: 240	AW
≦0.025	2.60~ 3.20	0.40~ 0.90	Cr: 0.10~ 0.60	≦0.50	Gt	≧665	≧760	≧15	-60°C ≧27	AW

## Diameter (mm)

<b>TG-S62</b>	1.2, 1.6, 2.0, 2.4
<b>TG-S60A</b>	1.2, 1.6, 2.0, 2.4
<b>TG-S80AM</b>	1.2, 1.6, 2.0, 2.4

## TIG Welding Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical				
					C	Si	Mn	P	
TG-S1N	A5.28 ER70S -G	Ar	DC- EN	▪ Suitable for low temperature steel	Ex	0.05	0.31	1.07	0.005
					Gt	≤0.09	≤0.60	0.70~ 1.30	≤0.025
TG-S3N	A5.28 ER70S -G	Ar	DC- EN	▪ Suitable for 3.5% Ni steel	Ex	0.04	0.36	0.89	0.004
					Gt	≤0.06	≤0.60	0.60~ 1.10	≤0.020

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

TG-S1N ABS, LR, DNV, BV, NK, GL

### Identification color

Product names

TG-S1N	Black
TG-S3N	Yellowish green

composition of rod and wire (%)					Mechanical properties of all-weld metal				
S	Ni	Mo	Cu		YP (MPa)	TS (MPa)	EL (%)	IV (J)	PWHT (°C/h)
0.007	0.82	0.15	0.12	Ex	460	540	33	-60°C: 200	AW
					390	450	35	-60°C: 250	620 x1
≤0.025	0.60~ 1.00	≤0.30	≤0.40	Gt	≥360	≥480	≥24	-60°C ≥27	AW
					-	-	-	-60°C ≥27	620±15 x1
0.007	3.48	0.15	0.11	Ex	510	580	30	-101°C: 69	AW
					490	570	31	-101°C: 78	620 x1
≤0.020	3.20~ 3.90	≤0.30	≤0.50	Gt	≥360	≥480	≥24	-105°C ≥27	AW
					≥360	≥480	≥24	-105°C ≥27	620±15 x1

## Diameter (mm)

**TG-S1N** 1.6, 2.0, 2.4

**TG-S3N** 1.6, 2.0, 2.4

# FAMILIARC™ MF-38/ TRUSTARC™ US-49

## Flux and wire combination

**Classification:** ASME / AWS A5.23 F8A4-EG-A4  
F8P6-EG-A4

**Features:** • Suitable for butt and fillet welding  
• Applicable for 0.5%Mo steel

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

## Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.09	0.03	1.58	0.014	0.013	0.52	0.10
Guaranty	0.07~ 0.12	≤0.05	1.25~ 1.80	≤0.025	≤0.025	0.45~ 0.60	≤0.35

## Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.10	0.37	1.35	0.014	0.014	0.53	0.09
Guaranty	≤0.15	≤0.80	≤1.60	≤0.030	≤0.030	0.40~ 0.65	≤0.35

## Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	520	640	28	-40°C: 37	AW
Guaranty	510	600	29	-51°C: 40	600x3
	≥470	550~690	≥20	-40°C≥27	AW
	≥470	550~690	≥20	-51°C≥27	620±15x1

## Polarity

Example	AC
Guaranty	AC

## Approvals (Single)

ABS	LR	DNV	BV	NK	CCS
3YTM	3T, 3YM, 3YT	III YTM	A3YTM	KAW3Y46TM H10	3YTM



## Packages

### Wire

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	20
2.4	Coil	25
	Spool	10
3.2	Coil	25, 76
4.0	Coil	25, 75
4.8	Coil	25, 75
6.4	Coil	25

### Flux

<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
12x65	Can	25
20x200	Can	25
20xD	Can	25

# FAMILIARC™ MF-38/ TRUSTARC™ US-A4

## Flux and wire combination

**Classification:** ASME / AWS A5.23 F8A4-EA4-A4  
F8P6-EA4-A4

**Features:** • Suitable for butt and fillet welding  
• Applicable for 0.5%Mo steel

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

## Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.09	0.04	1.59	0.010	0.014	0.52	0.10
Guaranty	0.05~ 0.15	≤0.20	1.20~ 1.70	≤0.025	≤0.025	0.45~ 0.65	≤0.35

## Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.10	0.39	1.35	0.013	0.013	0.52	0.11
Guaranty	≤0.15	≤0.80	≤1.60	≤0.030	≤0.030	0.40~ 0.65	≤0.35

## Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	520	640	28	-40°C: 37	AW
	510	600	29	-51°C: 40	620x1
Guaranty	≥470	550~690	≥20	-40°C≥27	AW
	≥470	550~690	≥20	-51°C≥27	620±15x1

## Polarity

Example	AC
Guaranty	AC

## Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	12x65	Can	25
4.0	Coil	25	20x200	Can	25
4.8	Coil	25	20xD	Can	25

# FAMILIARC™ MF-38 / TRUSTARC™ US-40

## Flux and wire combination

**Classification:** ASME / AWS A5.23 F9A6-EA3-A3  
F8P6-EA3-A3

**Features:** • Suitable for butt and fillet welding  
• Applicable for 0.5%Mo steel

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

## Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.13	0.04	1.80	0.008	0.010	0.52	0.12
Guaranty	0.05~ 0.17	≤0.20	1.65~ 2.20	≤0.025	≤0.025	0.45~ 0.65	≤0.35

## Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.08	0.34	1.58	0.017	0.009	0.45	0.12
Guaranty	≤0.15	≤0.80	≤2.10	≤0.030	≤0.030	0.40~0.65	≤0.35

## Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	PWHT (°Cxh)
Example	580	670	28	-51°C: 51	AW
	560	630	29	-51°C: 58	620x1
Guaranty	≥540 ≥470	620~760 550~690	≥17 ≥20	-51°C ≥27 -51°C ≥27	AW 620±15x1

## Polarity

Example	AC
Guaranty	AC

## Approvals

	<b>ABS</b>	<b>NK</b>
Single	MG	KAW3Y50MH10

## Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
2.4	Coil	25	12x65	Can	25
3.2	Coil	25	20x200	Can	25
4.0	Coil	25, 75	20xD	Can	25
4.8	Coil	25, 75			

## Flux and wire combination

**Classification:** ASME / AWS A5.23 F12A10-EG-G

**Features:** • Suitable for butt and flat fillet welding of heavy duty structures  
• Excellent impact value at low temperatures down to -80°C

**Type of flux:** Bonded

**Redrying conditions of flux:** 250~350°Cx1h

## Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo	Cu
Example	0.12	0.15	2.03	0.007	0.002	2.75	0.77	0.10
Guaranty	≤0.15	≤0.25	1.75~ 2.25	≤0.015	≤0.015	2.40~ 2.90	0.60~ 0.90	≤0.40

## Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Mo	Cu
Example	0.08	0.28	1.65	0.009	0.004	2.45	0.74	0.12
Guaranty	≤0.12	≤0.80	1.20~ 2.20	≤0.030	≤0.030	2.10~ 2.90	0.50~ 1.00	≤0.35

## Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT
Example	760	840	22	-73°C: 90	AW
Guaranty	≥750	830~970	≥14	-73°C≥27	AW

## Polarity

Example	AC
Guaranty	AC

## Approvals

	DNV	NK
Single	V Y69M	KAW5Y69MH5

## Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	10x48	Can	20
4.0	Coil	25			
4.8	Coil	25			

**Flux and wire combination****Classification:** ASME / AWS A5.23 F11A10-EG-G**Features:** • Suitable for butt and flat fillet welding of heavy duty structures  
• Excellent impact value at low temperatures down to -80°C**Type of flux:** Bonded**Redrying conditions of flux:** 250~350°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo	Cu
Example	0.12	0.15	2.03	0.007	0.002	2.75	0.77	0.10
Guaranty	≤0.15	≤0.25	1.75~ 2.25	≤0.015	≤0.015	2.40~ 2.90	0.60~ 0.90	≤0.40

**Chemical composition of weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Mo	Cu
Example	0.06	0.51	1.64	0.011	0.002	2.42	0.73	0.11
Guaranty	≤0.12	≤0.80	1.20~ 2.20	≤0.030	≤0.030	2.10~ 2.90	0.50~ 1.00	≤0.35

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	PWHT
Example	740	860	23	-73°C: 83	AW
Guaranty	≥680	760~900	≥15	-73°C ≥27	AW

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Approvals**

	DNV	ABS
Single	IVY69M(H5)	4YQ690

**Packages**

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	10x48	Can	20
4.0	Coil	25			
4.8	Coil	25			

## Flux and wire combination

**Classification:** ASME / AWS A5.17 F7A8-EH14, F7P8-EH14

**Features:**

- Suitable for butt welding of structures for low temperature service
- AC current is only applicable
- Excellent impact value at low temperatures down to -60°C and CTOD at temperatures down to -50°C

**Type of flux:** Bonded

**Redrying conditions of flux:** 200~300°Cx1h

## Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Cu
Example	0.12	0.03	1.95	0.013	0.008	0.08
Guaranty	0.10~0.18	≤0.05	1.70~2.20	≤0.030	≤0.030	≤0.30

## Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Ti	B
Example	0.08	0.19	1.42	0.013	0.005	0.02	0.004

## Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	490	555	34	-62°C: 180	AW
	460	540	34	-62°C: 160	620x1
Guaranty	≥400	480~660	≥22	-62°C≥27	AW
	≥400	480~660	≥22	-62°C≥27	620±15x1

## Polarity

Example	AC
Guaranty	AC

## Approvals

	ABS	LR	DNV	BV	NK
Single	3M, 3YM, MG	5Y40M, H5	VYM, NV2-4, NV4-4	A4YM, UP	KAWL3M
Tandem	4YM, MG	-	VYM	-	KAWL3M

## Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25, 76	10x48	Can	20
4.0	Coil	25, 75, 150			
4.8	Coil	25, 75, 150			

**Flux and wire combination****Classification:** ASME / AWS A5.17 F7A8-EH14, F7P8-EH14

- Features:**
- Suitable for butt welding of structures for low temperature service
  - DC-EP current is only applicable
  - Excellent impact value at low temperatures down to -60°C and CTOD at temperatures down to -20°C

**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Cu
Example	0.13	0.01	2.00	0.012	0.007	0.08
Guaranty	0.10~0.18	≤0.05	1.70~2.20	≤0.030	≤0.030	≤0.30

**Chemical composition of weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ti	B
Example	0.07	0.23	1.42	0.009	0.004	0.02	0.004

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	485	555	33	-62°C: 170	AW
	430	530	31	-62°C: 180	620x1
Guaranty	≥400	480~660	≥22	-62°C≥27	AW
	≥400	480~660	≥22	-62°C≥27	620±15x1

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Approvals**

	ABS	LR	DNV
Single	5Y400 H5	5Y40M, H5	VY40M, NV2-4L, NV4-4L
Tandem	5Y400 H5	5Y40M, H5	VY40M(H5), NV2-4L, NV4-4L

**Packages**

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25, 76	10x48	Can	20
4.0	Coil	25, 75			
4.8	Coil	25, 75			

## SAW Flux and Wire Combinations

Trade Designation	ASME AWS Class.	Type of flux	Pol.	Features	Chemical		
					C	Si	
[F]MF-38/ [T]US-49A	A5.17 F7A6 -EH14	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for multi-layer butt welding of structures for low temperature service</li> <li>▪ Excellent impact value at temperatures down to -40°C</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Wire-Ex	0.12	0.02
					Wire-Gt	0.10~ 0.18	≤0.10
					Weld-Ex	0.09	0.40
[T]PF-H80AK/ [T]US-80BN	A5.23 F11A4 -EG-G	Bonded	AC	<ul style="list-style-type: none"> <li>▪ Suitable for butt and flat fillet welding of heavy structures</li> <li>▪ Bead appearance and slag removal are excellent</li> <li>▪ RC: 250~350°Cx1h</li> </ul>	Wire-Ex	0.10	0.13
					Wire-Gt	≤0.13	≤0.30
					Weld-Ex	0.07	0.30
					Weld-Gt	≤0.12	≤0.80
[T]PF-H203/ [T]US-203E	A5.23 F7P15 -ENi3 -Ni3	Bonded	AC	<ul style="list-style-type: none"> <li>▪ Suitable for multi-layer butt welding of 3.5% Ni steel</li> <li>▪ Excellent impact value at temperatures down to -100°C after PWHT</li> <li>▪ RC: 200~300°Cx1h</li> </ul>	Wire-Ex	0.06	0.18
					Wire-Gt	≤0.13	0.05~ 0.30
					Weld-Ex	0.04	0.21
					Weld-Gt	≤0.12	≤0.80

Note: Welding tests as per AWS, Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)



composition (%)					Mechanical properties of weld metal					
Mn	P	S	Mo	Cr or Ni	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)	
1.99	0.005	0.002	0.27	-	Ex	540	620	28	-51°C: 50	AW
1.70~2.20	≦0.025	≦0.025	0.20~0.35	-		490	590	30	-51°C: 60	620x1
1.63	0.019	0.013	0.21	-	Gt	≧400	480~660	≧22	-51°C ≧27	AW
						≧400	480~660	≧22	-51°C ≧27	620±15 x1
2.59	0.013	0.002	0.88	Cr: 0.78	Ex	720	820	24	-40°C: 80	AW
2.10~2.80	≦0.020	≦0.020	0.70~1.05	Cr: 0.70~0.90						
2.01	0.007	0.004	0.85	Cr: 0.79	Gt	≧680	760~900	≧15	-40°C ≧27	AW
1.50~2.50	≦0.020	≦0.020	0.60~1.20	Cr: 0.50~1.00						
0.98	0.007	0.005	-	Ni: 3.48	Ex	440	530	34	-101°C: 130	610x1
0.60~1.20	≦0.020	≦0.020	-	Ni: 3.10~3.80						
0.73	0.008	0.004	-	Ni: 3.35	Gt	≧400	480~660	≧22	-101°C ≧27	620±15 x1
≦1.60	≦0.030	≦0.025	-	Ni: 2.80~3.80						

Weld-Ex: Example of weld metal, Weld-Gt: Guaranty of weld metal

#### Diameter of wire (mm)

<b>US-49A</b>	2.4, 3.2, 4.0, 4.8
<b>US-80BN</b>	3.2, 4.0, 4.8
<b>US-203E</b>	4.0

#### Mesh size of flux

<b>MF-38</b>	12x65, 20x200, 20xD
<b>PF-H80AK</b>	10x48
<b>PF-H203</b>	10x48



**For Heat-Resistant Steel**

## **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Gas Metal Arc Welding (GMAW)**

**Gas Tungsten Arc Welding (GTAW)**

**Submerged Arc Welding (SAW)**

## For Heat-Resistant Steel

### A guide for selecting welding consumables

Steel type	ASTM / ASME steel grade		SMAW
	Plate	Pipe / Tube	
Mn-Mo Mn-Mo-Ni	A302Gr.B, C, D A533Type A, B, C, D	-	<b>BL-96</b>
0.5Mo	A204Gr.A, B, C	A209Gr.T1 A335Gr.P1	<b>CM-A76</b>
0.5Cr-0.5Mo	A387Gr.2 Cl.1, Cl.2	A213Gr.T2 A335Gr.P2	<b>CM-B83</b>
1Cr-0.5Mo 1.25Cr-0.5Mo	A387Gr.12 Cl.1, Cl.2 A387Gr.11 Cl.1, Cl.2	A213Gr.T11,T12 A335Gr.P11,T12	<b>CM-A96</b> <b>CM-A96MB (AC)</b> <b>CM-A96MBD (DC-EP)</b> <b>CM-B98</b>
2.25Cr-1Mo	A387Gr.22 Cl.1, Cl.2	A213Gr.T22 A335Gr.P22	<b>CM-A106</b> <b>CM-A106N (AC)</b> <b>CM-A106ND (DC-EP)</b> <b>CM-B108</b>
2.25Cr-1Mo-V	A542Type D Cl.4a A832Gr.22V	-	<b>CM-A106H (AC)</b> <b>CM-A106HD (DC-EP)</b>
Low C 2.25Cr-W-V-Nb	-	SA213Gr.T23 SA335Gr.P23	<b>CM-2CW</b>
5Cr-0.5Mo	A387Gr.5 Cl.1, Cl.2	A213Gr.T5 A335Gr.P5	<b>CM-5</b>
9Cr-1Mo	A387Gr.9 Cl.1, Cl.2	A213Gr.T9 A335Gr.P9	<b>CM-9</b>
9Cr-1Mo-V-Nb	A387Gr.91 Cl.2	A213Gr.T91 A335Gr.P91	<b>CM-9Cb</b> <b>CM-95B9</b> <b>CM-96B9</b>
9Cr-W-V-Nb 12Cr-W-V-Nb	-	A213Gr.T92 A335Gr.P92 SA213Gr.T122 SA335Gr.P122	<b>CR-12S</b>

	<b>GMAW</b>	<b>GTAW</b>	<b>SAW</b>
	<b>MG-S56</b>	<b>TG-S56</b>	<b>PF-200/US-56B</b>
	<b>MG-SM</b>	<b>TG-SM</b>	<b>MF-38/US-40</b> <b>MF-38/US-49</b> <b>MF-38/US-A4</b>
	<b>MG-CM</b>	<b>TG-SCM</b>	-
	<b>MG-S1CM</b>	<b>TG-S1CM</b> <b>TG-S1CML</b> <b>TG-S80B2</b>	<b>PF-200/US-511N (AC)</b> <b>PF-200D/US-511ND (DC-EP)</b>
	<b>MG-S2CM</b> <b>MG-S2CMS</b>	<b>TG-S2CM</b> <b>TG-S2CML</b> <b>TG-S90B3</b>	<b>PF-200/US-521S (AC)</b> <b>PF-200D/US-521S (DC-EP)</b>
	-	<b>TG-S2CMH</b>	<b>PF-500/US-521H (AC)</b> <b>PF-500D/US-521HD (DC-EP)</b>
	<b>MG-S2CW</b>	<b>TG-S2CW</b>	<b>PF-H80AK/US-2CW</b>
	<b>MG-S5CM</b>	<b>TG-S5CM</b>	<b>PF-200S/US-502</b>
	<b>MG-S9CM</b>	<b>TG-S9CM</b>	-
	<b>MG-S9Cb</b>	<b>TG-S9Cb</b> <b>TG-S90B9</b>	<b>PF-200S/US-9Cb (AC)</b> <b>PF-90B9/US-90B9 (DC-EP)</b>
	<b>MG-S12CRS</b>	<b>TG-S12CRS</b>	<b>PF-200S/US-12CRS (AC)</b> <b>PF-200S/US-12CRSD (DC-EP)</b>

## For Heat-Resistant Steel

### Tips for better welding results for individual welding processes

#### SMAW

- (1) Remove scale, rust, oil, grease, water, and other dirt from welding grooves beforehand to prevent defects such as porosity and cracking in the weld metal.
- (2) Use welding currents in the recommended range because the use of excessively high currents can cause imperfections such as poor X-ray soundness, much undercuts, much spatter, and hot cracking.
- (3) With low-hydrogen type electrodes, keep the arc length as short as possible to prevent porosity caused by nitrogen in the atmosphere. Limit the weaving width within two and a half times the diameter of the electrode. When striking an arc in the welding groove directly, use the backstep technique or strike an arc on a scrap plate before welding the groove to prevent blowholes in the arc starting bead.
- (4) Use preheating and interpass temperatures in the recommended range as shown in Table 1 in order to prevent the occurrence of cold cracks.
- (5) Use proper postweld heat treatment (PWHT) temperatures to ensure good mechanical properties of the weld. The use of an excessively high temperature can damage the weld causing inadequate tensile strength and impact value of the weld. In contrast, the use of an excessively low temperature can cause poor ductility and impact toughness of the weld in addition to inadequate stress relieving. The recommended ranges of PWHT temperatures are shown in Table 1. Hold weldments at PWHT temperatures for appropriate time according to the thickness of the base metal to ensure the quality of the weld.
- (6) Control heat input in predetermined ranges because heat input can markedly affect the crack resistibility and mechanical properties of the weld.

Table 1 Recommended temperatures for preheating and interpass control and PWHT

Type of steel	Preheating and interpass temperature (°C)	PWHT temperature (°C)
Mn-Mo-Ni steel	150-250	590-650
0.5Mo and 0.5Cr-0.5Mo steel	100-250	620-680
1Cr-0.5Mo and 1.25Cr-0.5Mo steel	150-300	650-700
2.25Cr-1Mo steel	200-350	680-730
5Cr-0.5Mo and 9Cr-1Mo steel	250-350	710-780
9Cr-1Mo-Nb-V steel	250-350	710-760* <sup>1</sup> 710-800* <sup>2</sup>

\*1: For CM-9Cb, MG-9Cb, TS-S9Cb, and PF-200S/US-9Cb

\*2: For CM-95B9, CM-96B9, TG-S90B9, and PF-90B9/US-90B9

## GMAW

- (1) Use DC-EP polarity.
- (2) Use and appropriate shielded gas flow rate as shown in Table 2 for recommendation.
- (3) In spray arc welding with a shielding gas of Ar/O<sub>2</sub> or Ar/5-20%CO<sub>2</sub> admixture, short circuiting noise may occur when the arc voltage is excessively low. In such a case, keep the arc length about 4-5 mm in order to prevent blowholes in the weld metal.
- (4) Refer to (1), (4), (5), (6) of the tips for SMAW.

Table 2 Recommended shielding gas flow rate

Flow rate (liter/min)	Nozzle standoff (mm)	Max wind velocity (m/sec)
20-25	20	2

## GTAW

- (1) Use DC-EN polarity.
- (2) Use an appropriate shield gas flow rates as shown in Table 3.
- (3) Use back-shielding to ensure good reverse bead appearance and prevent the occurrence of porosity in the weld metal for low-alloy steels containing Cr over 1.25%.
- (4) Refer to (1), (4), (5), (6) of the tips for SMAW.

Table 3 Recommended shielding gas flow rate

Flow rate (liter/min)	Max. wind velocity (m/sec)
10-15	1

## SAW

- (1) Control flux supply at an appropriate flux-burden height. The flux-burden height can affect the appearance of beads and X-ray soundness. The most appropriate height varies depending on flux mesh size, shape of welding groove and other welding conditions; however, single electrode welding commonly use 25-35 mm while tandem welding generally use 30-45 mm.
- (2) Use lower currents and slower speeds for root pass welding of thick plates to prevent cracking.
- (3) Refer to (1), (4), (5), (6) of the tips for SMAW.

## For Heat-Resistant Steel

### How to select the proper welding consumable for joining dissimilar metals

The structural components of high temperature service equipment such as power generation boiler use several types of steels; therefore, joining dissimilar steels is unavoidable at the interface of different service condition areas. When joining carbon steels and Cr-Mo steels, or when joining dissimilar Cr-Mo steels, a filler metal with a composition similar to the lower-alloy steel or with an intermediate composition is commonly used for butt joints.


For instance, carbon steel can readily be joined to 2.25Cr-1Mo steel by using either a carbon steel or a 1.25Cr-0.5Mo steel filler metal; however, carbon steel filler metals are usually selected except where carbon migration (the diffusion of carbon from lower-Cr metal to higher-Cr metal during PWHT and high temperature service) must be decreased. Likewise, 2.25Cr-1Mo steel can be joined to 9Cr-1Mo-V-Nb steel by using a 2.25Cr-1Mo filler metal.

In contrast, Cr-Mo steel and austenitic stainless steel are joined with a high Cr-Ni stainless (e.g. E309) or, where carbon migration and thermal stress are important factors, nickel alloy (e.g. ENiCrFe-1) filler metal. For a quick guide to recommended welding consumables for joining dissimilar metals, refer to Table 1.

Table 1 A quick guide to recommended welding consumables for joining dissimilar metals <sup>(1) (2)</sup>

Base metal	Mild steel	0.5Mo	1.25Cr-0.5Mo	2.25Cr-1Mo	5Cr-0.5Mo	9Cr-1Mo 9Cr-1Mo-V-Nb
<b>Type 304 stainless steel</b>	<ul style="list-style-type: none"> <li>• NC-39 (E309), NC-39L (E309L), TG-S309 (ER309), TG-S309L (ER309L)</li> <li>• NI-C703D (ENiCrFe-3), NI-C70A (ENiCrFe-1), TG-S70NCb (ERNiCr-3)</li> </ul>					
<b>9Cr-1Mo 9Cr-1Mo-V-Nb</b>	LB-52 (E7016) TG-S50 (ER70S-G)	CM-A76 (E7016-A1) TG-SM (ER80S-G)	CM-A96 (E8016-B2) TG-S1CM (ER80S-G)	CM-A106 (E9016-B3) TG-S2CM (ER90S-G)	CM-5 (E8016-B6) TG-S5CM (ER80S-B6)	
<b>5Cr-0.5Mo</b>	LB-52 (E7016) TG-S50 (ER70S-G)	CM-A76 (E7016-A1) TG-SM (ER80S-G)	CM-A96 (E8016-B2) TG-S1CM (ER80S-G)	CM-A106 (E9016-B3) TG-S2CM (ER90S-G)		
<b>2.25Cr-1Mo</b>	LB-52 (E7016) TG-S50 (ER70S-G)	CM-A76 (E7016-A1) TG-SM (ER80S-G)	CM-A96 (E8016-B2) TG-S1CM (ER80S-G)			
<b>1.25Cr-0.5Mo</b>	LB-52 (E7016) TG-S50 (ER70S-G)	CM-A76 (E7016-A1) TG-SM (ER80S-G)				
<b>0.5Mo</b>	LB-52 (E7016) TG-S50 (ER70S-G)					





Note: (1) This table guides to recommended filler metals matching the lower-alloy steels in various dissimilar metal joints, excepting for Type 304 steel. Other types of filler metals may be needed where a specific requirement is imposed.

Note: (2) Preheating and postweld heat treatment for dissimilar Cr-Mo steels should be sufficient to the higher-alloy steel; however, the PWHT temperature should be lower to avoid damage to the lower-alloy steel and minimize the carbon migration. Type 304 stainless steel should not be preheated or postweld heat-treated to avoid sensitization.

## Covered electrode for 1-1.25%Cr-0.5%Mo steel

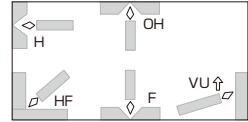
Classification: ASME / AWS A5.5 E8016-B2

Features: • Applied for ASTM A387 Gr.11, Gr.12 and equivalents

Redrying Conditions: 325~375°Cx1h

Identification color: 1st Silver, 2nd Black

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Cr	Mo
Example	0.06	0.38	0.72	0.008	0.004	1.31	0.54
Guaranty	0.05~0.12	≤0.60	≤0.90	≤0.03	≤0.03	1.00~1.50	0.40~0.65

## Mechanical properties of all-weld metal as per AWS

	Temp. (°C)	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	RT	570	650	26	0°C: 210	690x1
	450	460	520	21	-	690x1
Guaranty	RT	≥460	≥550	≥19	-	690±15x1

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	80~120A	125~175A	185~235A	240~300A
VU, OH	50~80A	75~110A	100~160A	-	-

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Approvals

ABS	LR	DNV	BV	NK	Others
MG(E8016-B2)	MG(E8016-B2)	H10, NV1Cr0.5Mo	UP(E8016-B2)	MG(E8016-B2)	TÜV

## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	17
3.2	350	5	20	29
4.0	400	5	20	53
5.0	400	5	20	82
6.0	400	5	20	122

**CM-A96MB ■ CM-A96MBD**

**Covered electrode for 1~1.25%Cr-0.5%Mo steel**

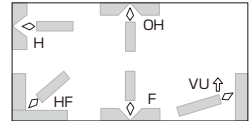
**Classification:** ASME / AWS A5.5 E8016-B2

**Features:** • Applicable for ASTM A387 Gr.11, Gr.12 and equivalents  
• Lower tensile strength and higher impact value

**Redrying Conditions:** 325~375°Cx1h

**Identification color:** **CM-A96MB** 1st Silver, 2nd Silver gray  
**CM-A96MBD** 1st Black, 2nd Silver gray

**Welding Positions:**



**Chemical composition of all-weld metal (%) as per AWS**

		C	Si	Mn	P	S	Cr	Mo
<b>CM-A96MB</b>	Example	0.06	0.45	0.74	0.007	0.003	1.30	0.54
	Guaranty	0.05~0.12	≤0.60	≤0.90	≤0.03	≤0.03	1.00~1.50	0.40~0.65
<b>CM-A96MBD</b>	Example	0.06	0.37	0.76	0.006	0.004	1.29	0.57
	Guaranty	0.05~0.12	≤0.60	≤0.90	≤0.03	≤0.03	1.00~1.50	0.40~0.65

**Mechanical properties of all-weld metal as per AWS**

		Temp. (°C)	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
<b>CM-A96MB</b>	Example	RT	490	590	30	-18°C: 200	690x1
		450	360	450	24	-18°C: 170*	690x1
	Guaranty	RT	≥460	≥550	≥19	-	690±15x1
<b>CM-A96MBD</b>	Example	RT	515	617	27	-20°C: 174	690x1
		450	394	484	19	-40°C: 78*	690x1
	Guaranty	RT	≥460	≥550	≥19	-	690±15x1

\* 690x1+Step Cooling

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	80~120A	125~175A	185~235A	240~300A
VU, OH	50~80A	75~110A	100~160A	-	-

**Polarity**

		AC			DC-EP
<b>CM-A96MB</b>	Example	AC	<b>CM-A96MBD</b>	Example	DC-EP
	Guaranty	AC		Guaranty	DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	17
3.2	350	5	20	30
4.0	400	5	20	54
5.0	400	5	20	84
6.0	400	5	20	120

## Covered electrode for 2.25%Cr-1%Mo steel

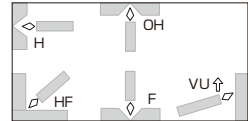
Classification: ASME / AWS A5.5 E9016-B3

Features: • Applied for ASTM A387 Gr.22 and equivalents

Redrying Conditions: 325~375°Cx1h

Identification color: 1st Silver, 2nd Brown

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Cr	Mo
Example	0.07	0.34	0.61	0.006	0.004	2.10	0.96
Guaranty	0.05~0.12	≤0.60	≤0.90	≤0.03	≤0.03	2.00~2.50	0.90~1.20

## Mechanical properties of all-weld metal as per AWS

	Temp. (°C)	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	RT	630	730	22	0°C: 120	690x1
	450	520	580	17	-	690x1
Guaranty	RT	≥530	≥620	≥17	-	690±15x1

## Recommended welding parameters

	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	90~130A	140~190A	190~240A	240~300A
VU, OH	50~80A	75~115A	100~160A	-	-

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Approvals (CM-A106)

ABS	LR	DNV	BV	NK	Others
MG(E9016-B3)	MG(E9016-B3)	H10, NV.2.25Cr1Mo	UP(E9016-B3)	MG(E9016-B3)	TÜV

## Packages

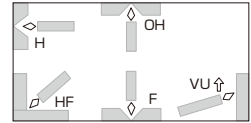
Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	17
3.2	350	5	20	30
4.0	400	5	20	55
5.0	400	5	20	85
6.0	400	5	20	121

**CM-A106N - CM-A106ND****TRUSTARC™****Covered electrode for 2.25%Cr-1%Mo steel****Classification:** ASME / AWS A5.5 E9016-B3

**Features:** • Applicable for ASTM A387 Gr.22 and equivalents  
 • Lower tensile strength, higher impact value and less sensitive to temper embrittlement

**Redrying Conditions:** 325~375°Cx1h

**Identification color:** **CM-A106N** 1st Silver, 2nd White  
**CM-A106ND** 1st Black, 2nd White

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

		C	Si	Mn	P	S	Cr	Mo
<b>CM-A106N</b>	Example	0.11	0.33	0.81	0.005	0.002	2.28	0.98
	Guaranty	0.05~0.12	≤0.60	≤0.90	≤0.03	≤0.03	2.00~2.50	0.90~1.20
<b>CM-A106ND</b>	Example	0.11	0.32	0.84	0.004	0.002	2.41	1.04
	Guaranty	0.05~0.12	≤0.60	≤0.90	≤0.03	≤0.03	2.00~2.50	0.90~1.20

**Mechanical properties of all-weld metal as per AWS**

		Temp. (°C)	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
<b>CM-A106N</b>	Example	RT	510	650	28	-29°C: 120	690x8
		450	430	510	20	-29°C: 108*	690x8
	Guaranty	RT	≥530	≥620	≥17	-	690±15x1
<b>CM-A106ND</b>	Example	RT	501	635	26	-40°C: 151	690x8
		450	402	483	19	-60°C: 109*	690x8
	Guaranty	RT	≥530	≥620	≥17	-	690±15x1

\*690x8 + Step Cooling

**Recommended welding parameters**

Dia.	2.6mm (CM-A106N only)	3.2mm	4.0mm	5.0mm	6.0mm
F, HF, H	55~85A	90~130A	140~190A	190~240A	240~300A
VU, OH	50~80A	75~115A	100~160A	-	-

**Polarity**

<b>CM-A106N</b>	Example	AC	<b>CM-A106ND</b>	Example	DC-EP
	Guaranty	AC		Guaranty	DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6 (CM-A106N only)	300	2	20	18
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	86
6.0	400	5	20	122

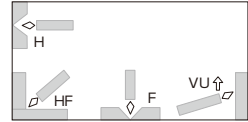
**Covered electrode for 2.25%Cr-1%Mo-V steel**

**Features:**

- Applied for ASTM A336 Gr F22V and equivalents
- Excellent tensile strength at high temperatures and good creep rupture strength

**Redrying Conditions:** 325~375°Cx1h

**Identification color:** 1st Silver, 2nd Green

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	V	Nb
Example	0.08	0.31	1.18	0.004	0.001	2.42	1.01	0.29	0.017
Guaranty	0.05~ 0.12	0.20~ 0.50	0.50~ 1.30	≤0.015	≤0.015	2.00~ 2.60	0.90~ 1.20	0.20~ 0.40	0.010~ 0.040

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	612	713	23	-18°C: 147	705x7
Guaranty	≥420	≥590	≥18	-	705±15x8

**Recommended welding parameters**

	3.2mm	4.0mm	5.0mm
Dia.	3.2mm	4.0mm	5.0mm
F, HF, H	90~130A	140~190A	190~240A
VU	75~115A	100~160A	-

**Polarity**

Example	AC
Guaranty	AC

**Packages**

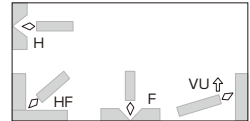
Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
3.2	350	5	20	32
4.0	400	5	20	56
5.0	400	5	20	87

**Covered electrode for 2.25%Cr-1%Mo-V steel**

**Features:** - Applicable for ASTM A336 Gr F22V and equivalents  
 - Excellent tensile strength at high temperatures and good creep rupture strength

**Redrying Conditions:** 325~375°Cx1h

**Identification color:** 1st Silver, 2nd Green

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	V	Nb
Example	0.08	0.24	1.12	0.005	0.002	2.48	1.05	0.27	0.012
Guaranty	0.05~ 0.15	0.20~ 0.50	0.50~ 1.30	≤0.015	≤0.015	2.00~ 2.60	0.90~ 1.20	0.20~ 0.40	0.010~ 0.040

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	520	636	24	-30°C: 130	*1
Guaranty	≥420	≥590	≥18	-	705±15x8

\*1: 705°Cx 8h for impact test, 705°Cx 26h for tensile test

**Recommended welding parameters**

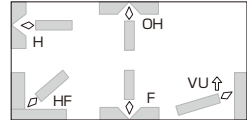
	3.2mm	4.0mm	5.0mm
Dia.	3.2mm	4.0mm	5.0mm
F, HF, H	90~130A	140~190A	190~240A
VU	75~115A	100~160A	-

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Packages**

Dia. (mm)	Length (mm)	Weight per pack(kg)	Weight per carton(kg)	Weight per piece(g)
3.2	350	5	20	32
4.0	400	5	20	56
5.0	400	5	20	87

**Covered electrode for 9%Cr-1%Mo steel****Classification:** ASME / AWS A5.5 E8016-B8**Features:** • Applied for ASTM A387 Gr.9 and equivalents**Redrying Conditions:** 325~375°Cx1h**Identification color:** 1st Yellow, 2nd Blue**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo
Example	0.08	0.40	0.68	0.007	0.004	9.56	1.03
Guaranty	0.05~0.10	≤0.90	≤1.0	≤0.03	≤0.03	8.0~10.5	0.85~1.20

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C x h)
Example	510	680	26	0°C: 110	740x10
Guaranty	≥460	≥550	≥19	-	740±15x1

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	55~85A	75~115A	120~160A	160~220A
VU, OH	50~80A	70~110A	90~150A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

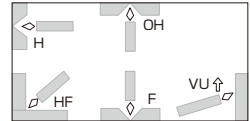
**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	30
4.0	400	5	20	55
5.0	400	5	20	85



**CM-9Cb****Covered electrode for 9%Cr-1%Mo-Nb-V steel****Classification:** ASME / AWS A5.5 E9016-G**Features:** • Applicable for ASTM A387 Gr.91 and equivalents

- Excellent creep rupture strength
- Good performance by AC current

**Redrying Conditions:** 325~375°Cx1h**Identification color:** 1st Yellow, 2nd Purple**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr	Mo	Nb	V
Example	0.06	0.31	1.51	0.006	0.003	0.94	9.11	1.06	0.03	0.18
Guaranty	≤0.12	≤0.60	≤2.00	≤0.025	≤0.025	≤1.00	8.00~10.50	0.80~1.20	≤0.15	≤0.50

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	600	750	25	0°C: 81	750x5
Guaranty	≥530	≥620	≥17	-	740±15x1

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	55~85A	75~115A	120~160A	160~220A
VU, OH	50~80A	70~110A	90~150A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

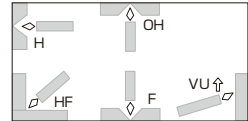
NK
MG

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	85

**CM-95B9 - CM-96B9****TRUSTARC™****Covered electrode for 9%Cr-1%Mo-Nb-V steel****Classification:** ASME / AWS A5.5 E9015-B9: CM-95B9  
E9016-B9: CM-96B9**Features:**

- Applied for ASTM A387 Gr.91 and equivalents
- Excellent creep rupture strength
- Good performance by DC-EP current

**Redrying Conditions:** 325~375°Cx1h**Identification color:** **CM-95B9** 1st Yellow, 2nd Brown  
**CM-96B9** 1st Yellow, 2nd Brown**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr	Mo	Nb	V
<b>CM-95B9</b> Example	0.10	0.20	0.82	0.006	0.001	0.49	9.09	1.03	0.03	0.25
Guaranty	0.08~ 0.13	≤0.30	≤1.20	≤0.01	≤0.01	≤0.80	8.0~ 10.5	0.85~ 1.20	0.02~ 0.10	0.15~ 0.30
<b>CM-96B9</b> Example	0.1	0.23	0.83	0.005	0.001	0.48	9.08	1.06	0.03	0.24
Guaranty	0.08~ 0.13	≤0.30	≤1.20	≤0.01	≤0.01	≤0.80	8.0~ 10.5	0.85~ 1.20	0.02~ 0.10	0.15~ 0.30
	Cu	Al	N	Mn+Ni						
<b>CM-95B9</b> Example	0.03	0.006	0.04	1.31						
Guaranty	≤0.25	≤0.04	0.02~ 0.07	≤1.50						
<b>CM-96B9</b> Example	0.03	0.006	0.04	1.31						
Guaranty	≤0.25	≤0.04	0.02~ 0.07	≤1.50						

**Mechanical properties of all-weld metal as per AWS**

		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C x h)
<b>CM-95B9</b>	Example	651	768	22	20°C: 74	760x2
	Guaranty	≥530	≥620	≥17	-	760±15x2
<b>CM-96B9</b>	Example	657	771	21	20°C: 71	760x2
	Guaranty	≥530	≥620	≥17	-	760±15x2

**Recommendable welding parameters**

	Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	55~85A	75~115A	120~160A	160~220A	
VU, OH	50~80A	70~110A	90~140A	-	

**Polarity**

Example	DC-EP	
Guaranty	DC-EP	AC (CM-96B9 only)

**Packages**

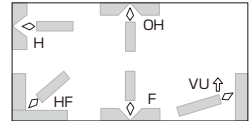
Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	85

**Covered electrode for T92/P92 and equivalent steel****Classification:** -

**Features:** - Applicable for T92/P92 and equivalents  
 - Excellent creep rupture strength

**Redrying Conditions:** 325~375°Cx1h

**Identification color:** 1st -, 2nd -

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>	<b>Ni</b>
Example	0.08	0.41	0.94	0.008	0.001	0.02	0.52
Guaranty	≤0.15	≤0.60	0.50~1.50	≤0.025	≤0.025	≤0.25	≤1.50
	<b>Co</b>	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Nb</b>	<b>W</b>	<b>N</b>
Example	1.57	9.62	0.23	0.37	0.03	1.63	0.05
Guaranty	0.50~1.80	8.60~13.00	≤0.50	≤0.50	≤0.080	1.30~2.50	0.03~0.07

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°Cxh)</b>
Example	645	771	22	0°C: 40	740x8
Guaranty	≥440	≥620	≥17	-	740±x8

**Recommended welding parameters**

Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	55~85A	75~115A	120~160A	160~220A
VU, OH	50~80A	70~110A	90~150A	-

**Polarity**

Example	DC-EP
Guaranty	DC-EP, AC

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	18
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	85

# Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical			
						C	Si		
CM-A76	A5.5 E7016 -A1	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for 0.5%Mo steel</li> <li>RC: 325~375°Cx1h</li> </ul>	F	Ex	0.06	0.49	
			DC-EP		H VU OH	Gt	≤0.12	≤0.60	
CM-B95	A5.5 E7015 -B2L	Low hydro- gen	DC-EP	<ul style="list-style-type: none"> <li>Suitable for 1~1.25%Cr-0.5%Mo steel</li> <li>DC-EP is only applicable.</li> <li>RC: 325~375°Cx1h</li> </ul>	F	Ex	0.03	0.87	
					H VU OH	Gt	≤0.05	≤1.00	
CM-B98	A5.5 E8018 -B2	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for 1~1.25%Cr-0.5%Mo steel</li> <li>RC: 325~375°Cx1h</li> </ul>	F	Ex	0.07	0.68	
			DC-EP		H VU OH	Gt	0.05~0.12	≤0.80	
CM-B105	A5.5 E8015 -B3L	Low hydro- gen	DC-EP	<ul style="list-style-type: none"> <li>Suitable for 2.25%Cr-1%Mo steel</li> <li>DC-EP is only applicable</li> <li>RC: 325~375°Cx1h</li> </ul>	F	Ex	0.03	0.85	
					H VU OH	Gt	≤0.05	≤1.00	
CM-B108	A5.5 E9018- B3	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for 2.25%Cr-1%Mo steel</li> <li>RC: 325~375°Cx1h</li> </ul>	F	Ex	0.07	0.68	
			DC-EP		H VU OH	Gt	0.05~0.12	≤0.80	

Note: Welding tests are as per AWS. Ex: Example (polarity: AC, except DC-EP for CMB-95/-105),

## Approvals

CM-B98	LR
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## Identification color

Product names	1st	2nd
CM-A76	Brown	-
CM-B95	Black	Yellow
CM-B98	Black	Yellowish green
CM-B105	Black	Blue
CM-B108	Black	Pink

composition of all-weld metal (%)					Mechanical properties of all-weld metal					
Mn	P	S	Cr	Mo		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C <sub>xh</sub> )
0.79	0.006	0.002	-	0.49	Ex	550	630	29	0°C: 210	620x1
≤0.90	≤0.03	≤0.03	-	0.40~ 0.65	Gt	≥390	≥480	≥25	-	620±15 x1
0.71	0.005	0.004	1.20	0.49	Ex	470	580	29	0°C: 78	690x1
≤0.90	≤0.03	≤0.03	1.00~ 1.50	0.40~ 0.65	Gt	≥390	≥520	≥19	-	690±15 x1
0.75	0.012	0.006	1.29	0.52	Ex	590	690	26	0°C: 66	690x1
≤0.90	≤0.03	≤0.03	1.00~ 1.50	0.40~ 0.65	Gt	≥460	≥550	≥19	-	690±15 x1
0.87	0.006	0.004	2.14	0.95	Ex	550	650	25	0°C: 79	690x1
≤0.90	≤0.03	≤0.03	2.00~ 2.50	0.90~ 1.20	Gt	≥460	≥550	≥17	-	690±15 x1
0.70	0.012	0.007	2.14	0.95	Ex	610	720	23	0°C: 106	690x1
≤0.90	≤0.03	≤0.03	2.00~ 2.50	0.90~ 1.20	Gt	≥530	≥620	≥17	-	690±15 x1

Gt: Guaranty (polarity: As specified above)

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0	6.0
<b>CM-A76</b>	300	350	400	400	400
<b>CM-B95</b>	300	350	400	400	-
<b>CM-B98</b>	300	400	450	450	450
<b>CM-B105</b>	300	350	400	400	-
<b>CM-B108</b>	300	400	450	450	-

# Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical			
						C	Si	Mn	
BL-96	A5.5 E9016 -G	Low hydrogen	AC	▪ Suitable for Mn-Mo and Mn-Mo-Ni steel ▪ RC: 325~375°Cx1h	F HF H VU OH	Ex	0.06	0.54	1.30
			DC-EP		Gt	≤0.12	≤0.60	0.90~1.70	
CM-5	A5.5 E8016 -B6	Low hydrogen	AC	▪ Suitable for 5%Cr-0.5%Mo steel ▪ RC: 325~375°Cx1h	F HF H VU OH	Ex	0.08	0.36	0.52
			DC-EP		Gt	0.05~0.10	≤0.90	≤1.0	
CM-2CW	-	Low hydrogen	AC	▪ Suitable for T23 tubes and P23 pipes ▪ RC: 325~375°Cx1h	F HF H VU OH	Ex	0.05	0.28	0.73
			DC-EP		Gt	≤0.15	≤0.60	0.10~1.60	

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

## Approvals

CM-2CW	NK
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## Identification color

Product names	1st	2nd
BL-96	Red	Green
CM-2CW	Orange	Green
CM-5	Orange	-

composition of all-weld metal (%)					Mechanical properties of all-weld metal					
P	S	Cr	Mo	Others		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
0.005	0.004	-	0.53	Ni: 0.37	Ex	540	620	26	-12°C: 31	635x26
≤0.020	≤0.020	-	0.35~ 0.65	Ni: 0.20~ 1.00	Gt	≥530	≥620	≥17	-	620±15 x1
0.008	0.002	5.39	0.58	-	Ex	400	560	33	0°C: 150	750x8
≤0.03	≤0.03	4.0~ 6.0	0.45~ 0.65	-	Gt	≥460	≥550	≥19	-	740±15 x1
0.007	0.005	2.25	0.09	W: 1.60 V: 0.22 Nb: 0.02	Ex	565	652	20	0°C: 105	715x2
≤0.020	≤0.010	1.90~ 2.60	0.05~ 0.85	W: 1.00~ 2.00 V: 0.15~ 0.30 Nb: 0.01~ 0.08	Gt	≥300	≥510	≥17	-	715±15 x2

Gt: Guaranty (polarity: As specified above)

## Diameter and Length (mm)

	Dia.	2.6	3.2	4.0	5.0	6.0
<b>BL-96</b>	-	-	350	400	400	450
<b>CM-5</b>	300	-	350	400	400	400
<b>CM-2CW</b>	300	-	350	400	-	-

## Solid Wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical					
						C	Si	Mn	P	S	
MG-S56	A5.28 ER80S -G	Ar- 5~20% CO <sub>2</sub>	DC- EP	▪ Suitable for Mn-Mo & Mn-Mo-Ni steel	F HF H VU OH	Ex	0.08	0.41	1.50	0.006	0.007
					Gt	≤0.10	0.30~ 0.90	1.00~ 1.60	≤0.020	≤0.020	
MG-SM	A5.28 ER80S -G	Ar- 2~5% O <sub>2</sub>	DC- EP	▪ Suitable for 0.5%Mo steel	F HF H VU OH	Ex	0.07	0.59	1.10	0.006	0.009
		Ar- 5~20% CO <sub>2</sub>			Gt	≤0.15	0.30~ 0.90	0.60~ 1.60	≤0.025	≤0.025	
MG-S1CM	A5.28 ER80S -G	Ar- 2~5% O <sub>2</sub>	DC- EP	▪ Suitable for 1~1.25%Cr-0.5%Mo steel	F HF H VU OH	Ex	0.09	0.55	1.15	0.007	0.009
		Ar- 5~20% CO <sub>2</sub>			Gt	≤0.15	0.30~ 0.90	0.60~ 1.50	≤0.025	≤0.025	
MG-S2CM	A5.28 ER90S -G	Ar- 2~5% O <sub>2</sub>	DC- EP	▪ Suitable for 2.25%Cr-1%Mo steel	F HF H VU OH	Ex	0.08	0.56	1.07	0.005	0.009
		Ar- 5~20% CO <sub>2</sub>			Gt	≤0.15	0.20~ 0.90	0.40~ 1.40	≤0.025	≤0.025	
MG-S2CMS	A5.28 ER90S -G	Ar- 10~20% CO <sub>2</sub>	DC- EP	▪ Suitable for 2.25%Cr-1%Mo steel	F HF H VU OH	Ex	0.12	0.39	0.85	0.004	0.003
				▪ Better toughness and lower sensitivity to temper embrittlement	Gt	≤0.15	0.20~ 0.90	0.40~ 1.40	≤0.025	≤0.025	

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

MG-SM	ABS
MG-S1CM	ABS, BV, NK, LR
MG-S2CM	NK



composition of wire (%)				Mechanical properties of all-weld metal					PWHT (°C <sub>xh</sub> ) & SG
Ni	Cr	Mo	Cu	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)		
0.89	-	0.34	0.17	Ex	500	590	29	-40°C: 69	620x40 80%Ar-20%CO <sub>2</sub>
0.50~ 1.00	-	0.20~ 0.60	≤0.35	Gt	≥470	≥550	≥19	-	620±15x1 80%Ar-20%CO <sub>2</sub>
-	-	0.55	0.17	Ex	520	610	25	0°C: 98	AW 80%Ar-20%CO <sub>2</sub>
-	-	0.40~ 0.65	≤0.40	Gt	≥470	≥550	≥19	0°C: 160	620x1 80%Ar-20%CO <sub>2</sub>
-	-	0.55	0.18	Ex	570	680	22	0°C: 69	AW 80%Ar-20%CO <sub>2</sub>
-	1.45	0.55	0.18	Ex	420	540	28	0°C: 170	620x1 80%Ar-20%CO <sub>2</sub>
-	1.00~ 1.60	0.40~ 0.65	≤0.40	Gt	≥470	≥550	≥19	-	620±15x1 80%Ar-20%CO <sub>2</sub>
-	2.35	1.11	0.17	Ex	550	670	26	0°C: 110	680x1 80%Ar-20%CO <sub>2</sub>
-	2.10~ 2.70	0.90~ 1.20	≤0.40	Gt	≥540	≥620	≥17	0°C: 140	690x15 80%Ar-20%CO <sub>2</sub>
-	2.27	0.97	0.14	Ex	600	720	21	-20°C: 120	690±15x1 80%Ar-20%CO <sub>2</sub>
-	2.10~ 2.70	0.92~ 1.20	≤0.40	Gt	≥530	≥620	≥17	-20°C: 130	670x1 85%Ar-15%CO <sub>2</sub>
-	2.27	0.97	0.14	Ex	410	560	28	-20°C: 130	690x25 85%Ar-15%CO <sub>2</sub>
-	2.10~ 2.70	0.92~ 1.20	≤0.40	Gt	≥530	≥620	≥17	-	690±15x1 85%Ar-15%CO <sub>2</sub>

## Diameter (mm)

<b>MG-S56</b>	1.2	<b>MG-S2CM</b>	0.9, 1.0, 1.2, 1.4, 1.6
<b>MG-SM</b>	0.9, 1.0, 1.2, 1.6	<b>MG-S2CMS</b>	0.8, 1.2, 2.4
<b>MG-S1CM</b>	0.9, 1.0, 1.2, 1.4, 1.6		

## Solid Wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical					
						C	Si	Mn	P	S	
MG-S2CW	A5.28 ER90S -G	Ar- 5-20% CO <sub>2</sub>	DC- EP	▪ Suitable for T23 tubes & P23 pipes	F	Ex	0.03	0.38	1.30	0.005	0.004
					HF H VU OH						
MG-S5CM	A5.28 ER80S -B6	Ar- 2~5% O <sub>2</sub> Ar- 5~20% CO <sub>2</sub>	DC- EP	▪ Suitable for 5%Cr- 0.5%Mo steel	F	Ex	0.08	0.40	0.53	0.011	0.010
					HF H VU OH						
MG-S9CM	S5.28 ER80S -B8	Ar- 2~5% O <sub>2</sub> Ar- 5~20% CO <sub>2</sub>	DC- EP	▪ Suitable for 9%Cr- 1%Mo steel	F	Ex	0.07	0.40	0.52	0.007	0.008
					HF H VU OH						
MG-S9Cb	A5.28 ER90S -G	Ar- 5% CO <sub>2</sub>	DC- EP	▪ Suitable for 9%Cr- 1%Mo- Nb-V steel	F	Ex	0.08	0.35	1.59	0.007	0.008
					HF H VU OH						
MG-S12CRS	-	Ar- 2~5% O <sub>2</sub> Ar- 5~20% CO <sub>2</sub>	DC- EP	▪ Suitable for T92/P92 & equivalents	F	Ex	0.04	0.40	1.19	0.004	0.006
					HF H VU OH						

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

MG-S2CW NK

composition of wire (%)						Mechanical properties of all-weld metal					
Ni	Cr	Mo	Cu	Nb	Others	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h) & SG	
0.51	2.35	0.11	0.18	0.031	V:0.29 W:1.83	Ex	656	727	19	0°C: 38	715x2 80%Ar- 20%CO <sub>2</sub>
0.01~ 1.20	1.90~ 2.60	0.05~ 0.85	≦0.40	0.01~ 0.08	V:0.15~0.30 W:1.00~2.00	Gt	≧530	≧620	≧17	-	690±15x1 80%Ar- 20%CO <sub>2</sub>
0.08	5.52	0.55	0.18	-	-	Ex	480	640	26	0°C: 78	700x2 98%Ar- 2%O <sub>2</sub>
≦0.6	4.50~ 6.00	0.45~ 0.65	≦0.35	-	-	Gt	≧470	≧550	≧17	-	745±15x1 98%Ar- 2%O <sub>2</sub>
0.02	8.99	1.00	0.01	-	-	Ex	480	640	24	0°C: 130	720x2 98%Ar- 2%O <sub>2</sub>
≦0.5	8.00~ 10.5	0.8~ 1.2	≦0.35	-	-	Gt	≧470	≧550	≧17	-	745±15x1 98%Ar- 2%O <sub>2</sub>
0.45	8.79	0.88	0.01	0.02	V:0.17	Ex	570	700	27	0°C: 98	740x8 95%Ar- 5%CO <sub>2</sub>
≦1.00	8.00~ 10.00	0.80~ 1.20	≦0.35	≦0.10	V:≦0.50	Gt	≧410	≧620	≧16	-	745±15x1 95%Ar- 5%CO <sub>2</sub>
0.52	10.10	0.40	0.01	0.04	V:0.30 W:1.59 N:0.04 Co:1.59	Ex	592	721	25	20°C: 72	750x8 95%Ar- 5%O <sub>2</sub>
0.30~ 1.00	9.50~ 11.50	0.25~ 0.50	≦0.40	0.01~ 0.08	V:0.10~0.50 W:1.00~2.00 N:0.02~0.07 Co:1.00~1.70	Gt	≧530	≧620	≧15	-	740x8 98%Ar- 2%O <sub>2</sub>

### Diameter (mm)

<b>MG-S5CM</b>	1.2, 1.6	<b>MG-S2CW</b>	0.8, 1.0, 1.2
<b>MG-S9CM</b>	1.2	<b>MG-S12CRS</b>	0.8, 1.2
<b>MG-S9Cb</b>	0.9, 1.0, 1.2, 1.6		

TIG welding rod and wire for 1-1.25%Cr-0.5%Mo steel

**Classification:** ASME / AWS A5.28 ER80S-G**Features:** • Applied for ASTM A387 Gr.11, Gr.12 and equivalents**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Silver**Chemical composition of rod and wire (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.08	0.52	1.10	0.007	0.009	1.40	0.55	0.02	0.11
Guaranty	0.05~ 0.12	≤0.70	0.60~ 1.20	≤0.025	≤0.025	1.00~ 1.50	0.40~ 0.65	≤0.20	≤0.35

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C x h)
Example	540	630	28	0°C: 270	690x1
Guaranty	≥470	≥550	≥19	-	620±15x1

**Approvals**

ABS	LR	DNV	BV	NK	KR	Others
MG	MG	MG	UP (ER80S-G)	MG (ER80S-G)	MG (ER80S-G)	TÜV

**Packages**

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Tube	5	1,000	9
	Spool	10	-	-
1.6	Tube	5	1,000	16
	Spool	10	-	-
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire for 1-1.25%Cr-0.5%Mo steel****Classification:** ASME / AWS A5.28 ER80S-G**Features:** • Applied for ASTM A387 Gr.11, Gr.12 and equivalents  
• Lower carbon content**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Blue**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cr</b>	<b>Mo</b>	<b>Ni</b>	<b>Cu</b>
Example	0.03	0.50	1.13	0.005	0.009	1.40	0.49	0.04	0.12
Guaranty	≤0.05	≤0.70	≤1.30	≤0.025	≤0.025	1.00~ 1.50	0.40~ 0.65	≤0.20	≤0.35

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C x h)</b>
Example	480	580	31	0°C: 300	620x1
Guaranty	≥470	≥550	≥19	-	AW

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Tube	5	1,000	-
	Spool	10	-	-
1.6	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire for 1-1.25%Cr-0.5%Mo steel****Classification:** ASME / AWS A5.28 ER80S-B2**Features:** • Applicable for ASTM A213 Gr.11 and equivalents**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Silver**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cr</b>	<b>Mo</b>	<b>Ni</b>	<b>Cu</b>
Example	0.11	0.50	0.67	0.004	0.004	1.40	0.55	0.01	0.15
Guaranty	0.07~ 0.12	0.40~ 0.70	0.40~ 0.70	≤0.025	≤0.025	1.20~ 1.50	0.40~ 0.65	≤0.25	≤0.35

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	490	625	32	-20°C: 246	620x1
Guaranty	≥470	≥550	≥19	-	620±15x1

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
1.0	Spool	10	-	-
1.2	Spool	10	-	-
1.6	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

TIG welding rod and wire for 2.25%Cr-1%Mo steel

**Classification:** ASME / AWS A5.28 ER90S-G**Features:** • Applied for ASTM A387 Gr.22 and equivalents**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Brown**Chemical composition of rod and wire (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.11	0.36	0.75	0.004	0.008	2.29	1.07	0.05	0.12
Guaranty	0.05~ 0.13	≤0.70	0.50~ 1.20	≤0.025	≤0.025	2.00~ 2.50	0.90~ 1.20	≤0.20	≤0.35

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	610	720	28	0°C: 250	690x1
Guaranty	≥540	≥620	≥17	-	690±15x1

**Approvals**

ABS	DNV	BV	NK	KR	Others
MG	MG	UP(ER90S-G)	MG	MG(ER90S-G)	TÜV

**Packages**

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Spool	10	-	-
	Tube	5	1,000	9
1.6	Spool	10	-	-
	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire for 2.25%Cr-1%Mo steel****Classification:** ASME / AWS A5.28 ER80S-G**Features:** • Applied for ASTM A387 Gr.22 and equivalents  
• Lower carbon content**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Red**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cr</b>	<b>Mo</b>	<b>Ni</b>	<b>Cu</b>
Example	0.03	0.50	1.14	0.007	0.009	2.33	1.09	0.03	0.12
Guaranty	≤0.05	≤0.70	≤1.30	≤0.025	≤0.025	2.10~ 2.60	0.90~ 1.20	≤0.20	≤0.35

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	520	630	28	0°C: 250	690x1
Guaranty	≥470	≥550	≥19	-	690±15x1

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Spool	10	-	-
	Tube	5	1,000	-
1.6	Spool	10	-	-
	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	-



**TIG welding rod and wire for 2.25%Cr-1%Mo steel**

**Classification:** ASME / AWS A5.28 ER90S-B3

**Features:** • Applied for ASTM A387 Gr.22 and equivalents

**Shielding Gas:** Ar

**Polarity:** DC-EN

**Identification color:** Brown

#### Chemical composition of rod and wire (%) as per AWS

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.11	0.64	0.67	0.006	0.006	2.44	1.09	0.01	0.14
Guaranty	0.07~ 0.12	0.40~ 0.70	0.40~ 0.70	≤0.025	≤0.025	2.30~ 2.70	0.90~ 1.20	≤0.25	≤0.35

#### Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)
Example	596	725	27	-20°C: 237	690x1
Guaranty	≥540	≥620	≥17	-	690±15x1

#### Packages

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
1.0	Spool	10	-	-
1.2	Spool	10	-	-
1.6	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire for 2.25%Cr-1%Mo-V steel**

- Features:**
- Applicable for ASTM A336 Gr. F22V and equivalents
  - Excellent tensile strength at high temperatures and good creep rupture strength

**Shielding Gas:** Ar

**Polarity:** DC-EN

**Identification color:** Silver

**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cr</b>
Example	0.12	0.16	0.43	0.005	0.008	2.31
Guaranty	0.10~0.13	≤0.70	0.20~0.70	≤0.025	≤0.025	2.00~2.50
	<b>Mo</b>	<b>V</b>	<b>Nb</b>	<b>Ni</b>	<b>Cu</b>	
Example	1.06	0.28	0.037	0.01	0.11	
Guaranty	0.90~1.20	0.20~0.40	0.015~0.040	≤0.20	≤0.35	

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	623	730	22	-18°C: 300	705x7
Guaranty	≥420	≥590	≥18	-	705±15x8

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
1.2	Tube	5	1,000	9
1.6	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35

**TIG welding rod and wire for 9%Cr-1%Mo steel****Classification:** ASME / AWS A5.28 ER80S-B8**Features:** • Applied for ASTM A387 Gr.9 and equivalents**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Purple**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cr</b>
Example	0.07	0.39	0.52	0.006	0.009	8.98
Guaranty	≤0.10	≤0.50	0.40~0.70	≤0.025	≤0.025	8.00~10.50
	<b>Mo</b>	<b>Ni</b>	<b>Cu</b>			
Example	1.00	0.18	0.01			
Guaranty	0.8~1.2	≤0.50	≤0.35			

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	410	590	32	0°C: 220	750x2
Guaranty	≥470	≥550	≥17	-	745±15x1

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
1.2	Spool	20	-	-
1.6	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire for 9%Cr-1%Mo-Nb-V steel****Classification:** ASME / AWS A5.28 ER90S-G**Features:**

- Applied for ASTM A387 Gr.91 and equivalents
- Excellent creep rupture strength

**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Gray**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cr</b>
Example	0.08	0.16	1.01	0.006	0.005	9.01
Guaranty	≤0.12	≤0.60	≤1.20	≤0.020	≤0.010	8.00~10.00
	<b>Mo</b>	<b>Ni</b>	<b>Nb</b>	<b>V</b>	<b>Cu</b>	
Example	0.90	0.71	0.04	0.18	0.01	
Guaranty	0.85~1.20	≤0.80	0.02~0.12	0.10~0.35	≤0.35	

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°Cxh)</b>
Example	700	780	24	0°C: 240	740x8
Guaranty	≥410	≥620	≥16	-	745±15x1

**Approvals**

NK

MG

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece (g)</b>
0.8	Spool	10	-	-
1.0	Spool	10	-	-
1.2	Spool	10	-	-
1.6	Spool	10	-	-
	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35
3.2	Tube	5	1,000	63

**TIG welding rod and wire for 9%Cr-1%Mo-Nb-V steel****Classification:** ASME / AWS A5.28 ER90S-B9**Features:** • Applied for ASTM A387 Gr.91 and equivalents  
• Excellent creep rupture strength**Shielding Gas:** Ar**Polarity:** DC-EN**Identification color:** Black**Chemical composition of rod and wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>	<b>Cr</b>
Example	0.12	0.25	0.75	0.006	0.004	0.01	9.20
Guaranty	0.07~0.13	0.15~0.50	≤1.20	≤0.010	≤0.010	≤0.20	8.00~10.50
	<b>Mo</b>	<b>Ni</b>	<b>V</b>	<b>Al</b>	<b>Nb</b>	<b>N</b>	<b>Mn+Ni</b>
Example	1.00	0.49	0.21	-	0.05	0.04	1.24
Guaranty	0.85~1.20	≤0.80	0.15~0.30	≤0.04	0.02~0.10	0.03~0.07	≤1.50

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	706	809	22	0°C: 160	760x2
Guaranty	≥410	≥620	≥16	-	760±15x2

**Packages**

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Length (mm)</b>	<b>Weight per piece(g)</b>
1.0	Spool	10	-	-
1.2	Spool	10	-	-
1.6	Spool	10	-	-
	Tube	5	1,000	16
2.0	Tube	5	1,000	25
2.4	Tube	5	1,000	35

## TIG Welding Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical					
					C	Si	Mn	P	S	
TG-S70SA1	A5.28 ER70S -A1	Ar	DC-EN	▪ Suitable for 0.5%Mo steel	Ex	0.07	0.58	1.08	0.005	0.008
					Gt	≤0.12	0.30~0.70	≤1.30	≤0.025	≤0.025
TG-S56	A5.28 ER80S -G	Ar	DC-EN	▪ Suitable for Mn-Mo and Mn-Mo-Ni steel	Ex	0.10	0.41	1.59	0.007	0.007
					Gt	≤0.12	0.20~0.60	1.20~1.80	≤0.025	≤0.025
TG-S63S	A5.28 ER90S -G	Ar	DC-EN	▪ Suitable for Mn-Mo and Mn-Mo-Ni steel	Ex	0.10	0.39	1.23	0.008	0.005
					Gt	≤0.15	0.20~0.50	1.05~1.45	≤0.025	≤0.025
TG-SM	A5.28 ER80S -G	Ar	DC-EN	▪ Suitable for 0.5%Mo steel	Ex	0.08	0.54	1.04	0.004	0.007
					Gt	0.05~0.12	≤0.80	≤1.50	≤0.025	≤0.025
TG-S5CM	A5.28 ER80S -B6	Ar	DC-EN	▪ Suitable for 5%Cr-0.5%Mo steel	Ex	0.09	0.41	0.49	0.006	0.009
					Gt	≤0.10	≤0.50	0.40~0.70	≤0.025	≤0.025
TG-S2CW	-	Ar	DC-EN	▪ Suitable for SA213Gr. T23 tubes and SA335Gr. P23 pipes	Ex	0.04	0.41	0.45	0.005	0.004
					Gt	≤0.15	≤0.60	0.10~1.60	≤0.020	≤0.010
TG-S12CRS	-	Ar	DC-EN	▪ Suitable for T92/P92 and equivalents ▪ Excellent creep rupture strength	Ex	0.07	0.36	0.74	0.004	0.003
					Gt	≤0.15	≤0.50	≤1.00	≤0.020	≤0.010

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

Approvals		Diameter (mm)			
TG-S56	TÜV	TG-S56	1.2, 1.6, 2.0, 2.4, 3.2	TG-S5CM	1.2, 2.0, 2.4, 3.2
TG-S2CW	NK	TG-S63S	1.2, 1.6, 2.0, 2.4, 3.2	TG-S2CW	0.8, 1.0, 1.2, 1.6, 2.0, 2.4
		TG-SM	0.8, 1.0, 1.2, 1.6, 2.0, 2.4, 3.2	TG-S12CRS	0.8, 1.0, 1.2, 1.6, 2.0, 2.4

composition of rod and wire (%)					Mechanical properties of all-weld metal					
Ni	Cr	Mo	Cu	Others	0.2%OS (MPa)	TS (MPa)	EL (%)	IV (J)	PWHT (°C×h)	
0.03	-	0.56	0.13	-	Ex	534	611	32	0°C: 267	620x1
≤0.20	-	0.40~ 0.65	≤0.35	-	Gt	≥400	≥515	≥19	-	620±15 x1
0.66	-	0.50	0.11	-	Ex	520	590	31	-12°C: 290	620x1
0.40~ 0.80	-	0.40~ 0.60	≤0.35	-	Gt	≥470	≥550	≥19	-	620±15 x1
1.58	-	0.39	0.10	-	Ex	566	655	27	-12°C: 256	625 x15
1.45~ 1.75	-	0.25~ 0.55	≤0.35	-	Gt	≥480	≥620	≥16	-	620x1
0.02	-	0.53	0.12	-	Ex	500	580	32	0°C: 280	620x1
≤0.20	-	0.40~ 0.65	≤0.35	-	Gt	≥470	≥550	≥19	-	AW
0.04	5.44	0.55	0.12	-	Ex	480	600	26	0°C: 280	750x2
≤0.60	4.50~ 6.00	0.45~ 0.65	≤0.35	-	Gt	≥470	≥550	≥17	-	745±15 x1
-	2.32	0.52	0.10	V: 0.33 Nb: 0.031 W: 1.22, Al: -	Ex	467	578	31	0°C: 205	715x2
-	1.90~ 2.60	0.05~ 0.85	≤0.40	V: 0.15~0.40 Nb: 0.01~0.08 W:1.00~2.00 Al≤0.03	Gt	≥300	≥510	≥20	-	715±15 x2
0.51	9.92	0.35	0.01	V: 0.21, Nb: 0.04 W: 1.45, Co: 1.01 N: 0.04	Ex	686	790	23	0°C: 44	740x8
≤0.80	9.50~ 12.00	0.10~ 0.70	≤0.25	V: 0.05~0.35 Nb: 0.01~0.10 W:1.00~2.00 Co: 0.80~1.20 N:0.03~0.07	Gt	≥440	≥620	≥17	-	740x8

## Identification color

Product names	Product names
<b>TG-S70SA1</b>	Green
<b>TG-S56</b>	Silver gray
<b>TG-S63S</b>	Light green
<b>TG-SM</b>	Green
<b>TG-S5CM</b>	White
<b>TG-S2CW</b>	Blue white
<b>TG-S12CRS</b>	-

# FAMILIARC™ MF-38/ TRUSTARC™ US-49

## SAW flux and wire combination

**Classification:** ASME / AWS A5.23 F8P6-EG-A4  
F8A4-EG-A4

**Features:** • Suitable for single or multi-pass butt welding of  
0.5%Mo steel

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

### Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.09	0.03	1.58	0.014	0.013	0.52	0.10
Guaranty	0.07~ 0.12	≤0.05	1.25~ 1.80	≤0.025	≤0.025	0.45~ 0.60	≤0.35

### Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.10	0.37	1.35	0.014	0.014	0.53	0.09
Guaranty	≤0.15	≤0.80	≤1.60	≤0.030	≤0.030	0.40~0.65	≤0.35

### Mechanical properties of weld metal (AC) as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	510	600	29	-51°C: 40	600x3
Guaranty	≥470	550~690	≥20	-51°C≥27	620±15x1

### Polarity

Example	AC
Guaranty	AC

### Approvals (Single)

ABS	LR	DNV	BV	NK	CCS
3YTM	3T, 3YM, 3YT	III YTM	A3YTM	KAW3Y46TMH10	3YTM



## Packages

### Wire

<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	20
2.4	Coil	25
	Spool	10
3.2	Coil	25, 76
4.0	Coil	25, 75
4.8	Coil	25, 75
6.4	Coil	25

### Flux

<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
12x65	Can	25
20x200	Can	25
20xD	Can	25

# FAMILIARC™ MF-38/ TRUSTARC™ US-A4

## SAW flux and wire combination

**Classification:** ASME / AWS A5.23 F8P4-EA4-A4  
F8A4-EA4-A4

**Features:** • Suitable for single or multi-pass butt welding of 0.5%Mo steel

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

### Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.09	0.04	1.59	0.010	0.014	0.52	0.10
Guaranty	0.05~ 0.15	≤0.20	1.20~ 1.70	≤0.025	≤0.025	0.45~ 0.65	≤0.35

### Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.10	0.39	1.35	0.013	0.013	0.52	0.11
Guaranty	≤0.15	≤0.80	≤1.60	≤0.030	≤0.030	0.40~0.65	≤0.35

### Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	PWHT (°C×h)
Example	510	600	29	-51°C: 40	620x1
Guaranty	≥470	550~690	≥20	-51°C≥27	620±15x1

### Polarity

Example	AC
Guaranty	AC

### Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	12x65	Can	25
4.0	Coil	25	20x200	Can	25
4.8	Coil	25	20xD	Can	25

# FAMILIARC™ MF-38/ TRUSTARC™ US-40

## SAW flux and wire combination

**Classification:** ASME / AWS A5.23 F8P6-EA3-A3  
F9A6-EA3-A3

**Features:** • Suitable for single or multi-pass butt welding of 0.5%Mo steel

**Type of flux:** Fused

**Redrying conditions of flux:** 150~350°Cx1h

### Chemical composition of wire (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.13	0.04	1.80	0.008	0.010	0.52	0.12
Guaranty	0.05~0.17	≤0.20	1.65~2.20	≤0.025	≤0.025	0.45~0.65	≤0.35

### Chemical composition of weld metal (%) as per AWS

	C	Si	Mn	P	S	Mo	Cu
Example	0.08	0.34	1.58	0.017	0.009	0.45	0.12
Guaranty	≤0.15	≤0.80	≤2.10	≤0.030	≤0.030	0.40~0.65	≤0.35

### Mechanical properties of weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	560	630	29	-51°C: 58	620x1
Guaranty	≥470	550~690	≥20	-51°C≥27	620±15x1

### Polarity

Example	AC
Guaranty	AC

### Approvals

	ABS	NK
Single	MG	KAW3Y50MH10

### Packages

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
2.0	Spool	20	12x65	Can	25
2.4	Coil	25	20x200	Can	25
3.2	Coil	25, 75, 150	20xD	Can	25
4.0	Coil	25, 75			
4.8	Coil	25, 75, 150			
6.4	Coil	25			

# PF-200/US-511N

**TRUSTARC™****SAW flux and wire combination****Classification:** ASME / AWS A5.23 F8P2-EG-B2**Features:** • Suitable for multi-pass butt welding of 1~1.25%Cr-0.5%Mo steel  
• Excellent notch toughness**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.08	0.30	0.90	0.004	0.002	1.45	0.52	0.17	0.14
Guaranty	≤0.15	≤0.40	0.50~ 1.00	≤0.015	≤0.015	1.25~ 1.80	0.40~ 0.65	≤0.25	≤0.25

**Chemical composition of weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.08	0.20	0.88	0.007	0.002	1.39	0.55	0.15	0.11
Guaranty	0.05~ 0.15	≤0.80	≤1.20	≤0.030	≤0.030	1.00~ 1.50	0.40~ 0.65	≤0.20	≤0.35

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°Cxh)
Example	450	560	31	-29°C: 120	690x8
Guaranty	≥470	550~690	≥20	-29°C ≥27	690±15x1

**Polarity**

Example	AC
Guaranty	AC

**Packages**

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	10x48	Can	20
4.0	Coil	25			
4.8	Coil	25			

**SAW flux and wire combination****Classification:** ASME / AWS A5.23 F8P2-EG-B2**Features:** • Suitable for multi-pass butt welding of 1~1.25%Cr-0.5%Mo steel**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.13	0.09	0.92	0.005	0.003	1.49	0.56	0.17	0.10
Guaranty	≤0.15	≤0.40	0.50~ 1.00	≤0.015	≤0.015	1.25~ 1.80	0.40~ 0.65	≤0.25	≤0.25

**Chemical composition of weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.08	0.21	0.82	0.007	0.003	1.39	0.56	0.15	0.09
Guaranty	0.05~ 0.15	≤0.80	≤1.20	≤0.030	≤0.030	1.00~ 1.50	0.40~ 0.65	≤0.20	≤0.35

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	PWHT (°C×h)
Example	477	589	27	-29°C: 116	690x4
Guaranty	≥470	550~690	≥20	-29°C≥27	690±15x1

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Packages**

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	10x48	Can	20
4.0	Coil	25			

# PF-200/US-521S

**TRUSTARC™****SAW flux and wire combination****Classification:** ASME / AWS A5.23 F9P2-EG-B3**Features:** • Suitable for multi-pass butt welding of 2.25%Cr-1%Mo steel  
• Excellent notch toughness**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.16	0.14	1.00	0.005	0.002	2.45	1.05	0.14	0.12
Guaranty	0.08~ 0.18	≤0.25	0.80~ 1.20	≤0.012	≤0.012	2.20~ 2.70	0.90~ 1.20	≤0.25	≤0.30

**Chemical composition of weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.12	0.10	0.82	0.008	0.001	2.34	1.04	0.13	0.12
Guaranty	0.05~ 0.15	≤0.80	≤1.20	≤0.030	≤0.030	2.00~ 2.50	0.90~ 1.20	≤0.20	≤0.35

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	PWHT (°Cxh)
Example	470	610	27	-29°C: 150	690x8
Guaranty	≥540	620~760	≥17	-29°C≥27	690±15x1

**Polarity**

Example	AC
Guaranty	AC

**Packages**

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	10x48	Can	20
4.0	Coil	25			
4.8	Coil	25			

**SAW flux and wire combination****Classification:** ASME / AWS A5.23 F9P2-EG-B3**Features:** • Suitable for multi-pass butt welding of 2.25%Cr-1%Mo steel**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.17	0.14	0.96	0.004	0.002	2.44	1.07	0.14	0.13
Guaranty	0.08~ 0.18	≤0.25	0.80~ 1.20	≤0.012	≤0.012	2.20~ 2.70	0.90~ 1.20	≤0.25	≤0.30

**Chemical composition of weld metal (%) as per AWS**

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Example	0.09	0.16	0.81	0.006	0.003	2.41	1.07	0.13	0.13
Guaranty	0.05~ 0.15	≤0.80	≤1.20	≤0.030	≤0.030	2.00~ 2.50	0.90~ 1.20	≤0.20	≤0.35

**Mechanical properties of weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	PWHT (°C×h)
Example	507	621	26	-29°C: 164	690x6
Guaranty	≥540	620~760	≥17	-29°C ≥27	690±15x1

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Packages**

Wire			Flux		
Dia. (mm)	Type	Weight (kg)	Mesh size	Type	Weight (kg)
3.2	Coil	25	10x48	Can	20
4.0	Coil	25			
4.8	Coil	25			

# PF-500/US-521H

**TRUSTARC™****SAW flux and wire combination for 2.25%Cr-1%Mo-V steel**

- Features:**
- Suitable for multi-pass butt welding of ASTM A336 Gr. F22V and equivalents
  - Excellent tensile strength at high temperatures and good creep rupture strength

**Type of flux:** Bonded

**Redrying conditions of flux:** 200~300°Cx1h

**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.13	0.20	1.27	0.004	0.002
Guaranty	≤0.18	≤0.25	0.30~1.40	≤0.025	≤0.025
	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Nb</b>	<b>Cu</b>
Example	2.55	0.98	0.39	0.02	0.12
Guaranty	2.00~2.65	0.90~1.20	0.25~0.45	0.010~0.040	≤0.30

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.08	0.13	1.16	0.006	0.001
Guaranty	0.05~0.15	0.05~0.35	0.50~1.30	≤0.015	≤0.015
	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Nb</b>	
Example	2.53	1.03	0.35	0.015	
Guaranty	2.00~2.60	0.90~1.20	0.20~0.40	0.010~0.040	

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°Cxh)</b>
Example	620	710	26	-18°C: 150	705x7
Guaranty	≥420	590~760	≥16	-	705±15x8

**Polarity**

Example	AC
Guaranty	AC

**Packages**

Wire			Flux		
<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
4.0	Coil	25	10x48	Can	20



**SAW flux and wire combination for 2.25%Cr-1%Mo-V steel**

- Features:**
- Suitable for multi-pass butt welding
  - Applicable for ASTM A336 Gr F22V and equivalents
  - Excellent tensile strength at high temperatures and good creep rupture strength

**Type of flux:** Bonded

**Redrying conditions of flux:** 200~300°Cx1h

**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.16	0.21	1.30	0.003	0.001
Guaranty	≤0.18	≤0.25	0.30~1.40	≤0.025	≤0.025
	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Nb</b>	<b>Cu</b>
Example	2.54	1.03	0.38	0.022	0.11
Guaranty	2.00~2.65	0.90~1.20	0.25~0.45	0.010~0.040	≤0.30

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.07	0.17	1.26	0.007	0.001
Guaranty	0.05~0.15	0.05~0.35	0.50~1.30	≤0.015	≤0.015
	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Nb</b>	<b>Cu</b>
Example	2.44	1.03	0.34	0.011	0.10
Guaranty	2.00~2.60	0.90~1.20	0.20~0.40	0.010~0.040	-

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	518	634	26	-30°C:106	*1
Guaranty	≥420	≥590	≥18	-	705±15x8

\*1: 705°Cx8h for impact test, 705°Cx26h for tensile test

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Packages**

Wire			Flux		
<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
4.0	Coil	25	10x48	Can	20

**SAW flux and wire combination****Classification:** ASME / AWS A5.23 F10PZ-EG-G**Features:** • Suitable for multi-pass butt welding of 9%Cr-1%Mo-Nb-V steel  
• Excellent creep rupture strength**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.08	0.13	1.73	0.007	0.005
Guaranty	≤0.14	≤0.30	≤2.00	≤0.020	≤0.020
	<b>Cr</b>	<b>Mo</b>	<b>Nb</b>	<b>V</b>	<b>Ni</b>
Example	8.91	0.90	0.05	0.23	0.60
Guaranty	8.00~10.50	0.80~1.20	≤0.10	≤0.50	≤1.00

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>
Example	0.06	0.12	1.58	0.008	0.004
Guaranty	≤0.12	≤0.60	≤2.00	≤0.025	≤0.025
	<b>Cr</b>	<b>Mo</b>	<b>Nb</b>	<b>V</b>	<b>Ni</b>
Example	8.31	0.88	0.03	0.21	0.55
Guaranty	8.00~10.50	0.80~1.20	≤0.15	≤0.50	≤1.00

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>	<b>PWHT (°Cxh)</b>
Example	580	710	24	0°C: 68	740x8
Guaranty	≥610	690~830	≥16	-	745±15x1

**Polarity**

Example	AC
Guaranty	AC

**Packages**

Wire			Flux		
<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	20	10x48	Can	20
2.4	Coil	25			
3.2	Coil	25			
4.0	Coil	25			

**SAW flux and wire combination****Classification:** ASME / AWS A5.23 F9PZ-EB9-B9**Features:** • Suitable for multi-pass butt welding of 9%Cr-1%Mo-Nb-V steel  
• Excellent creep rupture strength**Type of flux:** Bonded**Redrying conditions of flux:** 200~300°Cx1h**Chemical composition of wire (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>	<b>Ni</b>
Example	0.11	0.26	0.74	0.004	0.005	0.01	0.51
Guaranty	0.07~0.13	≤0.50	≤1.25	≤0.010	≤0.010	≤0.10	≤1.00
	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Al</b>	<b>Nb</b>	<b>N</b>	
Example	9.30	1.05	0.23	< 0.001	0.06	0.04	
Guaranty	8.50~10.50	0.85~1.15	0.15~0.25	≤0.04	0.02~0.10	0.03~0.07	

