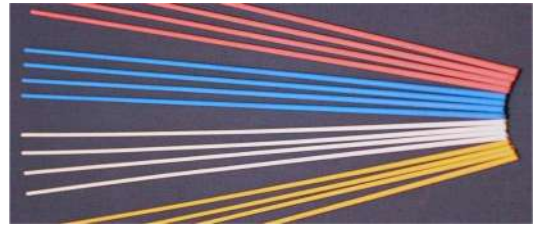


# Brazing Rods

<b>Undiluted Weld Metal</b>	<b>Maximum Value Up to:</b>
Tensile Strength	45,000 PSI (310 MPa)
Elongation	20%
Conductivity	24.4
Density (Troy oz./cu in.)	4.66



**Torch Setting:** Slightly carburizing

**Temperature Ranges:**

Working Temperature:	Liquidus	Solidus
1255°F (679 °C)	1410°F (765°C)	1250°F (676°C)

## BRAZING INSTRUCTIONS

**Welding Techniques:** After cleaning metal, preheat generally to 350°F (200°C) then heat the joint area to 800°F (420°C). Melt off some flux and allow it to flow throughout the joint. Then add alloy.

**Deposition Rates:**

Diameter (mm)	Length (mm)	Weldmetal/ Rod	Joint Length/ 1" (25mm) of Rod
1/16 (1.6)	18" (450)	.33 oz (9.2g)	24" (600mm)
3/32 (2.5)	18" (450)	.65 oz (18g)	44" (1100mm)

## APPROXIMATE ROD PACKAGING & DIMENSIONS

Diameter (mm)	1/16 (1.6)	3/32 (2.5)
Length (mm)	18" (450)	18" (450)
Rods / lb	32	16
Rods / kg	70	35
Feet / lb	48	24
Cm / kg	3150	1575



# Brazing Rods



Silver 5%.

CuP-3

## INTERNATIONAL CLASSIFICATIONS

AWS/ASME A5.8 B CuP-3

## FEATURES & APPLICATIONS

- Fabricate and repair copper air conditioning components, refrigeration components, radiators, heat exchangers, and other devices made from copper sheet and fittings.
- Join copper bus bars, electrical conduit, cable, and fabricated copper vessels.
- Join copper without flux in applications where flux is detrimental.

High strength, self-fluxing torch alloy for copper to copper; and copper to brass with flux.

- Designed to produce smooth thin fillets in clean copper-to-copper joints without flux.
- Provides excellent corrosion resistance and will withstand severe vibrations.
- Use with flux for joining copper to brass or bronze.
- Not recommended for steel or nickel alloys.

## ALL WELD METAL ANALYSIS (TYPICAL WEIGHT %)

P	Ag	Cu
6	5	Bal.

## TYPICAL MECHANICAL PROPERTIES

### Undiluted Weld Metal

Tensile Strength

Melting Temperature

### Maximum Value Up to:

up to 60,000 PSI (400 MPa)

1300°F (700°C)

## BRAZING INSTRUCTIONS

**Welding Techniques:** Clean joint area well. When joining copper to copper use without flux. Use a large size tip, carburizing flame and heat area broadly. Keep flame 2" to 3" from base metal and keep torch in constant motion.

When joining brass or bronze to copper or brass to bronze, use 5130 flux. Paint paste along joint line and heat broadly until flux first dries and then melts. Feed rod into the joint, keeping torch in constant motion. When a continuous fillet is observed, remove flame and allow molten metal to solidify. Flux residue should be removed by washing in warm water.



# Brazing Rods



Copper Ph.

CuP-2

## INTERNATIONAL CLASSIFICATIONS

AWS/ASME A5.8 B CuP-2

## FEATURES & APPLICATIONS

- Fabricate and repair copper air conditioning components, refrigeration components, radiators, heat exchangers, and other devices made from copper sheet and fittings.
- Join copper bus bars, electrical conduit, cable, and fabricated copper vessels.
- Join copper without flux in applications where flux is detrimental.

High strength, self-fluxing torch alloy for copper to copper; and copper to brass with flux.

- Designed to produce smooth thin fillets in clean copper-to-copper joints without flux.
- Provides excellent corrosion resistance and will withstand severe vibrations.
- Use with flux for joining copper to brass or bronze.
- Not recommended for steel or nickel alloys.

## ALL WELD METAL ANALYSIS (TYPICAL WEIGHT %)

P	Ag	Cu
7.5	Tr.	Bal.

## TYPICAL MECHANICAL PROPERTIES

### Undiluted Weld Metal

Tensile Strength  
Melting Temperature

### Maximum Value Up to:

up to 60,000 PSI (400 MPa)  
1300°F (700°C)

## BRAZING INSTRUCTIONS

**Welding Techniques:** Clean joint area well. When joining copper to copper use without flux. Use a large size tip, carburizing flame and heat area broadly. Keep flame 2" to 3" from base metal and keep torch in constant motion.

When joining brass or bronze to copper or brass to bronze, use 5130 flux. Paint paste along joint line and heat broadly until flux first dries and then melts. Feed rod into the joint, keeping torch in constant motion. When a continuous fillet is observed, remove flame and allow molten metal to solidify. Flux residue should be removed by washing in warm water.

# HWS-5356 and T-5356

For Al-Mg Aluminium alloys

## Specifications

AWS A5.10: ER5356  
GB/T 10858: S Al 5356

## Applications

**HWS YM-5356 and YT-5356** are aluminum alloy filler metal for welding Al-Mg aluminum alloys, as well as dissimilar aluminum alloys with maximum 5% of magnesium. It can be used in joining or overlay forging and casting alloys process. It has high toughness, good forgeability, anti-corrosive property, and it is also a good choice for color-matching in welding after anodic process.

Main applications in construction of boats, ships, bicycles, trucks, engine carriage, pressure vessels, storage tanks, railways and in the automotive industry

## Weldable base materials

Series 5xxx aluminum alloys and Al-Mg alloys

## Chemical composition

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Be
≤0.25	≤0.40	≤0.10	0.05-0.20	4.50-5.50	0.05-0.20	≤0.10	0.06-0.20	≤0.0003

## All-weld metal mechanical properties

Tensile strength (Rm)	Yield strength (Rp <sub>0.2</sub> )	Elongation	Test temperature (°C)
≥275 N/mm <sup>2</sup>	≥110 N/mm <sup>2</sup>	≥17%	20

## Standard packaging data

Product	Welding process	Diameter (mm)	Packing Type	Weight kg	Length mm
YM-5356	GMAW	0.8-2.4	spool BS300/D300	0.5/2/7	n.a.
YT-5356	GTAW	1.6-6.0	cardboard boxes/tubes	5/10	1000



# HWS-4043 and T-4043

For Al-Si Aluminium alloys

## Specifications

AWS A5.10: ER4043  
GB/T 10858: S Al 4043

## Applications

**HWS YM-4043 and YT-4043** are aluminum alloy filler metal which can be used in forging and casting alloy welding as it contains 5% silicon. Good performance in anti-thermal crack. Main application in ship building, engine, chemistry, food, sports, equipment, mould, furniture, vessel, container.

## Weldable base materials

Series 6xxx aluminum alloys

## Chemical composition

Si	Fe	Cu	Mn	Mg	Zn	Ti	Be
4.5-6.0	≤0.80	≤0.30	≤0.05	≤0.05	≤0.10	≤0.20	≤0.0003

## All-weld metal mechanical properties

Tensile strength (Rm)	Yield strength (Rp <sub>0.2</sub> )	Elongation	Test temperature (°C)
≥170 N/mm <sup>2</sup>	≥70 N/mm <sup>2</sup>	≥10%	20

## Standard packaging data

Product	Welding process	Diameter (mm)	Packing Type	Weight kg	Length mm
YM-4043	GMAW	0.8-2.4	spool BS300/D300	0.5/2/7	n.a.
YT-4043	GTAW	1.6-6.0	cardboard boxes/tubes	5/10	1000



# HWS-70S

*For Mild Steel and 490 N/mm<sup>2</sup> High Tensile Strength Steel*

## Classification

AWS A 5.18 : ER70S-6  
JIS Z 3312 : YGW12

## Applications

Welding of mild steels and 490 N/mm<sup>2</sup> high tensile strength steels for automobiles, rolling stocks, electric appliances, machinery, air conditioners, light gauge steels, pipes, steel frames, bridges and ships.

## Characteristics

HWS-70S is a gas metal arc welding wire to be used with CO<sub>2</sub> or Ar+10~50% CO<sub>2</sub> shield gas and assures stable arc, less spatter, smooth feeding, good electrical contact and low tip wear. Arc transfer characteristics are excellent with Argon based gas mixtures, particularly in spray and pulsed modes of transfer. It is ideal for positional, single pass welding of sheet steel and steel pipes.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.10	0.88	1.45	0.012	0.014

## Typical Mechanical Properties of Deposited Metal

Shield Gas	Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -20°C, J (kgf.m)
CO <sub>2</sub>	560 (57)	460 (47)	28	80 (8.2)
Ar+20% CO <sub>2</sub>	580 (59)	480 (49)	26	70 (7.1)

## Sizes & Recommended Current Range (DC +)

Diameter (mm)	0.8	0.9	1.0	1.2	1.6
Welding Position	Current (A)				
All	60~180	60~200	100~290	120~350	160~390

## Packing

Diameter/ Length (mm)	0.8	0.9	1.0	1.2	1.6
Weight per spool (kg)	15				
Weight per pail pack (kg)	250				

# HWS-5356 and T-5356

## For Al-Mg Aluminium alloys

### Specifications

AWS A5.10: ER5356  
GB/T 10858: S Al 5356

### Applications

**HWS -5356 and YT-5356** are aluminum alloy filler metal for welding Al-Mg aluminum alloys, as well as dissimilar aluminum alloys with maximum 5% of magnesium. It can be used in joining or overlay forging and casting alloys process. It has high toughness, good forgeability, anti-corrosive property, and it is also a good choice for color-matching in welding after anodic process.

Main applications in construction of boats, ships, bicycles, trucks, engine carriage, pressure vessels, storage tanks, railways and in the automotive industry

### Weldable base materials

Series 5xxx aluminum alloys and Al-Mg alloys

### Chemical composition

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Be
≤0.25	≤0.40	≤0.10	0.05-0.20	4.50-5.50	0.05-0.20	≤0.10	0.06-0.20	≤0.0003

### All-weld metal mechanical properties

Tensile strength (Rm)	Yield strength (Rp <sub>0.2</sub> )	Elongation	Test temperature (°C)
≥275 N/mm <sup>2</sup>	≥110 N/mm <sup>2</sup>	≥17%	20

### Standard packaging data

Product	Welding process	Diameter (mm)	Packing Type	Weight kg	Length mm
YM-5356	GMAW	0.8-2.4	spool BS300/D300	0.5/2/7	n.a.
YT-5356	GTAW	1.6-6.0	cardboard boxes/tubes	5/10	1000





# HWS-4043 and T-4043

For Al-Si Aluminium alloys

## Specifications

AWS A5.10: ER4043  
GB/T 10858: S Al 4043

## Applications

**HWS -4043 and YT-4043** are aluminum alloy filler metal which can be used in forging and casting alloy welding as it contains 5% silicon. Good performance in anti-thermal crack.  
Main application in ship building, engine, chemistry, food, sports, equipment, mould, furniture, vessel, container.

## Weldable base materials

Series 6xxx aluminum alloys

## Chemical composition

Si	Fe	Cu	Mn	Mg	Zn	Ti	Be
4.5-6.0	≤0.80	≤0.30	≤0.05	≤0.05	≤0.10	≤0.20	≤0.0003

## All-weld metal mechanical properties

Tensile strength (Rm)	Yield strength (Rp <sub>0.2</sub> )	Elongation	Test temperature (°C)
≥170 N/mm <sup>2</sup>	≥70 N/mm <sup>2</sup>	≥10%	20

## Standard packaging data

Product	Welding process	Diameter (mm)	Packing Type	Weight kg	Length mm
YM-4043	GMAW	0.8-2.4	spool BS300/D300	0.5/2/7	n.a.
YT-4043	GTAW	1.6-6.0	cardboard boxes/tubes	5/10	1000





# HWS-28E

For Mild Steel and Low Temperature Service

## Classification

AWS A 5.18 : ER70S-6 JIS: Z3316W49AP4U12

## Applications & Characteristics

Welding of mild steels, 490 N/mm<sup>2</sup> high tensile strength steels and aluminium killed steels for low temperature service.

