Section D : NICKEL BASE ALLOYS

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NICKEL BASE CONSUMABLES

As a whole, nickel-base consumables have a very wide range of applications. They can be roughly divided into those with compositions matching specific parent materials, usually for corrosion resistance, and those with compositions unique to weld metal specifications some of which have specialised uses and others more general purpose applications.

Electrode characteristics vary according to the intended application and the constraints dictated by particular alloys.
Most types have basic flux coverings, those with the suffix KS being suitable for positional welding of fixed pipework. Rutile flux systems are compatible with some of the high molybdenum corrosion-resistant alloys. A low level of impurities is desirable in all cases to minimise sensitivity to hot cracking and microfissuring.

The most important general purpose group are the 'Inconel' types, very loosely based on heat-resistant alloy 600 with 15%Cr-75%Ni-8%Fe. Compared with alloy 600, all these weld metals have significant additions of manganese and niobium which give resistance to hot cracking and raise hot strength. **Nimrod 182/182KS** have the highest manganese to maximise resistance to hot cracking, whereas in **Nimrod AB/AKS** manganese is partially replaced by molybdenum which has the additional effect of improving creep resistance. In many applications these two types can be used interchangeably, particularly in dissimilar metal welds between nickel base and most steels or other ferrous alloys. Useful service properties range from cryogenic up to elevated temperatures of 1000°C plus. Related to these is the more specialised heat resisting type **Nimrod 132KS** used primarily for welding 600 and similar materials in cast or wrought form.

Nimrod 625/625KS electrodes and **62-50** wires are designed to match alloy 625 which was originally developed for heat-resisting applications. However, parent material and consumables of this alloy have gained more widespread use for many applications exploiting its excellent pitting and crevice corrosion resistance and high strength at all service temperatures.

Electrode types **Nimrod C276KS, C22KS and Nimax B2L** and complimentary solid wires match the current specifications for corrosion-resistant parent alloys C276, C22 and B2 respectively. Also related to this group is the higher alloy **Nimrod 59KS**, matching alloy 59. Their uses include overmatching welds for various superaustenitic stainless steels.

The precursor to alloy C276 was alloy C which is represented by rutile electrodes **Nimrod C** and the high efficiency type **Nimax** C. Their general corrosion resistance is useful for overlays and high work-hardening rate and thermal fatigue resistance for build-up and repair of hot-work dies.

Nickel, nickel-copper (Monel®) and cupronickel consumables are well established for use in high integrity fabrication welds between their respective parent alloys. For surfacing steels or dissimilar welds it should be noted that tolerance to iron dilution decreases with increasing copper content and the pure nickel type is therefore used as a buffer layer.

DataSheet	Alloy	Process	Product	AWS Classifications	EN / EN ISO Classifications
D-10	182	MMA	Nimrod 182KS	ENiCrFe-3	E Ni6182
			Nimrod 182	ENiCrFe-3	E Ni6182
			Nimax 182	ENiCrFe-3	E Ni6182
		TIG/MIG/SAW	20.70.Nb	ERNiCr-3	SNi6082
D-11	AB	MMA	Nimrod AKS	ENiCrFe-2	E Ni 6133
		TIG/MIG/SAW	20.70.Nb	ERNiCr-3	S Ni 6082
D-12	132	MMA	Nimrod 132KS	ENiCrFe-1	E Ni6062
D-20	625	MMA	Nimrod 625	ENiCrMo-3	E Ni 6625
			Nimrod 625KS	ENiCrMo-3	E Ni 6625
		TIG/MIG/SAW	62-50	ERNiCrMo-3	SNi6625
		FCW	Supercore 625P	ENiCrMo3T1-4	T Ni 6625 P M/C 2