**Chemical composition of weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Cu</b>	<b>Ni</b>
Example	0.10	0.21	0.92	0.009	0.004	0.01	0.50
Guaranty	0.08~0.13	≤0.80	≤1.20	≤0.010	≤0.010	≤0.25	≤0.80
	<b>Cr</b>	<b>Mo</b>	<b>V</b>	<b>Al</b>	<b>Nb</b>	<b>N</b>	<b>Mn+Ni</b>
Example	9.00	0.97	0.21	0.01	0.04	0.04	1.42
Guaranty	8.00~10.50	0.85~1.20	0.15~0.25	≤0.04	0.02~0.10	0.02~0.07	≤1.50

**Mechanical properties of weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>El (%)</b>	<b>IV (J)</b>	<b>PWHT (°C×h)</b>
Example	582	716	23	20°C: 37	760x2
Guaranty	≥530	620~758	≥17	-	760x2

**Polarity**

Example	DC-EP
Guaranty	DC-EP

**Packages**

<b>Wire</b>			<b>Flux</b>		
<b>Dia. (mm)</b>	<b>Type</b>	<b>Weight (kg)</b>	<b>Mesh size</b>	<b>Type</b>	<b>Weight (kg)</b>
1.6	Spool	20	10x48	Can	20
2.4	Coil	25			
3.2	Coil	25			
4.0	Coil	25			

## SAW Flux and Wire Combinations

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical			
					C	Si	Mn	
MF-27/ US-56B	A5.23 F9P4 -EG-G	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for multi-pass butt welding of Mn-Mo and Mn-Mo-Ni steels</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Wire-Ex	0.10	0.14	1.62
					Wire-Gt	≤0.15	≤0.35	1.40~2.20
					Weld-Ex	0.08	0.28	1.05
					Weld-Gt	≤0.12	≤0.50	0.90~1.80
PF-200/ US-56B	A5.23 F9P4 -EG-G	Bonded	AC	<ul style="list-style-type: none"> <li>▪ Suitable for multi-pass butt welding of Mn-Mo and Mn-Mo-Ni steels</li> <li>▪ RC: 200~300°Cx1h</li> </ul>	Wire-Ex	0.10	0.14	1.62
					Wire-Gt	≤0.15	≤0.35	1.40~2.20
					Weld-Ex	0.08	0.11	1.33
					Weld-Gt	≤0.12	≤0.50	0.90~1.80

Note: Welding tests are as per AWS. Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)

### Approvals

MF-27/US-56B	TÜV
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composition (%)				Mechanical properties of weld metal					
P	S	Mo	Others		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C/h)
0.005	0.003	0.47	Ni: 0.84 Cu: 0.08	Ex	480	560	32	-40°C: 85	635 x26
≤0.018	≤0.018	0.40~ 0.70	Ni: 0.70~1.20 Cu≤0.30						
0.009	0.002	0.45	Ni: 0.87 Cu: 0.08	Gt	≥540	620~ 760	≥17	-40°C ≥27	620±15 x1
≤0.020	≤0.020	0.40~ 0.70	Ni: 0.70~1.20 Cu≤0.30						
0.007	0.003	0.47	Ni: 0.84 Cu: 0.08	Ex	490	580	30	-40°C: 182	620 x11
≤0.018	≤0.018	0.40~ 0.70	Ni: 0.70~1.20 Cu≤0.30						
0.007	0.003	0.43	Ni: 0.83 Cu: 0.08	Gt	≥540	620~ 760	≥17	-40°C ≥27	620±15 x1
≤0.020	≤0.020	0.40~ 0.70	Ni: 0.70~1.20 Cu≤0.30						

Weld-Ex: Example of weld metal, Weld-Gt: Guaranty of weld metal

### Diameter of wire (mm)

**US-56B** 3.2, 4.0, 4.8

### Mesh size of flux

**MF-27** 48xD  
**PF-200** 10x48

## SAW Flux and Wire Combination

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical				
					C	Si	Mn	P	
MF-29A/ US-2CW	-	Fused	DC-EP	▪ Suitable for T23 tubes and P23 pipes	Wire-Ex	0.04	0.13	1.15	0.004
					Wire-Gt	≤0.15	≤0.60	0.10~1.60	≤0.020
					Weld-Ex	0.04	0.25	1.15	0.006
					Weld-Gt	≤0.15	≤0.60	0.10~1.60	≤0.020
PF-200S/ US-502	A5.23 F7P2 -EG-B6	Bonded	AC	▪ Suitable for multi-pass butt welding of 5%Cr-0.5%Mo steel ▪ RC: 200~300°Cx1h	Wire-Ex	0.07	0.18	0.50	0.008
					Wire-Gt	≤0.15	≤0.35	0.30~0.85	≤0.025
					Weld-Ex	0.06	0.21	0.78	0.012
					Weld-Gt	≤0.12	≤0.80	≤1.20	≤0.030

Note: Welding tests are as per AWS. Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)

composition (%)							Mechanical properties of weld metal					
S	Cu	Cr	Mo	W	V	Nb	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C/h)	
0.004	0.11	2.26	0.12	1.75	0.24	0.026						
Ex							521	615	27	20°C: 98	715 x2	
≤0.010	≤0.40	1.90~ 2.60	0.05~ 0.85	1.00~ 2.00	0.15~ 0.30	≤0.040						
0.002	0.13	2.12	0.12	1.69	0.22	0.016						
Gt							≥300	≥510	≥17	-	715 x2	
≤0.010	≤0.40	1.90~ 2.60	0.05~ 0.85	1.00~ 2.00	0.15~ 0.30	≤0.040						
0.002	0.12	5.50	0.55	-	-	-						
Ex							460	590	32	-29°C: 133	720 x1	
≤0.025	≤0.30	4.80~ 6.00	0.40~ 0.65	-	-	-						
0.002	0.12	5.25	0.55	-	-	-						
Gt							≥400	480~ 660	≥22	-29°C ≥27	745±15 x1	
≤0.030	≤0.35	4.50~ 6.00	0.40~ 0.65	-	-	-						

Weld-Ex: Example of weld metal, Weld-Gt: Guaranty of weld metal

### Diameter of wire (mm)

<b>US-2CW</b>	1.6, 2.4, 3.2, 4.0
<b>US-502</b>	3.2, 4.0, 4.8

### Mesh size of flux

<b>MF-29A</b>	48xD
<b>PF-200S</b>	10x48

## SAW Flux and Wire Combination

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical					
					C	Si	Mn	P	S	
PF-200S/ US-12CRSD	-	Bonded	DC-EP	<ul style="list-style-type: none"> <li>▪ Suitable for T92/P92</li> <li>▪ RC: 200~300°Cx1</li> </ul>	Wire-Ex	0.07	0.35	0.74	0.004	0.003
					Wire-Gt	≤0.15	≤0.50	≤1.00	≤0.020	≤0.010
					Weld-Ex	0.06	0.24	0.88	0.008	0.004
					Weld-Gt	≤0.15	≤0.60	≤1.50	≤0.010	≤0.010

Note: Welding tests are as per AWS. Wire-Ex: Example of wire, Wire-Gt: Guaranty of wire, Ex: Example of weld metal (polarity: AC), Gt: Guaranty of weld metal (polarity: AC)



composition (%)							Mechanical properties of weld metal					
Cu	Cr	Mo	W	V	Nb	Others	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C/h)	
0.01	9.92	0.35	1.45	0.21	0.035	Ni:0.51 Co:1.01 N:0.040	Ex	652	775	23	20°C: 31	745 x8
≤1.30	9.50~ 12.00	0.10~ 0.70	1.00~ 2.00	0.05~ 0.35	0.01~ 0.10	Ni:≤0.80 Co:0.80~1.20 N:≤0.10						
0.02	9.48	0.32	1.36	0.20	0.03	Ni:0.52 Co:0.98 N:0.04	Gt	≥440	≥620	≥17	-	740 x8
≤0.80	8.60~ 13.00	0.10~ 0.70	1.00~ 2.00	≤0.35	≤0.080	Ni:≤1.50 Co:0.50~1.80 N:≤0.10						

Weld-Ex: Example of weld metal, Weld-Gt: Guaranty of weld metal

### Diameter of wire (mm)

US-12CRSD 2.4, 3.2

### Mesh size of flux

PF-200S 10x48



**For Stainless Steel**

# **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Flux Cored Arc Welding (FCAW)**

**Gas Metal Arc Welding (GMAW)**

**Gas Tungsten Arc Welding (GTAW)**

**Submerged Arc Welding (SAW)**

## For Stainless Steel

### A guide for selecting welding consumables (Product names)

Steel type	Key note for application	SMAW
304	▪ General	<b>NC-38</b>
304L	▪ Cryogenic temperatures	<b>NC-38LT</b>
	▪ Low carbon 0.04% max.	<b>NC-38L</b>
	▪ High temperature service and solution treatment	<b>NC-38L</b>
304H	▪ High temperatures	<b>NC-38H</b>
304N2	▪ General	-
Dissimilar metals	▪ General	<b>NC-39 NC-39L NC-39MoL NC-32</b>
	▪ High temperature service and solution treatment	-
316	▪ General	<b>NC-36</b>
316L	▪ Cryogenic temperatures	<b>NC-36LT</b>
	▪ Low carbon (0.04% max.)	<b>NC-36L</b>
	▪ High temperature service and solution treatment	<b>NC-36L</b>
316H	▪ High temperatures	-
316L Mod.	▪ Urea (Low ferrite content)	<b>NC-316MF</b>
317L	▪ Low carbon (0.04% max.)	<b>NC-317L</b>
347	▪ General	<b>NC-37</b>
	▪ Low carbon	<b>NC-37L</b>
	▪ High temperatures	<b>NC-37</b>
321	▪ General	<b>NC-37</b>
	▪ High temperatures	<b>NC-37</b>
310S	▪ General	<b>NC-30</b>
-	▪ Normal duplex	<b>NC-329M NC-2209</b>
	▪ Super duplex	<b>NC-2594</b>
	▪ Lean duplex	-
410	▪ General	<b>CR-40</b>
405, 409	▪ Overlaying in cladding	<b>CR-40Cb</b>
	▪ Underlying in cladding	<b>CR-43Cb CR-43CbS</b>
-	▪ Low carbon martensite	-
409,430,436,410L	▪ Car exhaust system	-

	<b>FCAW</b>	<b>GMAW</b>	<b>GTAW</b>	<b>SAW</b>
	DW-308 DW-308LP	MG-S308	TG-S308	PF-S1/US-308
	DW-308LT	-	TG-S308L	PF-S1/US-308L
	DW-308L DW-308LP	MG-S308LS	TG-S308L TG-X308L	PF-S1/US-308L
	DW-308LH	-	-	-
	DW-308H	-	-	-
	DW-308N2	-	-	-
	DW-309 DW-309L DW-309MoL DW-309LP DW-309MoLP DW-312	MG-S309 MG-S309LS	TG-S309 TG-S309L TG-X309L	PF-S1/US-309 PF-S1/US-309L
	DW-309LH	-	-	-
	DW-316 DW-316LP	-	TG-S316	PF-S1M/US-316 (single pass) PF-S1/US-316 (multi-pass)
	DW-316LT	-	TG-S316L	-
	DW-316L DW-316LP	MG-S316LS	TG-S316L TG-X316L	PF-S1M/US-316L (single pass) PF-S1/US-316L (multi-pass)
	DW-316LH	-	-	-
	DW-316H	-	-	-
	-	-	N04051 TG-S310MF	-
	DW-317L	-	TG-S317L	PF-S1/US-317L
	DW-347	MG-S347S	TG-S347 TG-X347	PF-S1/US-347
	-	MG-S347LS	TG-S347L	-
	DW-347H	MG-S347S	TG-S347	-
	DW-347	MG-S347S	TG-S347	PF-S1/US-347
	DW-347H	MG-S347S	TG-S347	-
	DW-310	-	TG-S310	-
	DW-329A DW-329AP DW-2209	-	TG-S329M TG-S2209	-
	DW-2594	-	TG-S2594	-
	DW-2101	-	-	-
	-	MG-S410	TG-S410	PF-S4M/US-410
	DW-410Cb	-	TG-S410Cb	-
	DW-430CbS	-	-	-
	MX-A135N MX-A410NM	-	-	-
	MX-A430M	MG-S430M	-	-

# For Stainless Steel

## Tips for better welding results for individual welding processes

### SMAW

- (1) Use proper welding currents because the use of an excessive current causes overheating electrodes and thereby welding usability and weld metal mechanical properties can be deteriorated.
- (2) Keep the arc as short as possible.
- (3) Control the weaving width of electrode within two and a half times the diameter of the electrode.

### FCAW

#### 1. Features:

- (1) DW stainless flux-cored wires are cost-effective wires because of high welding efficiency with the deposition rate 2-4 times as high as those of stick electrodes as shown in Fig. 1 and deposition efficiency of about 90%.
- (2) DW stainless wires offer a wider range of current and voltage in comparison with solid wire as shown in Fig. 2, which facilitates easier application for both semi-automatic and automatic welding.
- (3) DW stainless series has excellent usability and weldability with stable arc, low spatter, good slag removal, smooth bead appearance, and high X-ray soundness.

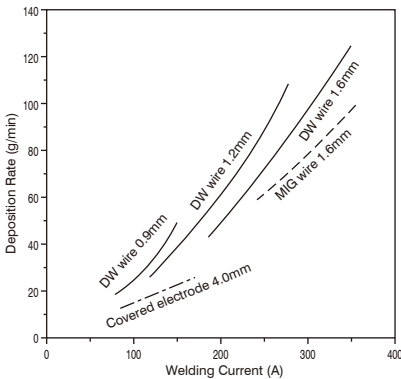


Fig. 1 Deposition rate as a function of welding current

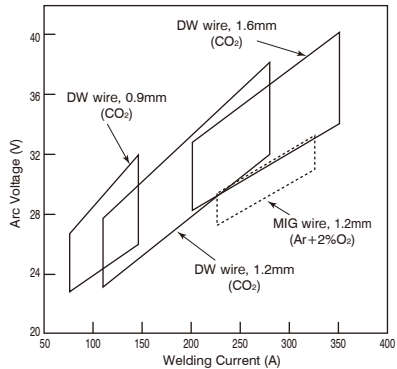


Fig. 2 Proper ranges of welding current and arc voltage

## 2. Notes on usage

(1) Welding power source:

Use a DC power source with constant voltage and the polarity DC-EP. Inverter-type welding power sources can also be used. When the use of a certain pulsed arc power source causes much spatter, use the wire with ordinary currents, turning off the pulse switch.

(2) Shielding gas:

Use CO<sub>2</sub> for shielding gas for general applications. Ar-CO<sub>2</sub> mixtures with 20-50% CO<sub>2</sub> can also be used, but compared with CO<sub>2</sub>, porosity (pit and blowhole) is apt to occur. The proper flow rate of shielding gas is 20-25 liter/min.

(3) Wire extension:

Keep the wire extension at about 15 mm for 0.9-mm wire and 15-20 mm for 1.2- and 1.6-mm wire. The use of a shorter wire extension may cause pit and worm-tracking porosity. The wire extension in welding with an Ar-CO<sub>2</sub> mixture should be 5 mm longer than in use of CO<sub>2</sub>.

(4) Protection against wind:

When wind velocity at the vicinity of an arc is more than 1 m/sec., blowhole is apt to occur, and dissolution of nitrogen into the weld metal may deteriorate slag removal and decrease the ferrite content of the weld metal, thereby causing hot cracking. To prevent these problems, use an adequate shielding gas flow rate and a windscreen.

(5) Welding fumes:

Flux-cored wires generate much more welding fumes in terms of the amount of fumes at unit time in comparison with that of covered electrodes. To protect welders from harmful welding fumes, be sure to use a local ventilator and an appropriate respirator.

(6) Storage of wire:

Once a DW stainless wire picked up moisture, it cannot be dried at high temperatures, unlike covered electrodes. If a DW wire was left in a wire feeder in a high-temperature high-humidity atmosphere in summer season, a wet environment in rainy season or a dewfall environment at night in winter season, the use of it may cause pit and worm-tracking porosity due to moisture pick up. Once a wire was unpacked, the wire should be kept in an area of low humidity, taking appropriate preventive measures against dewfall water and dust.

## For Stainless Steel

### 3. Applications

(1) Butt welding:

Applicable plate thicknesses are 2 mm or larger with a 1.2mm wire and 5 mm or larger with a 1.6mm wire in flat position. P-series wires enable to weld thin plates with 3-4 mm thickness in vertical position. One-side welding can be applied for similar-shape grooves in flat, horizontal and vertical positions by using a backing material of FBB-3 (T size). In this case, the root opening should be about 3-4 mm to obtain good reverse beads.

(2) Horizontal fillet welding:

Proper welding speeds are approximately 30-70 cm/min in horizontal fillet welding. With a 309 type wire, dissimilar-metal welding of stainless steel to carbon steel can be done in the same welding condition as used for welding stainless steels. However to secure the ferrite content of weld metal, welding currents should be 200A or lower and welding speeds should be 40 cm/mm or slower with a 1.2mm wire.

(3) Overlaying and joining of clad steels:

The 1st layer of overlaying onto carbon steel should be welded with a 309 (or 309MoL) type wire by the half lapping method. In case where the dilution by the base metal is excessive, the ferrite content of the weld metal decreases and thereby hot cracking may occur. Therefore, it is important to use appropriate welding conditions to control the dilution particularly for the first layer. In order to obtain the proper dilution ratio, welding currents should be 200A or lower and welding speeds should be 20-40 cm/min with a 1.2mm wire. With a 1.6mm wire, use welding currents in the 200-250 range and welding speeds in the 20-30 cm/min range. Refer to Fig. 3.

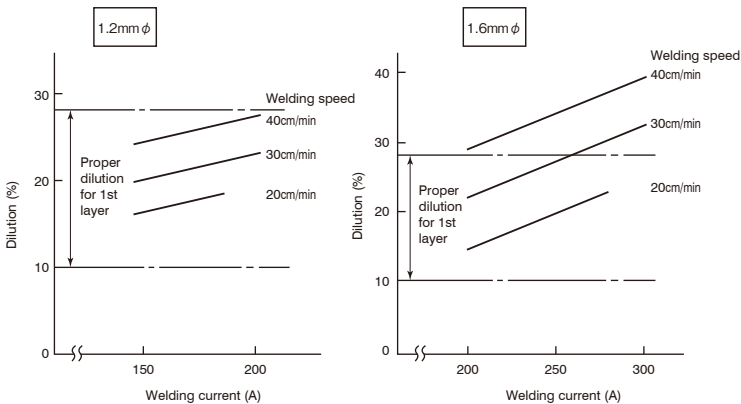


Fig. 3 Dilution ratios as a function of welding currents



## **GMAW**

- (1) Polarity:  
DC-EP is suitable.
- (2) Shielding gas:  
98% Ar-2%O<sub>2</sub> mixture is recommended for general applications. Proper gas flow rates range in 20-25 l/min. Ar-CO<sub>2</sub> mixture is not suitable for low carbon stainless steel (Type 304L) because the carbon content of deposited metal increases.
- (3) Arc length:  
GMAW of stainless steel generally uses the spray arc transfer mode due to lower spatter generation. Adjust arc voltage so that arc length becomes 4-6 mm. When arc length is excessively short, blowholes are apt to occur. Inversely, when arc length is excessively long, the wetting of deposited metal on the base metal becomes poor.
- (4) Protection against wind:  
GMAW is likely to be influenced by wind and thereby blowholes may occur. Use a windscreen to protect the arcing area against wind when the wind velocity near the arc is 0.5m/sec or more.
- (5) Pulsed arc welding:  
In pulsed arc welding, a stable spray arc can be obtained even with low welding currents. Pulsed arc is suitable for overlaying, welding of thin plates and vertical welding.

## **GTAW**

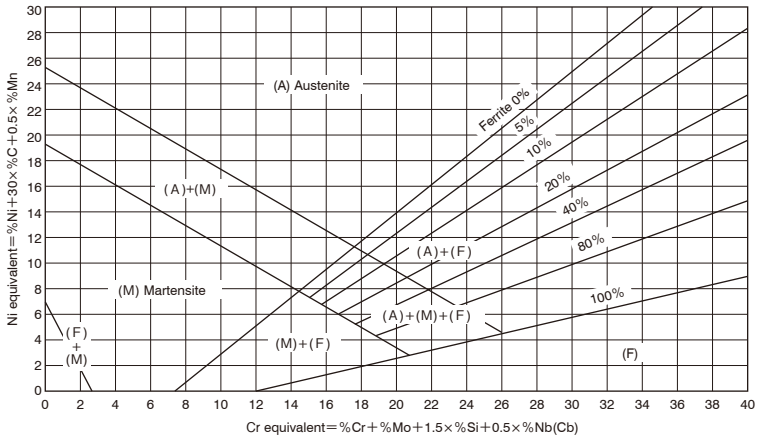
- (1) Polarity:  
DC-EN is suitable.
- (2) Shielding gas:  
Argon gas is mainly used for shielding. Suitable flow rates of shielding gas are in the range of 7-15 l/min. at 100-200A of welding current and 12-20 l/min. at 200-300A in manual GTAW.
- (3) Torch:  
Two types of GTAW torches are available. One has a gas lens, another has no gas lens. A torch with a gas lens provides better shielding effect preventing the weld bead from oxidation since the gas lens can provide a regular gas flow.
- (4) Tungsten electrode extension:  
Proper tungsten electrode extensions are generally in the range of 4-5 mm. In the case where shielding effect tends to be lower as in welding corner joint, tungsten extension is recommended to be 2-3 mm. In welding of deep groove joints, tungsten extension should be longer as 5-6 mm.
- (5) Arc length:  
Proper arc lengths are in the range of 1-3 mm. When it is excessively long, the shielding effect becomes poor.
- (6) One-side welding without backing materials:  
In the case of one-side welding without backing materials, adopt back shielding in order to prevent oxidization of the penetration bead. However, with a flux-cored filler rod for GTAW, sound penetration bead can be obtained without back shielding.
- (7) Fully austenitic type filler wires:  
With a fully austenitic type filler wire (e.g., TGS-310, TGS-310MF), use lower welding currents and welding speeds to prevent hot cracking.

# For Stainless Steel

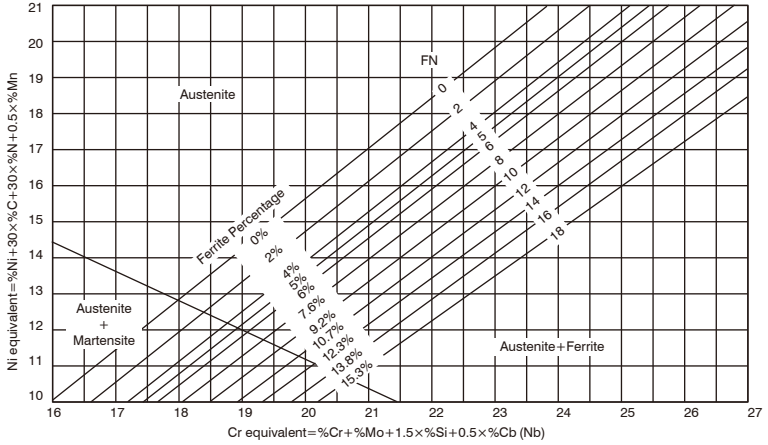
## Ferrite content measuring methods for austenitic stainless steel weld metal

Method	Principles of measuring ferrite content
Ferrite Indicator:	Comparing the magnetic attraction between a standard ferrite percent insert and a test specimen
Ferrite Scope:	Measuring a change of magnetic induction affected by the ferrite content of a test specimen
Magne Gage:	Measuring the pull off force necessary to detach a standard permanent magnet from a test specimen
Structure Diagram:	Calculating Ni equivalent and Cr equivalent of the chemical composition of a test specimen and reading the crossing point of the two equivalents in a structure diagram. Three structure diagrams are available: Schaeffler diagram, DeLong diagram and WRC diagram. See Figs. 1, 2 and 3.
Point Counting:	Calculating the area percentage of ferrite in the microstructure of a test specimen, by using a optical microscope

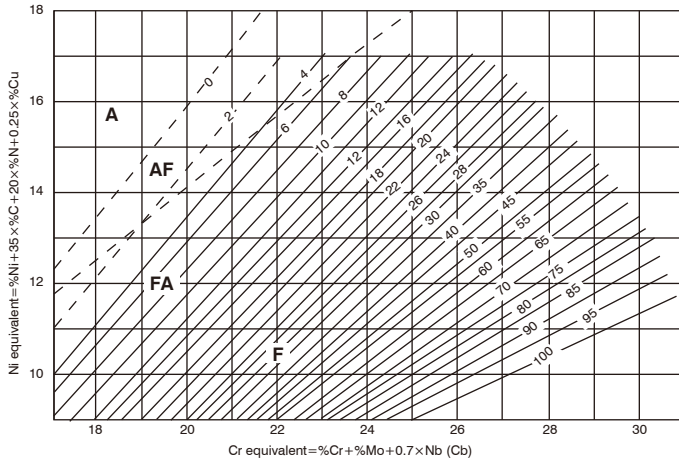
Fig. 1 Schaeffler Diagram



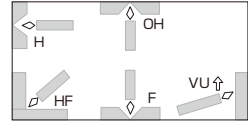
**Fig. 2 DeLong Diagram**



**Fig. 3 WRC Diagram**



- A, AF, FA, F stand for solidification modes
- A : Austenitic single phase( r )
- AF : Primary phase ( r ) + Eutectic Ferrite ( δ )
- FA : Primary phase ( δ ) + Peritectic / Eutectic phase ( r )
- F : δ Single phase Solidification

**Covered electrode for 18%Cr-8%Ni steel****Classification:** ASME / AWS A5.4 E308-16**Features:** • Applicable for 304 type steel**Redrying Conditions:** 150~200°Cx0.5~1h**Identification color:** 1st Yellow, 2nd -**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr
Example	0.07	0.35	1.69	0.023	0.002	9.58	20.49
Guaranty	≤0.08	≤0.90	0.5~2.5	≤0.04	≤0.03	9.0~11.0	18.0~21.0

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	410	600	46	0°C: 74
Guaranty	-	≥550	≥35	-

**Recommended welding parameters**

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	25~55A	50~85A	70~115A	95~145A	135~180A
VU, OH	20~50A	45~80A	65~110A	85~135A	-

**Polarity**

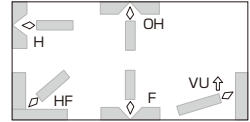
Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS	DNV	NK
MG(E308-16)	308	KD308

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.0	250	2	20	11
2.6	300	2	20	20
3.2	350	5	20	36
4.0	350	5	20	54
5.0	350	5	20	80

**Covered electrode for low carbon 18%Cr-8%Ni steel****Classification:** ASME / AWS A5.4 E308L-16**Features:** • Applicable for 304L type steel  
• Lower carbon content than **NC-38****Redrying Conditions:** 150~200°Cx0.5~1h**Identification color:** 1st Red, 2nd -**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>	<b>Cr</b>
Example	0.034	0.33	1.43	0.022	0.006	9.57	20.07
Guaranty	≤0.04	≤0.90	0.5~2.5	≤0.04	≤0.03	9.0~11.0	18.0~21.0

**Mechanical properties of all-weld metal as per AWS**

	<b>0.2%OS (MPa)</b>	<b>TS (MPa)</b>	<b>EI (%)</b>	<b>IV (J)</b>
Example	410	580	48	0°C: 78
Guaranty	-	≥520	≥35	-

**Recommended welding parameters**

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	25~55A	50~85A	70~115A	95~145A	135~180A
VU, OH	20~50A	45~80A	65~110A	85~135A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

<b>LR</b>	<b>BV</b>	<b>NK</b>	<b>GL</b>
304Lm(Chem.)	UP(E308L-16)	KD308L	4306

**Packages**

<b>Dia. (mm)</b>	<b>Length (mm)</b>	<b>Weight per pack (kg)</b>	<b>Weight per carton (kg)</b>	<b>Weight per piece (g)</b>
2.0	250	2	20	9
2.6	300	2	20	18
3.2	350	5	20	33
4.0	350	5	20	51
5.0	350	5	20	79

# NC-38H

# PREMIARC™

Covered electrode for 18%Cr-8%Ni steel for high temperatures

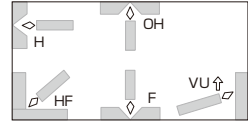
**Classification:** ASME / AWS A5.4 E308H-16

**Features:** • Applicable for 304 type steel for high temperature  
• Low ferrite, low impurity, and excellent mechanical properties at high temperatures

**Redrying Conditions:** 150~200°Cx0.5~1h

**Identification color:** 1st Yellow, 2nd -

**Welding Positions:**



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Cr
Example	0.06	0.45	1.95	0.020	0.002	9.50	19.50
Guaranty	0.04~0.08	≤0.90	0.5~2.5	≤0.04	≤0.03	9.0~11.0	18.0~21.0

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	403	572	48	0°C: 79
Guaranty	-	≥550	≥35	-

## Recommended welding parameters

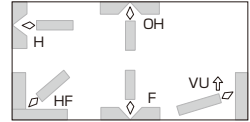
	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	50~85A	70~115A	95~145A	135~180A
VU, OH	45~80A	65~110A	85~135A	-

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	20
3.2	350	5	20	36
4.0	350	5	20	54
5.0	350	5	20	80

**Covered electrode for 22%Cr-12%Ni steel and dissimilar metals****Classification:** ASME / AWS A5.4 E309-16**Features:** • Suitable for dissimilar-metal joint and underlaying on ferritic steels in stainless steel weld metal overlaying**Redrying Conditions:** 150~200°Cx0.5~1h**Identification color:** 1st Black, 2nd White**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr
Example	0.08	0.53	1.50	0.020	0.003	12.72	23.97
Guaranty	≤0.15	≤0.90	0.5~2.5	≤0.04	≤0.03	12.0~14.0	22.0~25.0

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	410	590	39	0°C: 62
Guaranty	-	≥550	≥30	-

**Recommended welding parameters**

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	25~55A	50~85A	70~115A	95~145A	135~180A
VU, OH	20~50A	45~80A	65~110A	85~135A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS	LR	DNV	BV	NK	Others
MG(E309-16)	SS/CMn m(Chem.)	309	UP(E309-16)	KD309	GL:4332 CCS:AS2-B

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.0	250	2	20	9
2.6	300	2	20	20
3.2	350	5	20	35
4.0	350	5	20	51
5.0	350	5	20	78

## Covered electrode for dissimilar metals

**Classification:** ASME / AWS A5.4 E309L-16

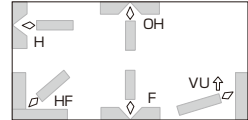
**Features:**

- Suitable for dissimilar-metal joint and underlaying on ferritic steels in stainless steel weld metal overlaying
- Lower carbon content than **NC-39**

**Redrying Conditions:** 150~200°Cx0.5~1h

**Identification color:** 1st Yellow green, 2nd Blue white

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Cr
Example	0.030	0.60	1.50	0.020	0.005	12.50	23.13
Guaranty	≤0.04	≤0.90	0.5~2.5	≤0.04	≤0.03	12.0~14.0	22.0~25.0

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	410	560	42	0°C: 67
Guaranty	-	≥520	≥30	-

## Recommended welding parameters

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	25~55A	50~85A	70~115A	95~145A	135~180A
VU, OH	20~50A	45~80A	65~110A	85~135A	-

## Polarity

Example	AC
Guaranty	AC, DC-EP

## Approvals

LR	DNV	BV	NK	Others
SS/CMn(Chem.)	309L	UP(E309L-16)	KD309L	TÜV

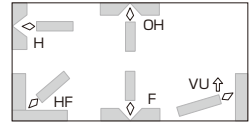
## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	19
3.2	350	5	20	34
4.0	350	5	20	55
5.0	350	5	20	85



**Covered electrode for dissimilar metals****Classification:** ASME / AWS A5.4 E309LMo-16**Features:**

- Suitable for dissimilar-metal joint and underlaying on ferritic steels in stainless steel weld metal overlaying
- Lower carbon content than **NC-39**

**Redrying Conditions:** 150~200°Cx0.5~1h**Identification color:** 1st Silver, 2nd Blue**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr	Mo
Example	0.029	0.51	1.28	0.024	0.005	12.65	23.08	2.29
Guaranty	≤0.04	≤0.90	0.5~ 2.5	≤0.04	≤0.03	12.0~ 14.0	22.0~ 25.0	2.0~ 3.0

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	450	630	41	0°C: 65
Guaranty	-	≥520	≥30	-

**Recommended welding parameters**

	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	50~85A	70~115A	95~145A	135~180A
VU, OH	45~80A	65~110A	85~135A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS	NK
MG	KD309Mo

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece(g)
2.6	300	2	20	19
3.2	350	5	20	33
4.0	350	5	20	54
5.0	350	5	20	85

## Covered electrode for 18%Cr-12%Ni-2%Mo steel

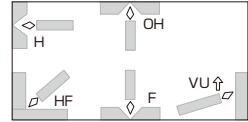
**Classification:** ASME / AWS A5.4 E316-16

**Features:** • Applicable for 316 type steel

**Redrying Conditions:** 150~200°Cx0.5~1h

**Identification color:** 1st White, 2nd -

## Welding Positions:



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Cr	Mo
Example	0.06	0.32	1.33	0.022	0.004	11.79	19.17	2.25
Guaranty	≤0.08	≤0.90	0.5~ 2.5	≤0.04	≤0.03	11.0~ 14.0	17.0~ 20.0	2.0~ 3.0

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	410	570	46	0°C: 80
Guaranty	-	≥520	≥30	-

## Recommended welding parameters

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
Dia.	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	25~55A	50~85A	70~115A	95~145A	135~180A
VU, OH	20~50A	45~80A	65~110A	85~135A	-

## Polarity

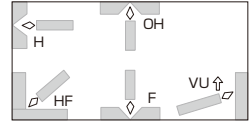
Example	AC
Guaranty	AC, DC-EP

## Approvals

NK
KD316

## Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.0	250	2	20	10
2.6	300	2	20	19
3.2	350	5	20	33
4.0	350	5	20	51
5.0	350	5	20	78

**Covered electrode for low carbon 18%Cr-12%Ni-2%Mo steel****Classification:** ASME / AWS A5.4 E316L-16**Features:** - Applicable for 316L type steel  
- Lower carbon content than **NC-36****Redrying Conditions:** 150~200°Cx0.5~1h**Identification color:** 1st Green, 2nd -**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS**

	C	Si	Mn	P	S	Ni	Cr	Mo
Example	0.023	0.57	1.56	0.025	0.003	12.17	18.68	2.20
Guaranty	≤0.04	≤0.90	0.5~ 2.5	≤0.04	≤0.03	11.0~ 14.0	17.0~ 20.0	2.0~ 3.0

**Mechanical properties of all-weld metal as per AWS**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	420	580	45	0°C: 83
Guaranty	-	≥485	≥30	-

**Recommended welding parameters**

	2.0mm	2.6mm	3.2mm	4.0mm	5.0mm
F, HF, H	25~55A	50~85A	70~115A	95~145A	135~180A
VU, OH	20~50A	45~80A	65~110A	85~135A	-

**Polarity**

Example	AC
Guaranty	AC, DC-EP

**Approvals**

ABS	LR	DNV	BV	NK	GL
MG(E316-16)	316Lm(Chem.)	316L	UP(E316L-16)	KD316L	4435

**Packages**

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.0	250	2	20	10
2.6	300	2	20	19
3.2	350	5	20	34
4.0	350	5	20	51
5.0	350	5	20	78

# CR-40 - CR-40Cb

# PREMIARC™

## Covered electrodes for 13%Cr steel

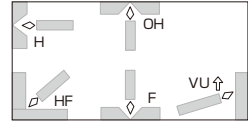
**Classification:** ASME / AWS A5.4 E410-16: CR-40  
E409Nb-16: CR-40Cb

- Features:**
- CR-40 is suitable for 13%Cr martensitic stainless steels such as 403 and 410 types.
  - CR-40Cb is suitable for 13%Cr martensitic stainless steels such as 403 and 410 types and 13%Cr ferritic stainless steels such as 405 type.
  - Preheat: 200~400°C (CR-40), 100~250°C (CR-40Cb)
  - PWHT: 700~760°C (CR-40), 600~760°C (CR-40Cb)

**Redrying Conditions:** 300~350°Cx0.5~1h

**Identification color:** **CR-40** 1st Purple, 2nd -  
**CR-40Cb** 1st Purple, 2nd Orange

### Welding Positions:



### Chemical composition of all-weld metal (%) as per AWS

		C	Si	Mn	P	S	Cr	Nb
<b>CR-40</b>	Example	0.08	0.47	0.28	0.020	0.006	12.83	-
	Guaranty	≤0.12	≤0.90	≤1.0	≤0.04	≤0.03	11.0~13.5	-
<b>CR-40Cb</b>	Example	0.09	0.40	0.42	0.018	0.002	13.18	0.81
	Guaranty	≤0.12	≤0.90	≤1.00	≤0.040	≤0.030	11.0~14.0	0.50~1.50

### Mechanical properties of all-weld metal as per AWS

		0.2%OS (MPa)	TS (MPa)	EI (%)	PWHT
<b>CR-40</b>	Example	290	510	33	850°Cx2h*
	Guaranty	-	≥450	≥20	
<b>CR-40Cb</b>	Example	270	500	35	850°Cx2h*
	Guaranty	-	≥450	≥20	

### Recommended welding parameters

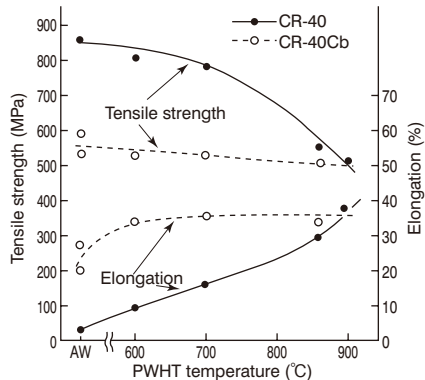
Dia.	3.2mm	4.0mm	5.0mm
F, HF, H	70~115A	95~145A	135~180A
VU, OH	65~110A	85~135A	-

### Polarity

Example	AC
Guaranty	AC, DC-EP

### Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
3.2	350	5	20	31
4.0	400	5	20	53
5.0	400	5	20	78



**Mechanical properties at room temperature vs. postweld heat treatment temperature**

# CR-43 ▪ CR-43Cb ▪ CR-43CbS PREMIARC™

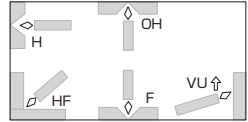
## Covered electrodes for 17%Cr steel

**Classification:** ASME / AWS A5.4 E430-16: CR-43

E430Nb-16: CR-43Cb

- Features:**
- CR-43 and CR-43Cb are suitable for 17%Cr ferritic stainless steels such as 430 type.
  - CR-43CbS is suitable for underlay welding on clad side groove of 405 type clad steel and on carbon and low alloy steels for overlaying 13%Cr stainless weld metal.
  - Preheat: 150~250°C (CR-43), 100~250°C (CR-43Cb), 100~200°C (CR-43CbS)
  - PWHT: 700~820°C (CR-43), 600~820°C (CR-43Cb, CR-43CbS)

### Welding Positions:



**Redrying Conditions:** 300~350°Cx0.5~1h

**Identification color:** CR-43 1st Brown, 2nd Silver gray

CR-43Cb 1st Brown, 2nd Blue white

CR-43CbS 1st Brown, 2nd Purple

### Chemical composition of all-weld metal (%) as per AWS

		C	Si	Mn	P	S	Cr	Nb
CR-43	Example	0.09	0.60	0.27	0.021	0.003	17.65	-
	Guaranty	≤0.10	≤0.90	≤1.0	≤0.040	≤0.030	15.0~18.0	-
CR-43Cb	Example	0.09	0.46	0.40	0.020	0.002	17.24	0.80
	Guaranty	≤0.10	≤0.90	≤1.00	≤0.040	≤0.030	15.0~18.0	0.50~1.50
CR-43CbS	Example	0.05	0.36	0.39	0.016	0.003	15.41	0.97
	Guaranty	≤0.08	≤0.90	≤1.00	≤0.040	≤0.030	14.5~17.0	0.50~1.50

### Mechanical properties of all-weld metal as per AWS

		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT
CR-43	Example	300	560	24	0°C: 5	770x2h*
	Guaranty	-	≥450	≥20	-	
CR-43Cb	Example	290	520	33	0°C: 75	770x2h*
	Guaranty	-	≥480	≥20	-	
CR-43CbS	Example	300	600	26	-	770x2h*
	Guaranty	-	≥480	≥16	-	

\* FC to 600°C, followed by AC

### Recommended welding parameters

	3.2mm	4.0mm	5.0mm
Dia.	3.2mm	4.0mm	5.0mm
F, HF, H	70~115A	95~145A	135~180A
VU, OH	65~110A	85~135A	-

### Polarity

Example	AC
Guaranty	AC, DC-EP

### Packages

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
3.2	350	5	20	31
4.0	400	5	20	55
5.0	400	5	20	78

## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical		
						C	Si	
NC-38LT	A5.4 E308L -16	Lime titania	AC	▪ Suitable for 18%Cr-8%Ni steel for cryogenic temperature service ▪ RC: 150~200°Cx 0.5~1h	F HF	Ex	0.034	0.38
			DC- EP		H VU OH	Gt	≤0.04	≤0.90
NC-36LT	A5.4 E316L -16	Lime titania	AC	▪ Suitable for 18%Cr-12%Ni- 2%Mo steel for cryogenic temperature service ▪ RC: 150~200°Cx 0.5~1h	F HF	Ex	0.030	0.52
			DC- EP		H VU OH	Gt	≤0.04	≤0.90
NC-317L	A5.4 E317L -16	Lime titania	AC	▪ Suitable for low carbon 19%Cr-13%Ni-3%Mo steel ▪ RC: 150~200°Cx 0.5~1h	F HF	Ex	0.030	0.50
			DC- EP		H VU OH	Gt	≤0.04	≤0.90