## Typical Chemical Composition of Deposited Metal (%)

Shield Gas	C	Si	Mn	P	S
Ar	0.09	0.84	1.56	0.012	0.010

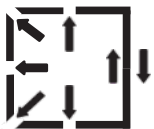
## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)	Heat Treatment
580 (59)	440 (45)	31	-20°C 260 (27)	As welded

## Sizes Available

Diameter (mm)	1.6	2.0	2.4	3.2
Length (mm)	1,000			

## Welding Positions



All positions

# HWS-308 -308L

## Gas Tungsten Arc Welding Wire for Stainless Steels

### Classification

AWS A 5.9	: ER308	JIS: Z3321YS308
AWS A 5.9	: ER308L	JIS: Z3321YS308L

### Applications & Characteristics

HWS-308 is for welding of 18%Cr-8%Ni stainless steels (SUS304). Deposited metal contains an adequate amount of ferrite and shows excellent crack resistance.

YAWATA YT-308L is for welding of low carbon 18%Cr-8%Ni stainless steels (SUS304L). Deposited metal contains less carbon and shows excellent resistance to intercrystalline corrosion and cracking.

### Typical Chemical Composition of Deposited Metal (%)

Brand Name	C	Si	Mn	Cr	Ni
308	0.05	0.35	1.62	20.2	10.0
308L	0.022	0.38	1.61	20.1	10.1

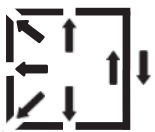
### Typical Mechanical Properties of Deposited Metal

Brand Name	Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
308	650 (66)	40	0°C 200 (20) -196°C 78 (8)
308L	620 (63)	39	0°C 170 (17) -196°C 88 (9)

### Sizes Available

Diameter (mm)	1.6	2.0	2.4	3.2
Length (mm)	1,000			

### Welding Positions



*All positions*

# HWS TG-50T

*For Mild Steel and 490 N/mm<sup>2</sup> High Tensile Steel*

## Classification

AWS A 5.18 : ER70S-G

## Applications

Welding of mild steel, 490 N/mm<sup>2</sup> high tensile strength steel and aluminium-killed steel for low temperature use. Its tensile strength after long time postweld heat treatment is high enough for 490 N/mm<sup>2</sup>.

## Characteristics

HWSTG-50T is a gas tungsten arc welding wire. All positions welding and steel sheet welding can be performed easily. It is most suitable for one-side welding of tubes.

## Typical Chemical Composition of Deposited Metal (%)

Shield Gas	C	Si	Mn	P	S
Ar	0.10	0.82	1.55	0.011	0.012

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
580 (59)	440 (45)	31	-20°C 260 (27) -40°C 89 (9.1)

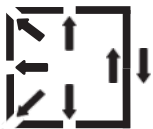
## Sizes Available

Diameter (mm)	1.6	2.0	2.4	3.2
Length (mm)	1,000			

## Guideline in Usage

It is welded in AC or DC (-) polarity.

## Welding Positions



*All positions*

# HWS-309 - 309L

## Gas Tungsten Arc Welding Wire for Stainless Steels

### Classification

AWS A 5.9 : ER309  
AWS A 5.9 : ER309L

### Applications & Characteristics

YAWATA YT-309 is for welding of 22%Cr-12%Ni stainless steels (SUS309), 18%Cr-8%Ni stainless clad steels and dissimilar metals such as stainless steel to mild steel.

YAWATA YT-309L is for welding of low carbon 22%Cr-12%Ni stainless steels (SUS309L), 18%Cr-8%Ni stainless clad steels and dissimilar metals such as stainless steel to mild steel.

### Typical Chemical Composition of Deposited Metal (%)

Brand Name	C	Si	Mn	Cr	Ni
309	0.05	0.40	1.65	23.8	12.4
309L	0.023	0.39	1.70	23.6	12.5

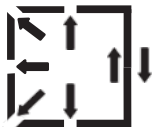
### Typical Mechanical Properties of Deposited Metal

Brand Name	Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %
309	600 (61)	43
309L	570 (58)	40

### Sizes Available

Diameter (mm)	1.6	2.0	2.4	3.2
Length (mm)	1,000			

### Welding Positions



*All positions*

# HWS-310

## Gas Tungsten Arc Welding Wire for Stainless Steels

### Classification

AWS A 5.9 : ER310, JIS Z 3321 : Y310

### Applications & Characteristics

HWS -310 is for welding of 25%Cr-20%Ni stainless steels (SUS310), stainless clad steels and dissimilar metals such as stainless steel to Cr-Mo or mild steel. Deposited metal is fully austenitic structure and shows excellent corrosion and heat resistance.

### Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Ni	Nb
0.04	0.35	1.56	26.9	21.5	-

### Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %
600 (61)	43

### Sizes Available

Diameter (mm)	1.6	2.0	2.4	3.2
Length (mm)	1,000			

# HWS-316 - 316L

## Gas Tungsten Arc Welding Wire for Stainless Steels

### Classification

AWS A 5.9 : ER316  
AWS A 5.9 : ER316L

### Applications & Characteristics

HWS-316 is for welding of 18%Cr-12%Ni-2%Mo stainless steels (SUS316). Deposited metal contains an adequate amount of ferrite and shows excellent crack resistance.

HWS-316L is for welding of low carbon 18%Cr-12%Ni-2%Mo stainless steels (SUS316L). Deposited metal contains less carbon and an adequate amount of ferrite and shows excellent resistance to intercrystalline corrosion and cracking.

### Typical Chemical Composition of Deposited Metal (%)

Brand Name	C	Si	Mn	Cr	Ni	Mo
316	0.04	0.35	1.52	19.0	12.2	2.47
316L	0.023	0.40	1.52	18.3	12.1	2.42

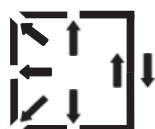
### Typical Mechanical Properties of Deposited Metal

Brand Name	Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch 0°C, J (kgf.m)
316	620 (63)	31	67 (7)
316L	670 (68)	37	78 (8)

### Sizes Available

Diameter (mm)	1.2	1.6	2.0	2.4
Length (mm)	1,000			

### Welding Positions



*All positions*

# HWS 71T-1

*For Mild Steel and 490 N/mm<sup>2</sup> High Tensile Strength Steel*

## Classification

AWS A 5.20 : E71T-1

## Applications

All position welding of mild and medium strength steel for machinery, structures, ships, bridges, towers, chemical engineering apparatus or storage tank.

## Characteristics

HWS71T-1 is a flux cored arc welding wire to be used with CO<sub>2</sub> shield gas. Smooth running, very low spatter, easily removable slag and excellent X-ray quality. Recommended for high speed fillet and butt welding of mild and medium strength steel.

## Typical Chemical Composition of Deposited Metal (%)

Shield Gas	C	Si	Mn	P	S
CO <sub>2</sub>	0.05	0.51	1.26	0.010	0.008

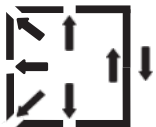
## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup>	Yield Strength N/mm <sup>2</sup>	Elongation %	Charpy 2V-notch J (kgf.m)
570	510	29	-18°C 100 (9.8)

## Sizes & Recommended Current Range (DC +)

Diameter (mm)	1.2	1.4	1.6
Welding Position	Current (A)		
F, HF	120~300	150~400	180~450
H	120~280	150~320	180~350
VD	200~260	220~270	230~280

## Welding Positions



*All positions*



# HWS 347

For 18%Cr-8%Ni-Nb Stainless Steel

## Classification

AWS A 5.4 : E347-16

## Applications

Welding of 18%Cr-8%Ni stainless steels containing titanium and niobium and places where postheat treatment is impossible.

## Characteristics

HWS347 is a lime-titania type stainless steel electrode. 19%Cr-9%Ni deposited metal containing niobium shows, even as welded, better intercrystalline corrosion resistance than that of 308L type stainless steel electrode and also assures excellent heat resistance.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni	Nb
0.05	0.70	1.20	0.018	0.013	20.5	10.1	0.73

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Creep-rupture Strength (as welded, x1,000h), N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )
640 (65)	37	650°C 160 (16)
		732°C 71 (7.2)

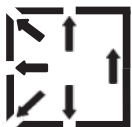
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	55~70	80~100	110~140	140~170
V, OH	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



All positions, except vertical down

# HWS 316R

For 18%Cr-12%Ni-2%Mo Stainless Steel

## Classification

AWS A 5.4 : E316-16  
JIS Z 3221 : ES316-16

## Applications

Welding of 18%Cr-12%Ni-2%Mo stainless steels for chemical engineering plants.

## Characteristics

HWS 316R is a lime-titania type stainless steel electrode. Deposited metal contains 18% chromium, 12% nickel and 2% molybdenum, and shows high creep rupture strength at high temperatures and corrosion resistance to non-oxidizing acids.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni	Mo
0.06	0.63	1.36	0.023	0.012	18.6	12.5	2.60

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Creep-rupture Strength (as welded, x1,000h), N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )
590 (60)	42	650°C 140 (14)
		732°C 61 (6.2)

## Typical Corrosion Resistance of Deposited Metal

Boiling 5% (weight) H <sub>2</sub> SO <sub>4</sub>	7.0 max (g/m <sup>2</sup> .h)
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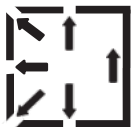
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~50	55~70	80~100	110~140	140~170
V, OH	35~45	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Dirt such as oil, grease and dust should be completely removed from groove.
3. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



All positions, except vertical down

# HWS 312-16

*For Stainless Steel and Dissimilar Metals*

## Classification

AWS A 5.4 : E312-16  
DIN 8556 : E 29 9 R 26

## Applications

Welding of austenitic-manganese steel, welding spring steel, tool steel and armour steel. Joining non-alloy and high alloy steels. Also suitable as a buffer layers in hardenable steel.

## Characteristics

HWS 312-16 is a rutile type austenitic-ferritic electrode with a 25~30% ferrite content. The weld metal is extremely crack resistant and lends itself admirably to the welding of dissimilar and difficult to weld steels. It can be used for the welding of high nickel alloys without becoming fully austenitic due to nickel pick-up.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni
0.08	0.90	1.10	0.024	0.016	30.4	9.8

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)
750 (76)	550 (56)	23	60 (6.1)

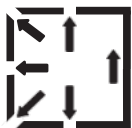
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	50~75	75~110	110~150	140~190
V, OH	50~70	70~100	100~140	-

## Guideline in Usage

Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.

## Welding Positions



*All positions, except vertical down*

# HWS310-16 *For 25%Cr-20%Ni Stainless Steel and Dissimilar Metals*

## Classification

AWS A 5.4 : E310-16  
DIN 8556 : E 25 20 R 26

## Applications

Welding of 25%Cr-20%Ni steels, i.e. 310, 310S, ASTM CR20, DIN 1.4841, 1.4848, AISI 309, 310 and 314. Also for dissimilar welds which require post weld heat treatment, if the joint is to be subject to thermal cycling in service then Ni based electrodes should be used in preference to YAWATA 310.

## Characteristics

HWS 310-16 is a rutile type electrode deposits nominally 25%Cr-20%Ni fully austenitic stainless steel weld metal and is normally used for joint welding and hardsurfacing of 25%Cr-20%Ni heat-resistance ferritic Cr steels, provided corrosion resistance in reducing sulphurous combustion gases is not specified. It can be used for welding mild steel to stainless steels though the heat input should be kept low during welding to avoid hot cracking. The weld metal is resistant to oxidation and scaling at temperature up to 1050°C.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni
0.10	0.65	1.90	0.020	0.012	25.0	20.0

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)
550 (56)	400 (41)	30	70 (7.1)

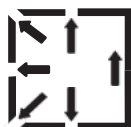
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	40~70	70~100	110~140	140~170
V, OH	40~70	70~90	90~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Sufficient crater treatment is required since deposited metal is a completely austenitic structure and crack resistance is slightly low.
3. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



*All positions, except vertical down*

# HWS 308R

For 18%Cr-8%Ni Stainless Steel

## Classification

AWS A 5.4 : E308-16  
JIS Z 3221 : ES308-16  
DIN 8556 : E 19 9 nCR 26

## Approvals

TIS

## Applications

Welding of 18%Cr-8%Ni austenitic stainless steels for chemical apparatus, containers and plants.

## Characteristics

HWS308R is a rutile type stainless steel electrode depositing 18%Cr-8%Ni metal. Slag is easy to remove, arc is stable, spatter is less and bead appearance is beautiful.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni
0.05	0.70	1.10	0.020	0.011	19.2	9.3

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Creep-rupture Strength (as welded, 650°C x 1,000h) N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )
610 (62)	47	130 (13)

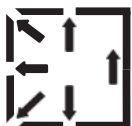
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~50	55~70	80~100	110~140	140~170
V, OH	35~45	45~65	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrodes diameter.

## Welding Positions



All positions, except vertical down

# HWS 316L-16 *For Low Carbon 18%Cr-12%Ni-2%Mo Stainless Steel*

## Classification

AWS A 5.4 : E316L-16  
DIN 8556 : E19 12 2 LR 26

## Applications

Welding of all chromium-nickel steel with low or medium C content, as well as titanium and niobium stabilized chromium-nickel steel of 18%Cr-12%Ni-2%Mo type, e.g. material DIN No. 1.4401, 1.4404, 1.4435, 1.4436, 1.4571, 1.4573, 1.4580, 1.4583, AISI 316, 316L, 318.