DataSheet	Alloy	Process	Product	AWS Classifications	EN / EN ISO Classifications
D-30	C276	MMA	Nimrod C276KS	ENiCrMo-4	E Ni6276
		TIG/MIG/SAW	HAS C276	ERNiCrMo-4	SNi6276
D-31	59	MMA	Nimrod 59KS	ENiCrMo-13	E Ni6059
		TIG/MIG	HAS 59	ERNiCrMo-13	SNi6059
D-32	C22	MMA	Nimrod C22KS	ENiCrMo-10	SNi6022
		TIG/MIG	HAS C22	ERNiCrMo-10	E Ni6117
D-33	9% Nickel	FCW	SUPERCORE 620P	-	-
D-40	617	MMA	Nimrod 617KS	ENiCrCoMo-1	E Ni6117
		TIG/MIG	61-70	ERNiCrCoMo-1	SNi2061
D-41	690	MMA	Nimrod 690KS	ENiCrFe-7	E Ni 6152
		TIG/MIG	ER690	ERNiCrFe-7	S Ni6052
D-50	Nickel	MMA	Nimrod 200Ti	ENi-1	E Ni2061
		TIG/MIG	Nickel 2Ti	ERNi-1	SNi6617
D-60	Monel	MMA	Nimrod 190	ENiCu-7	E Ni4060
		TIG/MIG/SAW	65NiCu	ERNiCu-7	SNi4060
D-70	Cupronickel	MMA	Cupromet N30	ECuNi	-
		TIG/MIG	70CuNi	ERCuNi	BS: C18
		TIG	90CuNi	-	BS C16
D-80	B2	MMA	Nimax B2L	ENiMo-7	E Ni1066
D-87	Dissimilar	MMA	EPRI P87	-	-
		TIG	EPRI P87	-	-
E-45	C	MMA	Nimax C	(ENiCrMo-5)	DIN: E23-UM-200CKT

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NICKEL BASE 182 CONSUMABLES

ALLOY TYPE

Inconel™ type consumables with manganese and niobium additions.

MATERIALS TO BE WELDED

Nickel alloys such as Inconel™ 600, Nimonic 75. Nickel base alloys to themselves and to mild, low alloy and stainless steels. High temperature transition joints. Cryogenic 3% and 5% Ni steels.

APPLICATIONS

These weld metals have no directly equivalent parent material, although the composition is related to Inconel™ 600. Mn and Nb are added to give high resistance to hot cracking, tolerance to dilution by many combinations of nickel-base and ferrous alloys, with stable properties over a wide range of service temperatures from –269°C to above 900°C.

Applications include heat-resisting nickel-base alloys to themselves for use in **furnace equipment** up to about 900°C. Other applications include:

Mixed welds between most nickel-base alloys, including Monel 400 and stainless, low alloy or CMn steels without need to preheat.

Transition welds between creep-resisting ferritic and austenitic steels, such as 2CrMo and 316H for long term service at elevated temperature in petrochemical and power generation plants.

Low temperature applications such as 3% or 5% Ni steels used for cryogenic vessels and pipework in service at or below –100°C.

Stress relief may be carried out if required.

MICROSTRUCTURE

High nickel austenite with some carbides.

WELDING GUIDELINES

Requirements for preheat and PWHT will be dependent on the base material being welded. For most nickel-base materials, no preheat is required.

RELATED ALLOY GROUPS

The AB alloys (data sheet D-11) cover similar applications.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 182KS**	AWS ENiCrFe-3
	Nimrod 182	AWS ENiCrFe-3
	Nimax 182	AWS ENiCrFe-3
TIG/MIG/SAW	**20.70.Nb**	AWS ERNiCr-3
SAW flux	**NiCr**	BS EN SA FB2

NIMROD 182KS

ALL-POSITIONAL INCONEL™ TYPE MMA ELECTRODE

PRODUCT DESCRIPTION

MMA electrode – This electrode is made on a nearly matching core wire with a basic flux system designed to produce optimum operability and radiographically sound weld metal.
Nimrod 182KS is optimised for DC+ welding in all positions including pipework qualified in the ASME 6G position.
Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrFe-3
BS EN ISO 14172	E Ni 6182
APPROVALS	TÜV

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Cu	Ti	Co *	Ta *
min.	--	5.0	--	--	--	13.0	61	1.0	2.0	--	--	--	--
max.	0.10	9.5	1.0	0.015	0.02	17.0	bal	2.5	9.0	0.50	1.0	0.12	0.30
Typical	0.05	7	0.5	0.01	0.01	16	~ 65	1.5	< 8	0.1	0.1	< 0.05	0.05

* Co and Ta maximums only when specified at time of order.