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Approvals

NC-38LT LR, DNV, NK

### Identification color

Product names	1st	2nd
NC-38LT	Red	Yellow
NC-36LT	Green	-
NC-317L	Sorrel	Orange

composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Mn	P	S	Ni	Cr	Mo		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
2.12	0.022	0.002	10.89	18.36	0.06	Ex	370	540	51	-196°C: 52
0.5~ 2.5	≦0.04	≦0.03	9.0~ 11.0	18.0~ 21.0	≦0.75	Gt	-	≧520	≧35	-196°C ≧34
2.02	0.021	0.003	13.06	17.28	2.25	Ex	390	530	44	-196°C: 40
0.5~ 2.5	≦0.04	≦0.03	11.0~ 14.0	17.0~ 20.0	2.0~ 3.0	Gt	-	≧485	≧30	-196°C ≧27
1.17	0.027	0.004	13.28	19.11	3.50	Ex	440	600	39	-
0.5~ 2.5	≦0.04	≦0.03	12.0~ 14.0	18.0~ 21.0	3.0~ 4.0	Gt	-	≧520	≧30	-

Gt: Guaranty (polarity: as specified above)

## Diameter of wire (mm)

Dia.	2.6	3.2	4.0	5.0
<b>NC-38LT</b>	300	350	350	350
<b>NC-36LT</b>	300	350	350	350
<b>NC-317L</b>	300	350	350	-

## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical			
						C	Si		
NC-37	A5.4 E347 -16	Lime titania	AC	<ul style="list-style-type: none"> <li>• Suitable for 18%Cr-8%Ni-Nb steel</li> <li>• RC: 150~200°C x0.5~1h</li> </ul>	F	Ex	0.060	0.60	
			DC-EP		H	Gt	≤0.08	≤0.90	
NC-37L	A5.4 E347 -16	Lime titania	AC		F				Ex
			DC-EP		H	Gt	≤0.04	≤0.90	
NC-316MF	-	Lime titania	AC	<ul style="list-style-type: none"> <li>• Suitable for urea plant in cryogenic temperature service</li> <li>• RC: 150~200°C x0.5~1h</li> </ul>	F				Ex
			DC-EP		H	Gt	≤0.04	≤0.90	
NC-32	A5.4 E312 -16	Lime titania	AC		<ul style="list-style-type: none"> <li>• Suitable for dissimilar joint between carbon steel and stainless steel rich in carbon or nickel.</li> <li>• RC: 150~250°C x0.5~1h</li> </ul>				F
			DC-EP			H	Gt	≤0.15	≤1.00
			VU						
						OH			

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Approvals

NC-37L	TÜV
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### Identification color

Product names	1st	2nd
NC-37	Blue	Blue
NC-37L	Blue	Green
NC-316MF	Green	Pink
NC-32	Green	Red



Mn	composition of all-weld metal (%)					Mechanical properties of all-weld metal				
	P	S	Ni	Cr	Others	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	
1.66	0.018	0.002	9.82	20.22	Nb: 0.67	Ex	470	670	34	-
0.5~ 2.5	≤0.04	≤0.03	9.0~ 11.0	18.0~ 21.0	Nb: 8xC%~ 1.00	Gt	-	≥520	≥30	-
2.33	0.022	0.004	9.42	18.80	Nb: 0.52	Ex	420	600	45	-
0.5~ 2.5	≤0.04	≤0.03	9.0~ 11.0	18.0~ 21.0	Nb: 8xC%~ 1.00	Gt	-	≥520	≥30	-
5.39	0.014	0.002	17.13	18.80	Mo: 2.85	Ex	370	520	44	-257°C: 70
4.00~ 7.00	≤0.030	≤0.020	15.00~ 18.00	17.00~ 19.50	Mo: 2.20~ 3.00	Gt	-	≥480	≥35	-
1.21	0.010	0.001	9.61	28.17	Mo: 0.01	Ex	624	785	20	-
0.5~ 2.5	≤0.04	≤0.03	8.0~ 10.5	28.0~ 32.0	Mo: ≤0.75	Gt	-	≥655	≥22	-

Gt: Guaranty (polarity: as specified above)

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0
<b>NC-37</b>	250	300	350	350
<b>NC-37L</b>	300	350	350	350
<b>NC-316MF</b>	300	350	350	350
<b>NC-32</b>	-	300	350	350

## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical		
						C	Si	
NC-329M	-	Lime titania	AC	<ul style="list-style-type: none"> <li>Suitable for normal duplex stainless steel</li> <li>RC: 150~200°C x0.5~1h</li> </ul>	F HF H VU OH	Ex	0.030	0.71
			DC-EP			Gt	≤0.04	≤0.90
NC-2209	A5.4 E2209 -16	Lime titania	AC	<ul style="list-style-type: none"> <li>Suitable for normal duplex stainless steel (S32205,S31803,etc.)</li> <li>RC: 250~350°C x1~2h</li> </ul>	F HF H VU OH	Ex	0.028	0.54
			DC-EP			Gt	≤0.04	≤1.00
NC-2594	A5.4 E2594 -16	Lime titania	AC	<ul style="list-style-type: none"> <li>Suitable for super duplex stainless steel (S32750,S32760,etc.)</li> <li>RC: 250~350°C x1~2h</li> </ul>	F HF H VU OH	Ex	0.034	0.55
			DC-EP			Gt	≤0.04	≤1.00

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Identification color

Product names	1st	2nd
NC-329M	Yellow	White
NC-2209	-	-
NC-2594	-	-

composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Mn	P	S	Ni	Cr	Others	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	
0.62	0.013	0.002	9.44	24.51	Mo: 3.25 N:0.16	Ex	640	860	28	0°C: 70
0.50~ 2.50	≦0.040	≦0.030	8.00~ 10.00	23.00~ 25.00	Mo: 2.50~ 4.00	Gt	-	≧620	≧18	-
1.14	0.017	0.001	8.81	23.09	Mo: 3.34 N:0.15	Ex	667	845	30	-50°C: 72
0.50~ 2.00	≦0.040	≦0.030	8.50~ 10.50	21.50~ 23.50	Mo: 2.50~ 3.50 N:0.08~ 0.20	Gt	-	≧690	≧20	-
0.66	0.017	0.001	9.32	25.42	Mo: 3.86 N:0.24	Ex	750	935	28	-50°C: 40
0.50~ 2.00	≦0.040	≦0.030	8.00~ 10.50	24.00~ 27.00	Mo: 3.50~ 4.50 N:0.20~ 0.30	Gt	-	≧760	≧15	-

Gt: Guaranty (polarity: as specified above)

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0
<b>NC-329M</b>	-	350	350	-
<b>NC-2209</b>	300	350	350	350
<b>NC-2594</b>	300	350	350	350

# DW-308

Flux cored wire for 18%Cr-8%Ni steel

**Classification:** ASME / AWS A5.22 E308T0-1/4  
EN ISO 17633-A-T Z 19 9 R C/M 3

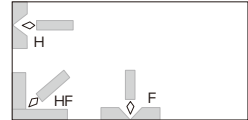
**Features:** - Applicable for 304 type steel

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:**



## Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.050	0.57	1.52	0.020	0.009	9.68	19.72	0.02	0.03
Guaranty	≤0.08	≤1.00	0.50~ 2.50	≤0.040	≤0.030	9.00~ 11.00	18.00~ 21.00	≤0.50	≤0.50

## Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	390	570	41	0°C: 39
Guaranty	-	≥550	≥35	-

## Recommended welding parameters

	0.9mm	1.2mm	1.6mm
Dia.	0.9mm	1.2mm	1.6mm
F, HF	80~150A	130~270A	190~340A
H	90~130A	150~220A	220~270A

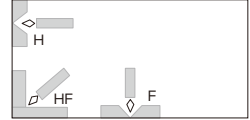
## Approvals

ABS	NK
MG (A5.22 E308T0-1)	KW308G(C)

## Packages

Dia. (mm)	Type	Weight (kg)
0.9	Spool	5, 12.5
1.2	Spool	12.5
1.6	Spool	12.5

# DW-308L

**Flux cored wire for low carbon 18%Cr-8%Ni steel****Classification:** ASME / AWS A5.22 E308LT0-1/4  
EN ISO 17633-A-T 19 9 L R C/M 3**Features:** • Applied for 304L type steel  
• Lower carbon content than DW-308**Type of flux:** Rutile**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture**Polarity:** DC-EP**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.027	0.56	1.49	0.019	0.008	10.02	19.53	0.02	0.03
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	9.00~ 11.00	18.00~ 21.00	≤0.50	≤0.50

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	370	550	42	0°C: 41
Guaranty	-	≥520	≥35	-

**Recommended welding parameters**

Dia.	0.9mm	1.2mm	1.6mm
F, HF	80~150A	130~270A	190~340A
H	90~130A	150~220A	220~270A

**Approvals**

<b>ABS</b>	<b>LR</b>	<b>DNV</b>	<b>NK</b>	<b>GL</b>	<b>Others</b>
MG	304L S CRYO	308L	KW308LG(C)	4306S	CWB

**Packages**

Dia. (mm)	Type	Weight (kg)
0.9	Spool	5, 12.5
1.2	Spool	12.5
1.6	Spool	12.5

## Flux cored wire for low carbon 18%Cr-8%Ni steel

**Classification:** ASME / AWS A5.22 E308LT1-1/4  
EN ISO 17633-A-T 19 9 L P C/M 1

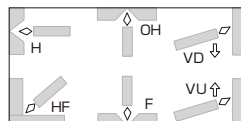
**Features:** • Applicable for 304 and 304L type steel  
• Lower carbon content than **DW-308**

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:

Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.027	0.55	1.51	0.022	0.010	9.89	19.45	0.02	0.03
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	9.00~ 11.00	18.00~ 21.00	≤0.50	≤0.50

Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	380	550	45	0°C: 57
Guaranty	-	≥520	≥35	-

## Recommended welding parameters

	1.2mm	1.2mm
Dia.	1.2mm	1.2mm
F, HF	130~270A	150~200A
H	150~220A	150~200A
VU	130~220A	

VD position: multi-pass welding is not recommended.

## Approvals

ABS	LR	DNV	BV	NK	KR	Others
MG	304L S CRYO	308L	308L B T	KW308LG(C)	RW308LG(C)	CWB

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5

**Flux cored wire for dissimilar metals**

**Classification:** ASME / AWS A5.22 E309T0-1/4  
 EN ISO 17633-A-T Z 23 12 R C/M 3

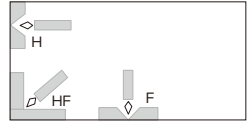
**Features:** • Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlying stainless steel weld metals

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:**



**Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.035	0.58	1.22	0.021	0.009	12.48	24.03	0.03	0.02
Guaranty	≤0.10	≤1.00	0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	22.00~ 25.00	≤0.50	≤0.50

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	450	590	32	0°C: 33
Guaranty	-	≥550	≥30	-

**Recommended welding parameters**

Dia.	1.2mm	1.6mm
F, HF	130~270A	190~340A
H	150~220A	220~270A

**Packages**

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5
1.6	Spool	12.5

# DW-309L

## Flux cored wire for dissimilar metals

**Classification:** ASME / AWS A5.22 E309LT0-1/4  
EN ISO 17633-A-T 23 12 L R C/M 3

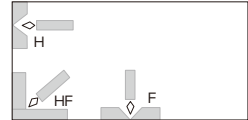
**Features:** • Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals  
• Lower carbon content than **DW-309**

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

### Welding Positions:



### Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.028	0.61	1.24	0.019	0.010	12.58	24.17	0.05	0.03
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	22.00~ 25.00	≤0.50	≤0.50

### Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	EI (%)
Example	450	580	33
Guaranty	-	≥520	≥30

### Recommended welding parameters

	0.9mm	1.2mm	1.6mm
Dia.	0.9mm	1.2mm	1.6mm
F, HF	80~150A	130~270A	190~340A
H	90~130A	150~220A	220~270A

### Approvals

ABS	LR	DNV	BV	NK	GL	Others
MG	SS/CMn S CHEM	309L	UP	KW309LG(C) (Based on KW309)	4332S	CWB

### Packages

Dia. (mm)	Type	Weight (kg)
0.9	Spool	5, 12.5
1.2	Spool	12.5
1.6	Spool	12.5



# DW-309LP

## Flux cored wire for dissimilar metals

**Classification:** ASME / AWS A5.22 E309LT1-1/4

EN ISO 17633-A-T 23 12 L P C/M 1

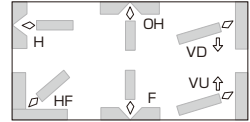
**Features:** • Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals  
• Lower carbon content than **DW-309**

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

### Welding Positions:



### Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.027	0.56	1.21	0.023	0.009	12.45	23.55	0.04	0.06
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	22.00~ 25.00	≤0.50	≤0.50

### Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	EI (%)
Example	430	570	38
Guaranty	-	≥520	≥30

### Recommended welding parameters

Dia.	1.2mm	Dia.	1.2mm
F, HF	130~270A	OH	150~200A
H	150~220A	VD	150~200A
VU	130~220A		

VD position: multi-pass welding is not recommended.

### Approvals

ABS	LR	DNV	BV	NK	Others
MG (A5.22 E309LT-1,4)	SS/CMn S CRYO(CO <sub>2</sub> ) SS/CMn S CHEM(Ar-CO <sub>2</sub> )	309L	309L	KW309LG(C)	CWB

### Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5

## Flux cored wire for dissimilar metals

**Classification:** ASME / AWS A5.22 E309LMoT0-1/4  
EN ISO 17633-A-T 23 12 2 L R C/M 3

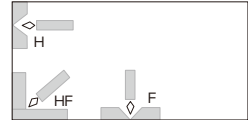
**Features:** • Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:

Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.027	0.61	1.18	0.019	0.009	12.60	23.20	2.37	0.03
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	22.00~ 25.00	2.00~ 3.00	≤0.50

Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	EI (%)
Example	540	720	30
Guaranty	-	≥520	≥25

## Recommended welding parameters

	0.9mm	1.2mm	1.6mm
Dia.	0.9mm	1.2mm	1.6mm
F, HF	80~150A	130~270A	190~340A
H	90~130A	150~220A	220~270A

## Approvals

ABS	LR	DNV	BV	NK
MG	SS/CMn S CHEM	309MoL	UP	MG

## Packages

Dia. (mm)	Type	Weight (kg)
0.9	Spool	5, 12.5
1.2	Spool	12.5
1.6	Spool	12.5

# DW-309MoLP

**Flux cored wire for dissimilar metals**

**Classification:** ASME / AWS A5.22 E309LMoT1-1/4  
 EN ISO 17633-A-T 23 12 2 L R C/M 1

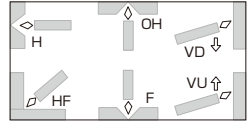
**Features:** • Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:**



**Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.025	0.62	0.81	0.020	0.010	12.44	22.60	2.21	0.05
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	22.00~ 25.00	2.00~ 3.00	≤0.50

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	EI (%)
Example	540	699	30
Guaranty	-	≥520	≥25

**Recommended welding parameters**

Dia.	1.2mm	Dia.	1.2mm
F, HF	130~270A	OH	150~200A
H	150~220A	VD	150~200A
VU	130~220A		

VD position: multi-pass welding is not recommended.

**Packages**

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5

## Flux cored wire for 18%Cr-12%Ni-2%Mo steel

**Classification:** ASME / AWS A5.22 E316T0-1/4  
EN ISO 17633-A-T Z 19 12 2 R C/M 3

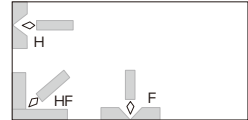
**Features:** - Applicable for 316 type steel

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:

Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.043	0.59	1.50	0.021	0.010	12.04	19.30	2.31	0.03
Guaranty	≤0.080	≤1.00	0.50~ 2.50	≤0.040	≤0.030	11.00~ 14.00	17.00~ 20.00	2.00~ 3.00	≤0.50

Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	390	555	40	0°C: 42
Guaranty	-	≥550	≥30	-

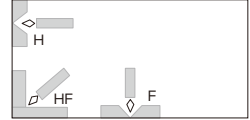
## Recommended welding parameters

Dia.	0.9mm	1.2mm	1.6mm
F, HF	80~150A	130~270A	190~340A
H	90~130A	150~220A	220~270A

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5
1.6	Spool	12.5

# DW-316L

**Flux cored wire for low carbon 18%Cr-12%Ni-2%Mo steel****Classification:** ASME / AWS A5.22 E316LT0-1/4  
EN ISO 17633-A-T Z 19 12 3 R C/M 3**Features:** • Applicable for 316L type steel  
• Lower carbon content than **DW-316****Type of flux:** Rutile**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture**Polarity:** DC-EP**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.026	0.59	1.43	0.020	0.010	12.02	18.95	2.54	0.06
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	11.00~ 14.00	17.00~ 20.00	2.00~ 3.00	≤0.50

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	380	540	41	0°C: 44
Guaranty	-	≥485	≥30	-

**Recommended welding parameters**

Dia.	0.9mm	1.2mm	1.6mm
F, HF	80~150A	130~270A	190~340A
H	90~130A	150~220A	220~270A

**Approvals**

ABS	LR	DNV	BV	NK	GL	Others
MG	316L S CHEM	316L	UP	KW316LG(C) (Based on KW316L)	4435S	CWB

**Packages**

Dia. (mm)	Type	Weight (kg)
0.9	Spool	5, 12.5
1.2	Spool	12.5
1.6	Spool	12.5

## Flux cored wire for low carbon 18%Cr-12%Ni-2%Mo steel

**Classification:** ASME / AWS A5.22 E316LT1-1/4  
EN ISO 17633-A-T 19 12 3 L P C/M 1

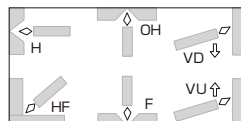
**Features:** • Applicable for 316 and 316L type steel  
• Lower carbon content than **DW-316**

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:

Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo
Example	0.028	0.60	1.50	0.021	0.008	12.65	18.35	2.68
Guaranty	≤0.040	≤1.00	0.50~ 2.50	≤0.040	≤0.030	11.00~ 14.00	17.00~ 20.00	2.00~ 3.00

Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	370	540	43	0°C: 54
Guaranty	-	≥485	≥30	-

## Recommended welding parameters

	Dia.	1.2mm	Dia.	1.2mm
F, HF	130~270A	OH	150~200A	
H	150~220A	VD	150~200A	
VU	130~220A			

VD position: multi-pass welding is not recommendable.

## Approvals

	LR	DNV	BV	NK	Others
316L S CHEM (Ar-CO <sub>2</sub> )		316L	316L (CO <sub>2</sub> )	KW316LG(C)	CWB

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5

**DW-329A****Flux cored wire for duplex stainless steel**

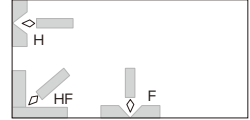
**Classification:** ASME / AWS A5.22 E2209T0-1/4  
EN ISO 17633-A-T 22 9 3 N L R C/M 3

**Features:** • Applied for SUS329J3L and ASTM S31803 steel

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

**Welding Positions:****Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)**

	C	Si	Mn	P	S	Ni	Cr	Mo	N	Cu
Example	0.030	0.58	1.12	0.018	0.008	9.34	22.91	3.08	0.12	0.01
Guaranty	≤0.040	≤1.00	0.50~ 2.00	≤0.040	≤0.030	8.00~ 10.00	22.00~ 24.00	2.50~ 4.00	0.08~ 0.20	≤0.50

**Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)**

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	610	810	29	-20°C: 42
Guaranty	-	≥690	≥20	-

**Recommended welding parameters**

Dia.	1.2mm	1.6mm
F, HF	130~250A	200~300A
H	150~220A	220~250A

**Packages**

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5
1.6	Spool	12.5

## Flux cored wire for duplex stainless steel

**Classification:** ASME / AWS A5.22 E2209T1-1/4  
EN ISO 17633-A-T 22 9 3 N L P C/M 1

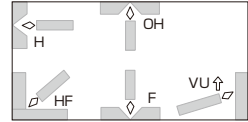
**Features:** • Applicable for SUS329J3L and ASTM S31803 steel  
• Suitable for butt and fillet welding in all positions

**Type of flux:** Rutile

**Shielding gas:** CO<sub>2</sub> or Ar-CO<sub>2</sub> mixture

**Polarity:** DC-EP

## Welding Positions:

Chemical composition of all-weld metal (%) as per AWS (Shielding gas: CO<sub>2</sub>)

	C	Si	Mn	P	S	Ni	Cr	Mo	N	Cu
Example	0.027	0.58	0.78	0.019	0.008	9.42	23.34	3.42	0.14	0.02
Guaranty	≤0.040	≤1.00	0.50~ 2.00	≤0.025	≤0.020	8.00~ 10.00	22.00~ 24.00	2.50~ 4.00	0.08~ 0.20	≤0.50

Mechanical properties of all-weld metal as per AWS (Shielding gas: CO<sub>2</sub>)

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	620	830	29	-20°C: 45
Guaranty	≥500	≥700	≥20	-

## Recommended welding parameters

Dia.	1.2mm
F, HF	130~250A
H	150~220A
VU	130~220A
OH	160~190A

## Packages

Dia. (mm)	Type	Weight (kg)
1.2	Spool	12.5





## Flux Cored Wires [Bi-free type]

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical			
							C	Si	Mn	
DW-308H	A5.22 E308H T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-8%Ni steel for high temperature service	F HF H VU OH	Ex	0.060	0.42	1.50
						Gt	0.040~ 0.080	≤1.00	0.50~ 2.50	
DW-308LH	A5.22 E308L T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-8%Ni steel with high temperature heat treatment such as solution treatment	F HF H VU OH	E	0.026	0.41	1.35
						Gt	≤0.040	≤1.00	0.50~ 2.50	
DW-309LH	A5.22 E309L T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for dissimilar metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	F HF H VU OH	Ex	0.029	0.41	1.25
						Gt	≤0.040	≤1.00	0.50~ 2.50	

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

DW-308H      CWB

composition of all-weld metal (%)					Mechanical properties of all-weld metal					
P	S	Ni	Cr	Others		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG
0.020	0.007	9.62	18.68	Bi: tr.	Ex	370	560	48	0°C: 71	CO <sub>2</sub>
≦0.040	≦0.030	9.00~ 11.00	18.00~ 21.00	Bi ≦0.001	Gt	-	≧550	≧35	-	
0.021	0.005	10.20	18.70	Bi: tr.	Ex	360	540	52	0°C: 76	CO <sub>2</sub>
≦0.040	≦0.030	9.00~ 11.00	18.00~ 21.00	Bi ≦0.001	Gt	-	≧520	≧35	-	
0.021	0.008	12.61	23.79	Bi: tr.	Ex	380	590	36	-	CO <sub>2</sub>
≦0.040	≦0.030	12.00~ 14.00	22.00~ 25.00	Bi ≦0.001	Gt	-	≧520	≧30	-	

## Diameter (mm)

DW-308H	1.2, 1.6
DW-308LH	1.2, 1.6
DW-309LH	1.2, 1.6

## Flux Cored Wires (Bi-free type)

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical			
							C	Si	Mn	
DW-316H	A5.22 E316 T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-12%Ni-2%Mo steel for high temperature service	F HF H VU OH	Ex	0.050	0.38	1.10
							Gt	≤0.08	≤1.00	0.50~ 2.50
DW-316LH	A5.22 E316L T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-12%Ni-2%Mo steel with high temperature heat treatment such as solution treatment	F HF H VU OH	Ex	0.023	0.45	1.08
							Gt	≤0.040	≤1.00	0.50~ 2.50
DW-347H	A5.22 E347 T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-8%Ni-Nb and 18%Cr-8%Ni-Ti steel for high temperature service	F HF H VU OH	Ex	0.027	0.38	1.18
							Gt	≤0.08	≤1.00	0.50~ 2.50

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)					Mechanical properties of all-weld metal					
P	S	Ni	Cr	Others		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG
0.019	0.006	11.60	18.75	Mo: 2.40 Bi: tr.	Ex	390	570	41	0°C: 68	CO <sub>2</sub>
≤0.040	≤0.030	11.00~ 14.00	17.00~ 20.00	Mo: 2.00~ 3.00 Bi ≤0.001	Gt	-	≥550	≥30	-	
0.020	0.007	11.94	18.47	Mo: 2.45 Bi: tr.	Ex	390	540	44	0°C: 66	CO <sub>2</sub>
≤0.040	≤0.030	11.00~ 14.00	17.00~ 20.00	Mo: 2.00~ 3.00 Bi ≤0.001	Gt	-	≥490	≥35	-	
0.018	0.008	10.20	18.87	Nb: 0.57 Bi: tr.	Ex	420	600	43	0°C: 80	CO <sub>2</sub>
≤0.040	≤0.030	9.00~ 11.00	18.00~ 21.00	Nb: 8xC~ 1.00 Bi ≤0.001	Gt	-	≥550	≥30	-	

## Diameter (mm)

DW-316H	1.2, 1.6
DW-316LH	1.2, 1.6
DW-347H	1.2, 1.6

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical		
							C	Si	
DW-308LT	A5.22 E308L T0-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-8%Ni steel for low temperature service	F HF	Ex	0.026	0.45
							Gt	≤0.040	≤1.00
DW-310	A5.22 E310 T0-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 25%Cr-20%Ni steel	F HF	Ex	0.18	0.58
							Gt	≤0.20	≤1.00
DW-312	A5.22 E312 T0-1	Rutile	CO <sub>2</sub>	DC- EP	▪ Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	F HF	Ex	0.11	0.53
							Gt	≤0.15	≤1.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

DW-308LT	LR, DNV, NK
DW-310	CWB
DW-312	CWB

composition of all-weld metal (%)					Mechanical properties of all-weld metal					
Mn	P	S	Ni	Cr		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG
2.37	0.023	0.009	10.30	18.60	Ex	380	530	51	-196°C: 39	CO <sub>2</sub>
0.50~ 2.50	≦0.040	≦0.030	9.00~ 11.00	18.00~ 21.00	Gt	-	≧520	≧35	-196°C ≧27	
2.10	0.016	0.005	20.36	25.50	Ex	420	620	33	0°C: 68	CO <sub>2</sub>
0.50~ 2.50	≦0.040	≦0.030	20.00~ 22.00	25.00~ 28.00	Gt	-	≧550	≧30	-	
1.62	0.019	0.009	10.23	28.44	Ex	600	720	23	-	CO <sub>2</sub>
0.50~ 2.50	≦0.040	≦0.030	8.00~ 10.50	28.00~ 32.00	Gt	-	≧660	≧22	-	

## Diameter (mm)

DW-308LT	1.2
DW-310	1.2
DW-312	1.2

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical		
							C	Si	
DW-316LT	A5.22 E316L T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-12%Ni-2%Mo steel for low temperature service	F HF H VU OH	Ex	0.027	0.41
							Gt	≤0.040	≤1.00
DW-317L	A5.22 E317L T0-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-12%Ni-2%Mo-N and 19%Cr-13%Ni-3%Mo steel	F HF	Ex	0.025	0.59
							Gt	≤0.040	≤1.00
DW-347	A5.22 E347 T0-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for 18%Cr-8%Ni-Nb and 18%Cr-8%Ni-Ti steel	F HF	Ex	0.026	0.41
							Gt	≤0.08	≤1.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

DW-316LT	ABS, LR, BV, KR
DW-317L	CWB
DW-347	CWB



composition of all-weld metal (%)						Mechanical properties of all-weld metal					
Mn	P	S	Ni	Cr	Others		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG
1.20	0.021	0.008	12.39	17.62	2.21	Ex	405	537	44	-196°C: 40	
CO <sub>2</sub>											
0.50~ 2.50	≦0.040	≦0.030	11.00~ 14.00	17.00~ 20.00	Mo: 2.00~ 3.00	Gt	-	≧490	≧35	-196°C ≧27	
1.10	0.020	0.010	13.01	19.81	Mo: 3.35	Ex	380	590	37	0°C: 43	
CO <sub>2</sub>											
0.50~ 2.50	≦0.040	≦0.030	12.00~ 14.00	18.00~ 21.00	Mo: 3.00~ 4.00	Gt	-	≧520	≧20	-	
1.48	0.018	0.008	10.46	18.66	Nb: 0.58	Ex	390	550	43	0°C: 49	
CO <sub>2</sub>											
0.50~ 2.50	≦0.040	≦0.030	9.00~ 11.00	18.00~ 21.00	Nb: 8xC~ 1.00	Gt	-	≧520	≧30	-	

## Diameter (mm)

DW-316LT	1.2
DW-317L	1.2, 1.6
DW-347	1.2, 1.6

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical		
							C	Si	
DW-317LP	A5.22 E317L T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for 18%Cr-12%Ni-2%Mo-N and 19%Cr-13%Ni-3%Mo stainless steel</li> <li>Suitable for butt and fillet welding in all positions</li> </ul>	F HF H VU OH	Ex	0.026	0.62
							Gt	≤0.040	≤1.00
DW-317LH	A5.22 E317L T1-1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for 18%Cr-12%Ni-2%Mo-N and 19%Cr-13%Ni-3%Mo stainless steel with high temperature heat treatment such as solution treatment</li> </ul>	F HF H VU OH	Ex	0.024	0.46
							Gt	≤0.040	≤1.00
DW-410Cb	A5.22 E409Nb T0-1	Rutile	CO <sub>2</sub>	DC- EP	<ul style="list-style-type: none"> <li>Suitable for 13%Cr martensitic stainless steel such as 403 and 410 types and 13%Cr ferritic stainless steels such as 405 type</li> </ul>	F HF	Ex	0.058	0.57
							Gt	≤0.10	≤1.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)						Mechanical properties of all-weld metal					
Mn	P	S	Ni	Cr	Others	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG	
1.28	0.022	0.003	13.79	18.64	Mo: 3.34	Ex	435	582	37	-	
										CO <sub>2</sub>	
0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	18.00~ 21.00	Mo: 3.00- 4.00	Gt	-	≥520	≥20	-	
										CO <sub>2</sub>	
0.97	0.024	0.003	13.54	18.69	Mo: 3.51 Bi.tr.	Ex	454	611	35	-	
										CO <sub>2</sub>	
0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	18.00~ 21.00	Mo: 3.00~ 4.00 Bi ≤0.001	Gt	-	≥520	≥20	-	
										CO <sub>2</sub>	
0.70	0.026	0.003	0.12	12.58	Nb+Ta: 0.65	Ex	282*	515*	30*	-	
										PWHT: 775°Cx2hr, FC to 595°C and AC to ambient	
≤1.20	≤0.040	≤0.030	≤0.60	10.50~ 13.50	Nb+Ta: 8xC- 1.50	Gt	-	≥450	≥15	-	
										PWHT: 760-790°C x2hr, FC to 595°C and AC to ambient	

## Diameter (mm)

DW-317LP	1.2
DW317LH	1.2, 1.6
DW-410Cb	1.2, 1.6

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical		
							C	Si	
DW-2209	A5.22 E2209T1 -1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for normal duplex stainless steel (S32205,S31803, etc.)	F HF H VU OH	Ex	0.026	0.56
							Gt	≤0.040	≤1.00
DW-2594	A5.22 E2594T1 -1/4	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for super duplex stainless steel (S32750,S32760, etc.)	F HF H VU OH	Ex	0.031	0.50
							Gt	≤0.040	≤1.00
DW-2101	-	Rutile	CO <sub>2</sub> Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for lean duplex stainless steel of S32101	F HF H VU	Ex	0.025	0.64

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)						Mechanical properties of all-weld metal					
Mn	P	S	Ni	Cr	Others		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	SG
0.76	0.017	0.003	9.22	23.49	Mo:3.43 N:0.14	Ex	630	815	28	-40°C: 60	Ar- CO <sub>2</sub>
0.50~ 2.00	≦0.040	≦0.030	7.50~ 10.00	21.00~ 24.00	Mo:2.50~ 4.00 N:0.08~ 0.20	Gt	-	≧690	≧20	-	
1.18	0.018	0.005	9.50	25.88	Mo:3.87 N:0.25	Ex	714	896	28	-40°C: 38	Ar- CO <sub>2</sub>
0.50~ 2.50	≦0.040	≦0.030	8.00~ 10.50	24.00~ 27.00	Mo:2.50~ 4.50 N:0.20~ 0.30	Gt	-	≧760	≧15	-	
1.41	0.017	0.003	8.3	24.6	N:0.13	Ex	590	754	29	20°C: 50	Ar- CO <sub>2</sub>

## Diameter (mm)

DW-2209	1.2
DW-2594	1.2
DW-2101	1.2

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical		
							C	Si	
MX-A410NM	-	Metal	Ar-CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>Suitable for 13%Cr-Ni steel</li> <li>Preheat (100°C) must be done depending on thickness of base metal</li> </ul>	F HF	Ex	0.020	0.57
							Gt	≤0.060	≤1.00
MX-A135N	-	Metal	Ar-CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>Suitable for 13%Cr-Ni steel</li> <li>Preheat (100°C) must be done depending on thickness of base metal</li> </ul>	F HF	Ex	0.015	0.58
							Gt	≤0.040	≤1.00
MX-A430M	-	Metal	Ar-CO <sub>2</sub>	DC-EP	<ul style="list-style-type: none"> <li>Suitable for 17%Cr and 13% Cr steel</li> <li>Applied for thin plate in short circuiting welding</li> </ul>	F HF	Ex	0.047	0.40

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)						Mechanical properties of all-weld metal					
Mn	P	S	Ni	Cr	Others	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	PWHT (°C×h)	
0.45	0.019	0.006	4.25	12.25	Mo: 0.46	Ex	870	920	20	0°C: 64	600 x1 AC
≤1.00	≤0.040	≤0.030	4.00~ 5.00	11.00~ 12.50	Mo: 0.40~ 0.70	Gt	≥540	≥760	≥15	-	595~ 620 x1
0.44	0.018	0.006	5.02	12.88	0.02	Ex	810	880	21	0°C: 55	590 x10 FC
≤1.00	≤0.030	≤0.025	4.60~ 5.40	11.50~ 13.50	Mo ≤0.50	Gt	≥540	≥740	≥17	-	580~ 600 x10
0.14	0.008	0.017	0.08	17.0	Nb: 0.75	Ex	390	540	26	-	AW

## Diameter (mm)

<b>MX-A410NM</b>	1.2, 1.6
<b>MX-A430M</b>	1.2, 1.4
<b>MX-A135N</b>	1.2, 1.4, 1.6

## Solid Wires

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical		
						C	Si	
MG-S308	A5.9 ER308	98%Ar-2%O <sub>2</sub>	DC-EP	▪ Suitable for 18%Cr-8%Ni steel	F HF H VU OH	Ex	0.04	0.43
						Gt	≤0.08	0.30~0.65
MG-S308LS	A5.9 ER308LSi	98%Ar-2%O <sub>2</sub>	DC-EP	▪ Suitable for low carbon 18%Cr-8%Ni steel	F HF H VU OH	Ex	0.017	0.79
						Gt	≤0.030	0.65~1.00
MG-S309	A5.9 ER309	98%Ar-2%O <sub>2</sub>	DC-EP	▪ Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	F HF H VU OH	Ex	0.05	0.46
						Gt	≤0.12	0.30~0.65
MG-S309LS	A5.9 ER309LSi	98%Ar-2%O <sub>2</sub>	DC-EP	▪ Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	F HF H VU OH	Ex	0.020	0.84
						Gt	≤0.030	0.65~1.00
MG-S316LS	A5.9 ER316LSi	98%Ar-2%O <sub>2</sub>	DC-EP	▪ Suitable for low carbon 18%Cr-12%Ni-2%Mo steel	F HF H VU OH	Ex	0.017	0.79
						Gt	≤0.030	0.65~1.00

Note; Welding tests are as per AWS. Ex: Example, Gt: Guaranty



composition of wire (%)							Mechanical properties of all-weld metal				
Mn	P	S	Ni	Cr	Mo	Cu	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	
1.70	0.022	0.003	9.68	19.89	0.08	0.11	Ex	410	600	40	-196°C: 49
1.00~ 2.50	≤0.030	≤0.030	9.00~ 11.00	19.50~ 22.00	≤0.75	≤0.75					
1.91	0.021	0.001	9.86	19.78	0.04	0.04	Ex	400	580	42	-196°C: 59
1.00~ 2.50	≤0.030	≤0.030	9.00~ 11.00	19.50~ 22.00	≤0.75	≤0.75					
1.97	0.021	0.002	13.66	23.29	0.03	0.03	Ex	430	610	39	-
1.00~ 2.50	≤0.030	≤0.030	12.00~ 14.00	23.00~ 25.00	≤0.75	≤0.75					
1.85	0.021	0.003	13.28	23.57	0.03	0.03	Ex	410	570	40	0°C: 88
1.00~ 2.50	≤0.030	≤0.030	12.00~ 14.00	23.00~ 25.00	≤0.75	≤0.75					
1.97	0.019	0.002	12.25	19.35	2.36	0.12	Ex	380	550	41	-196°C: 39
1.00~ 2.50	≤0.030	≤0.030	11.00~ 14.00	18.00~ 20.00	2.00~ 3.00	≤0.75					

## Diameter (mm)

<b>MG-S308</b>	1.2
<b>MG-S308LS</b>	0.8, 1.0, 1.2
<b>MG-S309</b>	1.2, 1.6
<b>MG-S309LS</b>	1.0, 1.2
<b>MG-S316LS</b>	1.2

# TG-X308L

# PREMIARC™

Flux cored filler rod for low carbon 18%Cr-8%Ni steel

**Classification:** ASME / AWS A5.22 R308LT1-5

**Features:**

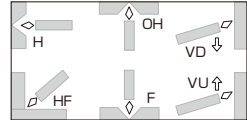
- Applicable for 304 and 304L type steels
- Suitable for root pass in one-side TIG welding without back shielding

**Shielding gas:** Ar

**Polarity:** DC-EN

**Identification color:** Red

**Welding Positions:**



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.018	0.80	1.66	0.023	0.005	10.31	19.62	0.02	0.03
Guaranty	≤0.03	≤1.20	0.50~ 2.50	≤0.040	≤0.030	9.00~ 11.00	18.00~ 21.00	≤0.50	≤0.50

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
Example	450	620	47	-196°C: 60
Guaranty	-	≥520	≥35	-

## Recommended welding parameters

Plate thickness	Welding current
3~5mm	80~90A
6~9mm	90~105A
≥10mm	90~110A

## Packages

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
2.2	Tube	5	1,000	25

# TG-X309L

## Flux cored filler rod for dissimilar metals

**Classification:** ASME / AWS A5.22 R309LT1-5

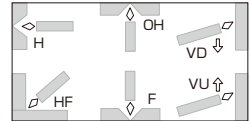
- Features:**
- Suitable for root pass in one-side TIG welding without back shielding
  - Applicable for dissimilar-metal joint of austenitic stainless steels and ferritic steels

**Shielding gas:** Ar

**Polarity:** DC-EN

**Identification color:** Yellow green

### Welding Positions:



### Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.017	0.81	1.52	0.022	0.006	12.62	24.26	0.02	0.03
Guaranty	≤0.03	≤1.20	0.50~ 2.50	≤0.040	≤0.030	12.00~ 14.00	22.00~ 25.00	≤0.50	≤0.50

### Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)
Example	530	680	32
Guaranty	-	≥520	≥30

### Recommended welding parameters

Plate thickness	Welding current
3~5mm	80~90A
6~9mm	90~105A
≥10mm	90~110A

### Packages

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
2.2	Tube	5	1,000	25

# TG-X316L

# PREMIARC™

Flux cored filler rod for low carbon 18%Cr-12%Ni-2%Mo steel

**Classification:** ASME / AWS A5.22 R316LT1-5

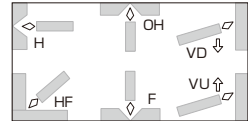
**Features:** • Applicable for 316 and 316L type steels  
 • Suitable for root pass in one-side TIG welding without back shielding

**Shielding gas:** Ar

**Polarity:** DC-EN

**Identification color:** Green

**Welding Positions:**



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
Example	0.016	0.87	1.55	0.023	0.004	12.47	18.89	2.32	0.03
Guaranty	≤0.03	≤1.20	0.50~ 2.50	≤0.040	≤0.030	11.00~ 14.00	17.00~ 20.00	2.00~ 3.00	≤0.50

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	440	600	38	0°C: 110
Guaranty	-	≥485	≥30	-

## Recommended welding parameters

Plate thickness	Welding current
3~5mm	80~90A
6~9mm	90~105A
≥10mm	90~110A

## Packages

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
2.2	Tube	5	1,000	25

# TG-X347

Flux cored filler rod for 18%Cr-8%Ni-Nb and 18%Cr-8Ni-Ti steel

**Classification:** ASME / AWS A5.22 R347T1-5

**Features:**

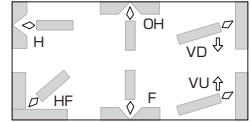
- Applicable for 347 and 321 type steels
- Suitable for root pass in one-side TIG welding without back shielding

**Shielding gas:** Ar

**Polarity:** DC-EN

**Identification color:** Blue

**Welding Positions:**



## Chemical composition of all-weld metal (%) as per AWS

	C	Si	Mn	P	S
Example	0.020	0.80	1.60	0.021	0.004
Guaranty	≤0.08	≤1.20	0.50~2.50	≤0.040	≤0.030
	Ni	Cr	Nb+Ta	Mo	Cu
Example	10.21	19.09	0.66	0.02	0.03
Guaranty	9.00~11.00	18.00~21.00	8xC%~1.0	≤0.50	≤0.50

## Mechanical properties of all-weld metal as per AWS

	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
Example	460	630	48	0°C: 130
Guaranty	-	≥520	≥30	-