## Characteristics

HWS 316L-16 is a rutile high-alloy extra-low carbon electrode (ELC) for non-stabilized and stabilized chromium-nickel steels resistant to atmospheric corrosion of the 18%Cr-12%Ni-2%Mo type. Resistant to grain disintegration of operating temperatures up to 350°C. Smooth running, good striking and restriking. Regular appearance. Finely rippled, smooth junction, easy slag removal.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni	Mo
0.03	0.70	1.25	0.024	0.011	18.7	12.4	2.65

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Creep-rupture Strength (as welded, x1,000h), N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )
560 (57)	46	650°C 140 (14) 732°C 57 (5.8)

## Typical Corrosion Resistance of Deposited Metal

Boiling 5% (weight) H <sub>2</sub> SO <sub>4</sub>	6.0 max (g/m <sup>2</sup> .h)
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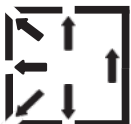
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~50	55~70	80~100	110~140	140~170
V, OH	35~45	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Dirt such as oil, grease and dust should be completely removed from groove.
3. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



*All positions, except vertical down*

# HWS 309R

For 22%Cr-12%Ni Stainless Steel and Dissimilar Metals

## Classification

AWS A 5.4	: E309-16
JIS Z 3221	: ES309-16
DIN 8556	: E 23 12 R 26

## Applications

Welding of 22%Cr-12%Ni stainless steels, dissimilar metals such as 18%Cr-8%Ni stainless steels to mild steels or low alloy steels, 18%Cr-8%Ni stainless clad steels, and the parts of hardenable steel for which postheat treatment is impossible, for petroleum, chemical and textile industries.

## Characteristics

HWS 309R is a lime-titania type stainless steel electrode. 22%Cr-12%Ni deposited metal shows extremely high crack resistance due to its high ferrite content.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni
0.06	0.70	1.20	0.020	0.012	24.2	13.2

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Creep-rupture Strength (as welded, 650°C x 1,000h) N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )
590 (60)	42	120 (12)

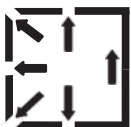
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~50	55~70	80~100	110~140	140~170
V, OH	35~45	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrodes diameter.

## Welding Positions



All positions, except vertical down



# HWS 309Mo-16

For Stainless Clad Steel Containing Mo

## Classification

AWS A 5.4	: E309Mo-16
JIS Z 3221	: ES309Mo-16
ISO 3581	: E 23 12 2 R 26

## Applications

Welding of 22%Cr-12%Ni-2%Mo stainless steels, dissimilar metals containing molybdenum, 316 stainless clad steels, and self harden type steels which contain molybdenum and for which postheat treatment is impossible.

## Characteristics

HWS 309Mo-16 is a lime-titania type stainless steel electrode. 22%Cr-12%Ni-2%Mo deposited metal shows excellent crack resistance especially in the welding of dissimilar metals such as stainless steel to mild steel.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni	Mo
0.05	0.68	1.14	0.018	0.013	23.5	12.8	2.65

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %
640 (65)	39

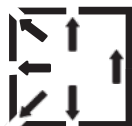
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	55~70	80~100	110~140	140~170
V, OH	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Dirt such as oil, grease and dust should be completely removed from groove.
3. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



All positions, except vertical down

# HWS 309L-16

For 22%Cr-12%Ni Stainless Steel and Dissimilar Metals

## Classification

AWS A 5.4	: E309L-16
JIS Z 3221	: ES309L-16
DIN 8556	: E 23 12 L 26

## Applications

Welding of 22%Cr-12%Ni stainless steels for petroleum, chemical and textile industries, low carbon 18%Cr-8%Ni stainless clad steels, and parts of hardenable steel for which post heat treatment is impossible.

## Characteristics

HWS 309L-16 is a lime-titania type stainless steel electrode. Low carbon 22%Cr-12%Ni deposited metal shows extremely high crack resistance due to its high ferrite content.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni
0.03	0.65	1.10	0.020	0.013	23.2	13.2

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %
560 (57)	40

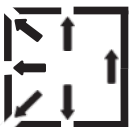
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~50	50~70	80~100	110~140	140~170
V, OH	35~45	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Dirt such as oil, grease and dust should be completely removed from groove.
3. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



All positions, except vertical down

# HWS 307-16

*For Stainless Steel*

## Classification

AWS A 5.4 : E307-16  
DIN 8556 : E 18 8 Mn 6 B 20

## Applications

For welding dissimilar metals and other steels that are difficult to weld, containing 18% Cr, 8% Ni and 6% Mn, such as high manganese alloy steel, armour steel and hardenable steels.

## Characteristics

HWS 307-16 is a basic coated, austenitic high-yielded electrode. The weld metal is tough with high tensile and elongation values, self-lifting slag, rust proof, wear resisting and crack-free.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni	Mo
0.08	0.75	5.54	0.024	0.010	18.2	9.0	0.53

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)
≥ 560 (≥ 57)	≥ 350 (≥ 36)	≥ 30	≥ 47 (≥ 4.8)

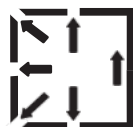
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
All	50~80	70~100	100~140	150~210

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Use short arc and avoid a large molten weldpool.

## Welding Positions



*All positions, except vertical down*

# HWS 410Nb

*For 13%Cr Stainless Steel*

## Classification

AWS A 5.4 : E410-16  
JIS Z 3221 : ES409Nb-16

## Applications

Welding of SUS 403, 405 and 410 for petroleum industry and chemical engineering plants and SUS 405 clad steels.

## Characteristics

HWS 410Nb is a lime-titania stainless steel electrode. 13%Cr deposited metal is fine ferritic structure stabilized by niobium and assures excellent crack resistance, ductility and toughness. Slag is easy to remove.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Nb
0.06	0.38	0.40	0.018	0.002	13.2	0.87

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	S.R.
520 (53)	270 (27)	33	850°C x 2h. Air cooling after slowly cooled down to 590°C.

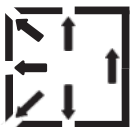
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	55~70	80~100	110~140	140~170
V, OH	50~65	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at 100~200°C and postheating at 700~800°C are required.
3. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrode diameter.

## Welding Positions



*All positions, except vertical down*

# HWS 308L-16

For Low Carbon 18%Cr-8%Ni Stainless Steel

## Classification

AWS A 5.4 : E308L-16  
JIS Z 3221 : ES308L-16  
DIN 8556 : E 19 9 LR 26

## Approvals

ABS, TIS

## Applications

Welding of all Cr-Ni steels with low or medium C content, as well as titanium and niobium stabilized Cr-Ni steels of the 18%Cr-8%Ni type, e.g. material DIN No 1.4300, 1.4301, 1.4306, 1.4541, 1.4543, 1.4550, AISI 302, 304, 304L, 321, 347.

## Characteristics

HWS 308L-16 is a rutile high-alloy extra-low carbon electrode (ELC) for non-stabilized and stabilized Cr-Ni steels resistant to atmospheric corrosion of the 18%Cr-8%Ni type. Resistant to grain disintegration of operating temperatures up to 350°C. Smooth running, good striking and restriking, regular appearance, finely rippled, smooth junction, easy slag removal.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni
0.03	0.70	1.10	0.025	0.011	18.9	9.9

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Creep-rupture Strength (as welded, 650°C x 1,000h) N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )
560 (57)	51	120 (12)

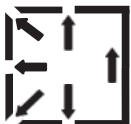
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~50	55~70	80~100	110~140	140~170
V, OH	35~45	45~65	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 200~250°C for 60 minutes before use.
2. Dirt such as oil, grease and dust should be completely removed from groove.
3. Excessively wide weaving may cause welding defects. Keep weaving width to less than 2.5 times electrodes diameter.

## Welding Positions



All positions, except vertical down

## Classification

AWS A 5.11 : ENiCrFe-2

## Applications

Welding of Inconel 600, Incoloy 800, and various dissimilar combinations of low alloy steels, stainless steels and nickel alloys for chemical engineering plants.

## Characteristics

HWS WELD B is an inconel type electrode which is a modified version of INCO-WELD A, by the International Nickel Company, Inc., for AC use. Deposited metal has the same properties as that of INCO-WELD A and shows excellent resistance to heat, corrosion and oxidization as well as remarkable toughness at extremely low temperatures. In welding of dissimilar metals, carbon migration and embrittlement are lower than stainless steel electrodes and coefficient of heat expansion is between those of carbon steel and austenitic stainless steel.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cu	Fe	Ni	Cr	Nb	Mo
0.06	0.30	2.91	0.008	0.004	0.06	10.1	68.5	16.65	1.69	0.76

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -196°C, J (kgf.m)
650 (66)	380 (39)	40	93 (9.5)

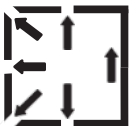
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	55~70	80~100	110~140	140~170
V, OH	45~60	70~90	100~130	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Arc length should be kept as short as possible.
3. Crater treatment or grinding off of crater is required.

## Welding Positions



All positions, except vertical down

# HWS Inc 3

*For Inconel and Incoloy*

## Classification

AWS A 5.11 : ENiCrFe-3

## Applications

Welding of Inconel 600, Incoloy 800, various dissimilar combinations of low alloy steels, stainless steels and nickel alloys, and surfacing of carbon steels for nuclear reactor vessels and chemical engineering plants.

## Characteristics

HWS WELD 182 is an inconel type electrode whose deposited metal has the same properties as that of INCONEL Welding Electrode 182. It is suitable for welding and surfacing extremely thick plates for nuclear reactor vessels since high titanium content in deposited metal checks the occurrence of blowholes. For the weldment to be used at high temperatures more than 1,000°F (538°C), YAWATA WELD B is recommended because it assures higher strength at high temperatures than YAWATA WELD 182.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cu	Fe	Ni	Cr	Nb	Ti	Co
0.08	0.52	6.85	0.010	0.004	0.14	7.30	68.4	14.2	1.66	0.53	0.03

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
660 (67)	400 (41)	44	131 (13)

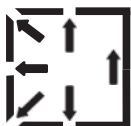
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	90~130	120~170	150~210	190~250
V, OH	70~110	100~140	120~150	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350°C for 60 minutes before use.
2. Arc length should be kept as short as possible.
3. Crater treatment or grinding off of crater is required.

## Welding Positions



*All positions, except vertical down*



# HWS 8018-G

*For Low Temperature Service Steel*

## Classification

AWS A 5.5 : E8018-G

## Applications

Welding of 590 N/mm<sup>2</sup> high tensile strength steel for pressure vessels, offshore platforms, earth moving equipment, hydro-electric penstocks, bridges, building, etc.

## Characteristics

HWS 8018-G is a basic type, hydrogen controlled electrode for all positions, except vertical down position. This electrode produces crack-free and tough welded joints. Weld metal is high mechanical properties and X-ray quality.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Ni
0.07	0.30	1.50	≤0.020	≤0.020	0.60

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
≥ 550 (≥ 56)	≥ 460 (≥ 47)	27	-20°C 120 (12.2) -40°C 70 (7.1)

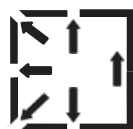
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
All	80~110	110~145	140~200	180~240

## Guideline in Usage

Use dry electrodes only. Redry, when necessary at 300~350°C for 60 minutes before use.

## Welding Positions



*All positions, except vertical down*

# HWS 7016-1

*For Low Temperature Service Steel*

## Classification

AWS A 5.1	: E7016-1
DIN 1913	: E 51 5 5 B 10
ISO 2560	: E 51 5 B 14 (H)

## Applications

For general purpose hydrogen controlled work in mild steel and low alloy structural where low temperature impact properties required. Such applications include offshore constructions, pressure vessel fabrication and ship building industry.

## Characteristics

HWS 7016-1 is a basic coated low hydrogen AC/DC electrode for excellent operator appeal in all positions. The weld metal has very good mechanical properties and is therefore very suitable for welding heavy duty structures under conditions of restraint.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
≤0.09	0.40~0.90	0.80~1.20	≤0.030	≤0.020

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
510~550 (52~56)	≥420 (≥43)	≥28	-20°C ≥150 (≥15.3) -40°C ≥80 (≥8.2) -60°C ≥47 (≥4.8)

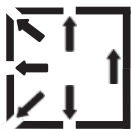
## Sizes & Recommended Current Range (AC or DC ±)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
All	55~85	80~140	110~180	170~240

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~400°C for 60 minutes.
2. When using DC without ceramic backing material, the welder may prefer electrode negative, but better mechanical properties will be obtained with electrode positive.