ALL-WELD MECHANICAL PROPERTIES

As-welded		Min.	Typical
Tensile strength (MPa)		550	640
0.2% proof strength (MPa)		360	385
Elongation (%)	4d	30	40
	5d	27	37
Reduction of area (%)		--	38
Impact ISO-V(J)	-196°C	--	100
Hardness (HV)		--	190

OPERATING PARAMETERS, DC +VE ONLY

Diameter (mm)	2.5	3.2	4.0	5.0
min. A	60	70	100	130
max. A	80	110	155	210

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0	5.0
Length (mm)	300	300	350	350
kg/carton	12.0	12.3	15.0	15.0
Pieces/carton	705	450	300	198

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 300°C/1-2h to restore to as-packed condition. Maximum 380° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Cr	Ni	Mo	Cu	F	OES (mg/m³)
2	13	5	10	0.2	0.1	15	1

NIMROD 182

INCONEL™ TYPE MMA ELECTRODE FOR DOWNHAND WELDING AND SURFACING

PRODUCT DESCRIPTION

MMA electrode – This electrode is made on a nearly matching core wire with a basic slag system designed to produce optimum operability and weld metal soundness for downhand/HV welding.
Optimised for DC+ operability primarily for surfacing and cladding applications.
Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrFe-3	(3.2mm will not necessarily satisfy 3G usability criteria)
BS EN ISO 14172	E Ni 6182	

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Cu	Ti	Co *	Ta *
min.	--	5.0	--	--	--	13.0	61	1.0	2.0	--	--	--	--
max.	0.10	9.5	1.0	0.015	0.02	17.0	bal	2.5	9.0	0.50	1.0	0.12	0.30
Typical	0.05	6	0.5	0.01	0.01	16	~ 65	1.5	< 8	0.1	0.1	< 0.05	0.05

* Co and Ta maximums only when specified at time of order.

ALL-WELD MECHANICAL PROPERTIES

As-welded		Min.	Typical
Tensile strength (MPa)		550	660
0.2% proof strength (MPa)		360	420
Elongation (%)	4d	30	40
	5d	27	37
Reduction of area (%)		--	38
Impact ISO-V(J)	-196°C	--	100
Hardness (HV)		--	190

OPERATING PARAMETERS, DC +VE

Diameter (mm)	3.2	4.0	5.0
min. A	70	100	130
max. A	110	155	210

PACKAGING DATA

Diameter (mm)	3.2	4.0	5.0
Length (mm)	300	350	330
kg/carton	12.0	14.1	14.1
Pieces/carton	375	249	165

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 300°C/1-2h to restore to as-packed condition. Maximum 380° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Cr	Ni	Mo	Cu	F	OES (mg/m³)
2	13	5	10	0.2	0.1	15	1

NIMAX 182

HIGH RECOVERY MMA ELECTRODE FOR CLADDING & SURFACING

PRODUCT DESCRIPTION

MMA electrode – high efficiency metal powder type with basic flux covering on high conductivity pure nickel core wire.
Nimax 182 is a high efficiency version of Nimrod 182KS, with versatile features for fabrication, repair and maintenance.
Recovery is about 140% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrFe-3
BS EN ISO 14172	E Ni 6182

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

PA/1G PB/2F PC/2G

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Cu	Ti
min.	--	5.0	--	--	--	13.0	61	1.0	2.0	--	--
max.	0.10	9.5	1.0	0.015	0.02	17.0	bal	2.5	9.0	0.50	1.0
Typical	0.06	6	0.4	0.008	0.01	15	~ 69	1.5	7	0.05	0.07