## Recommended welding parameters

Plate thickness	Welding current
3~5mm	80~90A
6~9mm	90~105A
≥10mm	90~110A

## Packages

Dia. (mm)	Type	Weight (kg)	Length (mm)	Weight per piece (g)
2.2	Tube	5	1,000	25

## Filler Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical			
					C	Si	Mn	
<b>TG-S308</b>	A5.9 ER308	Ar	DC-EN	▪ Suitable for 18%Cr-8%Ni steel	Ex	0.05	0.46	1.89
					Gt	≤0.08	0.30~0.65	1.00~2.50
<b>TG-S308L</b>	A5.9 ER308L	Ar	DC-EN	▪ Suitable for low carbon 18%Cr-8%Ni steel	Ex	0.013	0.43	1.86
					Gt	≤0.030	0.30~0.65	1.00~2.50
<b>TG-S309</b>	A5.9 ER309	Ar	DC-EN	▪ Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	Ex	0.05	0.45	1.85
					Gt	≤0.12	0.30~0.65	1.00~2.50
<b>TG-S309L</b>	A5.9 ER309L	Ar	DC-EN	▪ Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	Ex	0.016	0.41	1.84
					Gt	≤0.030	0.30~0.65	1.00~2.50
<b>TG-S309MoL</b>	A5.9 ER309LMo	Ar	DC-EN	▪ Suitable for dissimilar-metal joint and underlaying on ferritic steels for overlaying stainless steel weld metals	Ex	0.016	0.43	1.76
					Gt	≤0.030	0.30~0.65	1.00~2.50
<b>TG-S316</b>	A5.9 ER316	Ar	DC-EN	▪ Suitable for 18%Cr-12%Ni-2%Mo steel	Ex	0.04	0.42	1.71
					Gt	≤0.08	0.30~0.65	1.00~2.50

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

<b>TG-S308</b>	ABS, DNV, NK	<b>TG-S309</b>	DNV, NK, GL
<b>TG-S308L</b>	ABS, LR, DNV, BV, NK, GL, CCS		

### Identification color

Product names		Product names	
<b>TG-S308</b>	Yellow	<b>TG-S309L</b>	Yellow green
<b>TG-S308L</b>	Red	<b>TG-S309MoL</b>	Silver
<b>TG-S309</b>	Black	<b>TG-S316</b>	White

composition of rod and wire (%)						Mechanical properties of all-weld metal				
P	S	Ni	Cr	Mo	Cu	0.2%OS (MPa)	TS (MPa)	EL (%)	IV (J)	
0.024	0.001	9.69	20.00	0.05	0.07	Ex	410	580	42	-196°C: 39
≤0.030	≤0.030	9.00~ 11.00	19.50~ 22.00	≤0.75	≤0.75					
0.023	0.002	9.95	19.85	0.05	0.07	Ex	420	590	45	-196°C: 78
≤0.030	≤0.030	9.00~ 11.00	19.50~ 22.00	≤0.75	≤0.75					
0.025	0.001	13.58	23.37	0.03	0.07	Ex	410	580	39	0°C: 150
≤0.030	≤0.030	12.00~ 14.00	23.00~ 25.00	≤0.75	≤0.75					
0.019	0.002	13.68	23.28	0.03	0.04	Ex	410	570	38	0°C: 110
≤0.030	≤0.030	12.00~ 14.00	23.00~ 25.00	≤0.75	≤0.75					
0.016	0.005	13.54	23.35	2.19	0.05	Ex	440	590	36	-
≤0.030	≤0.030	12.00~ 14.00	23.00~ 25.00	2.00~ 3.00	≤0.75					
0.026	0.001	12.25	19.39	2.15	0.11	Ex	390	570	42	-196°C: 29
≤0.030	≤0.030	11.00~ 14.00	18.00~ 20.00	2.00~ 3.00	≤0.75					

### Diameter (mm)

<b>TG-S308</b>	1.0, 1.2, 1.6, 2.0, 2.4, 3.2	<b>TG-S309L</b>	1.0, 1.2, 1.6, 2.0, 2.4, 3.2
<b>TG-S308L</b>	1.0, 1.2, 1.6, 2.0, 2.4, 3.2	<b>TG-S309MoL</b>	1.2, 1.6, 2.0, 2.4, 3.2
<b>TG-S309</b>	1.0, 1.2, 1.6, 2.0, 2.4, 3.2	<b>TG-S316</b>	1.0, 1.2, 1.6, 2.0, 2.4, 3.2

## Filler Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical			
					C	Si	Mn	
TG-S316L	A5.9 ER316L	Ar	DC- EN	▪ Suitable for low carbon 18%Cr-12%Ni-2%Mo steel	Ex	0.014	0.41	1.74
					Gt	≤0.030	0.30~ 0.65	1.00~ 2.50
TG-S317L	A5.9 ER317L	Ar	DC- EN	▪ Suitable for low carbon 18%Cr-12%Ni-2%Mo-N and low carbon 19%Cr-13%Ni-3%Mo steel	Ex	0.010	0.38	1.80
					Gt	≤0.030	0.30~ 0.65	1.00~ 2.50
TG-S347	A5.9 ER347	Ar	DC- EN	▪ Suitable for 18%Cr-8%Ni-Nb and 18%Cr-8%Ni-Ti steel	Ex	0.05	0.43	2.29
					Gt	≤0.08	0.30~ 0.65	1.00~ 2.50
TG-S310	A5.9 ER310	Ar	DC- EN	▪ Suitable for 25%Cr-20%Ni steel	Ex	0.10	0.33	2.01
					Gt	0.08~ 0.15	0.30~ 0.65	1.00~ 2.50
TG-S310MF	-	Ar	DC- EN	▪ Suitable for 25%Cr-22%Ni-2%Mo steel of urea plant	Ex	0.009	0.03	4.87
					Gt	≤0.02	≤0.50	3.00~ 5.00
NO4051	-	Ar	DC- EN	▪ Suitable for modified 316 stainless steel of urea plant	Ex	0.005	0.16	6.10
					Gt	≤0.045	≤1.00	4.00~ 7.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

TG-S316L	ABS, LR, DNV, BV, NK, GL, CCS
TG-S317L	LR
TG-S347	NK

### Identification color

Product names		Product names	
TG-S316L	Green	TG-S310	Gold
TG-S317L	Sorrel	TG-S310MF	-
TG-S347	Blue	NO4051	-



composition of rod and wire (%)							Mechanical properties of all-weld metal				
P	S	Ni	Cr	Mo	Cu	Nb	0.2%OS (MPa)	TS (MPa)	EL (%)	IV (J)	
0.023	0.002	12.29	19.22	2.19	0.11	-	Ex	390	550	43	-196°C: 49
≤0.030	≤0.030	11.00~ 14.00	18.00~ 20.00	2.00~ 3.00	≤0.75	-					
0.007	0.001	13.11	18.76	3.49	0.03	-	Ex	410	570	39	0°C: 98
≤0.030	≤0.030	13.00~ 15.00	18.50~ 20.50	3.00~ 4.00	≤0.75	-					
0.020	0.003	9.85	19.51	0.06	0.07	0.66	Ex	460	630	40	0°C: 88
≤0.030	≤0.030	9.00~ 11.00	19.00~ 21.50	≤0.75	≤0.75	10xC~ 1.00					
0.003	0.004	21.17	26.61	0.01	0.01	-	Ex	450	610	39	0°C: 110
≤0.030	≤0.030	20.00~ 22.50	25.00~ 28.00	≤0.75	≤0.75	-					
0.005	0.002	22.52	25.33	2.27	-	-	Ex	480	630	40	-
≤0.030	≤0.020	21.00~ 23.00	24.00~ 26.00	1.90~ 2.70	-	-					
0.011	0.004	16.29	18.24	2.56	-	-	Ex	360	490	41	-257°C: 99
≤0.030	≤0.020	14.00~ 18.00	17.00~ 19.50	2.20~ 3.00	-	-					

## Diameter (mm)

<b>TG-S316L</b>	1.0, 1.2, 1.6, 2.0, 2.4, 3.2	<b>TG-S310</b>	1.6, 2.0, 2.4, 3.2
<b>TG-S317L</b>	2.0, 2.4	<b>TG-S310MF</b>	1.6, 2.4
<b>TG-S347</b>	1.2, 1.6, 2.0, 2.4, 3.2	<b>NO4051</b>	1.2, 1.6, 2.4

## Filler Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical			
					C	Si	Mn	
TG-S410	A5.9 ER410	Ar	DC- EN	▪ Suitable for 13%Cr steel	Ex	0.10	0.34	0.49
					Gt	≤0.12	≤0.50	≤0.60
TG-S410Cb	-	Ar	DC- EN	▪ Suitable for 13%Cr and 13%Cr-Al steel	Ex	0.09	0.41	0.47
					Gt	≤0.12	≤0.50	≤0.60
TG-S329M	-	Ar	DC- EN	▪ Suitable for normal duplex stainless steel	Ex	0.010	0.26	1.10
					Gt	≤0.030	≤0.65	0.50~ 2.50
TG-S2209	A5.9 ER2209	Ar	DC- EN	▪ Suitable for normal duplex stainless steel (S32205,S31803,etc.)	Ex	0.008	0.39	1.67
		Ar- 2%N <sub>2</sub>			Gt	≤0.03	≤0.90	0.50~ 2.5
TG-S2594	A5.9 ER2594	Ar	DC- EN	▪ Suitable for super duplex stainless steel (S32750,S32760,etc.)	Ex	0.016	0.43	0.51
		Ar- 2%N <sub>2</sub>			Gt	≤0.03	≤1.0	≤2.5

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Identification color

Product names	Product names
TG-S410	Purple
TG-S410Cb	Purple
TG-S329M	Red

composition of rod and wire (%)							Mechanical properties of all-weld metal					SG
P	S	Ni	Cr	Mo	Cu	N	0.2%OS (MPa)	TS (MPa)	EL (%)	IV (J)		
0.008	0.006	0.41	12.83	0.50	0.01	-	Ex 310 (PWHT : 850°Cx 2h, AC)	530	37	20°C: 210	Ar	
≤0.030	≤0.030	≤0.60	11.50~ 13.50	≤0.75	≤0.75	-						
0.016	0.004	0.10	11.68	0.05	0.03	0.89	Ex 270	540	23	20°C: 39	Ar	
≤0.030	≤0.030	≤0.60	11.50~ 13.50	≤0.75	≤0.75	0.70~ 1.10						
0.003	0.001	9.21	24.71	3.26	-	0.14	Ex 617	809	35	0°C: 160	Ar	
≤0.030	≤0.030	8.00~ 10.00	23.00~ 26.00	2.50~ 4.00	-	0.08~ 0.20						
0.020	0.002	8.72	22.71	3.11	0.09	0.16	Ex 615	814	38	-50°C: 150	Ar- 2%N <sub>2</sub>	
≤0.03	≤0.03	7.5~ 9.5	21.5~ 23.5	2.5~ 3.5	≤0.75	0.08~ 0.20						
0.016	0.001	9.17	24.96	3.91	0.06	0.27	Ex 646	859	38	-50°C: 171	Ar- 2%N <sub>2</sub>	
≤0.03	≤0.02	8.0~ 10.5	24.0~ 27.0	2.5~ 4.5	≤1.5	0.20~ 0.30						

## Diameter (mm)

<b>TG-S410</b>	1.6, 2.0, 2.4
<b>TG-S410Cb</b>	0.8, 1.2, 1.6, 2.0, 2.4, 3.2
<b>TG-S329M</b>	1.2, 1.6, 2.0, 2.4
<b>TG-S2209</b>	1.6, 2.0, 2.4, 3.2
<b>TG-S2594</b>	1.6, 2.0, 2.4, 3.2



# **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Flux Cored Arc Welding (FCAW)**

**Gas Metal Arc Welding (GMAW)**

**Submerged Arc Welding (SAW)**

## For Hardfacing

### A guide for selecting welding consumables

Weld metal microstructure and main alloying elements determine the performances of welding consumables for hardfacing as summarized in Table 1. In addition, PF-200S/US-63B is good for reclamation of mill rolls.

Table 1 Welding consumables and their characteristics

Weld metal microstructure and alloying formula	Hv	Features	Type of wear <sup>(1)</sup>						
			MTM	ABR	HTW	CAV	COR	HRT	IMP
Pearlite	200-400	<ul style="list-style-type: none"> <li>Good crack resistance</li> <li>Good machinability</li> </ul>	○	△	×	-	-	×	○
Martensite	350-800	<ul style="list-style-type: none"> <li>Good wear resistance</li> </ul>	○	○	△	-	×	△	△
13%Cr stainless steel type	350-500	<ul style="list-style-type: none"> <li>Good resistance to oxidation, heat and corrosion</li> <li>Good wear resistance</li> </ul>	○	△	○	○	○	○	△
Semi-Austenite	500-700	<ul style="list-style-type: none"> <li>High toughness and good wear resistance</li> </ul>	○	○	△	△	△	△	△
High Mn Austenite	13%Mn 150-500	<ul style="list-style-type: none"> <li>High toughness and good impact wear resistance</li> <li>High work hardenability</li> </ul>	×	○	×	△	×	×	◎
	16%Mn-16%Cr 200-400	<ul style="list-style-type: none"> <li>High hardness at high temperatures</li> <li>High toughness</li> </ul>	○	△	○	○	○	○	○
High Cr-Fe	600-800	<ul style="list-style-type: none"> <li>Excellent erosion resistance</li> <li>Good resistance to corrosion and heat</li> </ul>	△	◎	◎	×	○	○	×
Tungsten carbide type	800-1200	<ul style="list-style-type: none"> <li>Excellent resistance to heavy abrasion</li> </ul>	×	◎	×	×	×	×	×

Note (1) MTM: Metal-to-metal wear, ABR: Abrasion, HTW: High temp. wear, CAV: Cavitation, COR: Corrosion wear, HRT: Heat resistance, IMP: Impact wear  
 ◎: Excellent resistance, ○: Good resistance, △: Slightly inferior, ×: Inferior,  
 -: Not used for general applications

	<b>SMAW</b>	<b>FCAW</b>	<b>GMAW</b>	<b>SAW</b>
	HF-240 HF-260 HF-330 HF-350	DW-H250 DW-H350	MG-250 MG-350	G-50/US-H250N G-50/US-H350N
	HF-450 HF-500 HF-600 HF-650 HF-700 HF-800K	DW-H450 DW-H600 DW-H700 DW-H800	-	G-50/US-H400N G-50/US-H450N G-50/US-H500N MF-30/US-H550N MF-30/US-H600N
	HF-13	-	-	-
	HF-12	-	-	-
	HF-11	DW-H11	-	-
	HF-16	DW-H16	-	-
	HF-30	DW-H30 DW-H30MV	-	-
	HF-950	-	-	-

## For Hardfacing

### Tips for better welding results

#### Common to individual welding processes

Important points in hardfacing are to obtain sufficient hardness and to minimize cracking. In order to achieve them, proper selection of welding consumables and proper welding procedures mentioned below are necessary.

1) Preparation of base metal:

Rust, oil and soil attached on the base metal may cause blowholes. Cracks in the base metal may cause cracking of the weld metal; therefore, they must be removed completely beforehand.

2) Preheat and interpass temperature:

In order to minimize cracking, control of preheat and interpass temperature is a key technique. Table 1 shows a rule of thumb for proper preheat and interpass temperatures in relation to the carbon equivalent of the base metal. In practice, size of work, type of welding consumable and method of hardfacing should be taken into consideration to determine the most appropriate temperatures.

Table 1 A rule of thumb for preheat and interpass temperature in relation to base metal carbon equivalents

Type of steel	Carbon equivalent <sup>(1)</sup>	Preheat and interpass temperature (°C)
Carbon steel and Low alloy steel	Less than 0.3	100 max.
	0.3-0.4	100 min.
	0.4-0.5	150 min.
	0.5-0.6	200 min.
	0.6-0.7	250 min.
	0.7-0.8	300 min.
	Over 0.8	350 min.
High-Mn steel (13%Mn steel)		Use no preheat and cool each weld pass with water
Austenitic stainless steel		Use no preheat and control the interpass temperature 150°C or lower
High alloy steel (e.g., High-Cr steel)		400 min.

Note (1) Carbon equivalent =  $C + Mn/6 + Si/24 + Cr/5 + Mo/4 + Ni/15$

3) Immediate postweld heating:

Heating the weldment at 300-350°C for 10-30 minutes just after welding was finished is effective to prevent cold cracking. Control the temperature carefully, or the hardness of the weld will be decreased by excessive heating.



4) Postweld heat treatment:

Postweld heat treatment (PWHT) at 550-750°C is effective to prevent cold cracking and distortion in service, and to improve properties of the welds. It is important to set the PWHT conditions taking into account that the hardness of the weld is normally decreased by PWHT.

5) Underlaying:

Underlaying is effective to prevent cracking in welds where low-alloy steel having high hardenability is hardfaced or where high-hardness weld metal is deposited on carbon steel. For underlaying, mild steel type welding consumables or austenitic stainless steel type welding consumables should be used.

6) Penetration:

In hardfacing, the properties of the weld metal will considerably be affected by welding penetration into the base metal, because the chemical composition of the welding consumable is generally very different from those of the base metal. In order to use sufficiently the desired properties of the welding consumable, welding penetration must be controlled by using an appropriate welding procedure, for instance, multi-layer welding.

7) Welding distortion:

Intermittent and symmetrical welding sequences are effective to minimize welding distortion. Restraint of the work is also effective to minimize welding distortion.

### SMAW

- 1) Control the arc length as short as possible.
- 2) Use the backstep method for arc starting to prevent blowholes.
- 3) Control the weaving width less than 3-4 times the diameter of a covered electrode.
- 4) Re-dry covered electrodes before use.

### FCAW, GMAW

- 1) Control shielding gas flow rates within 20-25 l/mm for general applications. Note that poor shielding due to low flow rates and wind can cause blowholes and pits in the weld metal.
- 2) Refer to proper currents for individual wire sizes as shown in Table 2.

Table 2 Proper welding currents

Type of wire	Diameter (mm)	Polarity	Welding current (A)
DW-H series	1.2	DC-EP	120-360
	1.6	DC-EP	200-420
MG series	1.2	DC-EP	120-320
	1.6	DC-EP	200-420

## Covered Electrodes

Product names	Nominal hardness	Type of covering	Pol.	Features	WP	Chemical C
<b>HF-240</b>	Hv 240	Titania	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of gears and wheels</li> <li>▪ RC: 70~100°Cx0.5~1h</li> </ul>	F V OH	Ex 0.09
<b>HF-260</b>	Hv 260	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of shafts, crane wheels and couplings</li> <li>▪ RC: 300~350°Cx0.5~1h</li> </ul>	F V OH	Ex 0.17
<b>HF-330</b>	Hv 330	Titania	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of keys and clutch lugs</li> <li>▪ RC: 70~100°Cx0.5~1h</li> </ul>	F V OH	Ex 0.10
<b>HF-350</b>	Hv 350	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of upper rollers and sprockets of bulldozers</li> <li>▪ RC: 300~350°Cx0.5~1h</li> </ul>	F V OH	Ex 0.25

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example (polarity: AC)

### Identification color

Product names	1st	2nd
<b>HF-240</b>	Red	White
<b>HF-260</b>	Red	Green
<b>HF-330</b>	Red	Purple
<b>HF-350</b>	Orange	Green

composition of overlay weld metal (%)				Hardness of weld metal		Pre. H & IPT
Si	Mn	Cr		PWHT	Hv	
0.58	0.58	0.81	Ex	AW	240	≧ 150°C
				900°C, OQ	350	
0.69	1.81	-	Ex	AW	271	≧ 150°C
				900°C, OQ	395	
0.69	0.86	2.29	Ex	AW	340	≧ 150°C
				-	-	
0.49	1.38	1.16	Ex	AW	366	≧ 150°C
				850°C, OQ	510	

### Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0	6.0
<b>HF-240</b>	-	350	400	400	450
<b>HF-260</b>	300	350	400	400	450
<b>HF-330</b>	-	350	400	400	450
<b>HF-350</b>	300	350	400	400	450

## Covered Electrodes

Product names	Nominal hardness	Type of covering	Pol.	Features	WP	Chemical C	
<b>HF-450</b>	Hv 450	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of idlers, rollers and truck links of bulldozers</li> <li>▪ RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.20
<b>HF-500</b>	Hv 500	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of idlers and truck links of bulldozers</li> <li>▪ RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.45
<b>HF-600</b>	Hv 600	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of lower rollers and bucket edges</li> <li>▪ RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.48
<b>HF-650</b>	Hv 650	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>▪ Hardfacing of tamping dies and mixer blades</li> <li>▪ RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.67

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example (polarity: AC)

### Identification color

Product names	1st	2nd
<b>HF-450</b>	Red	Pink
<b>HF-500</b>	Orange	Blue white
<b>HF-600</b>	Red	Red
<b>HF-650</b>	Red	Orange

composition of overlay weld metal (%)						Hardness of weld metal			
Si	Mn	Cr	Mo	V	W	PWHT (°C/h)	Hv	Pre. H & IPT	
1.30	0.31	2.54	0.60	0.23	-	Ex	AW	456	≥150°C
							550x6	443	
1.37	0.91	-	0.98	0.28	-	Ex	AW	517	≥150°C
0.77	2.58	2.50	-	-	-	Ex	AW	595	≥200°C
0.90	0.87	4.91	1.17	0.55	1.42	Ex	AW	634	≥200°C
							600x1, AC	580	

### Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0	6.0
<b>HF-450</b>	-	-	400	400	450
<b>HF-500</b>	-	350	400	400	450
<b>HF-600</b>	300	350	400	400	450
<b>HF-650</b>	300	350	400	400	450

## Covered Electrodes

Product names	Nominal hardness	Type of covering	Pol.	Features	WP	Chemical C	
<b>HF-700</b>	Hv 700	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of cutter knives and casings</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.62
<b>HF-800K</b>	Hv 800	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of cutter knives and casings</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.80
<b>HF-950</b>	Hv 950	Graphite	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of shovel teeth and cutter knives</li> <li>RC: 150~200°Cx0.5~1h</li> </ul>	F	Ex	3.5

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example (polarity: AC)

### Identification color

Product names	1st	2nd
<b>HF-700</b>	Orange	Orange
<b>HF-800K</b>	Orange	Yellow
<b>HF-950</b>	Orange	-

composition of overlay weld metal (%)						Hardness of weld metal			
Si	Mn	Cr	Mo	W	B		PWHT (°C <sub>xh</sub> )	Hv	Pre. H, & IPT
0.80	0.78	5.12	2.21	-	-	Ex	AW	654	≥200°C
							600x1, AC	485	
1.65	1.24	3.82	-	2.42	0.29	Ex	AW	736	≥200°C
							600x1, AC	535	
0.1	2.6	-	-	26	-	Ex	AW	930	≥300°C

## Diameter and Length (mm)

Dia.	3.2	4.0	5.0	6.0
<b>HF-700</b>	-	400	400	450
<b>HF-800K</b>	350	400	400	450
<b>HF-950</b>	-	400	400	

## Covered Electrodes

Product names	Nominal hardness	Type of covering	Pol.	Features	WP	Chemical C
HF-11	Hv 250	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of crusher hammers and crusher jaws</li> <li>RC: 150~200°Cx0.5~1h</li> </ul>	F Ex	0.82
HF-12	Hv 500	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of ripper teeth, impellers and breakers</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F Ex	0.72
HF-13	Hv 450	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of valve seats and agitator propellers</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F Ex	0.13
HF-16	Hv 300	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of hot shears and hot dies</li> <li>RC: 150~200°Cx0.5~1h</li> </ul>	F Ex	0.71
HF-30	Hv 700	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Hardfacing of crusher rotors and liners</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F Ex	5.00

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example (polarity: AC)

### Identification color

Product names	1st	2nd
HF-11	Red	Black
HF-12	Red	Brown
HF-13	Red	Blue white
HF-16	Orange	Brown
HF-30	Red	Silver



composition of overlay weld metal (%)						Hardness of weld metal		
Si	Mn	Cr	Mo	V	Ni		PWHT (°C <sub>xh</sub> )	Hv
0.39	13.88	-	-	-	-	Ex	AW	266
0.89	1.17	7.30	1.12	-	-	Ex	AW	532
							500x2	630
0.50	0.74	12.97	0.97	-	0.99	Ex	AW	420
							750x1	260
0.48	14.59	15.33	1.85	0.42	2.20	Ex	AW	306
0.42	1.23	30.5	-	-	-	Ex	AW	770

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0	6.0
<b>HF-11</b>	-	350	400	400	450
<b>HF-12</b>	300	350	400	400	450
<b>HF-13</b>	-	350	400	400	-
<b>HF-16</b>	-	300	350	350	-
<b>HF-30</b>	-	-	400	450	-

## Flux Cored Wires

Product names	Nominal hardness	Type of cored flux	SG	Pol.	Features	WP
DW-H250	Hv 250	Rutile	CO <sub>2</sub>	DC-EP	▪ Suitable for metal-to-metal wear parts and underlaying for hardfacing and repair	F HF
DW-H350	Hv 350	Rutile	CO <sub>2</sub>	DC-EP	▪ Suitable for metal-to-metal wear and light abrasion parts	F HF
DW-H450	Hv 450	Rutile	CO <sub>2</sub>	DC-EP	▪ Suitable for metal-to-metal wear and abrasion parts	F HF
DW-H600	Hv 600	Rutile	CO <sub>2</sub>	DC-EP	▪ Suitable for abrasion parts	F HF
DW-H700	Hv 700	Rutile	CO <sub>2</sub>	DC-EP	▪ Suitable for abrasion parts	F HF
DW-H800	Hv 800	Metal	CO <sub>2</sub>	DC-EP	▪ Suitable for heavy abrasion parts	F HF

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example

Chemical composition of overlay weld metal (%)							Hardness of weld metal		
	C	Si	Mn	Cr	Mo	Others	PWHT (°C×h)	Hv	Pre. H, & IPT
Ex	0.09	0.49	1.30	1.02	0.40	-	AW	269	≥150°C
							600x2	270	
Ex	0.13	0.64	1.70	0.48	0.53	-	AW	370	≥150°C
							600x2	297	
Ex	0.15	0.57	1.40	3.70	0.47	V: 0.25	AW	431	≥150°C
							600x2	384	
Ex	0.45	0.48	0.97	4.31	0.51	-	AW	574	≥200°C
							600x2	398	
Ex	0.57	0.73	1.05	5.40	1.01	V: 0.54 W: 1.21	AW	673	≥250°C
							600x2	605	
Ex	1.10	0.68	1.83	4.22	-	W: 2.26 B: 0.54	AW	772	≥250°C
							600x2	612	

## Diameter (mm)

DW-H250	1.2, 1.6
DW-H350	1.2, 1.6
DW-H450	1.2, 1.6
DW-H600	1.2, 1.6
DW-H700	1.2, 1.6
DW-H800	1.2, 1.6

## Flux Cored Wires

Product names	Nominal hardness	Type of cored flux	SG	Pol.	Features	WP
DW-H11	Hv 250	Metal	Ar-CO <sub>2</sub>	DC-EP	▪ Suitable for abrasion accompanied by heavy impact parts and repair welding of 13%-Mn cast steel	F HF
DW-H16	Hv 300	Metal	Ar-CO <sub>2</sub>	DC-EP	▪ Suitable for high temperature wear, impact wear and cavitation parts such as hot shear bytes, hot saws, and hydraulic power water turbines	F HF
DW-H30	Hv 700	Metal	CO <sub>2</sub>	DC-EP	▪ Suitable for heavy abrasive parts such as crushers and hoppers	F HF
DW-H30MV	Hv 800	Metal	CO <sub>2</sub>	DC-EP	▪ Suitable for heavy abrasive and high temperature wear parts such as liners, screws, and crushers	F HF

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example

	Chemical composition of overlay weld metal (%)						Hardness of weld metal			
	C	Si	Mn	Cr	Mo	Others	PWHT	Hv	Pre. H, & IPT	
Ex	0.84	0.68	14.17	-	-	-	Ex	AW	233	-
Ex	0.60	0.51	16.76	16.21	1.49	V: 0.49	Ex	AW	278	≥150°C
Ex	2.92	1.16	0.16	24.06	-	B: 0.3	Ex	AW	755	≥250°C
Ex	5.03	2.39	0.19	21.60	0.94	B: 0.28 V: 2.61	Ex	AW	821	≥200°C

## Diameter (mm)

DW-H11	1.6
DW-H16	1.2
DW-H30	1.2, 1.6
DW-H30MV	1.2, 1.6

## Flux and Wire Combinations

Trade Designation	Nominal hardness	Type of flux	Pol.	Features	
<sup>[F]</sup> G-50/ <sup>[P]</sup> US-H250N	Hv 250	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of wheels and rollers and for underlaying of idlers and rollers</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex
<sup>[F]</sup> G-50/ <sup>[P]</sup> US-H350N	Hv 350	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of idlers and links of tractors and shovels, rollers for steel mills, and tires, and hutches</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex
<sup>[F]</sup> G-50/ <sup>[P]</sup> US-H400N	Hv 400	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of idlers and links of tractors and shovels, rollers for steel mills, and tires</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex
<sup>[F]</sup> G-50/ <sup>[P]</sup> US-H450N	Hv 450	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of rollers and idlers of tractors and shovels, rollers for steel mills, and bells for blast furnaces</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex

Note: Welding tests are as per Kobe Steel's Standard, Wire-Ex: Example of wire,

Chemical composition of overlay weld metal (%)						Hardness of weld metal		
C	Si	Mn	Cr	Mo	V		PWHT (°C <sub>xh</sub> )	Hv
0.06	0.60	1.82	-	0.62	-	Ex	AW	267
0.10	0.63	1.95	1.10	0.52	-	Ex	AW	361
0.13	0.65	2.02	2.21	0.36	0.17	Ex	AW	409
0.19	0.72	2.22	2.69	0.60	0.31	Ex	AW	453
							600x5	431

Weld-Ex: Example of weld metal, Ex: Example of weld metal (polarity: AC)

Diameter of wire (mm)	
US-H250N	3.2
US-H350N	3.2
US-H400N	3.2, 4.0
US-H450N	3.2, 4.0

Mesh size of flux	
G-50	8x48

## Flux and Wire Combinations

Trade Designation	Nominal hardness	Type of flux	Pol.	Features	
[F]G-50/ [P]US-H500N	Hv 500	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of rollers and idlers of tractors and shovels, rollers for steel mills, and bells for blast furnaces</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex
[P]MF-30/ [P]US-H550N	Hv 550	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of rollers for steel mills, and bells for blast furnaces</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex
[P]MF-30/ [P]US-H600N	Hv 600	Fused	AC	<ul style="list-style-type: none"> <li>▪ Suitable for hardfacing of rollers for steel mills, and crusher cones</li> <li>▪ RC: 150~350°Cx1h</li> </ul>	Weld-Ex

Note: Welding tests are as per Kobe Steel's Standard. Wire-Ex: Example of wire,



Chemical composition of overlay weld metal (%)							Hardness of weld metal		
C	Si	Mn	Cr	Mo	W	V	PWHT (°C×h)	Hv	
0.22	0.85	2.26	2.85	1.10	1.45	0.32	Ex	AW	509
								600x2	506
0.34	0.58	2.12	6.72	3.75	-	-	Ex	AW	540
								600x2	503
0.38	0.63	2.19	6.96	3.72	-	-	Ex	AW	596
								600x2	570

Weld-Ex: Example of weld metal, Ex: Example of weld metal (polarity: AC)

Diameter of wire (mm)	
US-H500N	3.2
US-H550N	3.2
US-H600N	3.2

Mesh size of flux	
G-50	8x48
MF-30	12x65



**For Cast Iron**

# **Welding Consumables and Proper Welding Conditions for**

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**Shielded Metal Arc Welding (SMAW)**

## For Cast Iron

### A guide for selecting welding consumables

Table 1 shows covered electrodes for shielded metal arc welding of cast irons in conjunction with weldability, usability, color matching, and machinability.

Table 1 Welding consumables for cast irons <sup>(1)</sup>

Product names	Preheat temperature (°C)	Wettability with base metal	Color matching with base metal	Joint efficiency	X-ray soundness	Machinability of weld metal	Machinability of HAZ
CI-A1	100-300	○	△	◎	○	◎	◎
CI-A2	150-350	◎	△	◎	○	◎	○
CI-A3	350-400	◎	◎	○	○	△	△

Note (1) ◎: Good, ○: Better, △: Inferior

### Tips for better welding results

#### 1) Preparation for base metal:

- (1) When cast irons have impregnated oil, the base metal must be heated at 400°C to burn off the oil before welding. Other contaminants should also be removed off before welding.
- (2) To repair a defect, it must be removed completely by machining or grinding (arc air gouging is not suitable for cast irons) before welding. The welding groove should have a round bottom for better fusion. Where a crack defect seems to be propagated by machining or grinding, make stop-holes at both ends of the crack.

#### 2) Welding procedure:

- (1) The most appropriate preheating temperature depends on the size and thickness of the work; however, Table 1 can be a rule of thumb.
- (2) Stringer welding with the maximum bead length of about 50 mm is recommended to prevent overheat, distortion and cracking.
- (3) Peening is needed to minimize residual stresses. Just after one bead was laid, it must be peened with a hammer to the extent that the ripple of the bead disappears.
- (4) Comparatively small conical groove should be welded in the spiral sequence from the bottom of the groove to the surface of the base metal. Backstep, symmetrical or intermittent sequence is recommended for a long welding line to prevent cracking. The buttering method, in which the surface of the groove is clad first and the filling passes are laid later, is recommended for a deep groove.



## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	C	
CI-A1	A5.15 ENi-CI	Graphite	AC	<ul style="list-style-type: none"> <li>Suitable for repairing and joining various kinds of cast irons</li> <li>Excellent welding usability and machinability</li> <li>RC: 70~100°Cx0.5~1h</li> </ul>	F	Ex	0.99
			DC-EP			Gt	≤1.80
CI-A2	A5.15 ENiFe-CI	Graphite	AC	<ul style="list-style-type: none"> <li>Suitable for repairing and joining various kinds of cast irons</li> <li>Crack resistibility is excellent</li> <li>RC: 70~100°Cx0.5~1h</li> </ul>	F	Ex	1.15
			DC-EP			Gt	≤2.00
CI-A3	A5.15 ESt	Low hydrogen	AC	<ul style="list-style-type: none"> <li>Suitable for repairing and joining various kinds of cast irons</li> <li>Hardenability of the fusion zone is larger than with Ni-bearing electrodes</li> <li>RC: 300~350°Cx0.5~1h</li> </ul>	F	Ex	0.04
			DC-EP			Gt	≤0.15

Note: Welding tests are as per AWS. Ex: Example (polarity: AC),

### Identification color

Product names	1st	2nd
CI-A1	Gold	Red
CI-A2	Gold	Pink
CI-A3	Black	Orange

## Chemical composition of all-weld metal (%)

## Mechanical properties of all-weld metal

Si	Mn	P	S	Ni	Fe	Others	TS (MPa)	EI (%)
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0.11	0.57	0.002	0.001	Bal.	1.71	-	Ex 480	-
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≤1.00	≤1.00	≤0.040	≤0.030	≥92.0	≤5.00	-		
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0.31	1.96	0.004	0.001	54.8	Bal.	-	Ex 520	-
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≤2.50	≤2.50	≤0.040	≤0.030	45.0~60.0	Bal.	-		
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0.50	0.48	0.006	0.002	-	Bal.	-	Ex 490	33
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≤1.00	≤0.80	≤0.030	≤0.020	-	Bal.	-		
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Gt: Guaranty (polarity: as specified above)

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0
<b>CI-A1</b>	-	350	350	350
<b>CI-A2</b>	300	300	350	-
<b>CI-A3</b>	300	350	400	-





**For 9%Ni Steel and Nickel-Based Alloy**

## **Welding Consumables and Proper Welding Conditions for**

**Shielded Metal Arc Welding (SMAW)**

**Flux Cored Arc Welding (FCAW)**

**Gas Metal Arc Welding (GMAW)**

**Gas Tungsten Arc Welding (GTAW)**

**Submerged Arc Welding (SAW)**

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## For 9%Ni Steel and Nickel-Based Alloy

### For 9%Ni Steel

For welding of 9%Ni steel, Ni-base alloys such as Ni-Cr alloy (e.g., Inconel) and Ni-Mo alloy (e.g., Hastelloy) welding consumables are commonly used to obtain sufficient notch toughness at cryogenic temperatures. 9%Ni steel is used for storage tanks for liquefied natural gas (LNG), liquefied oxygen and liquefied nitrogen, and LNG carriers. In the construction of such cryogenic temperature service equipment, automatic gas tungsten arc welding and submerged arc welding are often used to ensure consistent weld quality, as shown in Fig. 1.

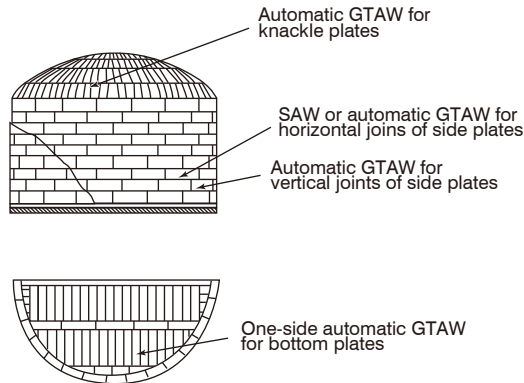


Fig. 1 Typical applications of automatic welding processes for a LNG storage tank

### Tips for better welding results

#### Common to individual welding processes

- (1) Remove scale, rust, and other dirt from welding grooves beforehand by grinding or other appropriate means.
- (2) Use no preheat and control interpass temperatures at 150°C or lower.
- (3) Minimize welding currents and welding speeds to prevent hot cracking.
- (4) Use no magnetic power crane because 9%Ni steel is likely to be magnetized.

#### SMAW

- (1) Re-dry covered electrodes by 200-250°C for 30-60 minutes before use.
- (2) Keep the arc length as short as possible.

#### FCAW, GMAW

- (1) Use Ar-CO<sub>2</sub> mixtures with 20-25%CO<sub>2</sub> for shielding gas. The gas flow rates should be 20-25 l/min.
- (2) Refer to Pages 211 and 213 of the stainless steel article about power source, wire extension, protection against wind and welding fumes, and storage of welding wires.

#### GTAW

- (1) Use multi-pass welding because the use of single-pass welding may cause a decrease of weld metal strength affected by the dilution from the base metal.

## **SAW**

- (1) Re-dry fluxes by 200-300°C for 1 hour before use.
- (2) Use multi-pass welding because the use of single-pass welding may cause a decrease of weld metal strength affected by the dilution from the base metal.

## **For Ni-base alloy**

Typical Ni-base alloys for welding are Ni-Cu alloy (e.g. Monel), Ni-Cr alloy (e.g. Inconel) and Ni-Fe-Cr alloys (e.g. Incoloy). Ni-base welding consumables are used for joining these Ni-base alloys and dissimilar-metal joints consisting of Ni-base alloy and low alloy steel, stainless steel, and low alloy steel.

## **Tips for better welding results for individual welding processes**

### **SMAW**

- (1) Use proper welding currents because the use of an excessive welding current causes electrode-burn and thereby usability and weld metal properties can be deteriorated.
- (2) Use no preheating for welding matching Ni-base alloys. Control interpass temperatures at 150°C or lower.
- (3) Use the backstep technique when an arc is struck in the welding groove, or strike an arc on a piece of metal outside the groove to prevent the occurrence of blowholes at the arc starting area of a bead.
- (4) Keep the arc length as short as possible.
- (5) Use flat-position welding as much as possible because vertical or overhead welding requires higher welding skill.
- (6) Minimize welding currents and speeds to prevent hot cracking.

### **FCAW**

- (1) Use Ar-CO<sub>2</sub> mixtures with 20-25%CO<sub>2</sub> for shielding gas. The gas flow rates should be 20-25 l/min.
- (2) Refer to Page 211 of the stainless steel article about power source, wire extension, protection against wind and welding fumes, and storage of welding wires.

### **GMAW**

- (1) Pulsed arc welding with the spray droplet transfer mode using low currents is most appropriate, although conventional gas metal arc welding power sources can be used. DC-EP polarity is suitable.
- (2) Argon gas shielding with gas flow rates in the 25-30 l/min range is suitable. Ar-He mixture gases are also suitable.
- (3) Use no preheating and control interpass temperatures at 150°C or lower.
- (4) Minimize welding currents and speeds to prevent hot cracking.

### **GTAW**

- (1) Use DC-EN polarity.
- (2) Argon gas shielding with gas flow rates in the 10-15 l/min range is suitable where welding currents are within 100-200A. In one-side welding, back shielding is needed to avoid oxidation of the back side bead.
- (3) Control the arc length at approximately 2-3 mm because the use of an excessive arc length may cause lack of shielding, thereby causing blowholes.
- (4) Use no preheating and control interpass temperatures at 150°C or lower.
- (5) Minimize welding currents and speeds to prevent hot cracking.