## Welding Positions



*All positions, except vertical down*

# HWS 9018-D1

*For Low Temperature Service Steel*

## Classification

AWS A 5.5 : E9018-D1

## Applications

Welding of mild and low alloy steel for structures working at low temperature, e.g. holders for liquid petroleum gas (LPG).

## Characteristics

HWS 9018-D1 is a basic coated hydrogen controlled electrode for low alloy. Good notch toughness down to  $-60^{\circ}\text{C}$ . Very suitable for enclosed joint welding of rail when a hardness of about 250 HV is desired.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Mo
0.06	0.35	1.50	0.35

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at $-60^{\circ}\text{C}$ , J (kgf.m)
670 (68)	610 (62)	24	40 (4.1)

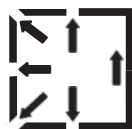
## Sizes & Recommended Current Range (AC or DC $\pm$ )

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
All	80~110	110~160	140~180	190~230

## Guideline in Usage

Use dry electrodes only. Damp electrodes should be re-dried at  $350^{\circ}\text{C}$  for 60 minutes before use.

## Welding Positions



*All positions, except vertical down*

# HWS 7018-1

*For Low Temperature Service Steel*

## Classification

AWS A 5.1 : E7018-1

## Applications

Welding of API X42, X46, X52 & X60 pipes.

## Characteristics

HWS 7018-1 is a basic coated hydrogen controlled electrode for high mechanical property requirements and crack resistance. Also suitable for crack-resistant joint welds on higher carbon steels. Weldability in all positions due to its stable arc, spatters are less and bead appearance is beautiful.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.06	0.30	1.50	≤0.020	≤0.020

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -46°C, J (kgf.m)
555 (57)	465 (47)	27	80 (8.2)

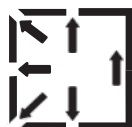
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F, V-down	60~100	90~140	140~190	180~240
V-up, OH	60~100	80~110	110~150	130~170

## Guideline in Usage

1. Use dry electrodes only.
2. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.

## Welding Positions



*All positions, except vertical down*

# HWS 9018-B3

*For Heat Resisting Steels*

## Classification

AWS A 5.5 : E9018-B3

## Applications

Welding of creep resisting steels of 2CrMo type, where creep properties can be maintained.

## Characteristics

HWS 9018-B3 is a basic coated hydrogen controlled electrode for welding 2.5%Cr-1.0%Mo type creep resisting steels. The electrode depositing a weld metal of high metallurgical and radiographic quality in all positions. Maximum operation temperature is 600°C. Suitable for welding of thick steam pipe and repairing of cast steel. Low spatter loss, ready slag detachment.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Mo
0.08	0.80	0.40	≤0.020	≤0.020	2.25	1.00

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)
755 (77)	665 (68)	22	85 (8.7)

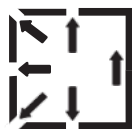
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	60~90	90~140	140~190	190~240
V, OH	50~80	80~120	110~150	140~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350~400°C for 60 minutes before use.
2. Keep the arc short as possible.
3. Preheating at 200~250°C and stress relieving at 620~740°C are required. DC welding by preference.

## Welding Positions



*All positions, except vertical down*

# HWS N-2

For 2.25%Cr-1%Mo Heat Resisting Steel

## Classification

AWS A 5.5 : E9016-B3  
DIN 8575 : E CrMo 2 B 20  
ISO 3580 : E 2 CrMo B 20

## Applications

Welding of piping steel (STP A24, A335, P22), boiler and heat exchanger (STB A24, A199-T22, A213-T22), rolled steels (SCM V4, A387 Grade 22), cast steels (A217-WC9) and forged steels (A182-F22, A336-F22).

## Characteristics

HWS N-2 is an extra low hydrogen type 2.25% Cr-1% Mo steel electrodes and suitable for welding 2.25% Cr-1% Mo steels to be used at high temperatures up to 600°C. Deposited metal shows extremely high creep-rupture strength at 500~600°C.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Mo
0.07	0.45	0.65	0.015	0.009	2.26	1.03

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Heat Treatment
670 (68)	570 (58)	24	690°C x 1 hr

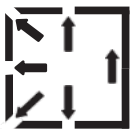
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	60~90	90~140	140~190	190~240
V, OH	50~80	80~120	110~150	140~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350~400°C for 60 minutes before use.
3. Preheating at 200~300°C and postheating at 680~730°C are required.

## Welding Positions



All positions, except vertical down

# HWS 7016-A1

*For 0.5% Mo Heat Resisting Steel*

## Classification

AWS A 5.5 : E7016-A1

## Applications

Welding of piping steel (STPA12, A335-P1), boiler and heat exchanger tubes (STBA12, A209-T1), rolled steels (A 204 A, B, C), cast steels (A 217 WC1) and forged steels (A 182-F1, A 336-F1).

## Characteristics

HWS 7016-A1 is an extra low hydrogen type electrode with 0.5% Mo low alloy steel electrode and is suitable for welding C-Mo steel to be used at high temperatures up to 500°C.

## Typical Chemical Composition of Deposited Metal (%)

Brand Name	C	Si	Mn	P	S	Mo
YAWATA 7016-A1	0.06	0.53	0.71	0.014	0.007	0.53

## Typical Mechanical Properties of Deposited Metal

Brand Name	Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Heat Treatment
YAWATA 7016-A1	580 (59)	500 (51)	34	620°C x 1h

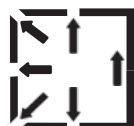
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	60~90	90~140	140~190	190~240
V, OH	50~80	80~120	110~150	140~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350~400°C for 60 minutes before use.
2. Preheating at 100~200°C and postheating at 600~650°C are required.

## Welding Positions



*All positions, except vertical down*



# HWS E8016B2

For 1.25%Cr-0.5%Mo Heat Resisting Steel

## Classification

AWS A 5.5 : E8016-B2

## Applications

Welding of piping steel (STPA22, 23, A335-P11, P12), boiler and heat exchanger tubes (STB22, 23, A199-T11, A213-T11, T12), rolled steels (SCMV2, 3, A387Gr11, 12), cast steels (A217 WC6) and forged steels (A 182-F11, F12, A 336-F12).

## Characteristics

HWSN-1 is an extra low hydrogen type with 1.25%Cr-0.5%Mo low alloy steel electrode. Suitable for welding 1~1.5%Cr-0.5%Mo steels to be used at high temperatures up to 550°C.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Mo
0.06	0.46	0.62	0.015	0.009	1.29	0.53

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Heat Treatment
630 (64)	540 (55)	28	690°C x 1h

## Typical Creep-rupture Strength of Deposited Metal

1,000h Creep-rupture Strength, N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )		Heat Treatment
550°C	600°C	
180 (18)	90 (9)	720°C x 1h

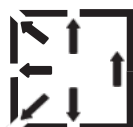
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450	6.0/450
Welding Position	Current (A)				
F	60~90	90~140	140~190	190~240	240~300
V, OH	50~80	80~120	110~150	140~180	-

## Guideline in Usage

1. Use dry electrodes only.
2. Damp electrodes should be re-dried at 300~400°C for 60 minutes before use.
3. Preheating at 150~300°C and postheating at 620~720°C are required.

## Welding Positions



All positions, except vertical down

**Classification**

DIN 8555 : E 6-UM-55

**Applications**

The electrode is recommended for metal to mineral wear applications, particularly where conditions of abrasion, accompanied by impact are experienced. Welding of earth moving equipment, farming machinery and forestry tool e.g. bulldozer blades and corners, crusher jaws scraper blades, bucket lips, chutes conveyors, landslide plates, ploughshares.

**Characteristics**

HWS MH is a basic coated, low hydrogen electrode depositing a hardfacing weld metal belonging to the martensitic class with chromium-carbides. The electrode is designed for all positional welding. The deposit is free of porosity and has a high crack resistance.

Structure : martensite and Cr-Carbides.

**Typical Chemical Composition of Deposited Metal (%)**

C	Si	Mn	P	S	Cr
0.40~0.60	0.40~0.60	0.70~1.20	≤0.030	≤0.025	6.00~7.50

**Typical Hardness of Deposited Metal**

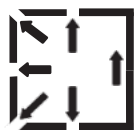
Vickers (HV)	Rockwell C (HRC)	Brinell (HB)
560~660	53~58	530~620

**Sizes & Recommended Current Range (AC Min. 65V OCV. or DC ±)**

Diameter/ Length (mm)	3.2/350	4.0/350, 400	5.0/450
Welding Position	Current (A)		
All	95~145	125~170	165~225

**Guideline in Usage**

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. The weld metal is non-machinable.
3. Preheating is not necessary for the weld metal, but can be required for the work piece.

**Welding Positions**

*All positions, except vertical down*

# HWS Manganese

*For Hardfacing*

## Classification

DIN 8555 : E 7-UM-200/50-KP

## Applications

Building up of parts subject to heavy impacts and to crushing loads. Joining and surfacing of 14% Mn steels provided that stress are not too high. (Thickness 8~10 mm max) Not to be used on non-austenitic steels.

## Characteristics

HWS Manganese is a low hydrogen electrode for wear resistant hardfacing on building machines and gravel mixers as well as for parts subject to impact and friction abrasion.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Mo
1.20	0.70	12.60	0.018	0.016	0.75

## Typical Hardness of Deposited Metal

As welded	230 HV	220 HB
After work hardened	580 HV	550 HB

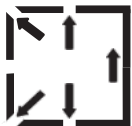
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
All	110~135	140~175	180~230

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350°C for 60 minutes before use.
2. At temperatures above 300°C, manganese-alloyed steels begin to lose ductility. Therefore, note the following:
  - deposit short run.
  - use thin electrodes.
  - weld at the lowest possible amperage.

## Welding Positions



*All positions, except horizontal and vertical down*

# HWS SUGAR WELD 80

*For Sugar mill*

## Classification

DIN 8555 : E 10-UM-60

## Applications

SUGAR WELD 80 process of surface treatment of sugar mill feed rolls is the depositing of wear-resistant cane gripping globular points or protrusions onto the sides and tips of roll teeth on a three-rollfeed and crushing assembly.

## Characteristics

HWS SUGAR WELD 80 is a high alloy electrode which is designed to maintain a constant self-regulating arc for the bonding of the hard metal globules to the cast iron roll in the presence of sucrose juice and cane fibre. These conditions are normally considered to be distinctly unfavourable for obtaining a rough bond between high alloy carbide deposits and grey iron.

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)
600~700	56~60

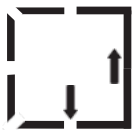
## Sizes & Recommended Current Range (AC Min. 55V OCV. or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F, V	100~140	140~180	180~240

## Guideline in Usage

Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.

## Welding Positions



*Flat butt and vertical up only*

# HWS H-800

*For Earth and Sand Abrasion*

## Classification

DIN 8555 : E 6-UM-65

## Applications

Surfacing of dredger pump mouths, impellers, liners and cutter knives.

## Characteristics

HWS H-800 is a low hydrogen type electrode to give extremely hard deposited metal due to dispersedly precipitated borides and carbides. Although it is not suitable for impact abrasion since deposited metal tends to crack, it shows excellent resistance to earth and sand abrasion.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Mo	B
0.82	1.28	1.10	8.67	0.57	0.45

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	Shore	Heat Treatment
813	65	90	As welded; preheat, interpass 250°C

## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	120~150	150~190	180~230

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at more than 200°C is required.
3. Multi-layer welding is not recommended. It should be used for the surfacing of the final layer.

## Welding Positions



*Flat butt only*

# HWS H-700R

*For Earth and Sand Abrasion*

## Classification

DIN 8555 : E 6-UM-60

## Applications

For a wide range of general hard surfacing, such as augers, cultivator blades, agricultural point and ploughshares, ripper teeth and other components subject to fatigue or flexing during service.

## Characteristics

HWS H-700R is a rutile coated hardfacing electrode which depositing an air hardening martensitic Cr-Mo-V alloy, exhibiting good resistance to all types of abrasion under low to moderate impact conditions, give smooth running with AC and DC, stable arc, low spatter and excellent slag removal.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Mo	V
0.70	0.50	0.30	8.00	0.30	0.40

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	(As-welded)
560~620	53~56	Single layer onto mild steel*
600~710	55~60	Multiple layer

\* Single layer deposit hardness will vary depending on base metal type and degree of dilution.

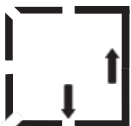
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F, V	90~130	140~180	160~240

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 120~150°C for 60 minutes before use.
2. Preheating at more than 150°C is recommended to avoid cracking.
3. A buffer layer with low hydrogen electrode is required to surface hardening metal or to deposit multiple layers.

## Welding Positions



*Flat butt and vertical up only*

# HWS H-650

*For Earth and Sand Abrasion*

## Classification

DIN 8555 : E 2-UM-60-G

## Applications

Surfacing of crusher parts, dipper teeth, shovel teeth, etc.