ALL-WELD MECHANICAL PROPERTIES

As-welded		Min.	Typical
Tensile strength (MPa)		550	660
0.2% proof strength (MPa)		360	390
Elongation (%)	4d	30	40
	5d	27	38
Reduction of area (%)		--	40
Impact ISO-V(J)	-196°C	--	> 80
Hardness (HV)		--	190

OPERATING PARAMETERS, DC +VE ONLY

Diameter (mm)	2.0	2.5	3.2	4.0	5.0
min. A	40	70	90	130	160
max. A	60	115	155	210	260

PACKAGING DATA

Diameter (mm)	2.0	2.5	3.2	4.0	5.0
Length (mm)	300	300	350	350	330
kg/carton	11.7	12.0	13.5	13.5	17.1
Pieces/carton	750	468	291	192	129

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 300°C/1-2h to restore to as-packed condition. Maximum 380° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Cr	Ni	Mo	Cu	F	OES (mg/m³)
2	13	5	10	0.2	0.1	15	1

20.70.Nb

SOLID WIRES FOR TIG, MIG AND SAW

PRODUCT DESCRIPTION

Solid wires for TIG, MIG and sub-arc welding of nickel base alloys and dissimilar joints between nickel alloys, ferritic and austenitic stainless steels.

SPECIFICATIONS

AWS A5.14M	ERNiCr-3
BS EN ISO 18274	S Ni 6082
UNS	N06082
APPROVALS	TÜV (TIG)

Also known generically as filler metal 82 (FM82)

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Cu	Ti	Fe
min.	--	2.5	--	--	--	18.0	67.0	2.0	--	--	--
max.	0.05	3.5	0.50	0.015	0.020	22.0	bal	3.0	0.50	0.7	3.0
Typical	0.02	3	0.1	0.005	0.01	20	73	2.5	0.01	0.4	1

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded	Typical
Tensile strength (MPa)	640
0.2% proof strength (MPa)	360
Elongation (%) 4d	40
Impact ISO-V(J) -196°C	> 100

TYPICAL OPERATING PARAMETERS

	Shielding	Current	Diameter (mm)	Parameters
TIG	Argon	DC-	2.4	100A, 12V
MIG	Argon	Pulsed	1.2	180A, 26V
SAW	NiCr flux	DC+	1.6	300A, 26V

PACKAGING DATA

Diameter (mm)	0.8	0.9	1.0	1.2	1.6	2.0	2.4	3.2
TIG	--	--	--	--	2. 5 kg tube	2. 5 kg tube	2. 5 kg tube	2. 5 kg tube
MIG	15kg spool	15kg spool	15kg spool	15kg spool	--	--	--	--
SAW	--	--	--	--	--	--	25kg spool	--

FUME DATA

MIG fume composition (wt %)(TIG fume negligible)

Fe	Mn	Cr3	Ni	Mo	Cu	OES (mg/m³)
1	6	15	56	< 0.1	< 0.5	0.9

NiCr FLUX

SUB-ARC FLUX

PRODUCT DESCRIPTION

Sub-arc flux – Agglomerated, fluoride basic flux of high basicity (Boniczewski B1~3).
The high basicity ensures low loss of critical alloying elements in the transfer from wire to weld deposit; the low silica content ensures a low silicon content of the weld metal and reduces the risk of hot cracking.
NiCr flux can be used DC+, DC- and AC, although DC+ operation is preferred.
Flux:wire ratio is 1-2:1 depending on operating conditions; recycled flux should be limited to about 10% to avoid build-up of fines.