## For 9%Ni Steel and Nickel-Based Alloy

### How to select the proper welding consumable for dissimilar metal joints

Recommended welding consumables for dissimilar metal joints and preheat temperatures are shown in Table 1. <sup>(1) (2)</sup>

Table 1 Recommended welding consumables for dissimilar metal joints

Base metal: A		Carbon steel and low alloy steel	Nickel and	
Base metal: B			Inconel	Incoloy
Stainless steel	Austenitic	NC-39, NC-39L NC-39MoL NI-C70A <sup>(3)</sup>  100~200°C	NI-C70A NI-C625  —	NI-C70A NI-C625  —
	Martensitic	NC-39, NC-39L CR-43Cb <sup>(4)</sup> NI-C70A <sup>(3)</sup>  200~400°C	NI-C70A  100~300°C	NI-C70A  100~300°C
	Ferritic	NC-39, NC-39L CR-43Cb <sup>(4)</sup> NI-C70A <sup>(3)</sup>  100~300°C	NI-C70A  100~200°C	NI-C70A  100~200°C
Nickel and nickel alloy	Nickel	NI-C70A  100~200°C	NI-C70A  —	NI-C70A  —
	Monel	NI-C70A ME-L34  100~200°C	NI-C70A ME-L34  —	NI-C70A ME-L34  —
	Incoloy	NI-C70A NI-C625  100~200°C	NI-C70A NI-C625  —	
	Inconel	NI-C70A NI-C625  100~200°C		

nickel alloy		Stainless steel	
Monel	Nickel	Ferritic	Martensitic
NI-C70A ME-L34 —	NI-C70A —	NC-39, NC-39L NI-C70A <sup>(3)</sup>  100~200°C	NC-39, NC-39L NI-C70A <sup>(3)</sup>  100~300°C
NI-C70A ME-L34 100~300°C	NI-C70A 100~300°C	NC-39 CR-43Cb <sup>(5)</sup> CR-40Cb <sup>(5)</sup> 200~400°C	
NI-C70A ME-L34 100~200°C	NI-C70A 100~200°C		
NI-C70A ME-L34 —			

Note: (1) This table shows only covered electrodes for SMAW. Other welding consumables having the similar chemical composition for GTAW, GMAW, and FCAW can also be used. Instead of NI-C70A, NI-C703D can also be used.

(2) The preheat temperature in this table is a rough guide. In a case where the welding joint consists of thick plates and is restrained to a great extent, a higher temperature may be necessary. Even when preheat temperature is given for particular dissimilar metal joints, austenitic stainless steel, nickel, and nickel alloy need not be preheated, and the counterpart base metals such as carbon steel, martensitic stainless steel, and ferritic stainless steel should be preheated sufficiently. In addition, for a dissimilar metal joint consisting of carbon steel (Base metal: A) and austenitic stainless steel, nickel, or nickel alloy (Base metal: B), both base metals need not be preheated.

(3) In a case where the weld is used at about 400°C or higher or under thermal cycles, NI-C70A should be selected.

(4) In a case where Ni is restricted in a special service environment, CR-43Cb should be used.

(5) In a case where Ni is restricted in a special service environment, CR-43Cb or CR-40Cb should be selected.

## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical			
						C	Si	Mn	
NI-C70S	A5.11 ENiCrFe -9	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for 9% Ni steel</li> <li>RC: 200~250°Cx 0.5~1h</li> </ul>	F HF H VU OH	Ex	0.09	0.23	2.20
						Gt	≤0.15	≤0.75	1.00~ 4.50
NI-C1S	A5.11 ENiMo -8	Low hydro- gen	AC	<ul style="list-style-type: none"> <li>Suitable for 9% Ni steel</li> <li>RC: 200~250°Cx 0.5~1h</li> </ul>	F HF H VU OH	Ex	0.03	0.49	0.28
						Gt	≤0.10	≤0.75	≤1.50

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty (polarity: AC)

### Approvals

NI-C70S	NK
NI-C1S	NK

### Identification color

Product names	1st	2nd
NI-C1S	Yellow	Green
NI-C70S	Silver gray	Pink

composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Ni	Cr	Nb	Fe	Mo	Others	0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)	
65.00	16.50	1.40	8.80	4.90	W: 0.6	Ex	430	710	41	-196°C: 62
≧55.00	12.00~ 17.00	0.50~ 3.00	≧12.00	2.50~ 5.50	W ≧1.5	Gt	-	≧650	≧25	-
68.60	1.90	-	6.80	18.60	W: 2.9	Ex	440	730	48	-196°C: 83
≧60.00	0.50~ 3.50	-	≧10.00	17.00~ 20.00	W: 2.0~ 4.0	Gt	-	≧650	≧25	-

## Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0
<b>NI-C70S</b>	-	300	350	350
<b>NI-C1S</b>	-	300	350	350

## Covered Electrodes

Product names	ASME AWS Class.	Type of covering	Pol.	Features	WP	Chemical			
						C	Si	Mn	
ME-L34	-	Lime titania	DC-EP	<ul style="list-style-type: none"> <li>Suitable for monel metal and dissimilar-metal joints and overlaying</li> <li>DC-EP is only applicable.</li> <li>RC: 150~200°Cx 0.5~1h</li> </ul>	F H VU OH	Ex	0.03	0.80	3.26
						Gt	≤0.15	≤1.25	≤4.0
NI-C70A	A5.11 ENiCrFe-1	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Suitable for Inconel and dissimilar-metal joints such as Inconel to low alloy steel, and stainless steel to low alloy steel</li> <li>AC is only applicable.</li> <li>RC: 200~250°Cx 0.5~1h</li> </ul>	F HF H VU OH	Ex	0.04	0.25	2.84
						Gt	≤0.08	≤0.75	≤3.50
NI-C703D	A5.11 ENiCrFe-3	Low hydrogen	DC-EP	<ul style="list-style-type: none"> <li>Suitable for Inconel and dissimilar-metal joints such as Inconel to low alloy steel, and stainless steel to low alloy steel</li> <li>DC-EP is only applicable.</li> <li>RC: 200~250°Cx 0.5~1h</li> </ul>	F HF H VU OH	Ex	0.06	0.34	6.55
						Gt	≤0.10	≤1.0	5.00~9.50
NI-C625	-	Low hydrogen	AC DC-EP	<ul style="list-style-type: none"> <li>Suitable for Inconel 625, Incoloy 825, dissimilar-metal joints and overlaying</li> <li>RC: 200~250°Cx 0.5~1h</li> </ul>	F HF H VU OH	Ex	0.04	0.32	0.67
						Gt	≤0.10	≤0.75	≤1.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty (Polarity: as specified above)

### Identification color

Product names	1st	2nd
ME-L34	Silver	Yellowish green
NI-C70A	Silver	Green
NI-C703D	Silver	Blue
NI-C625	Silver	Purple



composition of all-weld metal (%)						Mechanical properties of all-weld metal				
Ni	Cr	Nb	Fe	Mo	Others		0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
65.21	-	1.81	1.58	-	Cu: Bal Al: 0.25 Ti: 0.61	Ex	320	550	44	-
62.0~ 70.0	-	≦3.0	≦2.5	-	Cu: Bal Al≦1.0 Ti≦1.5	Gt	-	≧490	≧30	-
70.66	14.75	1.94	9.24	-	Co: 0.03	Ex	380	610	44	-196°C: 93
≧62.00	13.00~ 17.00	1.50~ 4.00	≧11.00	-	Co ≦0.12	Gt	-	≧550	≧30	-
69.40	13.21	2.00	7.90	Ti: 0.01	Co: 0.03	Ex	360	620	45	-196°C: 110
≧59.00	13.00~ 17.00	1.00~ 2.50	≧10.00	Ti ≦1.00	Co ≦0.12	Gt	-	≧550	≧30	-
61.10	21.65	3.41	3.66	8.70	-	Ex	420	760	47	-
≧55.0	20.00~ 23.00	3.15~ 4.15	≧7.00	8.00~ 10.00	-	Gt	-	≧690	≧30	-

### Diameter and Length (mm)

Dia.	2.6	3.2	4.0	5.0
<b>ME-L34</b>	-	350	400	400
<b>NI-C70A</b>	-	300	350	350
<b>NI-C703D</b>	250	300	350	350
<b>NI-C625</b>	-	300	350	350

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical	
DW-N70S	-	Rutile	Ar-CO <sub>2</sub>	DC-EP	▪ Suitable for 9% Ni steel	F HF	<b>C</b>	
							Ex	0.046
							Gt	≤0.15
							<b>Cr</b>	
							Ex	16.84
Gt	13.00~ 22.00							
DW-N82	A5.34 ENiCr3T0 -4	Rutile	Ar-CO <sub>2</sub>	DC-EP	▪ Suitable for Ni-based alloy of 600 and dissimilar-metal joints such as Ni-based alloy to low alloy steel and stainless steel to low alloy steel	F HF	<b>C</b>	
							Ex	0.038
							Gt	≤0.10
							<b>Cr</b>	
							Ex	21.2
Gt	18.0~ 22.0							

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)					Mechanical properties of all-weld metal				
Si	Mn	P	S	Ni		0.2%OS (MPa)	TS (MPa)	El (%)	IV (J)
0.20	5.91	0.003	0.002	62.61	Ex	425	716	46	-196°C: 106
≤0.75	≤8.00	≤0.020	≤0.015	≥55.00					
Mo	Cu	Fe	Nb						
10.22	0.01	1.88	2.02		Gt	-	≥650	≥25	-
≤12.00	-	≤15.00	≤4.00						
Si	Mn	P	S	Ni					
0.23	3.40	0.002	0.006	70.6	Ex	380	650	46	0°C: 128
≤0.50	2.5~ 3.5	≤0.03	≤0.015	≥67.0					
Cu	Fe	Nb+Ta	Ti						
< 0.01	1.51	2.30	0.31		Gt	-	≥550	≥25	-
≤0.50	≤3.0	2.0~ 3.0	≤0.75						

## Diameter (mm)

DW-N70S	1.2
DW-N82	1.2

## Flux Cored Wires

Product names	ASME AWS Class.	Type of cored flux	SG	Pol.	Features	WP	Chemical	
DW-N625	A5.34 ENiCrMo3T1 -4	Rutile	Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for Ni-based alloy of 625, dissimilar-metal joints and overlaying	F HF H VU	<b>C</b>	
							Ex	0.028
							Gt	≤0.10
							<b>Cr</b>	
Ex	21.6							
Gt	20.0~ 23.0							
DW-NC276	A5.34 ENiCrMo4T0 -4	Rutile	Ar- CO <sub>2</sub>	DC- EP	▪ Suitable for Ni-based alloy of C276 and super austenitic stainless steel	F HF H VU	<b>C</b>	
							Ex	0.016
							Gt	≤0.02
							<b>Cr</b>	
Ex	15.06							
Gt	14.5~ 16.5							

Note: Welding tests are as per Kobe Steel's Standard. Ex: Example, Gt: Guaranty

composition of all-weld metal (%)					Mechanical properties of all-weld metal				
					0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)	
<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>	Ex	472	752	38	0°C: 67
0.38	0.36	0.006	0.003	63.3					
≤0.50	≤0.50	≤0.02	≤0.015	≥58.0					
<b>Mo</b>	<b>Cu</b>	<b>Fe</b>	<b>Nb+Ta</b>	<b>Ti</b>	Gt	-	≥690	≥25	-
8.5	0.01	2.1	3.45	0.16					
8.0~ 10.0	≤0.50	≤5.0	3.15~ 4.15	≤0.4					
<b>Si</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>	Ex	466	719	46	0°C: 63
0.16	0.77	0.008	0.003	58.5					
≤0.2	≤1.0	≤0.03	≤0.03	Bal					
<b>Mo</b>	<b>Cu</b>	<b>Fe</b>	<b>W</b>	<b>Others</b>	Gt	-	≥690	≥25	-
16.19	0.022	5.37	3.67	Co:0.048 V:0.02					
15.0~ 17.0	≤0.50	4.0~ 7.0	3.0~ 4.5	Co≤2.5 V≤0.35					

## Diameter (mm)

DW-N625 1.2

DW-NC276 1.2

## Solid Wire

Product names	ASME AWS Class.	SG	Pol.	Features	WP	Chemical		
						C	Si	
MG-S70NCb	A5.14 ERNiCr -3	Ar	DC- EP	<ul style="list-style-type: none"> <li>Inconel 82 type filler wire</li> <li>Suitable for Inconel, Incoloy, dissimilar-metal joints and overlaying on carbon steel</li> </ul>	F HF H VU OH	Ex	0.03	0.22
						Gt	≤0.10	≤0.50
						Ex	Cr	Ti
							20.01	0.28
Gt	18.00~ 22.00	≤0.75						

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

composition of wire (%)				Mechanical properties of all-weld metal				
Mn	P	S	Ni		0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
3.05	0.003	0.002	72.01	Ex	370	660	41	-196°C: 140
2.50~ 3.50	≤0.030	≤0.015	≥67.0					
Fe	Nb+Ta	Cu						
1.73	2.63	0.01		Gt	-	≥550	≥30	-
≤3.00	2.00~ 3.00	≤0.50						

## Diameter (mm)

MG-S70NCb 0.8, 1.2, 1.6

## Filler Rods and Wires

Product names	ASME AWS Class.	SG	Pol.	Features	Chemical		
					C	Si	
TG-S709S	A5.14 ERNiMo -8	Ar	DC- EN	▪ Suitable for 9% Ni steel	Ex	0.017	0.02
					Gt	≤0.10	≤0.50
					Ex	1.97	19.07
					Gt	0.5~ 3.5	18.0~ 21.0
TG-S70NCb	A5.14 ERNiCr -3	Ar	DC- EN	▪ Suitable for Inconel and Incoloy, dissimilar-metal joints and overlaying	Ex	0.022	0.20
					Gt	≤0.10	≤0.50
					Ex	19.87	2.50
					Gt	18.00~ 22.00	2.00~ 3.00
TG-SN625	A5.14 ERNiCrMo -3	Ar	DC- EN	▪ Suitable for Inconel 625, dissimilar-metal joints and overlaying	Ex	0.010	0.08
					Gt	≤0.10	≤0.50
					Ex	21.85	8.95
					Gt	20.00~ 23.00	8.00~ 10.00

Note: Welding tests are as per AWS. Ex: Example, Gt: Guaranty

### Approvals

TG-S709S	NK
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### Identification color

Product names	
TG-S709S	Orange
TG-S70NCb	Purple
TG-SN625	Brown



composition of rod and wire (%)					Mechanical properties of all-weld metal				
					0.2%OS (MPa)	TS (MPa)	EL (%)	IV (J)	
<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>						
0.02	0.001	0.001	69.81	Ex	460	730	47	-196°C: 160	
≤1.0	≤0.015	≤0.015	≥60.0						
<b>W</b>	<b>Fe</b>	<b>Cu</b>							
2.99	5.56	0.01		Gt	-	≥650	≥30	-	
2.0~ 4.0	≤10.0	≤0.50							
<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>						
2.99	0.002	0.001	72.39						
2.5~ 3.5	≤0.030	≤0.015	≥67.0	Ex	370	680	40	-196°C: 150	
<b>Ti</b>	<b>Fe</b>	<b>Cu</b>							
0.30	1.65	0.01							
≤0.75	≤3.00	≤0.50							
<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Ni</b>						
0.05	0.002	0.001	63.58						
≤0.50	≤0.020	≤0.015	≥58.0	Ex	480	770	41	-	
<b>Nb+Ta</b>	<b>Al</b>	<b>Ti</b>	<b>Fe</b>	<b>Cu</b>					
3.55	0.21	0.21	1.44	0.02					
3.15~ 4.15	≤0.40	≤0.40	≤5.00	≤0.50					

## Diameter (mm)

<b>TG-S709S</b>	1.2, 1.6, 2.0, 2.4
<b>TG-S70NCb</b>	0.8, 0.9, 1.0, 1.2, 1.6, 2.0, 2.4, 3.2, 4.0
<b>TG-SN625</b>	1.6, 2.4

## Flux and Wire Combinations

Product names	ASME AWS Class.	Type of flux	Pol.	Features	Chemical		
					C	Si	
PF-N3/ US-709S	A5.14 ERNiMo -8	Bonded	AC  DC- EP	<ul style="list-style-type: none"> <li>▪ Hastelloy type consumables</li> <li>▪ Suitable for flat welding of 9%Ni steel</li> <li>▪ RC: 200~300°Cx1h</li> </ul>	Wire-Ex	0.02	0.01
					Wire-Gt	≤0.10	≤0.50
					Weld-Ex	0.03	0.12
PF-N4/ US-709S	A5.14 ERNiMo -8	Bonded	DC- EP	<ul style="list-style-type: none"> <li>▪ Hastelloy type consumables</li> <li>▪ Suitable for horizontal and horizontal fillet welding of 9%Ni steel</li> <li>▪ RC: 200~300°Cx1h</li> </ul>	Wire-Ex	0.02	0.01
					Wire-Gt	≤0.10	≤0.50
					Weld-Ex	0.03	0.74

Note: Welding tests are as per Kobe Steel's Standard. Wire-Ex: Example of wire, Ex: Example of weld metal (polarity: AC)

### Approvals

PF-N4/US-709S	NK
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Mn	Ni	composition (%)				Fe	Mechanical properties of weld metal			
		Cr	Mo	W			0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
0.01	Bal.	2.0	19.1	2.9	5.5	Ex	400	690	44	-196°C: 80
≤1.0	≥60.0	0.5~ 3.5	18.0~ 21.0	2.0~ 4.0	≤10.0					
1.70	64.1	1.6	16.6	2.5	14.7	Gt	-	≥650	≥30	-
0.01	Bal.	2.0	19.1	2.9	5.5	Ex	410	680	43	-196°C: 70
≤1.0	≥60.0	0.5~ 3.5	18.0~ 21.0	2.0~ 4.0	≤10.0					
0.58	64.0	1.7	17.2	2.7	14.9	Gt	-	≥650	≥30	-

Wire-Gt: Guaranty of wire, Weld-Ex: Example of weld metal

### Diameter of wire (mm)

**US-709S** 1.6, 2.4

### Mesh size of flux

**PF-N3** 12x48

**PF-N4** 12x65



# **Highly Efficient Welding Processes**

**FCB™ Process**

**FA-B**

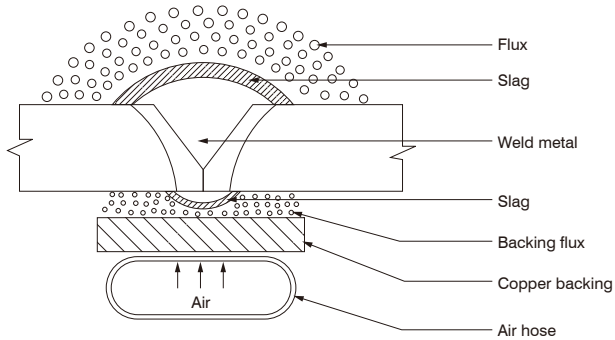
**Electrogas Arc Welding**

**Enclosed Arc Welding**

# FCB™ Process

**Principles:**

FCB™ is an automatic one-side submerged arc welding process by which a uniform reverse side bead can be obtained. Welding is conducted from the surface side of the welding groove after supplying the backing flux, MF-1R or PFI-50R, on the copper backing and pushing up the copper backing to the reverse side of the groove by the pressurized air hose.



**Features:**

The combination of the backing flux and copper plate provides better contact onto the reverse side of the groove, which can accommodate a fluctuation of root gap and wide welding conditions to ensure consistent reverse bead without excessive melt through.

**Applications:**

Plate-to-plate butt welding for shipbuilding

**Welding consumables**

Type of steel	Flux	Wire	Backing flux	Remarks
TMCP	PF-I55E	US-36	PF-I50R or MF-1R	MF-1R is more suitable for thin plate with thickness 20 mm or less.

Note: Redrying conditions of flux: 200~300°Cx1h  
(Backing fluxes must not be dried by heating)

### Approvals: PF-I55E/US-36/PF-I50R

Number of wires	ABS	LR	DNV	BV	NK	Others
Two	-	3A, 3YA	-	-	KAW53SP	CCS: 3Y, GL: 3Y, KR: 3YSR
Three	3Y, 3Y400	3A, 3YA	III Y	-	KAW53Y40	CCS: 3Y, GL: 3Y, KR: 3YSR
Four	3Y, 3Y400	3Y40A	-	-	KAW53Y40SP	CCS: 3Y

○: Subject to satisfactory procedure test by user

### Packages

Wire: **US-43, US-36**

Dia. (mm)	Type	Weight (kg)
4.8	Coil	25
	Coil	75
	Coil	150
6.4	Coil	25
	Coil	78
	Coil	159

Flux: **PF-I45, PF-I50, PF-I55E**

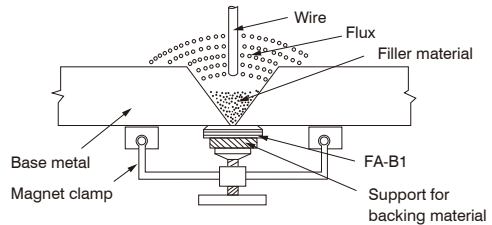
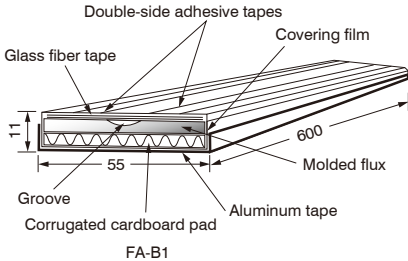
Mesh size	Type	Weight (kg)
10x48	Aluminum-laminated kraft paper package, Can	20

Flux: **PF-I50R, MF-1R**

Mesh size	Type	Weight (kg)
10x65	Can	20

**Principles:**

FA-B1 is a flexible backing material suitable for the simplified one-side welding process shown below. The structure of FA-B1 is as shown in the sketch below. It consists of glass fiber tapes for forming a reverse side bead, a solid flux for controlling reverse side bead protrusion, a refractory, a corrugated cardboard pad, a cover film and double-side adhesive tapes. FA-B1 is attached onto the reverse side of the groove with the adhesive tapes and fixed with an aluminum plate and magnetic clamps.



**Features:**

- (1) FA-B1 features good flexibility to assure smooth contact onto the reverse side of the groove to accommodate much more joint misalignment, distortion and dissimilar-thickness transition of the joint. FA-B1 is also suitable for a joint having a curvature on its reverse side.
- (2) Consistent reverse side beads can be obtained due to a wider tolerance in welding conditions.

**Applications:**

Curved shell plates, deck plates, bottom plates, tank top plates of ships, steel deck plates of bridges, and other one-side welding applications

**Welding consumables**

Type of steel	Flux	Wire	Metal powder	Backing material
Mild steel	MF-38	US-36	RR-2	FA-B1
	PF-I52E	US-36	RR-2	FA-B1
490MPa HT steel	MF-38	US-49	RR-2	FA-B1
	PF-I52E	US-36	RR-2	FA-B1

Note: Redrying conditions of flux: **PF-I52E**: 200~300°Cx1h, **MF-38**: 150~350°Cx1h  
(**FA-B1** and **RR-2** must not be dried by heating)



**Approvals: PF-I52E / US-36 / RR-2 / FA-B1**

Number of wires	ABS	DNV	BV	NK	Others
Single	-	-	-	KAW53	CR: 3Y, CCS: 3Y
Tandem	3*, 3Y*	III Y	A3YM	KAW53Y40SMP	GL: 3Y, CCS: 3Y

○: Subject to satisfactory procedure test by user

**Approvals: MF-38 / US-36 / RR-2 / FA-B1**

Number of wires	ABS	LR	DNV	BV	NK
Single	3*	3A	III M	A3M	KAW3

**Packages**

Wire: **US-36 / US-49**

Backing materials: **FA-B1**

Dia. (mm)	Type	Weight (kg)	Applicable type of joint	Length (mm)	Pieces per carton
4.8	Coil	25	Standard joint	600	30
	Coil	75	Transition joint	600	25
	Coil	150	Mismatch joint	600	30
6.4	Coil	25			
	Coil	78			
	Coil	159			

Flux: **PF-I52E**

Mesh size	Type	Weight (kg)
10x48	Aluminum-laminated kraft paper package, Can	20

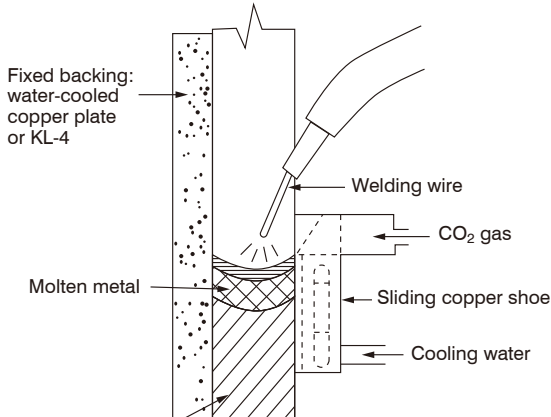
Flux: **MF-38**

Mesh size	Type	Weight (kg)
12x65	Can	20

# Electrogas Arc Welding

**Principles:**

Electrogas arc welding (EGW) is vertical-up butt welding. SEGARC is an automatic vertical welding process suitable for EGW. This process uses SEG-2Z equipment with the combination of a small diameter flux-cored wire, a sliding copper shoe on the front side of a joint, and a fixed backing on the reverse side of a joint.



**Features:**

- (1) High deposition rates (e.g., 180g/min at 380A) provide high welding efficiency.
- (2) Lightweight, compact-size equipment makes it easy to set up.
- (3) Wire extension can be controlled constant against varied welding conditions.
- (4) Welding line can be located either on the left side (Standard) or, by re-assembling, the right side of the tracking rail.
- (5) With the oscillator (Option), one-pass completion welding can be conducted for plates with a thickness of 32 mm max.
- (6) The carriage can be detached at any place of the tracking rail.

**Applications:**

- (1) Side shells, bulkheads, hoppers of bulk carriers in shipbuilding
- (2) Box girder webs and I-plate girder webs in bridge construction
- (3) Press flame, storage tanks, large diameter pipes, and other vertical welding lines

## Welding consumables and equipments

Type of steel	Product names	Backing material	Shielding gas	Equipment	Polarity
Mild steel & 490MPa HT steel	DW-S43G	KL-4	CO <sub>2</sub>	SEG-2Z	DC-EP
Mild steel & 490MPa HT steel for low temperature service	DW-S1LG	KL-4	CO <sub>2</sub>	SEG-2Z	DC-EP
550 to 610MPa HT steel	DW-S60G	KL-4	CO <sub>2</sub>	SEG-2Z	DC-EP

### Example of chemical composition of weld metal (%)

Product names	C	Si	Mn	P	S	Ni	Mo	Ti
DW-S43G	0.08	0.35	1.63	0.014	0.010	0.02	0.17	0.02
DW-S1LG	0.05	0.25	1.60	0.009	0.007	1.40	0.13	0.05
DW-S60G	0.08	0.32	1.67	0.010	0.008	0.71	0.25	0.03

### Example of mechanical properties of weld metal

Product names	0.2%OS (MPa)	TS (MPa)	EI (%)	IV (J)
DW-S43G	470	600	27	-20°C : 62
DW-S1LG	500	615	25	-60°C : 100
DW-S60G	520	650	26	-20°C : 65

### Approvals: DW-S43G (Backing: KL-4)

ABS	LR	DNV	BV	NK	Others
○	3, 3Y <sup>1</sup>	III Y	AV3, AV3Y	KEW53	GL: 3YV, KR: 3YV, CCS: 3Y, CR: 3Y

### Approvals: DW-S1LG (Backing: KL-4)

ABS	LR	DNV	Others
○	4Y <sup>2</sup> , 5Y40 <sup>2</sup>	VY, NV2-4L, NV4-4L	GL: 6Y40V

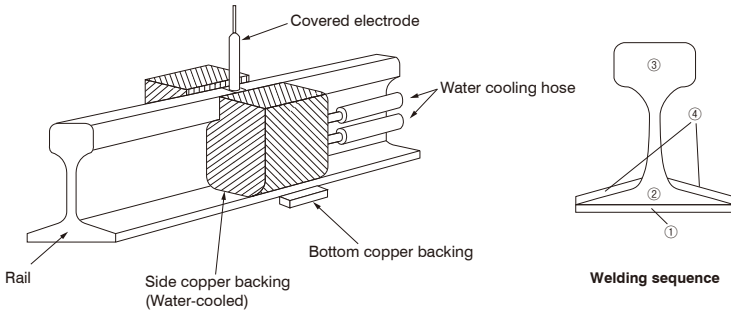
### Packages

Dia. (mm)	Type	Weight (kg)
1.6	Spool	20

# Enclosed Arc Welding

**Principles:**

With the enclosed arc welding process, welding is continuously progressed in a square groove enclosed by joining components and cooling jigs, using low hydrogen type covered electrodes without removing the slag in the groove during welding.



**Features:**

- (1) Simple, square groove can be used.
- (2) Highly efficient because it is no need to break the arc to remove slag during welding, a large diameter electrode can be used, and narrow groove can be used.

**Applications:**

Rails for rail roads and crane rails

**Welding consumables**

Place to be applied	Welding sequence	Product names	Polarity	Remarks
Bottom part of a rail	①, ②, ④	LB-116	AC, DC-EP	Preheating temp: 400~500°C
Top part of a rail	③	LB-80EM	AC, DC-EP	Postweld heating temp: 650~710°Cx 20 min

Note: Redrying conditions: 350~400°Cx1h

**Example of chemical composition of all-weld metal (%) (AC)**

Product names	C	Si	Mn	P	S	Ni	Cr	Mo
LB-116	0.08	0.63	1.50	0.010	0.006	1.83	0.28	0.43
LB-80EM	0.08	0.69	1.93	0.010	0.006	-	0.52	0.38

### Example of mechanical properties of all-weld metal (AC)

Product names	TS (MPa)	EI (%)
LB-116	830	24
LB-80EM	820	24

### Packages of LB-116

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
2.6	300	2	20	17
3.2	350	5	20	30
4.0	400	5	20	54
5.0	400	5	20	86

### Packages of LB-80EM

Dia. (mm)	Length (mm)	Weight per pack (kg)	Weight per carton (kg)	Weight per piece (g)
4.0	450	5	20	58
5.0	450	5	20	90
6.0	450	5	20	131

### Identification color

Product names	1st	2nd
<b>LB-80EM</b>	Green	Blue



**Approvals**

**Redrying Conditions**

**A Guide to Estimating the Consumption**

**Conversions for SAW Flux Sizes**

**Package Specifications for Wires**

**Some unit conversion Tables**

**F-No. and A-No. per ASME IX**

**AWS Classifications (A part is extracted)**

**EN Classification System**

## Notes on usage

The ship classification approvals of welding consumables shown below are those renewed as of April 7, 2011. They may be cancelled, added, or changed and may not necessarily be applied to all the welding consumables produced at the production plants (Ibaraki Plant, Saijo Plant, Fukuchiyama Branch, and Fujisawa Branch) of Kobe Steel. Therefore, please contact with the International Operations Dept. of the Welding Company of Kobe Steel when you need the ship classification approval of a particular welding consumable to be used. These tables abbreviate the names of ship classification societies and some designations to those noted in the following.

### Covered electrodes for mild steel and high tensile strength steel

Product names	ABS			LR		DNV	
	Grade	AP	F & HF	Grade	WP	Grade	WP
B-14	3	≦5.0	≦8.0	3m	F, V, O	3	F, V, O
B-17	3	≦5.0	≦8.0	3m	F, V, O	3	F, V, O
RB-26	2	≦5.0	-	2m	F, V, O	-	-
LB-26	3H15	≦5.0	≦8.0	3Ym H15	F, V, O	3YH10	F, V, O
LB-52	3H10,3Y,3Y400	≦5.0	≦6.0	3Ym H15	F, V, O	3YH10	F, V, O
LB-52A	-	-	-	-	-	-	-
LB-52U	3H10, 3Y	≦5.0	-	3Ym H15	F, V, O	3YH10	F, V, O
LB-52T	3H10, 3Y, 3Y400	≦5.0	-	3Ym H15	F, V, O	3YH10	F, V, O
LB-52-18	3Y H10	≦4.0	≦6.0	3Ym H15	F, V, O	3YH10	F, V, O
LB-62	3YQ500 H10	≦4.0	≦6.0	3Ym H15	F, V, O	3YH10	F, V, O
LB-62U	3YQ500 H10	≦4.0	-	-	-	-	-
LB-62UL	-	-	-	-	-	-	-
LB-67L	5YQ500 H5	≦4.0	≦5.0	-	-	-	-
LB-80UL	-	-	-	-	-	-	-
LB-106	MG(E10016-G)	≦6.0	-	-	-	-	-
LB-70L	4YQ620 H5	≦4.0	≦5.0	-	-	4Y62H5	F, V, O
LB-80L	5YQ690 H5	≦4.0	≦5.0	-	-	5Y69H5	F, V, O
LT-B50	3, 3Y*	-	≦8.0	3Ym, 3YG	F	3	F
LT-B52A	3H10, 3Y	≦4.5	≦8.0	3Ym, 3YG H15	F, V, O	3YH15	F, V, O
Z-44	3	≦6.0	-	3m	F, V, O	3	F, V, O

Note: (1) The maximum electrode diameter (mm) for all-position welding is indicated outside the parenthesis while that for flat welding is indicated inside the parenthesis.



[Ship classification societies]

ABS: American Bureau of Shipping LR: Lloyd's Register of Shipping DNV: Det Norske Veritas  
 BV: Bureau Veritas NK: Nippon Kaiji Kyokai CR: Central Research of Ships S. A.  
 GL: Germanischer Lloyd KR: Korean Register of Shipping CCS: China Classification Society

[Welding positions]

F: Flat position V: Vertical position VD: Vertical down O: Overhead; H: Horizontal

[Other abbreviations]

BV		NK			Others
Grade	WP	Grade	MED <sup>(1)</sup>	F & HF	
3	F, V, O	KMW3	5(8)	F, V, O	CR: 3, GL: 3
3	F, V, O	KMW3	5(8)	F, V, O	CR: 3, GL: 3
-	-	KMW2	5	F, V, O	
3, 3YH	F, V, O	KMW3H15	5(8)	F, V, O	CR: 3H,3YH
3H, 3YHH	F, V, O	KMW53Y40H10	5(8)	F, V, O	GL: 3YH15
-	-	KMW53H10	5(6)	F, V, O	
3, 3YHH	F, V, O	KMW53H10	5	F, V, O	CCS: 3YH10
3, 3YHH	F, V, O	KMW53Y40H10	5	F, V, O	CR: 3, 3YHH
-	-	KMW53H10	4(6)	F, V, O	
3 HH, 3Y HH	F, V, O	KMW3Y50H10	5(6)	F, V, O	CR: MG
-	-	-	-	-	
-	-	-	-	-	CCS: 3Y50H10
-	-	-	-	-	
-	-	KMW3Y69H5	4(5)	F, V, O	CCS: 3Y69H5
-	-	KMW3Y62H5	5(6)	F, V, O	CR: MG
-	-	-	-	-	
-	-	-	-	-	
3, 3Y	F	KMW53	8	F, H	CR: 3Y, GL: 3Y
3, 3YHH	F, V, O	KMW53H10	4.5(8)	F, V, O	
-	-	KMW3	5	F, V, O	

# Approvals

## Covered electrodes for low temperature steel

Product names	ABS			LR		DNV	
	Grade	AP	F & HF	Grade	WP	Grade	WP
LB-7018-1	4Y400 H10	≤4.0	-	4Y40m H10	F, V, O	-	-
LB-52NS	3Y, 4Y400 H10	≤5.0	≤6.0	5Y40m(H15)	F, V, O	5Y40H10 NV2-4(L), 4-4(L)	F, V, O
NB-1SJ	-	-	-	5Y40m(H15)	F, V, O	5YH10 NV2-4L, NV4-4L	F, V, O
LB-62L	5YQ500 H10, MG	≤5.0	-	-	-	-	-
NI-C70S	-	-	-	-	-	-	-
NI-C1S	-	-	-	-	-	-	-

Note: (1) The maximum electrode diameter (mm) for all-position welding is indicated outside the paren-

## Covered electrodes for heat-resistant low-alloy steel

Product names	ABS			LR		DNV	
	Grade	AP	F & HF	Grade	WP	Grade	WP
CM-A96	MG(E8016-B2)	≤4.0	≤6.0	MG(E8016-B2)	F, V, O	H10, NV1Cr0.5Mo	F, V, O
CM-A96MB	-	-	-	-	-	-	-
CM-B98	-	-	-	MG(E8018-B2)	F, V, O	-	-
CM-A106	MG(E9016-B3)	≤6.0	-	MG(E9016-B3)	F, V, O	H10, NV2.25Cr1Mo	F, V, O
CM-A106N	-	-	-	-	-	-	-

Note: (1) The maximum electrode diameter (mm) for all-position welding is indicated outside the paren-

## Covered electrodes for stainless steel

Product names	ABS			LR		DNV	
	Grade	AP	F & HF	Grade	WP	Grade	WP
NC-38	MG(E308-16)	≤5.0	-	-	-	308	F, V, O
NC-38L	-	-	-	304Lm(Chem.)	F, V, O	-	-
NC-38LT	-	-	-	304Lm(Cryo.)	F, V, O	308L	F, V, O
NC-39	MG(E309-16)	≤4.0	≤6.0	SS/CMn m(Chem.)	F, V, O	309	F, V, O
NC-39L	-	-	-	SS/CMn(Chem.)	-	309L	F, V, O
NC-39MoL	MG	≤4.0	≤5.0	-	-	-	-
NC-36	-	-	-	-	-	-	-
NC-36L	MG(E316L-16)	≤4.0	≤5.0	316Lm(Chem.)	F, V, O	316L	F, V, O

Note: (1) The maximum electrode diameter (mm) for all-position welding is indicated outside the paren-

BV		NK			Others
Grade	WP	Grade	MED <sup>(1)</sup>	F & HF	
-	-	-	-	-	
4Y40M HH(KV-60)	F, V, O	KMWL3H10, KMW54Y40	5(6)	F, V, O	
4Y40M HH, UP	F, V, O	KMW5Y42H10	5	F, V, O	
-	-	-	-	-	
-	-	KMWL91	4(5)	F, V, O	
-	-	KMWL92	4(5)	F, V, O	

thesis while that for flat welding is indicated inside the parenthesis

BV		NK			Others
Grade	WP	Grade	MED <sup>(1)</sup>	F & HF	
UP(E8016-B2)	F, V, O	MG(E8016-B2)	4(6)	F, V, O	
UP(E8016-B2)	F, V, O	-	-	-	
-	-	-	-	-	
UP(E9016-B3)	F, V, O	MG(E9016-B3)	4(6)	F, V, O	
UP(E9016-B3)	F, V, O	-	-	-	

thesis while that for flat welding is indicated inside the parenthesis.

BV		NK			Others
Grade	WP	Grade	MED <sup>(1)</sup>	F & HF	
-	-	KD308	4(5)	F, V, O	
UP(E308L-16)	F, V, O	KD308L	4(6)	F, V, O	GL: 4306
-	-	KD308L	4	F, V, O	
UP(E309-16)	F, V, O	KD309	4(5)	F, V, O	CCS: AS2-B, GL: 4332
UP(E309L-16)	F, V, O	KD309L	4	F, V, O	
-	-	KD309Mo	4(5)	F, V, O	
-	-	KD316	4(6)	F, V, O	
UP(E316L-16)	F, V, O	KD316L	5	F, V, O	GL: 4435

thesis while that for flat welding is indicated inside the parenthesis.