## Characteristics

HWS H-650 is a low hydrogen type electrode for surfacing worn parts of various machinery to be used without machining. Deposited metal of about 700 Vickers hardness and martensitic structure provides excellent resistance to earth and sand abrasion.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Mo	V
0.46	0.43	1.14	3.67	0.58	0.44

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	Shore	Heat Treatment
700	60	81	As welded; preheat, interpass 150°C

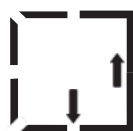
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F, V	90~130	140~180	160~240

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at more than 150°C is required.
3. A buffer layer with low hydrogen electrode is required to surface hardening metal or to deposit multiple layers.

## Welding Positions



*Flat butt and vertical up only*

# HWS H-600

*For Metal to Metal Heavy Abrasion and Sand Abrasion*

## Classification

DIN 8555 : E 3-UM-600

## Approvals

TIS

## Applications

Surfacing of track rollers, crusher teeth, mill hammers and bucket lips.

## Characteristics

HWS H-600 is a low hydrogen type electrode for surfacing worn parts of civil engineering, construction and mining machinery to be used without machining. Deposited metal of about 600 Vickers hardness and martensitic structure provides high toughness in spite of high hardness and excellent abrasion resistance to medium impact.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Mo
0.45	0.50	1.15	4.00~5.00	0.60

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	Shore	Heat Treatment
624	56	75	As welded; preheat, interpass 150°C
606	55	74	Tempered at 500°C
442	45	59	Tempered at 600°C

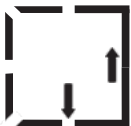
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	90~130	140~190	170~240
V	80~120	110~170	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at more than 150°C is required.
3. A buffer layer with low hydrogen electrode is required to surface hardening metal or to deposit multiple layers.

## Welding Positions



*Flat butt and vertical up only*



# HWS H-500

*For Metal to Metal and Sand Abrasion*

## Classification

DIN 8555 : E 1-UM-500

## Approvals

TIS

## Applications

Surfacing of track links, bulldozer idlers and bucket lips.

## Characteristics

HWS H-500 is a low hydrogen type electrode for surfacing machine parts which are subjected to metal to metal abrasion or earth and sand abrasion and are used without machining. Deposited metal of about 500 Vickers hardness and martensitic structure provides reasonable toughness and stress resistance to some extent.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Mo
0.34	0.76	1.13	3.06	0.44

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	Shore	Heat Treatment
537	51	69	As welded; preheat, interpass 150°C
507	50	67	As welded; preheat, interpass 300°C
494	48	65	Tempered at 500°C
388	40	54	Tempered at 600°C

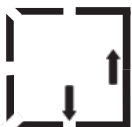
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	90~130	140~190	170~240
V	80~120	110~170	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at more than 150°C is required.
3. A buffer layer with low hydrogen electrode is required to surface hardening metal or to deposit multiple layers.

## Welding Positions



*Flat butt and vertical up only*

# HWS H-450R

*For Metal to Metal and Sand Abrasion*

## Classification

DIN 8555 : E 1-UM-450

## Applications

Surfacing of tractor grouser plate cleats, excavator drive tumblers, steel mill wobbler ends and coupling boxes, clipping tools and as an intermediate layer prior to the deposition of harder weld metal.

## Characteristics

HWS H-450R is a rutile coated hardfacing electrode depositing alloyed weld metal with approximately 450 Vickers hardness which for many applications can be applied directly on hardenable steels. Particularly suitable for the reclamation and fabrication of new metal cutting or forming equipment.

## Typical Chemical Composition of Deposited Metal (%)

C	Mn	Cr	Mo
0.25	0.75	3.00	0.50

## Typical Hardness of Deposited Metal

Vickers (HV)	(As-welded)
440	Single layer
470	Multiple layer

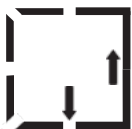
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	90~125	140~180	170~240
V	90~115	120~150	-

## Guideline in Usage

Use dry electrodes only. Damp electrodes should be re-dried at 70~120°C for 60 minutes before use.

## Welding Positions



*Flat butt and vertical up only*

# HWS H-350R

*For Metal to Metal and Sand Abrasion*

## Classification

DIN 8555 : E 1-UM-350

## Applications

Surfacing of shafts, rollers and bulldozer idlers and sprockets.

## Characteristics

HWS H-350R is a general purpose rutile coated hardfacing electrode depositing a tough chromium manganese alloy weld metal sufficiently hard to resist serious deformation under fairly heavy impact and rolling loads, yet with good resistance to medium abrasive wear. Recommended for hardfacing applications where maximum hardness consistent with reasonable machinability is required. Also suitable as a buffer layer and for building up multi-layer deposits on badly worn components.

## Typical Chemical Composition of Deposited Metal (%)

C	Mn	Cr
0.12	1.00	3.30

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	(As-welded)
320	32	Single layer
350	35	Multiple layer

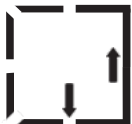
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	90~125	140~180	170~240
V	90~115	120~150	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 70~120°C for 60 minutes before use.
2. Preheating at more than 150°C is required to surface low alloy steels, high carbon steels, etc.

## Welding Positions



*Flat butt and vertical up only*

# HWS H-250C

*For Metal to Metal Moderate Abrasion*

## Classification

DIN 8555 : E 1-UM-250

## Approvals

TIS

## Applications

Surfacing of shafts, rollers, couplings and crane wheels.

## Characteristics

HWS H-250C is a low hydrogen type electrode with excellent weldability. It is suitable for surfacing worn machine parts since deposited metal has the hardness of about 250 Vickers and is easily machined. It is also suitable for depositing buffer layer in multi-layer welding due to its high crack resistance.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr
0.13	0.27	0.94	0.65

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
660 (67)	26	150 (15)

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	Shore	Heat Treatment
249	22	36	As welded; preheat, interpass 150°C
237	20	34	As welded; preheat, interpass 300°C
229	18	33	Tempered at 500°C
224	17	32	Tempered at 600°C

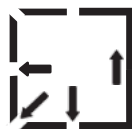
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
All	80~150	120~180	170~240

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at more than 150°C is required to surface low alloy steels, high carbon steel, etc.

## Welding Positions



*All position, except vertical down and overhead*

# HWS V-1000

*For Severe Earth and Sand Abrasion*

## Classification

DIN 8555 : E 10-UM-60R

## Applications

Surfacing of cutter knives, shovel teeth, coal cutters and parts in petrochemistry.

## Characteristics

HWS V-1000 is a heavy-coated rutile type electrode for highly wear resistant overlaying on parts subject to frictional abrasion. Not suitable for impact conditions. Clean and smooth bead appearance with minimal undercutting. Approximately 160% recovery. Machinable by grinding only.

## Typical Chemical Composition of Deposited Metal (%)

C	Cr
4.3	35

## Typical Hardness of Deposited Metal

Vickers (HV)	Rockwell C (HRC)	Shore	Heat Treatment
650~750	58~62	78~85	As welded; preheat, interpass 350°C

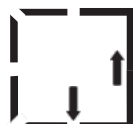
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F, V	120~140	170~190	220~250

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheating at more than 300°C and postheating at 600°C are required.
3. Chequered or rib-run reinforcement surfacing should be applied.

## Welding Positions



*Flat butt and vertical up only*

# HWS CNC 38

*For Hardfacing*

## Classification

DIN 8555 : E 10-UM-60-GR

## Applications

Surfacing of parts in crusher for soft rocks, conveyor screws, teeth and blades of shovels and bulldozers.

## Characteristics

HWS CNC 38 is a low hydrogen electrode for surfacing of parts subject to very intense abrasion and moderate impacts. It deposits an all weld metal structure of hard abrasion resistant chromium rich carbides in a tough austenite-carbide matrix; ideal for hard surfacing applications where resistance to all types of abrasion under impact conditions are required. The deposit is non-machinable, grindable, non-heat treatable and prone to relief cracking.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr
5.2	1.2	0.3	31.8

## Typical Hardness of Deposited Metal

SINGLE LAYER ONTO MILD STEEL *	560~650 HV	53~58 HRC
MULTILAYER	700~800 HV	60~65 HRC

\* Single layer deposit hardness will vary depending on base metal type and degree of dilution.

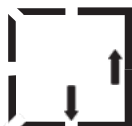
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F, H	105~120	165~185	220~240

## Guideline in Usage

Use dry electrodes only. Damp electrodes should be re-dried at 350°C for 60 minutes before use.

## Welding Positions



*Flat butt and vertical up only*

# HWS CNC 43

*For Hardfacing*

## Classification

DIN 8555 : E 10-UM-65-GR

## Applications

Surfacing of mixer blades, screws of refractory material presses, brick presses, cement presses, conveyor screws.

## Characteristics

HWS CNC 43 is a low hydrogen electrode for surfacing of parts subject to very intense abrasion with shock, capable of producing high deposition efficiencies (typically 190%), a fine regular bead and minimal, easily removed slag. It deposits an all weld metal structure of very hard, abrasion resistant chromium and niobium carbides in a moderately tough austenitic matrix; ideal for hard surfacing applications where resistance to extreme abrasion and moderate impact are required. The deposit is non-machinable, grindable, non-heat treatable and prone to relief cracking.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Nb
5.2	1.2	1.5	22.2	7.1

## Typical Hardness of Deposited Metal

SINGLE LAYER ONTO MILD STEEL *	700~800 HV	60~65 HRC
MULTILAYER	800~1000 HV	64~69 HRC

\* Single layer deposit hardness will vary depending on base metal type and degree of dilution.

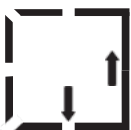
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F, V	115~140	140~170	190~230

## Guideline in Usage

Use dry electrodes only. Damp electrodes should be re-dried at 350°C for 60 minutes before use.

## Welding Positions



*Flat butt and vertical up only*

# HWS TOOLCORD

*For Hardfacing*

## Classification

AWS A 5.13 : EFe5-B  
DIN 8555 : E 4-UM-60-65-S

## Applications

Welding of cutting tools, e.g. for turning, planing, milling, reaming, drills, etc.

## Characteristics

HWS TOOLCORD is a basic type electrode with coating for manufacturing and repair- ing high-speed cutting tools.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Cr	Mo	V	W
0.9	0.5	0.5	4.2	8.5	0.9	1.1

## Typical Hardness of Deposited Metal

As welded	515~830 HV	50~64 HRC
After heat treatment	770~990 HV	62~66 HRC

## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400
Welding Position	Current (A)		
Horizontal	70~100	100~150	130~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Preheat the workpiece up to 600~700°C and maintain this temperature during welding.
3. Weld at the lowest possible amperage.

## Welding Positions



*Horizontal only*





## HWS E4043

### INTERNATIONAL CLASSIFICATIONS

AWS/ASME A 5.3 E 4043  
DIN 1732: EL -Al Si5

EN 573-3: E AISi5

### FEATURES & APPLICATIONS

For arc welding aluminums alloyed with copper, silicon, and magnesium. Also excellent for joining dissimilar grades of aluminum.

5% Silicon aluminum arc welding electrode with exclusive self lifting slag. Other aluminum grades such as Al 99, Al Mn, etc. are also available.

- Unique self lifting slag.
- The only aluminum electrode manufactured in a "Low Temperature" 5/64 (2.0mm) x 10" (250mm) size.
- Pure white long shelf life extruded flux coating outlasts conventional products in moisture resistance.
- Can be manufactured in a variety of custom colors.
- Available in hermetically sealed PURE ALUMINUM pull ring cans or vacuum packed foil bags for extended shelf life.
- Also available in TIG form as item code 6009, in MIG form as item code 7090 and as a bare torch brazing alloy as item code 2190.

### ALL WELD METAL ANALYSIS (TYPICAL WEIGHT %)

**Flux Color:** White or Custom Colors

Si	Cu	Fe	Mg	Mn	Zn	Ti	Be	Al
5.25	.01	.17	.002	.002	.001	.01	.0001	Bal.

### TYPICAL MECHANICAL PROPERTIES

Undiluted Weld Metal	Maximum Value Up to:
Tensile Strength	32,000 psi (230 MPa)
Yield Strength	20,000 psi (150 MPa)
Elongation	18%

## WELDING CURRENT & INSTRUCTIONS

**Recommended Current:** DC Reverse (+)

Diameter (mm)	5/64 (2.0)	3/32 (2.5)	1/8 (3.25)	5/32 (4.0)
Minimum Amperage	20	50	70	110
Maximum Amperage	60	80	120	150

**Welding Techniques:** Start by using the upper portion of the amperage range. Feed the Electrode quickly and move fast maintaining a very close arc gap.