SPECIFICATIONS

BS EN ISO 14174	SA FB2

COMPOSITION (TYPICAL)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Ti
20.70.Nb wire	0.02	3	0.1	0.005	0.01	20	bal	2.5	1	0.4
deposit	0.01	3	0.2	0.006	0.006	20.5	bal	2.3	1	0.08

ALL-WELD MECHANICAL PROPERTIES

With 20.70.Nb wire / as welded	**Typical**
Tensile strength (MPa)	640
0.2% proof strength (MPa)	360
Elongation (%) 4d	40

OPERATING PARAMETERS

Current: DC +ve ranges as below:

Diameter (mm)	amp-volt range	typical	stickout
1.6	200-350A, 27-31V	300A, 28V	20-25mm
2.4	250-450A, 28-32V	350A, 29V	20-25mm

PACKAGING DATA

Metrode **NiCr Flux** is supplied in sealed moisture resistant 25kg metal drums.
Preferred storage conditions for opened drums: < 60%RH, > 18°C.
If the flux has become damp or has been stored for a long period, it should be redried in the range 250-400°C/1-3h.

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NICKEL BASE AB CONSUMABLES

ALLOY TYPE

Inconel™ type consumables similar to the 182 but with lower Mn and a Mo addition.

MATERIALS TO BE WELDED

Inconel 600, Incoloy 800, Incoloy DS, Nilo, Brightray and other nickel base or high nickel alloys to themselves and to mild, low alloy, and stainless steels. Cryogenic 3-5%Ni steels.

APPLICATIONS

The weld metal deposited by these consumables has no directly equivalent parent material, although its composition is related to Inconel 600 (0.05C-75Ni-16Cr-8Fe). Mo and Nb are added to give high resistance to hot cracking, tolerance to dilution by many combinations of nickel base and ferrous alloys, and stable properties over a wide range of service temperatures from –269°C to above 900°C.

The presence of Mo improves elevated temperature properties above about 600°C, compared to the 182 alloys (data sheet D-10).

These consumables are used for welding Inconel 600, Incoloy 800/800H and similar heat resisting or high nickel alloys to themselves for use in **furnace equipment** and **petrochemical plants** up to about 900°C.

In addition they are suitable for **dissimilar** combinations of the above alloys and others such as Monel 400, Incoloy 825 to stainless, low alloy CMn steels without the need to preheat. Stress relief may be carried out if necessary, and transition welds for high temperature service have good structural stability.

They can also be used for low temperature applications such as 3%Ni or 5%Ni steels used for **cryogenic vessels and pipework** in service at or below –100°C.

MICROSTRUCTURE

In the as-welded condition this nickel base weld metal consists of austenite with a few carbides.

WELDING GUIDELINES

Requirements for preheat and PWHT will be dependent on the base material being welded. For most nickel base materials no preheat or PWHT is required.

RELATED ALLOY GROUPS

The 182 alloys (data sheet D-10) cover similar applications.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod AKS**	AWS ENiCrFe-2
TIG/MIG/SAW	**20.70.Nb**	AWS ERNiCr-3
SAW flux	**NiCr**	BS EN SA FB2

NIMROD AKS

ALL-POSITIONAL INCONEL™ TYPE MMA ELECTRODE

PRODUCT DESCRIPTION

MMA electrode with a basic flux system on a nearly matching core wire designed to give radiographically sound weld metal. It is optimised for DC+ welding in all positions including pipework in the ASME 5G/6G positions. Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrFe-2
BS EN ISO 14172	E Ni 6133

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Mo	Cu	Co *	Ta *
min.	--	1.0	--	--	--	13.0	62	1.5	--	1.0	--	--	--
max.	0.10	3.5	0.75	0.015	0.02	17.0	Bal	3.0	12.0	2.5	0.50	0.12	0.30
Typical	0.05	2.8	0.5	0.01	0.01	16	69	2	8	1.5	0.05	0.05	0.05

* Co and Ta maximums only when specified at time of order.