## Approvals

### Flux-cored wires for gas shielded arc welding of mild steel and high tensile strength steel <sup>(1)</sup>

Product names	ABS	LR	DNV
DW-100/CO <sub>2</sub>	2YSA, 2Y400SA, H10	2YS, 2YM H10	II YMS(H10)
DW-50/CO <sub>2</sub>	3YSA, H5	3YS, H5	III YMS(H5)
DW-50/Ar-CO <sub>2</sub>	3YSA, H5	3YS, H5	III YMS(H5)
DW-100V/CO <sub>2</sub>	2YSA, H10	2YS, 2YM, H10	II YMS
DW-100E/CO <sub>2</sub>	3YSA, 3Y400SA, H10	3YS, H10	III YMS
DW-200/CO <sub>2</sub>	3YSA	3YS, H10	III YMS
DW-A50/Ar-CO <sub>2</sub>	3YSA, H5	3YS, H5	III YMS(H5), MG
DW-A51B/Ar-CO <sub>2</sub>	-	3YS(H5)	III YMS(H5)
MX-100/CO <sub>2</sub>	2YSA	2YS, H10	II YMS
MX-100T/CO <sub>2</sub>	3YSA, H5	3YS, H5	III YMS(H5)
MX-100T/Ar-CO <sub>2</sub>	-	3YS, H5	III YMS(H5)
MX-200/CO <sub>2</sub>	2YSA, 2Y400SA, H5	2YS, H5	II YMS(H5)
MX-200E/CO <sub>2</sub>	4Y400SA, H5	4Y40S(H5)	IVY40MS(H5)
MX-200H(x2)/CO <sub>2</sub>	3YA, 3YSA, H5	3YM, H5	III YM
MX-A100/Ar-CO <sub>2</sub>	-	4YS, H5	IVYMS(H5)

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-

### Flux-cored wires for gas shielded arc welding of low temperature steel <sup>(1)</sup>

Product names	ABS	LR
DW-50LSR/CO <sub>2</sub>	5Y400SA, H5	5Y40S, H5
DW-55E/CO <sub>2</sub>	3YSA, 3Y400SA, H5	3YS, 4Y40S, H5
DW-A55E/Ar-CO <sub>2</sub>	4Y400SA(H5)	4Y40S, H5
DW-55L/CO <sub>2</sub>	3YSA, 4Y400SA, MG	5Y40S, H15
DW-55LSR/CO <sub>2</sub>	5YQ420SA(H5), 4Y400SA(H5)	5Y42S, 5Y42srS, MG, H10
DW-A55L/Ar-CO <sub>2</sub>	3YSA, MG	5Y46S, H5
DW-A55LSR/Ar-CO <sub>2</sub>	5YQ420SA(H5)	5Y42S, H5
DW-A55ESR/Ar-CO <sub>2</sub>	4Y400SA, H5	-
DW-A81Ni1/Ar-CO <sub>2</sub>	5YQ420SA(H5), 4Y400SA(H5)	5Y42S, H5
MX-55LF/CO <sub>2</sub>	3YSA, MG	5Y40S, H5
MX-A55T/Ar-CO <sub>2</sub>	-	5Y40S, H5
MX-A80L/Ar-CO <sub>2</sub>	5YQ690SA, H5	5Y69S, H5

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-

	<b>BV</b>	<b>NK</b>	<b>Others</b>
	SA2M,SA2YM, SA2Y40M HH	KSW52Y40G(C)H10	CR: 2YS-HH, GL: 2Y40H10S, KR: 2YSG(C), CCS: 2SH10, 2YSH10
	-	KSW53G(C)H5	GL: 3YH5S
	-	-	GL: 3YH5S
	SA2YM	KSW52Y40G(C)	GL: 2YS
	SA3, 3YM	KSW53G	GL: 3YS, CCS: 3YSH10
	SA3YM	KSW53G(C)	
	SA3YM HHH	KSW52G(M2)H5	GL: 3YH5S
	SA3YM HHH	-	GL: 3YH5S
	SA2YM	KSW52G(C)	CR: 2YS, GL: 2YS
	SA3YM HHH	-	CR: 3YS-HH, GL: 3YH5S
	SA3YM HHH	-	GL: 3YH5S
	SA2YM HHH	KSW52Y40G(C)H5	CR: 2YS-HH, GL: 3YH5S, KR: 2YSG(C)H10, CCS: 2YSH5
	SA4Y40M H5	KSW54Y40G(C)H5	GL: 4Y40H5S
	A3YM	KAW53Y40G(C)	CR: 3YSM, KR: 3YSMG(C), CCS: 3YM
	SA4YM HHH	-	GL: 4YH5S

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	VY40MS(H5)	-	-	
	III YMS(H5)	SA3, SA3YM HHH	KSW54Y40G(C)H5	CR: 3YS-HH, L1YS-HH mod. GL: 3YH5S
	IV YMS(H5)	SA4Y40M HHH	-	GL: 3YH5S
	VYMS(H10), NV2-4, 4-4	SA5Y40M HH	KSWL3G(C), KSW54Y40G(C)	GL: 6Y40H15S, KR: L 3SG(C)H10, 4Y40SG(C)H10 CCS: 5Y40SH10
	V 42MS(H10), MG, NV2-4L, 4-4L	SA4Y40M HH, UP	KSW5Y42G(C)H10, MG	
	VY46MS(H5), NV2-4, NV4-4	S5Y46 H5	-	
	VY42MS(H5), NV2-4L, 4-4L	SA5Y42 H5	-	
	-	-	-	
	VY42MS(H5), NV2-4L, 4-4L	-	-	
	VYMS, NV2-4L, 4-4L	SA3YM, UP	KSWL3G(C), 54G(C)	
	VYMS(H5), NV2-4, 4-4	SA3YM HHH, UP	-	
	VY69MS(H5)	-	-	GL: 6Y69H5S

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

## Approvals

### Flux-cored wires for gas shielded arc welding of stainless steel <sup>(1)</sup>

Product names	ABS	LR
DW-308/CO <sub>2</sub>	MG(A5.22 E308T0-1)	-
DW-308L/CO <sub>2</sub>	MG	304L S CRYO
DW-308L/Ar-CO <sub>2</sub>	-	-
DW-308LP/CO <sub>2</sub>	MG	304L S CRYO
DW-308LT/CO <sub>2</sub>	-	304L S CRYO
DW-309L/CO <sub>2</sub>	MG	SS/CMn S CHEM
DW-309L/Ar-CO <sub>2</sub>	-	SS/CMn S CHEM
DW-309LP/CO <sub>2</sub>	MG(A5.22 E309LT-1)	SS/CMn S CRYO
DW-309LP/Ar-CO <sub>2</sub>	MG(A5.22 E309LT-4)	SS/CMn S CHEM
DW-309MoL/CO <sub>2</sub>	MG	SS/CMn S CHEM
DW-309MoL/Ar-CO <sub>2</sub>	-	-
DW-316L/CO <sub>2</sub>	MG	316L S CHEM
DW-316L/Ar-CO <sub>2</sub>	-	316L S CHEM
DW-316LP/CO <sub>2</sub>	-	-
DW-316LP/Ar-CO <sub>2</sub>	-	316L S CHEM
DW-316LT/CO <sub>2</sub>	-	316L S CRYO
DW-317L/CO <sub>2</sub>	-	MG

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-

### Solid wires for gas shielded arc welding of mild steel and high tensile strength steel <sup>(1)</sup>

Product names	ABS	LR
MG-50/CO <sub>2</sub>	3SA, 3YSA	3YS, H15
MG-50T/CO <sub>2</sub>	3SA, 3YSA	3YS, H15
MG-60/CO <sub>2</sub>	-	-
MG-S80/Ar-CO <sub>2</sub>	MG	-
MG-S88A/Ar-CO <sub>2</sub>	4YQ690SA H5, MG	-
MIX-50/Ar-CO <sub>2</sub>	3SA, 3YSA	-
MIX-50S/Ar-CO <sub>2</sub>	3SA, 3YSA	3YS, H15
TG-S50/Ar	3, 3Y, MG	3Ym, H15

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-

	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	-	-	KW308G(C)	
	308L	-	KW308LG(C)	GL: 4306S
	308L	-	-	
	308L	308L B T	KW308LG(C)	KR: RW308LG(C)
	308L	-	MG	
	309L	UP	KW309LG(C) (Based on KW309)	GL: 4332S
	-	-	-	
	309L	309 L	KW309LG(C)	
	309L	309L	-	
	309MoL	UP	MG	
	309MoL	-	-	
	316L	UP	KW316LG(C) (Based on KW316L)	GL: 4435S
	316L	-	-	
	316L	316 L	KW316LG(C)	
	316L	-	-	
	-	316 L BT	-	KR: RW316LG(C)
	317L	UP	MG	

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	III YMS	SA3M, SA3YM	KSW53G(C)	CR: 3YS, GL: 3YS, KR: 3YSG(C)
	III YMS	SA3M, SA3YM	KSW53G(C)	CR: 3YS, KR: 3YSG(C)
	III Y46MS	-	KSW3Y50G(C)H5	
	IVY69MS	-	KSW4Y69	GL: 4Y69S
	IVY69MS(H5)	-	-	
	-	-	KSW53G	
	III YMS	SA3YM	KSW53G(M2)	GL: 3YS
	III YM	SA3YM	KSW53G( I )	CCS: 3, 3YSM

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

## Approvals

### Solid wires for gas shielded arc welding of low temperature steel <sup>(1)</sup>

Product names	ABS	LR
MG-S50LT/Ar-CO <sub>2</sub>	3YSA, MG	5Y40S, H15
TG-S1N/Ar	4YSA, MG	MG
TG-S709S/Ar	-	-

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-

### Solid wires for gas shielded arc welding of heat-resistant low-alloy steel <sup>(1)</sup>

Product names	ABS	LR
MG-SM/Ar-CO <sub>2</sub>	MG	-
MG-S1CM/Ar-CO <sub>2</sub>	MG	MG
MG-S2CM/Ar-CO <sub>2</sub>	-	-
MG-S9Cb/Ar-CO <sub>2</sub>	-	-
TG-SM/Ar	MG	-
TG-S1CM/Ar	MG	MG
TG-S2CM/Ar	MG	-
TG-S2CW/Ar	-	-
TG-S9Cb/Ar	-	-

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-

### Solid wires for gas shielded arc welding of stainless steel <sup>(1)</sup>

Product names	ABS	LR
TG-S308/Ar	ER308, MG	-
TG-S308L/Ar	ER308L, MG	MG
TG-S309/Ar	-	-
TG-S309L/Ar	-	SS/CMn m CRYO
TG-S316L/Ar	ER316L	MG
TG-S317L/Ar	-	317L m CHEM
TG-S347/Ar	-	-

Note: (1) The designators put before or after a numeral signify the following. G: the wire uses a shield-



	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	VYMS, NV2-4L, NV4-4L	-	KSWL3G	
	VYM, NV4-4L	4YM, UP	KSWL2G( I )	GL: 4Y
	-	-	KSWL92G(I)	

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	-	-	-	
	-	UP(ER80S-G)	MG	
	-	-	MG	
	-	-	MG	
	-	-	-	
	MG	UP(ER80S-G)	MG (AWS A5.28 ER80S-G)	KR: MG(AWS ER80S-G)
	MG	UP(ER90S-G)	MG	KR: MG(AWS ER90S-G)
	-	-	MG	
	-	-	MG	

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	308	-	KY308	
	308L	308 L BT	KY308L	CCS: AS1-A, GL: 4306
	309	-	KY309	GL: 4332
	-	-	KY309L	
	316L	316 L BT	KY316L	CCS: AS1-B, GL: 4435
	-	-	-	
	-	-	KY347( I )	

ing gas; S or SA: semiautomatic welding; M or MS: multiple-pass welding.

## Approvals

### Flux/wire combinations for submerged arc welding [Multi-pass and double-sided two pass

Product names	ABS	LR
US-36/G-60	1T	1T
US-36/MF-38	2T, 2YT, 3M, 3YM	2T, 2YT, 3YM
US-36/PF-H55E	3TM, 3YTM, 3Y400TM	3T, 3YM, 3YT
US-36(x2)/PF-H55E	-	3T, 3YM, 3YT
US-36/PF-H55LT	3M, 3YM, MG	5Y40M, H5
US-36(x2)/PF-H55LT	4YM, MG	-
US-40/MF-38	MG	-
US-40/PF-H50LT	3T, 3YT, MG	5Y40T, 4YT
US-40(x2)/PF-H50LT	-	5Y40T
US-40/PF-H55AS	-	-
US-40/PF-H55LT	4Y400T, MG	5Y40T, H5
US-40(x2)/PF-H55LT	4Y400T, MG	-
US-49/MF-38	3YTM	3T, 3YM, 3YT
US-36J/PF-H55AS	5Y400 H5	5Y40M, H5
US-36J(x2)/PF-H55AS	5Y400 H5	5Y40M, H5
US-36J/PF-H55LT	-	-
US-80LT/PF-H80AS	-	-
US-80LT/PF-H80AK	-	-
US-80LT(x2)/PF-H80AK	-	-
US-709S/PF-N4	-	-

Note: (1) The designators put after a numeral signify the following: T: Double-sided two pass welding

**welding] <sup>(1)</sup>**

	<b>DNV</b>	<b>BV</b>	<b>NK</b>	<b>Others</b>
	IT	A1T	KAW1TM	
	II YT, III YM	A2, 2YT, A3, 3YM	KAW52T, KAW53M	CR: 2YT, 3YM, GL: 2YT, 3YM, KR: 2YT, 3YM
	III YTM	A3YTM	KAW53Y40TM	CR: 3M, 3YTM, GL: 3YTM
	-	A3, A3YT	KAW53Y40M	GL: 3YTM
	V YM, NV2-4, NV4-4	A4YM, UP	KAWL3M	
	V YM	-	KAWL3M	
	-	-	KAW3Y50MH10	
	V YT	A4Y40M, A5Y40T	KAWL3T, KAW54Y40M	
	-	-	-	
	V YT, NV2-4L, NV4-4L	A5YT	-	
	-	A4Y40T, UP	-	
	-	-	KAW54Y40M, KAWL3T	
	III YTM	A3YTM	KAW3Y46TMH10	CCS: 3YTM
	V Y40M, NV2-4L, NV4-4L	-	-	
	V Y40M(H5), NV2-4L, NV4-4L	-	-	
	V Y42M	A4Y40M, UP	KAW5Y42	
	IV Y69M(H5)	-	-	
	V Y69M	-	KAW5Y69MH5	
	-	-	KAW5Y69MH5	
	-	-	KAWL92M	

M: Multi-pass welding.

## Redrying Conditions

### Covered electrodes

Applicable type of metal	Type of covering	Product names	Guideline of moisture content that needs redrying (%) <sup>(1)</sup>	Redrying temperature (°C)
Mild steel	Ilmenite	B-10, B-14, B-17	3	70-100
	Lime titania	Z-44	2	70-100
	High titanium oxide	RB-26, B-33	3	70-100
	Low hydrogen	LB-26, LB-52U	0.5	300-350
	Iron powder titania	KOBE-7024	2	70-100
Weather proof steel	Low hydrogen	LB-W52,	0.5	325-375
		LB-W52B, LB-W588, LB-W62G	0.5	350-400
High tensile strength steel or low temperature steel	Lime titania	LT-B50	2	70-100
	Low hydrogen	LB-52, LB-52-18, LB-52T, LB-76, LT-B52A, LB-52RC	0.5	300-350
		LB-52A, LB-7018-1, LB-57, LB-62, LB-62D, LB-62L, LB-62U, LB-65L, LB-67L, LB-106, LB-70L, LB-116, LB-80L, LB-78VS, LB-88VS, LB-98VS, LB-80EM	0.3-0.5	350-400
		LB-52NS, NB-1SJ, NB-3J	0.5	350-400
		LB-62UL, LB-80UL, LB-88LT	-	350-430
Heat-resistant low-alloy steel	High titanium oxide	CM-B83	3	70-100
	Low hydrogen	BL-96, CM-2CW, CM-5, CM-9, CM-95B9, CM-96B9, CM-9Cb, CM-A76, CM-A96, CM-A96MB, CM-A96MBD, CM-A106, CM-A106N, CM-A106ND, CM-A106H, CM-A106HD, CM-B95, CM-B98, CM-B105, CM-B108, CR-12S	0.5	325-375

Note: (1) Drying is needed if the moisture content (weight loss of the covering at 110°C) exceeds this guideline to recover the usability and weldability of welding consumables.

(2) Longer periods or more cycles of drying than indicated above may cause permanent damage of welding consumables. Welding consumables dried or held in the conditions indicated above should be confirmed that they have no change in color, no cracking in the covering, no covering detachment, and other damages before use, and that no abnormal performance is recognized during welding.

(3) Under the atmosphere of 30°C-80% relative humidity.

	<b>Redrying time (min.)</b>	<b>Max. allowable redrying time (h) <sup>(2)</sup></b>	<b>Max. allowable cycles of redrying (cycle) <sup>(2)</sup></b>	<b>Holding temperature (°C)</b>	<b>Max. holding time (h) <sup>(2)</sup></b>	<b>Min. time to reach guideline of moisture content after redrying (h) <sup>(3)</sup></b>
	30-60	24	5	-	-	8
	30-60	24	5	-	-	8
	30-60	24	5	-	-	8
	30-60	24	3	100-150	72	4
	30-60	24	5	-	-	8
	60	24	3	100-150	72	4
	60	24	3	100-150	72	4
	30-60	24	5	-	-	8
	30-60	24	3	100-150	72	4
	60	24	3	100-150	72	4
	60	24	3	100-150	72	4
	60	12	3	100-150	72	4
	30-60	24	5	-	-	8
	60	24	3	100-150	72	4

## Redrying Conditions

### Covered electrodes

Applicable type of metal	Type of covering	Product names	Guideline of moisture content that needs redrying (%) <sup>(1)</sup>	Redrying temperature (°C)
Cr-Ni stainless steel	Lime titania	NC-xxx	1	150-200
Cr stainless steel	Lime titania	CR-40, CR-43	0.5	300-350
	Lime	CR-40Cb, CR-43Cb, CR-43CbS	0.5	300-350
Hardfacing	High titanium oxide	HF-240, HF-330	3	70-100
	Lime	HF-12, HF-13, HF-30, HF-260, HF-350, HF-450, HF-500, HF-600, HF-650, HF-700, HF-800K	0.5	300-350
		HF-11, HF-16	1	150-200
	Graphite	HF-950	1	150-200
Cast iron	Lime	CI-A3	0.5	300-350
	Graphite	CI-A1, CI-A2	1.5	70-100
Ni alloy	Lime titania	ME-L34	1	150-200
	Lime	NI-C1S, NI-C70A, NI-C70S, NI-C625, NI-C703D	1	200-250

Note: (1) Drying is needed if the moisture content (weight loss of the covering at 110°C) exceeds this guideline to recover the usability and weldability of welding consumables.

(2) Longer periods or more cycles of drying than indicated here may cause permanent damage of welding consumables. Welding consumables dried or held in the conditions indicated above should be confirmed that they have no change in color, no cracking in the covering, no covering detachment, and other damages before use, and that no abnormal performance is recognized during welding.

(3) Under the atmosphere of 30°C-80% relative humidity.

	<b>Redrying time (min.)</b>	<b>Max. allowable redrying time (h) <sup>(2)</sup></b>	<b>Max. allowable cycles of redrying (cycle) <sup>(2)</sup></b>	<b>Holding temperature (°C)</b>	<b>Max. holding time (h) <sup>(2)</sup></b>	<b>Min. time to reach guideline of moisture content after redrying (h) <sup>(3)</sup></b>
	30-60	24	3	100-150	72	4
	30-60	24	3	100-150	72	4
	30-60	24	3	100-150	72	4
	30-60	24	5	-	-	8
	30-60	24	3	100-150	72	4
	30-60	24	3	100-150	72	4
	30-60	24	3	100-150	72	4
	30-60	24	3	100-150	72	4
	30-60	24	5	-	-	8
	30-60	24	3	100-150	72	4
	30-60	24	3	100-150	72	4

## Redrying Conditions

### Fluxes for submerged arc welding

Applicable type of metal	Type of flux	Product names	Redrying temperature (°C)	Redrying time (min.)
Mild steel, Weather proof steel, or High tensile strength steel (490MPa)	Fused type	G-50, G-60, G-80, MF-38, MF-53, MF-300	150-350	60
	Bonded type	PF-H55E, PF-I52E, PF-I55E, PF-H55AS	200-300	60
High tensile strength steel	Fused type	MF-38	150-350	60
	Bonded type	PF-H80AK, PF-H80AS	250-350	60
Low temperature steel or Heat-resistant low-alloy steel	Fused type	G-80, MF-27, MF-38	150-350	60
	Bonded type	PF-H203, F-H55AS, PF-H55LT, PF-200, PF-200S, PF-500, PF-200D, PF-500D, PF-90B9	200-300	60
Hardfacing	Fused type	G-50, MF-30	150-350	60
9%Ni steel	Bonded type	PF-N3, PF-N4,	200-300	60

Note: (1) Longer periods or more cycles of drying than indicated here may cause permanent damage of welding consumables. Welding consumables dried or held in the conditions indicated above should be confirmed that they have no change in color and other damages before use, and that no abnormal performance is recognized during welding.

(2) Under the atmosphere of 30°C-80% relative humidity.



	<b>Max. allowable redrying time (h) <sup>(1)</sup></b>	<b>Max. allowable cycles of redrying (cycle) <sup>(1)</sup></b>	<b>Holding temperature (°C)</b>	<b>Max. holding time (h) <sup>(1)</sup></b>	<b>Min. time to reach guideline of moisture content after redrying (h) <sup>(2)</sup></b>
	24	5	100-150	72	8
	24	5	100-150	72	8
	24	5	100-150	72	8
	24	5	100-150	72	8
	24	5	100-150	72	8
	24	5	100-150	72	8
	24	5	100-150	72	8
	24	5	100-150	72	8

# A Guide to Estimating the Consumption

Figure 1 shows the calculated consumption of welding consumables as a function of plate thickness, welding process, groove angle, and root opening for butt joints. Figure 2 shows the calculated consumption of welding consumables as a function of fillet size, welding process, and reinforcement size. These diagrams were developed using the calculations obtained by the following equation for both groove and fillet welding joints under the prerequisites given below.

$$C = [(A_1 + A_2) \times L \times G/E] \times 1/10$$

where C: Consumption of welding consumables (kg); A<sub>1</sub>: Area of Section A<sub>1</sub> weld metal (mm<sup>2</sup>) (See Fig. 3); A<sub>2</sub>: Area of Section A<sub>2</sub> reinforcement (mm<sup>2</sup>) (See Fig. 3); L: Weld length (m); G: Specific gravity of weld metal (7.85 g/cm<sup>3</sup>); E: Deposition Efficiency (%) — SMAW covered electrodes: 55%; GMAW solid/metal-cored wires: 95%; FCAW flux-cored wires: 90%; SAW solid wires: 100%.

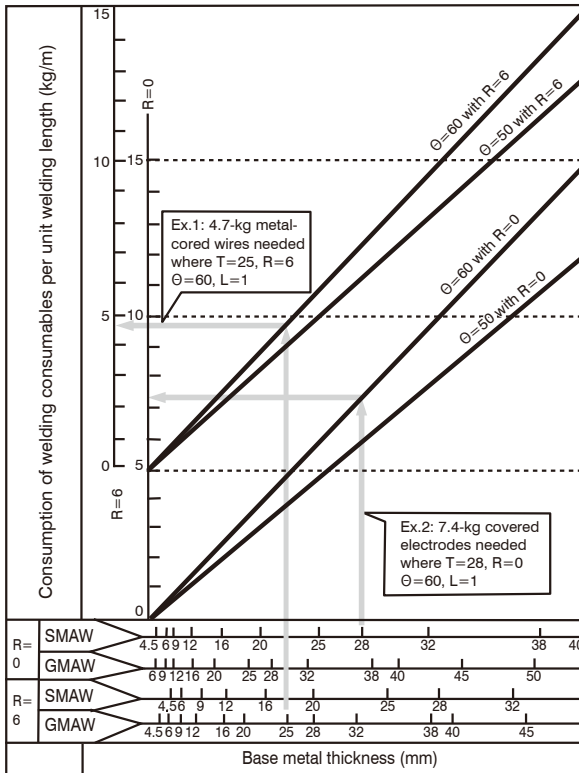


Fig. 1 Consumption of covered electrodes in SMAW and solid/metal-cored wires in GMAW of butt joints

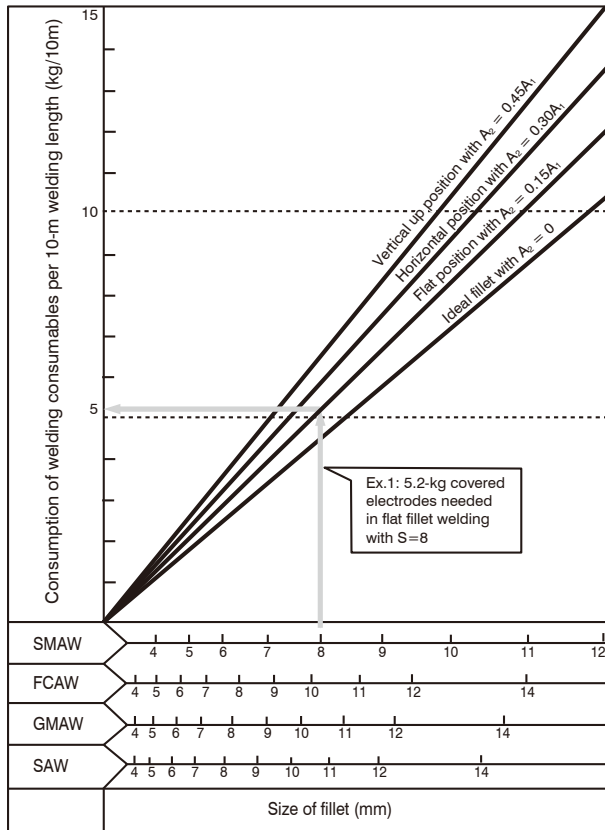


Fig. 2 Consumption of covered electrodes in SMAW, flux-cored wires in FCAW, solid/metal-cored wires in GMAW, and solid wires in SAW of fillet joints

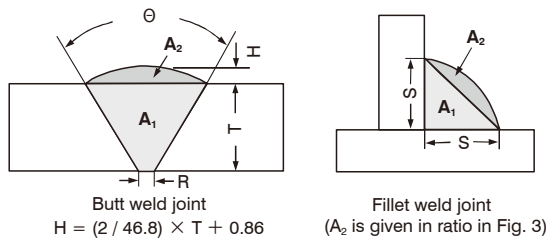


Fig. 3 Weld sizes ( $\theta$  in deg., H, R, S, and T in mm)

## Conversions for SAW Flux Sizes

The particle size of an individual Kobelco SAW flux is classified with two mesh numbers (e.g., 20 x 200) showing only the largest and the smallest particle size: 20 mesh designates the largest particle size and 200 mesh designates the smallest particle size contained in the bulk flux having specified uniform particle size distribution. These mesh numbers correspond to the largest and the smallest nominal metric sizes of flux particles as shown in Table 1.

**Table 1 Conversions for SAW flux sizes** <sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>

Nominal metric size	Mesh size
2.36 mm	8
1.70 mm	10
1.40 mm	12
1.18 mm	14
850 $\mu\text{m}$	20
500 $\mu\text{m}$	32
425 $\mu\text{m}$	36
300 $\mu\text{m}$	48
212 $\mu\text{m}$	65
150 $\mu\text{m}$	100
106 $\mu\text{m}$	150
75 $\mu\text{m}$	200

Note : (1) Nominal metric size is as per JIS Z 8801 (Standard sieve).

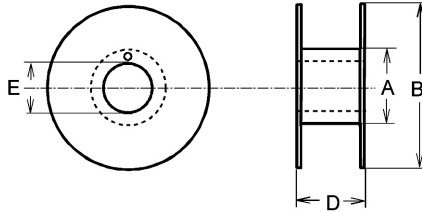
(2) Where the particle size of a certain flux is designated as 20 x D for example, this flux contains particles smaller than 75  $\mu\text{m}$ .

(3) Any SAW flux is specified to contain particles, by 70% or more in amount, within the designated maximum and minimum size range. Where a certain flux contains particles smaller than 75  $\mu\text{m}$ , this flux is specified to contain particles, by 60% or more in amount, within the maximum and minimum size (75  $\mu\text{m}$ ) range.

# Package Specifications for FCAW, GMAW and SAW Wires

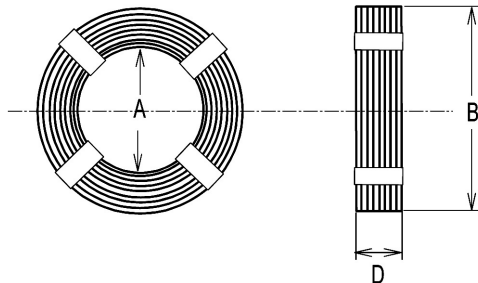
## FCAW and GMAW spooled wires

Kind of wire	Diameter of Barrel A (mm)	Outside diameter B (mm)	Outside width D (mm)	Inside diameter E (mm)
Solid 10 kg	149	225	102	52
Solid 20 kg	156	270	103	52
FCW 12.5 & 12.7 kg	192	280	103	52
FCW 15 kg	179	280	102	52
FCW 20 kg	140	280	103	52



## SAW coiled wires

Kind of wire	Inside diameter A (mm)	Outside diameter B (mm)	Width D (mm)
12.5 kg	305	375	64
25 kg (Except 4.8mm wire)	310	410	80
25 kg (4.8mm wire)	310	405	77
75 kg	640	750	115
150 kg (Except 6.4mm wire)	640	825	115
159 kg (6.4mm wire)	640	835	115



# Package Specifications for FCAW and GMAW Wires

## Arrow Pack

### 1. Principles:

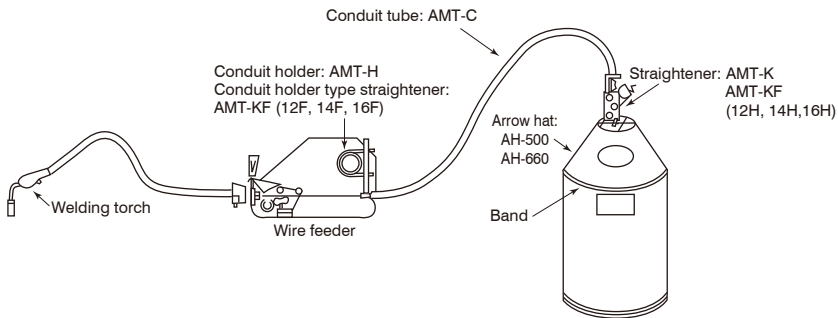
Arrow Pack is a pail-pack of large amounts of flux-cored wires and solid wires for gas shielded arc welding, in which the wire is spooled into the drum from its bottom to the top in coil by a unique way. The wire is spooled to be elastically twisted in the pail so that the wire can be pulled out straight without rotation of the pail. The wire makes good tracking on a welding seam. The use of Arrow Pack wires can reduce the downtime for changing wires when compared with conventional spooled wires, which is effective particularly for robotic welding and other automatic welding.

### 2. Package specifications:

Solid wire			
Wire size (mm)	Weight (kg)	Pack size dia. x height (mm)	Suitable Arrow Hat
0.8	100	510×500	AH-500
0.9 1.0 1.4	250	510×820	AH-500
1.2	300	510×820	AH-500
1.4 1.6	400	660×820	AH-660

Flux-cored wire			
Wire size (mm)	Weight (kg)	Pack size dia. x height (mm)	Suitable Arrow Hat
1.2 1.4	250	510×820	AH-500
1.6	350	660×820	AH-660

### 3. Arrangement of Arrow Pack



## Conversions for Temperature

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
-459.4	-273	-10	-23.3	86	30.0	174	78.9	430	221.1	1240	671
-440	-262	0	-17.8	88	31.1	176	80.0	440	226.7	1260	682
-430	-257	2	-16.7	90	32.2	178	81.1	450	232.2	1280	693
-420	-251	4	-15.6	92	33.3	180	82.2	460	237.8	1300	704
-410	-246	6	-14.4	94	34.4	182	83.3	470	243.3	1320	716
-400	-240	8	-13.3	96	35.6	184	84.4	480	248.9	1340	727
-390	-234	10	-12.2	98	36.7	186	85.6	490	254.4	1360	738
-380	-229	12	-11.1	100	37.8	188	86.7	500	260.0	1380	749
-370	-223	14	-10.0	102	38.9	190	87.8	520	271.1	1400	760
-360	-218	16	-8.9	104	40.0	192	88.9	540	282.2	1420	771
-350	-212	18	-7.8	106	41.1	194	90.0	560	293.3	1440	782
-340	-207	20	-6.7	108	42.2	196	91.1	580	304.4	1460	793
-330	-201	22	-5.6	110	43.3	198	92.2	600	315.6	1480	804
-320	-196	24	-4.4	112	44.4	200	93.3	620	326.7	1500	816
-310	-190	26	-3.3	114	45.6	202	94.4	640	337.8	1520	827
-300	-184	28	-2.2	116	46.7	204	95.6	660	348.9	1540	838
-290	-179	30	-1.1	118	47.8	206	96.7	680	360.0	1560	849
-280	-173	32	0.0	120	48.9	208	97.8	700	371.1	1580	860
-270	-168	34	1.1	122	50.0	210	98.9	720	382.2	1600	871
-260	-162	36	2.2	124	51.1	212	100.0	740	393.3	1620	882
-250	-157	38	3.3	126	52.2	214	101.1	760	404.4	1640	893
-240	-151	40	4.4	128	53.3	216	102.2	780	415.6	1660	904
-230	-146	42	5.6	130	54.4	218	103.3	800	426.7	1680	916
-220	-140	44	6.7	132	55.6	220	104.4	820	437.8	1700	927
-210	-134	46	7.8	134	56.7	230	110.0	840	448.9	1720	938
-200	-129	48	8.9	136	57.8	240	115.6	860	460.0	1740	949
-190	-123	50	10.0	138	58.9	250	121.1	880	471.1	1760	960
-180	-118	52	11.1	140	60.0	260	126.7	900	482.2	1780	971
-170	-112	54	12.2	142	61.1	270	132.2	920	493.3	1800	982
-160	-107	56	13.3	144	62.2	280	137.8	940	504.4	1820	993
-150	-101	58	14.4	146	63.3	290	143.3	960	515.6	1840	1004
-140	-96	60	15.6	148	64.4	300	148.9	980	527	1860	1016
-130	-90	62	16.7	150	65.6	310	154.4	1000	538	1880	1027
-120	-84	64	17.8	152	66.7	320	160.0	1020	549	1900	1038
-110	-79	66	18.9	154	67.8	330	165.6	1040	560	1920	1049
-100	-73	68	20.0	156	68.9	340	171.1	1060	571	1940	1060
-90	-68	70	21.1	158	70.0	350	176.7	1080	582	1960	1071
-80	-62	72	22.2	160	71.1	360	182.2	1100	593	1980	1082
-70	-57	74	23.3	162	72.2	370	187.8	1120	604	2000	1093
-60	-51	76	24.4	164	73.3	380	193.3	1140	616		
-50	-45.6	78	25.6	166	74.4	390	198.9	1160	627		
-40	-40.0	80	26.7	168	75.6	400	204.4	1180	638		
-30	-34.4	82	27.8	170	76.7	410	210.0	1200	649		
-20	-28.9	84	28.9	172	77.8	420	215.6	1220	660		

$$^{\circ}\text{F} = \left(\frac{9}{5} \times ^{\circ}\text{C}\right) + 32$$

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$$

# Conversions for Tensile Stress

ksi → MPa (Extracted from ASTM E380)

1 ksi = 6.89476 MPa

ksi	0	1	2	3	4	5	6	7	8	9
	<b>MPa</b>									
<b>0</b>	-	6.89	13.79	20.68	27.58	34.47	41.37	48.26	55.16	62.05
<b>10</b>	68.95	75.84	82.74	89.63	96.53	103.42	110.32	117.21	124.11	131.00
<b>20</b>	137.90	144.80	151.68	158.58	165.47	172.37	179.26	186.16	193.05	199.95
<b>30</b>	206.84	213.74	220.63	227.53	234.42	241.32	248.21	255.11	262.00	268.90
<b>40</b>	275.79	282.69	289.58	296.47	303.37	310.26	317.16	324.05	330.95	337.84
<b>50</b>	344.74	351.63	358.53	365.42	372.32	379.21	386.11	393.00	399.90	406.79
<b>60</b>	413.69	420.58	427.47	434.37	441.26	448.16	455.05	461.95	468.84	475.74
<b>70</b>	482.63	489.53	496.42	503.32	510.21	517.11	524.00	530.90	537.79	544.69
<b>80</b>	551.58	558.48	565.37	572.26	579.16	586.05	592.95	599.84	606.74	613.63
<b>90</b>	620.53	627.42	634.32	641.21	648.11	655.00	661.90	668.79	675.69	682.58
<b>100</b>	689.48									

MPa → ksi (Extracted from BS350 Part 2)

1 MPa = 0.145038 ksi

MPa	0	1	2	3	4	5	6	7	8	9
	<b>ksi</b>									
<b>0</b>	-	0.145	0.290	0.435	0.580	0.725	0.870	1.015	1.160	1.305
<b>10</b>	1.450	1.595	1.740	1.886	2.031	2.176	2.321	2.466	2.611	2.756
<b>20</b>	2.901	3.046	3.191	3.336	3.481	3.626	3.771	3.916	4.061	4.206
<b>30</b>	4.351	4.496	4.641	4.786	4.931	5.076	5.221	5.366	5.511	5.656
<b>40</b>	5.802	5.947	6.092	6.237	6.382	6.527	6.672	6.817	6.962	7.107
<b>50</b>	7.252	7.397	7.542	7.687	7.832	7.977	8.122	8.267	8.412	8.557
<b>60</b>	8.702	8.847	8.992	9.137	9.282	9.427	9.572	9.718	9.863	10.008
<b>70</b>	10.153	10.298	10.443	10.588	10.733	10.878	11.023	11.168	11.313	11.458
<b>80</b>	11.603	11.748	11.893	12.038	12.183	12.328	12.473	12.618	12.763	12.908
<b>90</b>	13.053	13.198	13.344	13.489	13.634	13.779	13.924	14.069	14.214	14.359
<b>100</b>	14.504									



# Conversions for Impact Energy

ft -lbf → J (Extracted from BS350 Part 2)

1 ft -lbf = 1.35582 J

ft -lbf	0	1	2	3	4	5	6	7	8	9
	<b>J</b>									
0	-									
10	13.56	1.36	2.71	4.07	5.42	6.78	8.13	9.49	10.85	12.20
20	27.12	14.91	16.27	17.63	18.98	20.34	21.69	23.05	24.40	25.76
30	40.67	28.47	29.83	31.18	32.54	33.90	35.25	36.61	37.96	39.32
40	54.23	42.03	43.39	44.74	46.10	47.45	48.81	50.17	51.52	52.88
50	67.79	55.59	56.94	58.30	59.66	61.01	62.37	63.72	65.08	66.44
60	81.35	69.15	70.50	71.86	73.21	74.57	75.93	77.28	78.64	79.99
70	94.91	82.70	84.06	85.42	86.77	88.13	89.48	90.84	92.20	93.55
80	108.47	96.26	97.62	98.97	100.33	101.69	103.04	104.40	105.75	107.11
90	122.02	109.82	111.18	112.53	113.89	115.25	116.60	117.96	119.31	120.67
100	135.58	123.38	124.74	126.09	127.45	128.80	130.16	131.51	132.87	134.23

J → ft -lbf (Extracted from BS350 Part 2)

1 J = 0.737563 ft -lbf

J	0	1	2	3	4	5	6	7	8	9
	<b>ft - lbf</b>									
0	-	0.738	1.475	2.213	2.950	3.688	4.425	5.163	5.901	6.638
10	7.376	8.113	8.851	9.588	10.326	11.063	11.801	12.539	13.276	14.014
20	14.751	15.489	16.226	16.964	17.702	18.439	19.177	19.914	20.652	21.389
30	22.127	22.864	23.602	24.340	25.077	25.815	26.552	27.290	28.027	28.765
40	29.503	30.240	30.978	31.715	32.453	33.190	33.928	34.665	35.403	36.141
50	36.878	37.616	38.353	39.091	39.828	40.566	41.304	42.041	42.779	43.516
60	44.254	44.991	45.729	46.466	47.204	47.942	48.679	49.417	50.154	50.892
70	51.629	52.367	53.105	53.842	54.580	55.317	56.055	56.792	57.530	58.267
80	59.005	59.743	60.480	61.218	61.955	62.693	63.430	64.168	64.906	65.643
90	66.381	67.118	67.856	68.593	69.331	70.068	70.806	71.544	72.281	73.019
100	73.756									

## Conversions for Hardness

Vickers Hardness (DPH)	Brinell hardness 10mm ball 3000kg load		Rockwell hardness		Shore hardness	Tensile Strength MPa (approx.)
	Standard ball	Tungsten carbide ball	B-scale	C-scale		
940	-	-	-	68.0	97	-
920	-	-	-	67.5	96	-
900	-	-	-	67.0	95	-
880	-	767	-	66.4	93	-
860	-	757	-	65.9	92	-
840	-	745	-	65.3	91	-
820	-	733	-	64.7	90	-
800	-	722	-	64.0	88	-
780	-	710	-	63.3	87	-
760	-	698	-	62.5	86	-
740	-	684	-	61.8	84	-
720	-	670	-	61.0	83	-
700	-	656	-	60.1	81	-
690	-	647	-	59.7	-	-
680	-	638	-	59.2	80	-
670	-	630	-	58.8	-	-
660	-	620	-	58.3	79	-
650	-	611	-	57.8	-	-
640	-	601	-	57.3	77	-
630	-	591	-	56.8	-	-
620	-	582	-	56.3	75	-
610	-	573	-	55.7	-	-
600	-	564	-	55.2	74	-
590	-	554	-	54.7	-	2095
580	-	545	-	54.1	72	2020
570	-	535	-	53.6	-	1981
560	-	525	-	53.0	71	1952
550	505	517	-	52.3	-	1912
540	496	507	-	51.7	69	1863
530	488	497	-	51.1	-	1824
520	480	488	-	50.5	67	1795
510	473	479	-	49.8	-	1755
500	465	471	-	49.1	66	1706
490	456	460	-	48.4	-	1657
480	448	452	-	47.7	64	1618
470	441	442	-	46.9	-	1569
460	433	433	-	46.1	62	1530
450	425	425	-	45.3	-	1500
440	415	415	-	44.5	59	1461
430	405	405	-	43.6	-	1412
420	397	397	-	42.7	57	1373

Note: These conversions are excerpted from the relevant JIS and ASTM standards, which are based on the data of carbon steels. Therefore, weld metals may exhibit different conversions more or less particularly in the case of alloyed weld metals with higher hardness.

# Conversions for Hardness

Vickers Hardness (DPH)	Brinell hardness 10mm ball 3000kg load		Rockwell hardness		Shore hardness	Tensile Strength MPa (approx.)
	Standard ball	Tungsten carbide ball	B-scale	C-scale		
410	388	388	-	41.8	-	1334
400	379	379	-	40.8	55	1285
390	369	369	-	39.8	-	1245
380	360	360	(110.0)	38.8	52	1206
370	350	350	-	37.7	-	1177
360	341	341	(109.0)	36.6	50	1128
350	331	331	-	35.5	-	1098
340	322	322	(108.0)	34.4	47	1069
330	313	313	-	33.3	-	1030
320	303	303	(107.0)	32.2	45	1010
310	294	294	-	31.0	-	981
300	284	284	(105.5)	29.8	42	951
295	280	280	-	29.2	-	941
290	275	275	(104.5)	28.5	41	922
285	270	270	-	27.8	-	902
280	265	265	(103.5)	27.1	40	892
275	261	261	-	26.4	-	873
270	256	256	(102.0)	25.6	38	853
265	252	252	-	24.8	-	843
260	247	247	(101.0)	24.0	37	824
255	243	243	-	23.1	-	804
250	238	238	99.5	22.2	36	794
245	233	233	-	21.3	-	775
240	228	228	98.1	20.3	34	765
230	219	219	96.7	(18.0)	33	736
220	209	209	95.0	(15.7)	32	696
210	200	200	93.4	(13.4)	30	667
200	190	190	91.5	(11.0)	29	637
190	181	181	89.5	(8.5)	28	608
180	171	171	87.1	(6.0)	26	579
170	162	162	85.0	(3.0)	25	549
160	152	152	81.7	(0.0)	24	520
150	143	143	78.7	-	22	490
140	133	133	75.0	-	21	451
130	124	124	71.2	-	20	431
120	114	114	66.7	-	-	392
110	105	105	62.3	-	-	-
100	95	95	56.2	-	-	-
95	90	90	52.0	-	-	-
90	86	86	48.0	-	-	-
85	81	81	41.0	-	-	-

## F-No. and A-No. per ASME IX

Note: The F-No. grouping and A-No. classification of welding consumables shown below are excerpted from ASME Sec. IX 2001 Edition and 2003 Addenda. The F No. and A No. of KOBELCO products are shown in the "List of Welding Consumables" listed at pages from 10 to 21.