**Welding Positions:** Flat, Horizontal

**Deposition Rates:**

Diameter (mm)	Length (mm)	Weldmetal/ Electrode	Electrodes per lb (kg) of Weldmetal	Arc Time of Deposition min/lb (kg)	Amperage Settings	Recovery Rate
5/64 (2.0)	10" (250)	.08oz (2.6g)	184 (404)	176 (337)	40	90%
3/32 (2.5)	14" (350)	.14oz (4.3g)	114 (251)	110 (242)	70	90%
1/8 (3.25)	14" (350)	.23oz (6.5g)	70 (153)	62 (136)	110	90%
5/32 (4.0)	14" (350)	.33oz (9.6g)	48 (107)	47 (103)	135	90%

## APPROXIMATE ELECTRODE PACKAGING & DIMENSIONS

Diameter (mm)	5/64 (2.0)	3/32 (2.5)	1/8 (3.25)	5/32 (4.0)
Length (mm)	10" (250)	14" (350)	14" (350)	14" (350)
Electrodes / lb	80	49	33	23
Electrodes / kg	176	108	73	51



# HWS E4047

## INTERNATIONAL CLASSIFICATIONS

**AWS/ASME 5.3 E 4047**  
**DIN 1732: EL-Al Si12**

**EN 573-3: E AlSi12**

## FEATURES & APPLICATIONS

For arc welding aluminums alloyed with copper, silicon, and magnesium. Also excellent for joining dissimilar grades of aluminum.

12% Silicon aluminum arc welding electrode with exclusive self lifting slag. Other aluminum grades such as Al 99, Al Mn, etc. are also available.

- Unique self lifting slag.
- Pure white long shelf life extruded flux coating outlasts conventional products in moisture resistance.
- Can be manufactured in a variety of custom colors.
- Available in hermetically sealed PURE ALUMINUM pull ring cans or vacuum packed foil bags for extended shelf life.
- Also available in TIG form as item code 6047, in MIG form as item code 7091 and as a bare torch brazing alloy as item code 2191.

## ALL WELD METAL ANALYSIS (TYPICAL WEIGHT %)

**Flux Color:** White or Custom Colors

Si	Cu	Fe	Mg	Mn	Zn	Ti	Be	Al
12.1	.001	.15	.01	.003	.001	.008	.0001	Bal.

## TYPICAL MECHANICAL PROPERTIES

<b>Undiluted Weld Metal</b>	<b>Maximum Value Up to:</b>
Tensile Strength	36,000 psi (250 MPa)
Yield Strength	20,000 psi (150 MPa)
Elongation	14%

## WELDING CURRENT & INSTRUCTIONS

# HWS E4047

**Recommended Current:** DC Reverse (+)

Diameter (mm)	3/32 (2.5)	1/8 (3.25)	5/32 (4.0)
Minimum Amperage	50	70	110
Maximum Amperage	80	120	150

**Welding Techniques:** Start by using the upper portion of the amperage range. Feed the electrode quickly and move fast maintaining a very close arc gap.

**Welding Positions:** Flat, Horizontal

**Deposition Rates:**

Diameter (mm)	Length (mm)	Weldmetal/ Electrode	Electrodes per lb (kg) of Weldmetal	Arc Time of Deposition min/lb (kg)	Amperage Settings	Recovery rate
3/32 (2.5)	14"(350)	.14oz (4.3g)	114 (251)	110 (242)	70	90%
1/8 (3.25)	14" (350)	.23oz (6.5g)	70 (153)	62 (136)	110	90%
5/32 (4.0)	14" (350)	.33oz (9.6g)	48 (107)	47 (103)	135	90%

## APPROXIMATE ELECTRODE PACKAGING & DIMENSIONS

	3/32 (2.5)	1/8 (3.25)	5/32 (4.0)
Length (mm)	14" (350)	14" (350)	14" (350)
Electrodes / lb	49	33	23
Electrodes / kg	108	73	51



## HWS E Cu & ER Cu

### INTERNATIONAL CLASSIFICATIONS

**AWS/ASME A 5.6 E Cu**

**DIN 1733: EL-CuMn2**

### FEATURES & APPLICATIONS

For joining and build-up on copper parts requiring corrosion resistance and thermal and/or electrical conductivity.

Pure copper electrode for joining and build-up

- Smooth arc characteristics allow easy joining of copper.
- Weld metal is extremely dense.
- High purity of weld metal allows for joining dissimilar grades of copper.

### ALL WELD METAL ANALYSIS (TYPICAL WEIGHT %)

**Microstructure:** A multi-phase copper base structure with complex eutectoids.

**Flux Color:** Lt. Grey

Mn	Al	Si	Pb	Fe	Other	Cu
.09	.07	.08	.02	.15	.50	Bal

### TYPICAL MECHANICAL PROPERTIES

**Undiluted Weld Metal**

**Maximum Value Up to:**

Tensile Strength	33,000 PSI (225 MPa)
Yield Strength	27,000 PSI (185 MPa)
Elongation	35%
Electrical Conductivity	25-45
Hardness	Brinell 50-60

## WELDING CURRENT & INSTRUCTIONS

**Recommended Current:** DC Reverse (+)

Diameter (mm)	3/32 (2.5)	1/8 (3.25)	5/32 (4.0)
Minimum Amperage	100	140	170
Maximum Amperage	130	170	200

**Welding Techniques:** Preheat thicker sections to 750°-1100°F (400°- 600°C). Use as large an electrode as possible and maintain a short arc.

**Welding Positions:** Flat, Horizontal, Vertical up, Overhead

**Deposition Rates:**

Diameter (mm)	Length (mm)	Weldmetal/ Electrode	Electrodes per lb (kg) of Weldmetal	Arc Time of Deposition min/lb (kg)	Amperage Settings
1/8 (3.25)	14" (350)	.8 oz. (22g)	20 (45)	25 (54)	115
5/32 (4.0)	14"(350)	1.1 oz (32g)	14 (31)	16 (36)	155
3/16 (5.0)	14" (350)	1.6 oz (45g)	10 (22)	13 (28)	185

## APPROXIMATE ELECTRODE PACKAGING & DIMENSIONS

Diameter (mm)	1/8 (3.25)	5/32 (4.0)	3/16 (5.0)
Length (mm)	14" (350)	14" (350)	14" (350)
Electrodes / lb	12	7	5
Electrodes / kg	27	15	11

# HWS Ni Cast 98

*For Cast Iron*

## Classification

AWS A 5.15 : ENi-CI  
DIN 8573 : E Ni BG 23

## Approvals

TIS

## Applications

Welding and filling up of cavities of cast iron products.

## Characteristics

HWS Ni Cast 98 is a graphite type electrode with a pure nickel core wire. Weld metal is not so hard and is easily machined. Arc is stable and slag is easy to remove. No preheating is required in general.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Ni
0.5	0.5	0.5	≤0.020	≤0.010	98.0

## Typical Tensile Strength & Hardness of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Vickers (HV)	Share	Heat Treatment
430 (43)	193	28	As welded

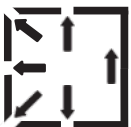
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350
Welding Position	Current (A)		
F	60~80	70~110	110~150
V, OH	50~70	80~100	120~140

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 80~120°C for 60 minutes before use.
2. Remove degenerated layer completely and avoid continuous welding.
3. Deposit short runs and give hot peening at each bead.
4. Preheating and postheating are not necessary in general. However, preheating at 100~200°C is required for a structure which is apt to cause stress cracks.

## Welding Positions



*All positions, except vertical down*

# HWSNi Cast 55

*For Cast Iron*

## Classification

AWS A 5.15 : ENiFe-CI  
DIN 8573 : E NiFe BG 23

## Approvals

TIS

## Applications

Welding of normal cast irons and ductile cast irons.

## Characteristics

HWSNi Cast 55 is a graphite type electrode. Its Fe-Ni composite wire assures no excessive heating of electrode and no change of operational characteristics during welding. Deposited metal shows excellent mechanical properties and crack resistance.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Ni
≤1.0	≤1.0	≤1.0	≤0.020	≤0.020	48~65

## Typical Tensile Strength & Hardness of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Vickers (HV)	Share	Heat Treatment
450 (46)	173	25	As welded

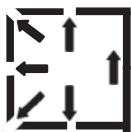
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350
Welding Position	Current (A)		
All	60~90	100~140	150~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 80~120°C for 60 minutes before use.
2. Preheating and postheating are not necessary in general. However, preheating at 100~200°C is required for a structure which is apt to cause stress cracks.

## Welding Positions



*All positions, except vertical down*



# HWS Free Ni

*For Cast Iron*

## Classification

AWS A 5.15 : ~ ESt

## Applications

For welding, surfacing, and joining of cast iron to mild and low carbon steel. It is suitable for most repair jobs and is recommended to repair defects and cracks in foundries.

## Characteristics

HWS Strongcast is a basic electrode that has mild steel core wire and is specially designed for cold welding of cast iron. The electrode is especially suitable for very dirty castings, but it gives non-machineable weld deposits which provide an excellent colour match and rust the cast iron. It is best used for non-critical applications.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.10	0.38	0.72	0.011	0.008

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %
490 (50)	33

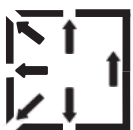
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/400
Welding Position	Current (A)		
All	70 ~ 110	100 ~ 140	150 ~ 180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 80 ~ 120°C for 60 minutes before use.
2. A preheating of 450 ~ 500°C should be uniformly applied to the casting and after welding it should be allowed to cool very slowly.

## Welding Positions



*All positions, except vertical down*

# HWS 9015-B3

*For Creep Resisting Steel*

## Classification

AWS A 5.5 : E9015-B3  
ISO 3580 : E 2 CrMo B 20

## Applications

Welding of creep resisting steels alloyed with 2.25% Cr and 1% Mo, such as 10CrMo9 10, and it is also recommended for welding GS-17 CrMoV5 11 steel.

## Characteristics

HWS9015-B3 is a basic-coated hydrogen controlled electrode for welding in all positions. The chemical composition of the weld metal guarantees a low sensitive to solidification cracking, a result of Mn/Si > 2:1 control. The weld metal fulfills the requirements of the step cooling test.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Mo
0.05~0.10	≤0.45	0.50~0.90	≤0.025	≤0.020	2.00~2.50	0.90~1.20

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -20°C, J (kgf.m)	Heat Treatment
≥ 620 (≥ 63)	≥ 530 (≥ 54)	≥ 17	≥ 47 (≥ 4.8)	675~705°C x 1h

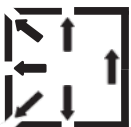
## Sizes & Recommended Current Range (DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
All	65~95	90~130	125~165	190~220

## Guideline in Usage

1. Use dry electrodes only. Re-bake, when necessary, to obtain ≤ 5 ml H<sub>2</sub>/100g at 400~420°C for 1 hour. For ≤ 10 ml H<sub>2</sub>/100g, re-bake at 350~370°C. Do not re-bake electrodes more than 5 times. Store in holding oven at 120~150°C.
2. Use short arc. A minimum preheat and interpass temperature of 165~190°C is recommended for all material thickness.

## Welding Positions



*All positions, except vertical down*

# HWS 8018-B2

*For Cr-Mo Creep Resisting Steel*

## Classification

AWS A 5.5 : E8018-B2  
DIN 8575 : E CrMo 1 B 20  
ISO 3580 : E 1 CrMo B 20

## Applications

Welding of creep resisting steels of Cr-Mo type, e.g. BS 1501-620, 621 equivalent castings and forging.

## Characteristics

HWS8018-B2 is a basic coated hydrogen controlled electrode for low alloy and creep resisting Cr-Mo steels. Maximum operation temperature is 550°C. Suitable for welding of thick steam pipe and repairing of cast steel. Low spatter loss, ready slag detachment.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Mo
0.10	0.40	0.80	≤0.020	≤0.020	1.20	0.50

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
700 (71)	550 (56)	20	40 (4.1)

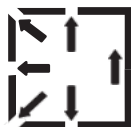
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	60~90	90~130	140~180	190~230
V, OH	60~90	80~110	110~150	130~170

## Guideline in Usage

1. Use dry electrodes only.
2. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
3. Keep the arc short as possible.
4. Preheating at 200~250°C and stress relieving at 620°C are required. DC welding by preference.

## Welding Positions



*All positions, except vertical down*

# HWS 7018-A1

*For C-Mo Creep Resisting Steel*

## Classification

AWS A 5.5 : E7018-A1  
DIN 8575 : E Mo B 20

## Applications

Welding of creep resisting steels of C-0.5% Mo type, e.g. ASTM A204, A209, A250 (all grades), A335P1, A369 FP1, A533A, etc.