ALL-WELD MECHANICAL PROPERTIES

As-welded		Min.	Typical
Tensile strength (MPa)		550	700
0.2% proof strength (MPa)		360	420
Elongation (%)	4d	30	42
	5d	27	39
Reduction of area (%)		--	50
Impact ISO-V(J)	-196°C	--	110
Hardness (HV)		--	200/215

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0	5.0
min. A	60	70	100	130
max. A	80	110	155	210

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0	5.0
Length (mm)	300	300	350	350
kg/carton	12.0	12.6	14.4	13.5
Pieces/carton	762	450	300	186

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life. Direct use from tin is satisfactory for longer than a working shift of 8h. Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.

For electrodes that have been exposed:

Redry 200 – 250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.

Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended. Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m3)
2	13	10	5	0.2	0.1	15	1

20.70.Nb

SOLID WIRES FOR TIG, MIG AND SAW

PRODUCT DESCRIPTION

Solid wires for TIG, MIG and sub-arc welding of nickel base alloys and dissimilar joints between nickel alloys, ferritic and austenitic stainless steels.

SPECIFICATIONS

AWS A5.14M	ERNiCr-3
BS EN ISO 18274	S Ni 6082
UNS	N06082
APPROVALS	TÜV (TIG)

Also known generically as filler metal 82 (FM82)

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Cu	Ti	Fe
min.	--	2.5	--	--	--	18.0	67.0	2.0	--	--	--
max.	0.05	3.5	0.50	0.015	0.020	22.0	bal	3.0	0.50	0.7	3.0
Typical	0.02	3	0.1	0.005	0.01	20	73	2.5	0.01	0.4	1

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded	Typical
Tensile strength (MPa)	640
0.2% proof strength (MPa)	360
Elongation (%) 4d	40
Impact ISO-V(J) -196°C	> 100

TYPICAL OPERATING PARAMETERS

	Shielding	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon**	DC+ ***	1.2	180A, 26V
SAW	NiCr flux	DC+	1.6	300A, 26V

* Also required as a purge for root runs.
** Proprietary Ar/He mixtures also suitable.
*** Pulsed current may provide benefits with respect to operability and arc transfer characteristics.

PACKAGING DATA

Diameter (mm)	0.8	0.9	1.0	1.2	1.6	2.0	2.4	3.2
TIG	--	--	--	--	2.5 kg tube	2.5 kg tube	2.5 kg tube	2.5 kg tube
MIG	15kg spool	15kg spool	15kg spool	15kg spool	--	--	--	--
SAW	--	--	--	--	--	--	25kg spool	--

FUME DATA

MIG fume composition (wt %)(TIG fume negligible)

Fe	Mn	Cr[3]	Ni	Mo	Cu	OES (mg/m³)
1	6	15	56	< 0.1	< 0.5	0.9

NiCr FLUX

SUB-ARC FLUX

PRODUCT DESCRIPTION

Sub-arc flux – Agglomerated, fluoride basic flux of high basicity (Boniczewski B1~3).
The high basicity ensures low loss of critical alloying elements in the transfer from wire to weld deposit; the low silica content ensures a low silicon content of the weld metal and reduces the risk of hot cracking.
NiCr flux can be used DC+, DC- and AC, although DC+ operation is preferred.
Flux:wire ratio is 1-2:1 depending on operating conditions; recycled flux should be limited to about 10% to avoid build-up of fines.

SPECIFICATIONS

BS EN ISO 14174 SA FB2

COMPOSITION (TYPICAL)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Ti
20.70.Nb wire	0.02	3	0.1	0.005	0.01	20	bal	2.5	1	0.4
deposit	0.01	3	0.2	0.006	0.006	20.5	bal	2.3	1	0.08

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded	Typical
Tensile strength (MPa)	640
0.2% proof strength (MPa)	360
Elongation (%) 4d	40

OPERATING PARAMETERS

Current: DC +ve ranges as below:

Diameter (mm)	amp-volt range	typical	stickout
1.6	200-350A, 27-31V	300A, 28V	20-25mm
2.4	250-450A, 28-32V	350A, 29V	20-25mm

PACKAGING DATA

Metrode NiCr Flux is supplied in sealed moisture resistant 25kg metal drums.
Preferred storage conditions for opened drums: < 60%RH, > 18°C.
If the flux has become damp or has been stored for a long period, it should be redried in the range 250-400°C/1-3h.