### F-No. grouping of welding consumables for steels and steel alloys

F No.	ASME Specification No.	AWS Classification No.
1	SFA-5.1, SFA-5.5	EXX20, EXX22, EXX24, EXX27, EXX28
1	SFA-5.4	EXX25, EXX26
2	SFA-5.1, SFA-5.5	EXX12, EXX13, EXX14, EXX19
3	SFA-5.1, SFA-5.5	EXX10, EXX11
4	SFA-5.1, SFA-5.5	EXX15, EXX16, EXX18, EXX48
4	SFA-5.4 (Other than austenitic and duplex)	EXX15, EXX16, EXX17
5	SFA-5.4 (Austenitic and duplex)	EXX15, EXX16, EXX17
6	SFA-5.2	All classifications
6	SFA-5.9	All classifications
6	SFA-5.17	All classifications
6	SFA-5.18	All classifications
6	SFA-5.20	All classifications
6	SFA-5.22	All classifications
6	SFA-5.23	All classifications
6	SFA-5.25	All classifications
6	SFA-5.26	All classifications
6	SFA-5.28	All classifications
6	SFA-5.29	All classifications
6	SFA-5.30	INMs-X, IN5XX, IN3XX

### F-No. grouping of welding consumables for nickel and nickel alloys

F No.	ASME Specification No.	AWS Classification No.
41	SFA-5.11	ENi-1
41	SFA-5.14	ERNi-1
41	SFA-5.30	IN61
42	SFA-5.11	ENiCu7
42	SFA-5.14	ERNiCu7, ERNiCu-8

(Continued)

F No.	ASME specification	AWS classification
42	SFA-5.30	IN60
43	SFA-5.11	ENiCrFe-1, ENiCrFe-2, ENiCrFe-3, ENiCrFe-4, ENiCrFe-7, ENiCrFe-9, ENiCrFe-10, ENiCrCoMo-1, ENiCrMo-2, ENiCrMo-3, ENiCrMo-4, ENiCrMo-5, ENiCrMo-6, ENiCrMo-7, ENiCrMo-10, ENiCrMo-12, ENiCrMo-13, ENiCrMo-14
43	SFA-5.14	ERNiCr-3, ERNiCr-4, ERNiCr-6, ERNiCrFe-5, ERNiCrFe-6, ERNiCrFe-7, ERNiCrFe-8, ERNiCrFe-11, ERNiCrCoMo-1, ERNiCrMo-2, ERNiCrMo-3, ERNiCrMo-4, ERNiCrMo-7, ERNiCrMo-10, ERNiCrMo-13, ERNiCrMo-14, ERNiCrWMo-1, ERNiMo-1,
43	SFA-5.30	IN82, IN62, IN6A, IN52
44	SFA-5.11	ENiMo-1, ENiMo-3, ENiMo-7, ENiMo-8,
44	SFA-5.11	ENiMo-9, ENiMo-10
44	SFA-5.14	ERNiMo-2, ERNiMo-3, ERNiMo-7, ERNiMo-8, ERNiMo-9, ERNiMo-10,
45	SFA-5.11	ENiCrMo-1, ENiCrMo-9, ENiCrMo-11,
45	SFA-5.14	ERNiCrMo-1, ERNiFeCr-1, ERNiCrMo-8, ERNiCrMo-9, ERNiCrMo-11,

#### A-No. classification of welding consumables

A No.	Types of weld deposit	Chemical composition of weld deposit (%)					
		C	Cr	Mo	Ni	Mn	Si
1	Mild steel	≤0.20	-	-	-	≤1.60	≤1.00
2	C-Mo	≤0.15	≤0.50	0.40-0.65	-	≤1.60	≤1.00
3	Cr (0.4-2%)-Mo	≤0.15	0.40-2.00	0.40-0.65	-	≤1.60	≤1.00
4	Cr (2-6%)-Mo	≤0.15	2.00-6.00	0.40-1.50	-	≤1.60	≤2.00
5	Cr (6-10.5%)-Mo	≤0.15	6.00-10.50	0.40-1.50	-	≤1.20	≤2.00
6	Cr-martensitic	≤0.15	11.00-15.00	≤0.70	-	≤2.00	≤1.00
7	Cr-ferritic	≤0.15	11.00-30.00	≤1.00	-	≤1.00	≤3.00
8	Cr-Ni	≤0.15	14.50-30.00	≤4.00	7.50-15.00	≤2.50	≤1.00
9	Cr-Ni	≤0.30	19.00-30.00	≤6.00	15.00-37.00	≤2.50	≤1.00
10	Ni up to 4%	≤0.15	-	≤0.55	0.80-4.00	≤1.70	≤1.00
11	Mn-Mo	≤0.17	-	0.25-0.75	≤0.85	1.25-2.25	≤1.00
12	Ni-Cr-Mo	≤0.15	≤1.50	0.25-0.80	1.25-2.80	0.75-2.25	≤1.00

## AWS A 5.1-2004 (A part is extracted)

### Carbon Steel Electrodes for Shielded Metal Arc Welding

Class.	Tensile test <sup>(1)</sup>			Impact test		Product names
	Tensile strength (ksi)	Yield strength at 0.2% offset (ksi)	Elongation (%)	Temp. (°F)	Average <sup>(1)</sup> (ft-lb)	
E6010	60	48	22	-20	20	KOBE-6010
E6013	60	48	17	Not specified		B-33, RB-26, Z-44
E6019	60	48	22	0	20	B-10, B-14, B-17
E7016	70	58	22	-20	20	LB-26, LB-47, LB-52 LB-52U, LB-M52, LB-52A, LB-57
E7018	70	58	22	-20	20	LB-52-18, LT-B52A LB-7018-1
E7024	70	58	17	Not specified		KOBE-7024
E7048	70	58	22	-20	20	LB-52T, LB-78VS

Note: (1) Single values are minimum

# AWS A 5.5-2006 (A part is extracted)

## Low-Alloy Steel Electrodes for Shielded Metal Arc Welding

Class.	Chemical composition (%)									Product names
	C	Mn	Si	P	S	Ni	Cr	Mo	Others	
E7016-A1	0.12	0.90	0.60	0.03	0.03	-	-	0.40-0.65	-	CM-A76
E8016-B2	0.05-0.12	0.90	0.60	0.03	0.03	-	1.00-1.50	0.40-0.65	-	CM-A96, CM-A96MB, CM-A96MBD
E8018-B2	0.05-0.12	0.90	0.80	0.03	0.03	-	1.00-1.50	0.40-0.65	-	CM-B98
E7015-B2L	0.05	0.90	1.00	0.03	0.03	-	1.00-1.50	0.40-0.65	-	CM-B95
E9016-B3	0.05-0.12	0.90	0.60	0.03	0.03	-	2.00-2.50	0.90-1.20	-	CM-A106, CM-A106N, CM-A106ND
E9018-B3	0.05-0.12	0.90	0.80	0.03	0.03	-	2.00-2.50	0.90-1.20	-	CM-B108
E8015-B3L	0.05	0.90	1.00	0.03	0.03	-	2.00-2.50	0.90-1.20	-	CM-B105
E8016-B6	0.05-0.10	1.0	0.90	0.03	0.03	0.40	4.0-6.0	0.45-0.65	-	CM-5
E8016-B8	0.05-0.10	1.0	0.90	0.03	0.03	0.40	8.0-10.5	0.85-1.20	-	CM-9
E9015-B9 <sup>(1)</sup>	0.08-0.13	1.20	0.30	0.01	0.01	0.80	8.0-10.5	0.85-1.20	V: 0.15-0.30 Cu: 0.25 Al: 0.04 Nb: 0.02-0.10 N: 0.02-0.07	CM-95B9
E9016-B9 <sup>(1)</sup>										CM-96B9
E8016-C1	0.12	1.25	0.60	0.03	0.03	2.00-2.75	-	-	-	LB-62L, LB-65L
E7016-C2L	0.05	1.25	0.50	0.03	0.03	3.00-3.75	-	-	-	NB-3J
E8016-C3	0.12	0.40-1.25	0.80	0.03	0.03	0.80-1.10	0.15	0.35	V: 0.05	LB-W588

Class.	Chemical composition (%)									Product names	
	C	Mn	Si	P	S	Ni	Cr	Mo	Others		
E7016-G										V: 0.10 min <sup>(2)</sup> Cu: 0.20 min <sup>(2)</sup>	LB-W52, LB-W52B, LB-52NS
E8013-G											CM-B83
E8016-G											NB-1SJ,
E8018-G											LB-88VS
E9016-G	-	1.00 min <sup>(2)</sup>	0.80 min <sup>(2)</sup>	0.03	0.03	0.50 min <sup>(2)</sup>	0.30 min <sup>(2)</sup>	0.20 min <sup>(2)</sup>			BL-96, CM-9Cb, LB-62, LB-62U, LB-62UL, LB-67L
E9018-G											LB-98VS, LB-62D
E10016-G											LB-106, LB-70L
E11016-G											LB-116, LB-80UL, LB-88LT
E11018-G											LB-80L
E7010-P1	0.20	1.20	0.60	0.03	0.03	1.00	0.30	0.50	V: 0.10		KOBE-7010S
E8010-P1										KOBE-8010S	
E8018-W2	0.12	0.50- 1.30	0.35- 0.80	0.03	0.03	0.40- 0.80	0.45- 0.70	-	Cu: 0.30- 0.75	LB-W62G	

Note: Single values are maximum.

(1) Mn + Ni shall be 1.50% Max.

(2) The "G" group shall have the minimum of at least one of the elements listed in this table.



# AWS A5.4-2006 (A part is extracted)

## Stainless Steel Electrodes for Shielded Metal Arc Welding

Class.	Chemical composition (%)											Product names					
	C	Cr	Ni	Mo	Nb+Ta	Mn	Si	P	S	N	Cu						
E308-16	0.08	18.0-21.0	9.0-11.0	0.75	-	0.5-2.5	1.00	0.04	0.03	-	0.75	NC-38					
E308H-16	0.04-0.08	18.0-21.0	9.0-11.0									NC-38H					
E308L-16	0.04	18.0-21.0	9.0-11.0									NC-38L					
E309-16	0.15	22.0-25.0	12.0-14.0									NC-39					
E309L-16	0.04	22.0-25.0	12.0-14.0									NC-39L					
E309LMo-16	0.04	22.0-25.0	12.0-14.0									2.0-3.0	NC-39MoL				
E310-16	0.08-0.20	25.0-28.0	20.0-22.5	0.75	1.0-2.5	0.75	0.03	NC-30									
E312-16	0.15	28.0-32.0	8.0-10.5	0.75	0.5-2.5	1.00	0.04	0.03	-	0.75	NC-32						
E316-16	0.08	17.0-20.0	11.0-14.0	2.0-3.0							NC-36						
E316L-16	0.04	17.0-20.0	11.0-14.0	2.0-3.0							NC-36L, NC-36LT						
E317L-16	0.04	18.0-21.0	12.0-14.0	3.0-4.0							NC-317L						
E347-16	0.08	18.0-21.0	9.0-11.0	0.75							8xC, min to 1.00 max	1.0	0.90	0.04	-	0.75	NC-37, NC-37L
E409Nb-16	0.12	11.0-14.0	0.6								0.50-1.50						CR-40Cb
E410-16	0.12	11.0-13.5	0.7	0.75	-	1.0	0.90	0.04	-	0.75	CR-40						
E430-16	0.10	15.0-18.0	0.6		CR-43												
E430Nb-16	0.10	15.0-18.0	0.6		0.50-1.50						CR-43Cb						
E2209-16	0.04	21.5-23.5	8.5-10.5		2.5-3.5						-	0.5-2.0	1.00	0.08-0.20	NC-2209, NC-2594		

Note: Single values are maximum.

## AWS A5.11-2005 (A part is extracted)

### Nickel and Nickel Alloy Welding Electrodes for Shielded Metal Arc Welding

Class.	Chemical composition (%)															Product names
	C	Mn	Fe	P	S	Si	Cu	Ni	Co	Ti	Cr	Nb+Ta	Mo	W	Other Elements Total	
ENiCrFe-1	0.08	3.5	11.0	0.03	0.015	0.75	0.50	62.0 min.	-	-	13.0 to 17.0	1.5 to 4.0 <sup>(2)</sup>	-	-	0.50	NI-C70A
ENiCrFe-3	0.10	5.0 to 9.5	10.0	0.03	0.015	1.0	0.50	59.0 min.	<sup>(1)</sup>	1.0	13.0 to 17.0	1.5 to 2.5 <sup>(2)</sup>	-	-	0.50	NI-C703D
ENiCrFe-9	0.15	1.0 to 4.5	12.0	0.02	0.015	0.75	0.50	55.0 min.	-	-	12.0 to 17.0	0.5 to 3.0	2.5 to 5.5	1.5	0.50	NI-C70S
ENiMo-8	0.10	1.5	10.0	0.02	0.015	0.75	0.50	60.0 min.	-	-	0.5 to 3.5	-	17.0 to 20.0	2.0 to 4.0	0.50	NI-C1S

Note: Single values are maximum.

(1) Cobalt - 0.12 maximum, when specified by the purchaser.

(2) Tantalum - 0.30 maximum, when specified by the purchaser.

## AWS A5.15-1990 [R 2006] (A part is extracted)

### Welding Electrodes and Rods for Cast Iron

Class.	Chemical composition (%)											Product names
	C	Mn	Si	P	S	Fe	Ni <sup>(1)</sup>	Mo	Cu <sup>(2)</sup>	Al	Other Elements Total	
ENi-CI	2.0	2.5	4.0	-	0.03	8.0	85 min.	-	2.5	1.0	1.0	CI-A1
ENiFe-CI	2.0	2.5	4.0	-	0.03	Rem.	45-60	-	2.5	1.0	1.0	CI-A2
Est	0.15	0.60	0.15	0.04	0.04	Rem.	-	-	-	-	-	CI-A3

Note: Single values are maximum.

(1) Nickel plus incidental cobalt.

(2) Copper plus incidental silver.

## AWS A5.17-1997 [R 2007], A5.23-2007 (A part is extracted)

### A5.17: Carbon Steel Electrodes and Fluxes for Submerged Arc Welding A5.23: Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding

Chemical composition of wire

Class.	Chemical composition (%) <sup>(1)</sup>													Product names
	C	Mn	Si	S	P	Cr	Ni	Mo	Cu	Nb	N	V	Al	
EA3	0.15	2.10	0.80	0.030	0.030	-	-	0.40 to 0.65	0.35	-	-	-	-	US-40
EA4	0.15	1.60	0.80	0.030	0.030	-	-	0.40 to 0.65	0.35	-	-	-	-	US-A4
EB9	0.08 to 0.13	1.20 <sup>(2)</sup>	0.80	0.010	0.010	8.0 to 10.5	0.80 <sup>(2)</sup>	0.85 to 1.20	0.25	0.02 to 0.10	0.02 to 0.07	0.15 to 0.25	0.04	US-90B9
EG	Not specified													US-49, US-80LT, US-80BN, US-502, US-511N, US-511ND, US-521S, US-56B, US-9Cb
EH14	0.10 to 0.20	1.70 to 2.20	0.10	0.030	0.030	-	-	-	0.35	-	-	-	-	US-36, US-36J, US-49A
ENi3	0.12	1.60	0.80	0.025	0.030	0.15	2.80 to 3.80	-	0.35	-	-	-	-	US-203E

Note: Single values are maximum.

(1) Other elements total (excluding iron) dose not exceed 0.50%.

(2) Mn + Ni = 1.50% maximum

# AWS A5.18-2005, A5.28-2005 (A part is extracted)

## A5.18: Carbon Steel Electrodes and Rods for Gas Shielded Metal Arc Welding A5.28: Low-Alloy Steel Electrodes and Rods for Gas Shielded Metal Arc Welding

Chemical composition requirements for solid electrodes and rods

Class.	Chemical composition (%)													Other Elements Total	Product names										
	C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Ti	Zr	Al												
ER70S-2	0.07	0.90 to 1.40	0.40 to 0.70	0.035	0.025	0.15	0.15	0.15	0.03	0.50	0.05 to 0.15	0.02 to 0.12	0.05 to 0.15	-	NO65G										
ER70S-3	0.06 to 0.15	0.90 to 1.40	0.45 to 0.75								0.15	0.15	0.15	0.03	0.50	-	-	-	-	MIX-50					
ER70S-6	0.06 to 0.15	1.40 to 1.85	0.80 to 1.15								0.20	1.20 to 1.50	0.40 to 0.65	-	-	0.35	-	-	-	-	MG-51T, TG-S51T				
ER80S-B2	0.07 to 0.12	0.40 to 0.70	0.40 to 0.70	0.025	0.010	0.20	2.30 to 2.70	0.90 to 1.20	-	0.35	-	-	-	0.50	TG-S80B2										
ER90S-B3	0.07 to 0.12	0.40 to 0.70	0.40 to 0.70												0.20	4.50 to 6.00	0.45 to 0.65	-	-	-	-	-	-	TG-S90B3	
ER80S-B6	0.10	0.40 to 0.70	0.50												0.60	8.00 to 10.50	0.80 to 1.20	-	-	-	-	-	-	0.50	MG-S5CM, TG-S5CM
ER80S-B8	0.10	0.40 to 0.70	0.50												0.50	0.85 to 1.20	0.15 to 0.30	-	-	-	-	-	-	0.50	MG-S9CM, TG-S9CM
ER90S-B9	0.07 to 0.13	1.20	0.15 to 0.50	0.010	0.010	0.80	8.00 to 10.50	0.85 to 1.20	0.15 to 0.30	0.20	-	-	0.04	-	TG-S90B9										

Chemical composition requirements for solid electrodes and rods

Class.	Chemical composition (%)														Other Elements Total	Product names
	C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Ti	Zr	Al			
A5.18 ER70S-G	Not specified <sup>(1)</sup>															MIX-50S, MG-50, MG-S50, MG-S50LT, TG-S50
A5.28 ER70S-G	Not specified <sup>(2)</sup>															MG-S1N, MG-S3N, TG-S1N, TG-S3N
ER80S-G																MG-W50TB, MG-60, MG-T1NS, MG-S56, MG-S56, MG-S1CM, MG-SM, MG-CM TG-S60A, TG-S62, TG-S1CML, TG-S2CML, TG-S56, TG-S1CM, TG-SM
ER90S-G																MG-S63B, MG-S9Cb, MG-S2CM, MG-S2CW, MG-S2CMS, TG-S63S, TG-S2CM, TG-S9Cb
ER100S-G																MG-70, MG-S70
ER110S-G																MG-80, MG-S80, TG-S80AM
ER120S-G																MG-S88A

Note: Single values are maximum.

(1) There shall be no intentional addition of Ni, Cr, Mo, or V.

(2) The electrode must have a minimum of one or more of the following: 0.50%Ni, 0.30%Cr, or 0.20%Mo

Chemical composition requirements for weld metal from composite electrodes

Class.	Chemical composition (%)														Product names
	C	Mn	Si	S	P	Ni	Cr	Mo	V	Cu	Ti	Zr	Al	Other Elements Total	
E70C-6C	0.12	1.75	0.90	0.03	0.03	0.50 <sup>(1)</sup>	0.20 <sup>(1)</sup>	0.30 <sup>(1)</sup>	0.08 <sup>(1)</sup>	0.50	-	-	-	-	MX-100T
E70C-6M	0.12	1.75	0.90	0.03	0.03	0.50 <sup>(1)</sup>	0.20 <sup>(1)</sup>	0.30 <sup>(1)</sup>	0.08 <sup>(1)</sup>	0.50	-	-	-	-	MX-100T, MX-A100
E80C-G	Not specified <sup>(2)</sup>														MX-A55T, MX-A55Ni1
E110C-G															MX-A80L

Note: Single values are maximum.

(1) The sum of Ni, Cr, Mo, and V shall not exceed 0.50%.

(2) The electrode must have a minimum of one or more of the following: 0.50%Ni, 0.30%Cr, or 0.20%Mo

## AWS A5.20-2005, A5.29-2005 (A part is extracted)

### A5.20: Carbon Steel Electrodes for Flux Cored Arc Welding A5.29: Low Alloy Electrodes for Flux Cored Arc Welding

Weld metal chemical requirement for classification

Class.		Chemical composition (%)										Product names	
		C	Mn	Si	S	P	Cr	Ni	Mo	V	Al		Cu
A5.20 <sup>(1)</sup>	E70T-1C	0.12	1.75	0.90	0.03	0.03	0.20	0.50	0.30	0.08	-	0.35	DW-200, MX-100, MX-200, MX-200H
	E70T-1M												MX-A200
	E70T-9C												MX-200E, MX-55LF
	E71T-1C												DW-100, DW-100V, DW-50
	E71T-1M												DW-50, DW-A50
	E71T-5M												DW-A51B
	E71T-9C												DW-100E, DW-50, DW-55E
	E71T-9M												DW-50, DW-A55E
	E71T-12M												DW-A55ESR
	E71T1-GC		<sup>(2)</sup>										1.75
A5.29	E81T1-K2C	0.15	0.50- 1.75	0.80	0.030	0.030	0.15	1.00- 2.00	0.35	0.05	1.8 <sup>(3)</sup>	-	DW-55L, DW-55LSR
	E81T1-K2M												DW-A55L
	E91T1-K2M												DW-A65L
	E81T1-Ni1M	0.12	1.50	0.80	0.030	0.030	0.15	0.80- 1.10	0.35	0.05	1.8 <sup>(3)</sup>	-	DW-A55LSR, DW-A81Ni1
	E91T1-Ni2C	0.12	1.50	0.80	0.030	0.030	-	1.75- 2.75	-	-	1.8 <sup>(3)</sup>	-	DW-62L
	E81T1-W2C	0.12	0.50- 1.30	0.35- 0.80	0.030	0.030	0.45- 0.70	0.40- 0.80	-	-	-	0.30- 0.75	DW-588
	E91T1-GM <sup>(4)</sup>	-	0.50 <sup>(5)</sup>	1.00	0.030	0.030	0.30 <sup>(5)</sup>	0.50 <sup>(5)</sup>	0.20 <sup>(5)</sup>	0.10 <sup>(5)</sup>	1.8 <sup>(3)</sup>	-	DW-A62L

Note: Single values are maximum unless otherwise noted.

(1) The total of all elements listed in this table shall not exceed 5%.

(2) The limit for gas shielded electrodes is 0.18%.

(3) Applicable to self-shielded electrodes only.

(4) In order to meet the alloy requirements of the G group, the undiluted weld metal shall have not less than the minimum specified for one or more following alloys: Mn, Ni, Cr, Mo, V.

(5) Minimum values.



# AWS A5.22-2010 (A part is extracted)

## Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods

Chemical composition requirement for flux cored electrodes for undiluted weld metal

Class.	Chemical composition (%)											Product names
	C	Cr	Ni	Mo	Nb + Ta	Mn	Si	P	S	N	Cu	
E308HT1-1/4	0.04-0.08	18.0-21.0	9.0-11.0	0.75	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-308H
E308LT0-1/4	0.04	18.0-21.0	9.0-11.0	0.75	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-308L, DW-308LT
E308LT1-1/4												DW-308LH, DW-308LP
E308T0-1/4	0.08	18.0-21.0	9.0-11.0	0.75	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-308
E309LMoT0-1/4	0.04	21.0-25.0	12.0-16.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-309MoL
E309LMoT1-1/4												DW-309MoLP
E309LT0-1/4	0.04	22.0-25.0	12.0-14.0	0.75	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-309L
E309LT1-1/4												DW-309LP, DW-309LH
E309T0-1/4	0.10	22.0-25.0	12.0-14.0	0.75	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-309
E310T0-1/4	0.20	25.0-28.0	20.0-22.5	0.75	-	1.0-2.5	1.0	0.03	0.03	-	0.75	DW-310
E312T0-1	0.15	28.0-32.0	8.0-10.5	0.75	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-312
E316LT0-1/4	0.04	17.0-20.0	11.0-14.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-316L
E316LT1-1/4												DW-316LT, DW-316LH, DW-316LP
E316T0-1/4	0.08	17.0-20.0	11.0-14.0	2.0-3.0	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-316
E316T1-1/4												DW-316H
E317LT0-1/4	0.04	18.0-21.0	12.0-14.0	3.0-4.0	-	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-317L
E347T0-1/4	0.08	18.0-21.0	9.0-11.0	0.75	8 x C min. - 1.0 max.	0.5-2.5	1.0	0.04	0.03	-	0.75	DW-347
E347T1-1/4												DW-347H

Note: Single values shown are maximum.

The total of other elements, except iron, shall not present in excess of 0.50%.

Class.	Chemical composition (%)											Product names
	C	Cr	Ni	Mo	Nb + Ta	Mn	Si	P	S	N	Cu	
E2209T0-1/4	0.04	21.0-24.0	7.5-10.0	2.5-4.0	-	0.5-2.0	1.0	0.04	0.03	0.08-0.20	0.75	DW-329A
E2209T1-1/4												DW-329AP, DW-2209, DW-2594
R308LT1-5	0.03	18.0-21.0	9.0-11.0	0.75	-	0.5-2.5	1.2	0.04	0.03	-	0.75	TG-X308L
R309LT1-5	0.03	22.0-25.0	12.0-14.0	0.75	-	0.5-2.5	1.2	0.04	0.03	-	0.75	TG-X309L
R316LT1-5	0.03	17.0-20.0	11.0-14.0	2.0-3.0	-	0.5-2.5	1.2	0.04	0.03	-	0.75	TG-X316L
R347T1-5	0.08	18.0-21.0	9.0-11.0	0.75	8 x C min. - 1.0 max.	0.5-2.5	1.2	0.04	0.03	-	0.75	TG-X347

Note: Single values shown are maximum.

The total of other elements, except iron, shall not present in excess of 0.50%.

## AWS A5.34-2007 (A part is extracted)

### Nickel-Alloy Electrodes for Flux Cored Arc Welding

Chemical composition requirement for undiluted weld metal

Class.	Chemical composition (%) <sup>(1)</sup>																Product name
	C	Mn	Fe	P	S	Si	Cu	Ni	Co	Ti	Cr	Nb+Ta	Mo	V	W	Other	
ENiCr3T0-4	0.10	2.5-3.5	3.0	0.03	0.015	0.50	0.50	67.0 min.	<sup>(2)</sup>	0.75	18.0-22.0	2.0-3.0	-	-	-	0.50	DW-N82
ENiCrMo3T1-4	0.10	0.50	5.0 <sup>(3)</sup>	0.02	0.015	0.50	0.50	58.0 min.	<sup>(2)</sup>	0.40	20.0-23.0	3.15-4.15	8.0-10.0	-	-	0.50	DW-N625
ENiCrMo4T0-4	0.02	1.0	4.0-7.0	0.03	0.03	0.2	0.50	Rem.	2.5	-	14.5-16.5	-	15.0-17.0	0.35	3.0-4.5	0.50	DW-NC276

Note: Single values shown are maximum.

- (1) The total of other elements shall not present in excess of 0.50%.
- (2) Cobalt is 0.10 maximum, when specified by the purchaser.
- (3) Iron is 1.0 maximum, when specified by the purchaser.

# EN ISO 2560:2009

## Covered electrodes for manual metal arc welding of non-alloy and fine grain steels

### Classification (System A)

EN ISO 2560-A-E ① ② ③ ④ ⑤ ⑥ ⑦

[Ex.] EN ISO 2560-A-E 46 3 1Ni B 5 4 H5

E: Designates covered electrodes for manual metal arc welding

①: All-weld metal yield strength and related requirements

Code	Yield strength or 0.2% offset strength, Min. (N/mm <sup>2</sup> )	Tensile strength (N/mm <sup>2</sup> )	Elongation (L=5D) Min. (%)
35	355	440-570	22
38	380	470-600	20
42	420	500-640	20
46	460	530-680	20
50	500	560-720	18

②: Impact value of all-weld metal

Code	Test temp. (°C)	Impact absorbed energy Min. (J)
Z	Not required	Average 47
A	+20	
0	0	
2	-20	
3	-30	
4	-40	
5	-50	
6	-60	

③: Chemical composition of all-weld metal

Code	Chemical composition <sup>(1)</sup> (%)		
	Mn	Mo	Ni
No symbol	2.0	-	-
Mo	1.4	0.3-0.6	-
MnMo	1.4-2.0	0.3-0.6	-
1Ni	1.4	-	0.6-1.2
2Ni	1.4	-	1.8-2.6
3Ni	1.4	-	2.6-3.8
Mn1Ni	1.4-2.0	-	0.6-1.2
1NiMo	1.4	0.3-0.6	0.6-1.2
Z	Other elements as agreed		

Note: (1) Single values are maximums.  
 If not specified, Mo<0.2%, Ni<0.3%,  
 Cr<0.2%, V<0.05%, Nb<0.05%,  
 Cu<0.3%

④: Type of covering

Code	Type of electrode covering
A	Acid covering
C	Cellulose covering
R	Rutile covering
RR	Rutile thick covering
RC	Rutile-cellulosic covering
RA	Rutile-acid covering
RB	Rutile-basic covering
B	Basic covering

⑤: Weld metal recovery and type of current (Option)

Code	Nominal electrode efficiency $\eta$ (%)	Type of current
1	$\eta \leq 105$	AC, DC
2	$\eta \leq 105$	DC
3	$105 < \eta \leq 125$	AC, DC
4	$105 < \eta \leq 125$	DC
5	$125 < \eta \leq 160$	AC, DC
6	$125 < \eta \leq 160$	DC
7	$\eta > 160$	AC, DC
8	$\eta > 160$	DC

⑥: Welding position (Option)

Code	Designation
1	All positions
2	All positions except vertical down
3	Flat butt , flat fillet and Horizontal-vertical fillet
4	Flat butt and fillet
5	Vertical-down and those specified in the code 3

⑦: Diffusible hydrogen (Option)

Code	Diffusible hydrogen, Max. ml/100g all-weld metal
H5	5
H10	10
H15	15

# EN ISO 17632:2008

## Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine-grain steels

### Classification (System A)

EN ISO 17632-A - T

[Ex.] EN ISO 17632-A - T 46 3 1Ni B M 4 H5

T: Designates tubular cored electrodes for metal arc welding

①: Yield strength and related requirements

(a) Multiple-layer welding:

Yield strength of all-weld metal

Code	Yield strength or 0.2% offset strength Min. (N/mm <sup>2</sup> )	Tensile strength (N/mm <sup>2</sup> )	Elongation (L=5D) Min. (%)
35	355	440~570	22
38	380	470~600	20
42	420	500~640	20
46	460	530~680	20
50	500	560~720	18

(b) Single pass welding:

Yield strength of weld joint

Code	Yield strength of base metal Min. (N/mm <sup>2</sup> )	Tensile strength of weld joint Min. (N/mm <sup>2</sup> )
3T	355	470
4T	420	520
5T	500	600

②: Impact value of all-weld metal or weld joint

Code	Test temp. (°C)	Impact absorbed energy Min. (J)
Z	Not required	Average 47
A	+20	
0	0	
2	-20	
3	-30	
4	-40	
5	-50	
6	-60	

③: Chemical composition of all-weld metal

Code	Chemical composition <sup>(1)</sup> (%)		
	Mn	Ni	Mo
-	2.0	-	-
Mo	1.4	-	0.3-0.6
MnMo	1.4~2.0	-	0.3-0.6
1Ni	1.4	0.6-1.2	-
1.5Ni	1.6	1.2-1.8	-
2Ni	1.4	1.8-2.6	-
3Ni	1.4	2.6-3.8	-
Mn1Ni	1.4~2.0	0.6-1.2	-
1NiMo	1.4	0.6-1.2	0.3-0.6
Z	Other elements as agreed		

Note: (1) Single values are maximum.

Where no specification, Mo<0.2%, Ni<0.5%, Cr<0.2%, V<0.08%, Nb<0.05%, Cu<0.3%, and for non-gas shielded wires, Al<2.0%.

④: Type of cored flux

Code	Features	Type of welding	Shielding gas
R	Rutile, Slow-freezing slag	Single pass or multiple pass	Required
P	Rutile, Fast-freezing slag		
B	Basic		
M	Metal powder		
V	Rutile or basic / Fluorides	Single pass	Not required
W	Basic / Fluorides, Slow-freezing slag	Single pass or multiple pass	
Y	Basic / Fluorides, Fast-freezing slag		
Z	Other types		

⑥: Welding position (Option)

Code	Designation
1	All positions
2	All positions except vertical downward
3	Flat butt and fillet, Horizontal fillet
4	Flat butt and fillet
5	Vertical downward and those specified in the code 3

⑤: Shielding gas

Code	Designation
M	Gas mixtures (Gases specified as M2 per EN 439, excepting He)
C	CO <sub>2</sub> (Gases specified as C1 per EN 439)
N	Non-gas shielded

⑦: Diffusible hydrogen (Option)

Code	Diffusible hydrogen, Max. ml/100g deposited metal
H5	5
H10	10
H15	15

# EN ISO 18276:2006

## Tubular cored electrodes for gas-shielded and non-gas shielded metal arc welding of high-strength steels

### Classification (System A)

EN ISO 18276-A - T 1 2 3 4 5 6 7 8

[Ex.] EN ISO 18276-A - T 55 5 Mn1,5Ni B M 4 H5 T

T: Designates tubular cored electrodes for gas-shielded and non-gas shielded metal arc welding

①: All-weld metal yield strength and related requirements

Code	Yield point or 0.2% offset strength, Min. (N/mm <sup>2</sup> )	Tensile strength (N/mm <sup>2</sup> )	Elongation (L=5D) (%)
55	550	640-820	18
62	620	700-890	18
69	690	770-940	17
79	790	880-1080	16
89	890	940-1180	15

②: Impact value of all-weld metal

Code	Absorbed energy of 47J, Three-specimen average, <sup>(1)</sup> Test temp. (°C)
Z	Not specified
A	+20
0	0
2	-20
3	-30
4	-40
5	-50
6	-60

Note: (1) One value can be lower than 47J but shall be 32J or higher

③: Chemical composition of all-weld metal

Code	Chemical composition (%) <sup>(1)</sup>			
	Mn	Ni	Cr	Mo
Z	Elements as agreed			
MnMo	1.4-2.0	-	-	0.3-0.6
Mn1Ni	1.4-2.0	0.6-1.2	-	-
Mn1, 5Ni	1.1-1.8	1.3-1.8	-	-
Mn2, 5Ni	1.1-2.0	2.1-3.0	-	-
1NiMo	1.4	0.6-1.2	-	0.3-0.6
1, 5NiMo	1.4	1.2-1.8	-	0.3-0.7
2NiMo	1.4	1.8-2.6	-	0.3-0.7
Mn1NiMo	1.4-2.0	0.6-1.2	-	0.3-0.7
Mn2NiMo	1.4-2.0	1.8-2.6	-	0.3-0.7
Mn2NiCrMo	1.4-2.0	1.8-2.6	0.3-0.6	0.3-0.6
Mn2Ni1CrMo	1.4-2.0	1.8-2.6	0.6-1.0	0.3-0.6

Note: (1) Single values are maximum.

⑥: Welding position

Code	Designation
1	All positions
2	All positions except vertical downward
3	Flat butt and fillet, Horizontal fillet
4	Flat butt and fillet
5	Vertical downward and those in Code 3

④: Type of flux

Code	Features
R	Rutile, Slow-freezing slag
P	Rutile, Fast-freezing slag
B	Basic
M	Metal powder
Z	Others

⑤: Shielding gas

Code	Designation
M	Gas mixtures
C	CO <sub>2</sub>

⑦: Diffusible hydrogen

Code	Diffusible hydrogen, Max. ml/100g deposited metal
H5	5
H10	10

⑧: Heat treatment: T: 560-600°C × 1h, FC to 300°C for mechanical tests of all-weld metal



# EN ISO 17634:2006

## Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels

### Classification (System A)

EN ISO 17634-A - T ① ② ③ ④ ⑤

[Ex.] EN ISO 17634-A - T CrMo1 B M 4 H5

T: Designates tubular cored electrodes for gas shielded metal arc welding

①: Chemical composition and mechanical properties of all-weld metal

Chemical composition of all-weld metal

Code	Chemical composition (%)		
	Cr	Mo	V
Mo	-	0.40-0.65	-
MoL	-	0.40-0.65	-
MoV	0.30-0.60	0.50-0.80	0.25-0.45
CrMo1	0.90-1.40	0.40-0.65	-
CrMo1L	0.90-1.40	0.40-0.65	-
CrMo2	2.00-2.50	0.90-1.30	-
CrMo2L	2.00-2.50	0.90-1.30	-
CrMo5	4.00-6.00	0.40-0.70	-
Z	Elements as agreed		

②: Type of flux

Code	Features
R	Rutile, Slow-freezing slag
P	Rutile, Fast-freezing slag
B	Basic
M	Metal powder
Z	Other types

③: Shielding gas

Code	Designation
M	Gas mixtures (Gases specified as M2 per EN 439, excepting He)
C	CO <sub>2</sub> (Gases specified as C1 per EN 439)

④: Welding position (Opt.)

Code	Designation
1	All positions
2	All positions except vertical downward
3	Flat butt and fillet, Horizontal fillet
4	Flat butt and fillet
5	Vertical downward and those in Code 3

⑤: Diffusible hydrogen (Option)

Code	Diffusible hydrogen, Max. ml/100g deposited metal
H5	5
H10	10

Mechanical properties of all-weld metal

Code	Proof strength, Min. Rp0.2 (N/mm <sup>2</sup> )	Tensile strength, Min. Rm (N/mm <sup>2</sup> )	Elongation (L=5D) Min. A (%)	Absorbed energy Kv (J) +20°C		Heat treatment of all-weld metal		
				Average of three values, Min. (J)	Single value, Min. (J)	Preheat and interpass temp. (°C)	PWHT	
							Temp. <sup>(1)</sup> (°C)	Time (min)
Mo/MoL	355	510	22	47	38	<200	570-620	60±10
MoV	355	510	18	47	38	200-300	690-730	60±10
CrMo1	355	510	20	47	38	150-250	660-700	60±10
CrMo1L	355	510	20	47	38	150-250	660-700	60±10
CrMo2	400	500	18	47	38	200-300	690-750	60±10
CrMo2L	400	500	18	47	38	200-300	690-750	60±10
CrMo5	400	590	17	47	38	200-300	730-760	60±10
Z	Mechanical properties as agreed							

Note (1) Cooling speed: 200°C/1h max. to 300°C by FC

# EN ISO 17633:2006

## Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels

### Classification (System A)

EN ISO 17633-A - T ① ② ③ ④ [Ex.] EN ISO 17633-A - T 19 12 3L R M 4

T: Designates tubular cored electrodes for gas shielded and non-gas shielded metal arc welding

①: chemical composition and mechanical properties of all-weld metal

Classification	Chemical composition (%)				Proof strength Min. Rp0.2 (N/mm <sup>2</sup> )	Tensile strength Min. Rm (N/mm <sup>2</sup> )	El. Min. A (L=5D) %	PWHT
	Cr	Ni	Mo	Others				
Martensite/ferrite type								
13	11.0-14.0	-	-	-	250	450	15	(3)
13 Ti	10.5-13.0	-	-	Ti (1)	250	450	15	(3)
13 4	11.0-14.5	3.0-5.0	0.4-1.0	-	500	750	15	(4)
17	16.0-18.0	-	-	-	300	450	15	(5)
Austenite type								
19 9 L	18.0-21.0	9.0-11.0	-	-	320	510	30	None
19 9 Nb	18.0-21.0	9.0-11.0	-	Nb (2)	350	550	25	None
19 12 3 L	17.0-20.0	10.0-13.0	2.5-3.0	-	320	510	25	None
19 12 3 Nb	17.0-20.0	10.0-13.0	2.5-3.0	Nb (2)	350	550	25	None
19 13 4 N L	17.0-20.0	12.0-15.0	3.0-4.5	N: 0.08-0.20	350	550	25	None
Austenite-ferrite high corrosion resistant type								
22 9 3 N L	21.0-24.0	7.5-10.5	2.5-4.0	N: 0.08-0.20	450	550	20	None
Full-austenite high corrosion resistant type								
18 16 5 N L	17.0-20.0	15.5-19.0	3.5-5.0	N: 0.08-0.20	300	480	25	None
Special type								
18 8 Mn	17.0-20.0	7.0-10.0	-	-	350	500	25	None
20 10 3	19.5-22.0	9.0-11.0	2.0-4.0	-	400	620	20	None
23 12 L	22.0-25.0	11.0-14.0	-	-	320	510	25	None
23 12 2 L	22.0-25.0	11.0-14.0	2.0-3.0	-	350	550	25	None
29 9	27.0-31.0	8.0-12.0	-	-	450	650	15	None
Heat resistant type								
22 12 H	20.0-23.0	10.0-13.0	-	-	350	550	25	None
25 20	23.0-27.0	18.0-22.0	-	-	350	550	20	None

Note: (1) Ti :10°C%-1.5%

(2) Nb:8°C%-1.1%: Nb can be replaced with Ta up to 20%

(3) 840-870°C × 2h heating, followed by FC to 600°C and later AC

(4) 580-620°C × 2h heating, followed by AC

(5) 760-790°C × 2h heating, followed by FC to 600°C and later AC

②: Type of flux

Code	Features
R	Rutile, Slow-freezing slag
P	Rutile, Fast-freezing slag
M	Metal powder
U	Self-shielded
Z	Other types

③: Shielding gas

Code	Designation
M	Gas mixtures (Gases specified as M2 per EN 439, excepting He)
C	CO <sub>2</sub> (Gases specified as C1 per EN 439)
N	Self-shielded

④: Welding position (Option)

Code	Designation
1	All positions
2	All positions except vertical downward
3	Flat butt and fillet, and horizontal fillet
4	Flat butt and fillet
5	Vertical downward and those in Code 3



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