## Characteristics

HWS7018-A1 is a basic coated hydrogen controlled electrode for welding low alloy and creep-resisting Mo-steels. Suitable for boiler, storage vessel and pipeline construction; for service temperatures up to 525°C. Low spatter loss, ready slag detachment.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Mo	P	S
0.07	0.50	0.80	0.50	≤0.020	≤0.020

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)
595 (61)	485 (50)	23	140 (14.3)

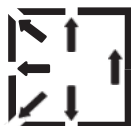
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	60~90	90~140	140~180	190~230
V, OH	60~80	80~120	120~160	-

## Guideline in Usage

1. Use dry electrodes only.
2. Damp electrodes should be re-dried at 350°C for 60 minutes before use.

## Welding Positions



*All positions, except vertical down*

# HWS 9015-B9

*High Purity Electrode For Creep Resisting Steel*

## Classification

AWS A 5.5 : E9015-B9

## Applications

Welding of creep resisting steels alloyed with 9%Cr and 1% Mo. This type of steel is mainly employed for construction and equipment used at high operating temperatures, such as modified creep resisting steel P91/T91.

## Characteristics

HWS 9015-B9 is a basic coated hydrogen controlled electrode for welding in all positions. By using a high purity raw materials in combination, this electrode is preferred for the high purity of deposited weld metal, excellent weldability and mechanical properties.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Cr	Ni	Mo	V
≤0.10	≤0.30	0.60~1.00	≤0.010	≤0.010	8.0~10.0	0.50~0.90	0.85~1.20	0.15~0.30

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)	Heat Treatment
≥ 620 (≥ 63)	≥ 530 (≥ 54)	≥ 17	≥ 55 (≥ 5.6)	760°C x 2h

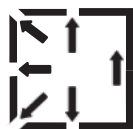
## Sizes & Recommended Current Range (DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400
Welding Position	Current (A)		
All	70~100	90~135	130~200

## Guideline in Usage

1. Use dry electrodes only. Re-bake, when necessary at 400~420°C for 60 minutes before use.
2. It is advisable for the welder not to expose to the atmosphere more electrode than will be needed for 2 hours of welding, at the same time keep the remainder in an oven at 120~150°C.
3. Use short arc. Preheat and interpass temperature 150~260°C is recommended for all material thicknesses.

## Welding Positions



*All positions, except vertical down*

# HWS 11016G

For 780 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.5 : E11016-G  
JIS Z 3211 : E7816-N5CM3U

## Applications

Welding of 780 N/mm<sup>2</sup> high tensile strength steels (WEL-TEN 780, 780C, 780P, 780E) for penstocks, pressure vessels, bridges, machinery and turbine casings.

## Characteristics

L-80 is an extra low hydrogen type electrode with high resistance to moisture absorption. Weldability in all positions, mechanical properties and X-ray quality are excellent. Extremely low diffusible hydrogen content in deposited metal assures satisfactory crack resistance.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Ni	Cr	Mo
0.05	0.44	1.35	2.52	0.18	0.54

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -20°C, J (kgf.m)
830 (85)	740 (75)	24	96 (9.8)

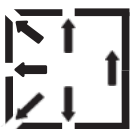
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	100~140	140~190	190~250
V, OH	90~130	120~170	140~190

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350~400°C for 60 minutes before use, kept at 100~150°C and taken out only as needed.
2. Preheating in accordance with the type of steel, plate thickness, restraint, etc., i.e. at 120~180°C for a 35 mm thick plate, is necessary to prevent cracks.
3. Welding with excessively high heat input, i.e. more than 45 kJ/cm for a 35 mm thick plate, should be avoided to assure strength and toughness of weld.

## Welding Positions



All positions, except vertical down

# HWS 9016G

For 590 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.5	: E9016-G
JIS Z 3211	: E6216-G
EN 499	: E 55 2 1Ni B 1 2 H5

## Applications

Welding of SPV 490 and 590 N/mm<sup>2</sup> high tensile strength steels (WEL-TEN 610) for penstocks, storage tanks, pressure vessels, bridges, off-shore structures and machinery.

## Characteristics

HWS L-62 is an extra low hydrogen type electrode with high resistance to moisture absorption. Weldability in all positions, mechanical properties and X-ray quality are excellent. Extremely low diffusible hydrogen content in deposited metal assures satisfactory crack resistance.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Ni	Mo
0.07	0.48	1.39	0.76	0.35

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -10°C, J (kgf.m)
670 (68)	600 (61)	31	170 (17.3)

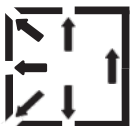
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	100~140	140~190	190~250
V, OH	90~130	120~170	140~190

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350~400°C for 60 minutes before use.
2. Preheating in accordance with the type of steel, plate thickness, restraint, etc., i.e. at 50~100°C for a 35 mm thick plate, is necessary to prevent cracks.
3. Welding with excessively high heat input, i.e. more than 55 kJ/cm for a 35 mm thick plate, should be avoided to assure strength and toughness of weld.

## Welding Positions



All positions, except vertical down

# HWS 8016G

For 590 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.5	: E8016-G
JIS Z 3211	: E5916-N1M1U
EN 499	: E 50 2 1Ni B 1 2 H5

## Applications

Welding of SM 570, SPV 450 and 590 N/mm<sup>2</sup> high tensile strength steels (WEL-TEN 590) for penstocks, storage tanks, pressure vessels, bridges, off-shore structures and machinery.

## Characteristics

HWS L-60 is an extra low hydrogen type electrode with high resistance to moisture absorption. Weldability in all positions, mechanical properties and X-ray quality are excellent. Deposited metal shows satisfactory crack resistance due to its extremely low diffusible hydrogen content.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	Ni	Mo
0.07	0.42	1.12	0.73	0.22

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -10°C, J (kgf.m)
640 (65)	540 (55)	29	180 (18.4)

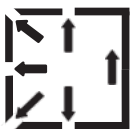
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)		
F	100~140	140~190	190~250
V, OH	90~130	120~170	140~190

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 350~400°C for 60 minutes before use.
2. Preheating in accordance with the type of steel, plate thickness, restraint, etc., i.e. at 50~100°C for a 35 mm thick plate, is necessary to prevent cracks.
3. Welding with excessively high heat input, i.e. more than 55 kJ/cm for a 35 mm thick plate, should be avoided to assure strength and toughness of weld.

## Welding Positions



All positions, except vertical down



# HWS 8010G

For 590 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.5 : E8010-G

## Applications

Welding of API 5LX, 5LS, X65~X70 pipes.

## Characteristics

HWS 8010 is a high cellulose type electrode for all positions welding. Stovepipe welding of line pipes is especially easy. X-ray quality and mechanical properties of deposited metal are excellent.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Ni	Mo
0.13	0.18	0.53	0.013	0.011	0.53	0.17

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -29°C, J (kgf.m)
630 (64)	550 (56)	27	110 (11.2)

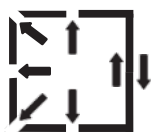
## Sizes & Recommended Current Range (DC +)

Diameter/ Length (mm)	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)		
F, V-down	70~110	120~160	180~220
V-up, OH	60~100	110~150	150~190

## Guideline in Usage

1. Use dry electrode only.
2. Care should be taken for storing since coating flux contains more organic matter than normal electrodes and is apt to absorb moisture. Damp electrodes should be re-dried at 80°C for 60 minutes before use.

## Welding Positions



All positions

# HWS 7016

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.1	: E7016
DIN 1913	: E 51 54 B(R) 10
EN 499	: E 46 2 B 12 H5
ISO 2560	: E 51 5 B 26 (H)
JIS Z 3211	: E4916U

## Approvals

ABS, BV, NK

## Applications

Welding of 490 N/mm<sup>2</sup> high tensile strength steels for constructures, pressure vessel industry, shipbuilding and bridges.

## Characteristics

HWS L-59 is a low hydrogen type electrode for all positions welding. Smooth arc, easy slag removal and provide good weld appearance. High performance X-ray quality and excellent mechanical properties.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Diffusible H <sub>2</sub>
0.08	0.59	1.11	0.010	0.008	≤ 5 ml/100 g

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
580 (59)	490 (50)	31	0°C 200 (20.4) -20°C 173 (17.6) -49°C 134 (13.7)

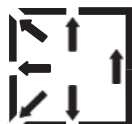
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
All	60~100	80~140	110~180	130~240

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Backstep method should be applied to prevent blowholes and pits at arc starting and arc length should be kept as short as possible during welding.
3. Completely removed all water, rust and oil in groove to prevent cracks and blowholes.

## Welding Positions



All positions, except vertical down

# HWS L-7016

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.1	: E7016
JIS Z 3211	: E4916U
DIN 1913	: E 51 3 3 B(R) 10
EN 499	: E 42 2 B 12 H5

## Approvals

ABS, BV, DNV, LR, NK, TIS

## Applications

Welding of 490 N/mm<sup>2</sup> high tensile strength steels for ships, structures and bridges.

## Characteristics

HWS L-55 is a low hydrogen type electrode for all positions welding. Deposited metal shows excellent crack resistance, mechanical properties and X-ray quality. Vertical and overhead welding are very easy.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Diffusible H <sub>2</sub>
0.07	0.62	1.18	0.011	0.008	≤ 5 ml/100 g

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
550 (56)	480 (49)	32	0°C 190 (19.4) -20°C 170 (17.3)

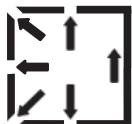
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	70~100	100~140	150~190	190~240
V-up, OH	60~90	80~120	110~150	130~170

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes.
2. Backstep method should be applied to prevent blowholes and pits at arc starting and arc length should be kept as short as possible during welding.
3. All water, rust and oil in groove should be completely removed to prevent cracks and blowholes.

## Welding Positions



All positions, except vertical down

# HWS L-7016W

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.1 : E7016  
EN 499 : E42 2 B 1 2 H5

## Approvals

ABS

## Applications

One side welding of pipes and general welding of 490 N/mm<sup>2</sup> high tensile strength steels for ships, and pressure vessels.

## Characteristics

HWS L-55W is a low hydrogen type electrode for one side welding in all positions. In low current range in root pass welding of pipes, a sound penetration bead free from blow-holes is obtained due to stable arc, strong arc force, and excellent slag fluidity and coverage.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Diffusible H <sub>2</sub>
0.07	0.63	0.92	0.012	0.010	≤ 5 ml/100 g

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch J (kgf.m)
580 (59)	500 (51)	31	0°C, 150 (15.3) -49°C, 102 (10.4)

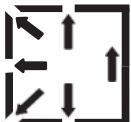
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	50~100	90~140	120~180	120~220
V, OH	40~80	80~120	100~160	140~200
One Side Welding	40~80	60~110	80~140	-

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. DC (-) should be used for one side welding.
3. 3.2 mm. diameter electrode is recommended for all positions welding of pipes with 6~15 mm. wall thickness.
4. Arc should started on a small plate or the side of the groove and cut after moving crater to the side of the groove.

## Welding Positions



All positions, except vertical down

# HWS 7018

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.1 : E7018  
JIS Z 3211 : E4918

## Approvals

ABS, BV, LR

## Applications

Welding of 490 N/mm<sup>2</sup> high tensile strength steels for ships, steel frames, bridges and pressure vessels.

## Characteristics

HWS 7018 is an iron powder low hydrogen type electrode containing a large amount of iron powder in coating flux. Deposited metal gives excellent mechanical properties, crack resistance and X-ray quality. Weldability is good and high welding efficiency is obtained.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.08	0.57	0.92	0.013	0.010

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -29°C J (kgf.m)
530 (54)	460 (47)	33	110 (11.2)

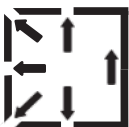
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/400	5.0/450
Welding Position	Current (A)			
F	70~100	100~140	150~200	190~240
V, OH	60~90	80~120	120~160	140~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Backstep method should be applied to prevent blowholes and pits at arc starting and arc length should be kept as short as possible during welding.
3. All water, rust and oil in groove should be completely removed to prevent cracks and blowholes.

## Welding Positions



All positions, except vertical down

# HWS 7028

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.1 : E7028

## Applications

Flat and horizontal fillet welding of 490 N/mm<sup>2</sup> high tensile strength steels for ships, machinery, rolling stock, bridges and steel frames.

## Characteristics

HWS 7028 is an iron powder low hydrogen type electrode for flat and horizontal fillet welding and assures high efficiency due to its high deposition rate. A sound bead free from pits is obtained even on a plate with primer, although its shape is slightly convex in horizontal fillet welding. Deposited metal shows excellent mechanical properties and crack resistance. It also is suitable for multi-layer fillet welding and gravity welding.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.06	0.56	1.03	0.011	0.008

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C J (kgf.m)
540 (55)	440 (45)	31	100 (10)

## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	4.0/400,450	5.0/450,700
Welding Position	Current (A)	
F, H-Fil	160~200	200~250
Leg Length (mm)	4.5~5.5	5.5~6.5

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 300~350°C for 60 minutes before use.
2. Backstep method should be applied to prevent blowholes and pits at arc starting and arc length should be kept as short as possible during welding.
3. Optimum bead length/burned up electrode length ratio for gravity welding is 0.9~1.1.