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NIMROD 132KS (ENiCrFe-1)

PRODUCT DESCRIPTION

MMA electrode with a special basic flux covering on a matching core wire. The electrode is optimised for DC+ welding in all positions including fixed pipework in the ASME 5G/6G positions.
Recovery about 105% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11	ENiCrFe-1
BS EN 14172	E Ni 6062
DIN 1736	EL-NiCr15FeNb (2.4805)

ASME IX QUALIFICATION

QW432 F-No 43

MATERIALS TO BE WELDED

Alloy 600 and similar:

UNS N06600	Inconel 600 (Special Metals)
BS NA14	Nicrofer 7216 (Krupp VDM)
DIN 2.4816 (NiCr15Fe)	Nicrofer 7216H (Krupp VDM)
AFNOR NC15Fe	Pyromet 600 (Carpenter)
ASTM A494 CY40 (cast)	RA600 (rolled Alloys)

Other alloys:

Alloy 330	Nimonic 75 (Special Metals)
Alloy 601 (to about 900°C)	

APPLICATIONS

Nimrod 132KS deposits an Inconel type weld metal similar in composition to the 182 types (data sheet D-10) but with lower manganese. The electrode is used mainly for welding alloy 600, the nearest equivalent base material, with service applications up to about 1000°C. The lower Mn level is preferred by some authorities, as Mn raises thermal expansion coefficient and high levels may reduce oxidation resistance at the upper service temperatures. Additions of both Mn and Nb are sufficient to suppress hot cracking and provide good hot strength.
The good oxidation and excellent nitriding and carburisation resistance of alloy 600 is exploited for **heat treatment equipment and annealing muffles**. Resistance to dry chlorine up to about 550°C is important in plants for **PVC synthesis**, and it has many applications in the **chemical, petrochemical, food processing and nuclear industries.**

MICROSTRUCTURE

High alloy austenite with some carbides.

WELDING GUIDELINES

No preheat or PWHT required.

WELDING POSITIONS (ISO/ASME)

RELATED ALLOY GROUPS

The 182 (data sheet D-10) and AB alloys (data sheet D-11) are very similar; and the 20.70.Nb solid wire would be used in conjunction with Nimrod 132KS.

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Nb	Fe
Min.	0.03	1.0	--	--	--	14.0	62.0	0.25	1.5	6.0
Max.	0.08	3.5	0.75	0.015	0.030	17.0	Bal	0.50	3.5	11.0
Typical	0.05	3	0.4	0.01	0.01	16.5	70	0.3	2.6	6.5

Cu<0.50%.
Minimum Mo and Fe applies to DIN only.
Residual Co<0.12% and Ta<0.30% when requested.

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		550	645
0.2% proof strength (MPa)		360	390
Elongation (%)	4d	30	38
	5d	27	35
Reduction of area (%)		--	38
Impact ISO-V(J)	- 196°C	--	100

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0	5.0
min. A	60	70	100	130
max. A	80	110	155	210

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0	5.0
Length (mm)	300	300	350	350
kg/carton	12.0	12.9	15.0	15.0
Pieces/carton	909	474	300	198

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life. Direct use from tin is satisfactory for much longer than an 8h working shift.
For electrodes that have been exposed:
Redry 200-250°C/1-2h to restore to as-packed condition. Maximum 350°C, 3 cycles, 10h total.
Storage of redried electrodes at 100-200°C in holding oven or 50-150°C in heated quiver: no limit, but maximum 6 weeks recommended. Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, >18°C.