## Welding Positions



*Flat butt and fillet welds only*

# HWS 7024

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.1 : E7024  
DIN 1913 : E51 32 RR 11 160

## Approvals

BV, LR

## Applications

All downhand welding work when high welding speed is sought: fillet welds or lap joints, for its higher deposition rate, the welding of high efficiency is attained when it is used in combination with a gravity welder or small angle welding apparatus. This electrode is particularly recommended for welding of sheet steels, naval and railroad construction, pipes boiler making, machine welding, etc.

## Characteristics

HWS7024 is a rutile iron powder electrode combining a recovery of approximately 160% with fast burn off to give very good deposition rates. Other characteristics include self-lifting slag, smooth arc, with very little nonadherent spatters, instantaneous striking and re-striking, smooth bead appearance with fine neat ripples.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
≤0.12	0.25~0.50	0.50~0.90	≤0.030	≤0.030

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C J (kgf.m)
480~550 (49~56)	430~500 (44~51)	≥22	≥55 (≥5.6)

## Sizes & Recommended Current Range (AC or DC -)

Diameter/ Length (mm)	3.2/350	4.0/400	5.0/450,700
Welding Position	Current (A)		
F, H-Fil	120~180	180~220	200~270

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 70~120°C for 60 minutes before use.
2. If coating flux absorbs excessive moisture, arc and slag fluidity become unstable, spatters increase, undercuts and blowholes are apt to occur.
3. Optimum bead length/burned up electrode length ratio is 0.8~1.8 for manual welding and 1.0~1.8 for gravity welding.

## Welding Positions



*Flat butt and fillet welds only*

# HWS 7010

For 490 N/mm<sup>2</sup> High Tensile Strength Steel

## Classification

AWS A 5.5 : E7010-G

## Applications

Welding of 490 N/mm<sup>2</sup> high tensile strength steels for structures, rolling-stocks, and API 5LX, 5LS X52~X65 pipes.

## Characteristics

HWS7010 is a high cellulose type electrode for all positions welding. Stovepipe welding of lines pipes is especially easy. X-ray quality and mechanical properties of deposited metal are excellent.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S	Mo
0.10	0.18	0.50	0.011	0.012	0.26

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -29°C, J (kgf.m)
570 (58)	470 (48)	27	70 (7.1)

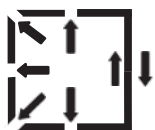
## Sizes & Recommended Current Range (DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F, V-down	50~80	70~110	120~160	160~200
V-up, OH	40~70	60~100	110~150	130~170

## Guideline in Usage

1. Use dry electrodes only.
2. Care in storing is especially needed since coating flux contains more organic matter than normal electrodes and is apt to absorb moisture. Damp electrodes should be re-dried at 80°C for 60 minutes.

## Welding Positions



All positions



# HWS S-13

*For Mild Steel*

## Classification

AWS A 5.1 : E6013  
JIS Z 3211 : E4313

## Applications

Welding of mild steel sheets, pipes and light gauges for drums and structures.

## Characteristics

HWS S-13Z is a high rutile type electrode for all positions welding. Special characteristics are soft arc, less spatter, self-lifting slag, shiny and beautiful beads. There is no fear of burning through. Welding in vertical downward and inclined positions is possible with electrodes of 3.2 mm or less.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.07	0.31	0.35	0.019	0.013

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
500 (51)	450 (46)	28	65 (7.0)

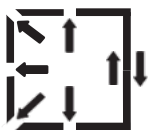
## Sizes & Recommended Current Range (AC or DC ±)

Diameter/ Length (mm)	2.0/300	2.6/300, 350	3.2/350, 400	4.0/400	5.0/400
Welding Position	Current (A)				
F	30~60	50~100	80~130	130~180	170~240
V, OH	30~60	50~90	60~110	100~160	120~200

## Guideline in Usage

1. Use dry electrodes only.
2. If coating flux absorbs excessive moisture, arc and slag fluidity become unstable, spatters increase, undercuts and blowholes are apt to occur. Damp electrodes should be re-dried at 70~120°C for 60 minutes.

## Welding Positions



*All positions*

# HWS 6011

*For Mild Steel*

## Classification

AWS A 5.1 : E6011

## Applications

Welding of mild steels for rolling-stocks, structures, and pipes.

## Characteristics

HWS 6011 is a high cellulose type electrode. Arc force is strong and penetration is deep. Since it produces little slag which is easily removed, it is especially suitable for narrow grooves, vertical and overhead positions on site. Also, vertical downward of butt joints of pipes and sheets are easily and efficiently performed.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.08	0.11	0.43	0.015	0.013

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
460 (47)	400 (41)	29	76 (7.8)

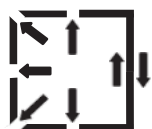
## Sizes & Recommended Current Range (AC or DC +)

Diameter/ Length (mm)	2.0/250	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)				
F	40~60	50~80	70~110	120~160	160~200
V, OH	30~50	40~70	60~100	110~150	130~170

## Guideline in Usage

1. Use dry electrodes only.
2. Care in storing is especially needed since coating flux contains large amount of organic matter and is apt to absorb moisture. Damp electrodes should be re-dried at 80°C for 60 minutes.
3. Excessively high current and wide weaving deteriorate X-ray quality. Use optimum current and limit weaving width to within 2.5 times electrode diameter.

## Welding Positions



*All positions*

# HWS 6010

*For Mild Steel*

## Classification

AWS A 5.1 : E6010

## Applications

Welding of mild steels for structures, rolling-stocks and API 5L, A, B, 5LX X42~X52.

## Characteristics

HWS 6010 is a high cellulose type electrode for all positions welding. "Stovepipe" welding of linepipes is especially easy and X-ray quality is excellent.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.09	0.20	0.50	0.017	0.010

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at -29°C, J (kgf.m)
490 (50)	450 (46)	29	64 (6.5)

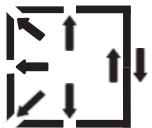
## Sizes & Recommended Current Range (DC +)

Diameter/ Length (mm)	2.6/300	3.2/350	4.0/350	5.0/350
Welding Position	Current (A)			
F	50~80	70~110	120~160	160~200
V, OH	40~70	60~100	110~150	130~170

## Guideline in Usage

1. Use dry electrodes only.
2. Care in storing is especially needed since coating flux contains more organic matter than normal electrodes and is apt to absorb moisture. Damp electrodes should be re-dried at 80°C for 60 minutes.

## Welding Positions



*All positions*

# HWS FT-51 RB56 *For Mild Steel*

## Classification

AWS A 5.1 : E6013  
JIS Z 3211 : E4313 *All positions*

## Approvals

ABS, BV, DNV, LR, TIS

## Applications

Welding of mild steel sheet for ships, rolling-stocks, structures, and finished welding of heavy structural works.

## Characteristics

HWS FT-51 is a high rutile type electrode for all positions welding and assures easy operation even in vertical downward position. Spatters are less and bead appearance is beautiful. Shallow penetration minimizes distortion in the welding of thin plates.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.08	0.33	0.42	0.014	0.013

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
510 (52)	460 (47)	28	60 (6.1)

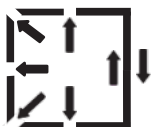
## Sizes & Recommended Current Range (AC or DC ±)

Diameter/ Length (mm)	2.0/300	2.6/350	3.2/350	4.0/400	5.0/400
Welding Position	Current (A)				
F	30~70	50~100	60~130	110~170	150~220
V-down	30~70	50~100	60~130	110~170	150~220
V, OH	30~70	50~100	60~130	100~150	130~190

## Guideline in Usage

1. Use dry electrodes only.
2. If coating flux absorbs excessive moisture, arc and slag fluidity become unstable, spatters increase, undercuts and blowholes are apt to occur. Damp electrodes should be re-dried at 70~120°C for 60 minutes.
3. For inclined and vertical downward positions, touch electrode tip lightly to the base metal and deposit a stringer bead with electrode slope 40~80° .

## Welding Positions



*All positions*

# HWS BT-52

*For Mild Steel*

## Classification

AWS A 5.1 : E6013  
DIN 1913 : E 43 22R (C)3

## Approvals

ABS, LR, TIS

## Applications

Welding of unalloyed structural steels St 33, St 37, St 44, St 52.3 boiler plate HI, HII, pipe steels USI 37.0, St 37.4, St 44.0, St 52.0, St 52.4, St 35.8, St E 210.7, cast steels GS-38, GS-45.

## Characteristics

HWS BT-52 is a rutile-cellulosic type electrode for a wide variety of mild steel fabrication and assembly application. Ideally suited for welding in the vertical-downward position where it produces slightly concave welds merging smoothly into the base metal without any undercutting. Due to its excellent all positions operability and weld pool control, it is preferably used for welding sheet metal containers, storage vessels, and oil tanks. In assembly work, it is possible to apply the same current setting in all positions. The slag comes off very easily as in most cases self-releasing. Welding bead appearance is smooth with fine ripple formation. Also use with welding transformers having a low O.C.V. (42V).

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.08	0.36	0.52	0.017	0.015

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 20°C, J (kgf.m)
498 (51)	390 (40)	25	66 (6.7)

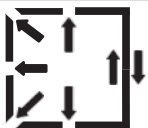
## Sizes & Recommended Current Range (AC or DC ±)

Diameter/ Length (mm)	2.6/350	3.2/350	4.0/400	5.0/400
Welding Position	Current (A)			
All	60~85	90~130	140~180	180~240

## Guideline in Usage

1. Use dry electrodes only.
2. If coating flux absorbs excessive moisture, arc and slag fluidity become unstable, spatters increase, undercuts and blowholes are apt to occur. Damp electrodes should be re-dried at 70~120°C for 60 minutes.

## Welding Positions



*All positions*

# HWS RU

*For Mild Steel*

## Classification

AWS A 5.1 : E6013

## Approvals

LR

## Applications

Welding of thin to medium thick plates mild steel in general fabrication.

## Characteristics

HWS RU is a rutile coated general purpose mild steel electrode for a wide range in all positions welding. Easy striking and re-striking make the electrode very suitable for tack-welding. Beautiful bead appearance with soft arc and stable slag fluidity. Operation is especially easy on AC with low O.C.V.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
≤ 0.10	0.20~0.40	0.30~0.60	≤ 0.030	≤ 0.025

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 29°C, J (kgf.m)
510 (52)	480 (49)	24	50 (5.1)

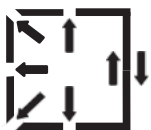
## Sizes & Recommended Current Range (AC or DC ±)

Diameter/ Length (mm)	2.0/250	2.6/350	3.2/350	4.0/350
Welding Position	Current (A)			
All	40~55	50~90	80~135	100~180

## Guideline in Usage

1. Use dry electrodes only. Damp electrodes should be re-dried at 80°C for 60 minutes before use.
2. Suitable for temperature of -10°C to +350°C.
3. Rust, mill scale, zinc, primers, etc. have to be removed.
4. YAWATA RU will operate on AC with low O.C.V.

## Welding Positions



*All positions*

# HWS 6019

*For Mild Steel*

## Classification

AWS A 5.1 : E6019  
JIS Z 3211 : E4319

## Approvals

ABS, BV, LR

## Applications

Welding of mild steels for ships, machinery, rolling-stocks, structures, and bridges.

## Characteristics

HWS G-300 is an ilmenite type electrode with an excellent weldability especially in vertical upward position. Beautiful bead appearance free from defects such as incomplete penetration and undercuts is obtained since manipulation is easy, due to smooth flow of slag round to the front of weld and even solidification of molten metal. Deposited metal shows good impact properties and ductility.

## Typical Chemical Composition of Deposited Metal (%)

C	Si	Mn	P	S
0.08	0.13	0.53	0.018	0.010

## Typical Mechanical Properties of Deposited Metal

Tensile Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Yield Strength N/mm <sup>2</sup> (kgf/mm <sup>2</sup> )	Elongation %	Charpy 2V-notch at 0°C, J (kgf.m)
460 (47)	400 (41)	32	110 (11.2)

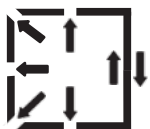
## Sizes & Recommended Current Range (AC or DC ±)

Diameter/ Length (mm)	2.6/300	3.2/350, 400	4.0/400, 450	4.5/450	5.0/450
Welding Position	Current (A)				
F	50~110	80~150	130~190	160~220	180~260
V, OH	40~90	60~120	100~160	120~180	140~210

## Guideline in Usage

1. Use dry electrodes only.
2. If coating flux absorbs excessive moisture, arc and slag fluidity become unstable, spatters increase, undercuts and blowholes are apt to occur. Damp electrodes should be re-dried at 70~120°C for 60 minutes.
3. Excessively high current and wide weaving deteriorate X-ray quality. Use optimum current and limit weaving width to within 2.5 times electrode diameter.

## Welding Positions



*All positions*