FUME DATA

Fe	Mn	Ni	Cr	Cu	F	OES (mg/m³)
2	12	11	5	0.1	15	1

Fume composition, wt % typical:

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NICKEL BASE 625 CONSUMABLES

ALLOY TYPE

Consumables matching the nickel base 625 alloy with typical composition of Ni-21%Cr-9%Mo-3.5%Nb.

MATERIALS TO BE WELDED

MATCHING ALLOY 625

ASTM / ASME	*DIN*	*BS*
UNS N06625	2.4856	NA21
A494 CW-6MC (cast)		

Proprietary

Inconel 625 (Inco)
Nicrofer 6020hMo (VDM)
Nicrofer 6022hMo (VDM)

OTHER ALLOYS

High Nickel Alloys:

Inconel 601 (Inco)
Incoloy 800H (Inco)
Incoloy 825 (Inco)
And equivalents

Cryogenic:

9%Ni steels

Superaustenitic alloys:

UNS S31254
254SMO (Avesta)
904L
Similar alloys

Dissimilar:

Combinations of above

APPLICATIONS

These consumables are designed to match the composition and properties of alloy 625. Originally developed to give high temperature strength and structural stability, alloy 625 is also widely used for its resistance to general corrosion, pitting, crevice and stress corrosion cracking in severe chloride media.

These properties are conferred by high levels of chromium, molybdenum and niobium, which also raise strength to the highest amongst standard nickel-base alloys. Useful properties from −269°C to above 1000°C are achieved.

In addition to matching alloy 625, suitable for welding heat resisting alloys including Inconel 601 (except severe sulphidising conditions), Incoloy 800/800H (preferred to Nimrod AKS above about 900°C), or combinations of these with other alloys for furnace equipment, petrochemical and power generation plants. Some other applications include:

Overmatching corrosion-resistant welds in alloy 825, Hastelloys G and G3, alloy 28, 904L, 6%Mo super-austenitic stainless 254SMo, and also overlays on pumps, valves and shafts, often in offshore and marine environments where high pitting resistance (PRE = 50) and tolerance to weld metal dilution are essential.

Welds in high strength ferrous alloys including cryogenic 9% nickel steels and for reclamation of dies where rapid work-hardening and toughness are required.

MICROSTRUCTURE

In the as-welded condition this nickel base weld metal consists of solid-solution strengthened austenite with carbides.

WELDING GUIDELINES

No preheat required and maximum interpass of 250°C. When welding superaustenitic alloys the interpass temperature should be controlled to a maximum of 100°C.

RELATED ALLOY GROUPS

For welding superaustenitic stainless steels C276 (D-30), alloy 59 (D-31) and alloy C22 (D-32) are also suitable.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 625**	AWS ENiCrMo-3
	Nimrod 625KS	AWS ENiCrMo-3
TIG/MIG	**62-50**	AWS ERNiCrMo-3
SAW	**62-50**	AWS ERNiCrMo-3
	NiCr	BS EN SA FB2
FCW	**Supercore 625P**	AWS ENiCrMo3T1-1/4

NIMROD 625

DOWNHAND MMA ELECTRODE FOR SURFACING

PRODUCT DESCRIPTION

MMA electrode designed to combine easy operation with the deposition of high quality weld metal and a finished bead of good appearance. The electrode has a basic-rutile flux system and is made on a nickel core wire.
Nimrod 625 operates on AC or DC+ and is designed primarily for the downhand/flat or H-V positions.
Optimised for surfacing and overlays, for joining Nimrod 625KS is preferred.
Recovery is about 170% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrMo-3
BS EN ISO 14172	E Ni 6625

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

PA/1G PB/2F PC/2G

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Mo	Cu
Min.	--	0.5	--	--	--	20.0	55	3.15	--	8.0	--
Max.	0.10	1.0	0.75	0.015	0.020	23.0	--	4.15	2.5	10.0	0.50
Typical	0.04	0.8	0.7	0.005	0.008	21.5	64	3.4	<1.5	9	0.05

ALL-WELD MECHANICAL PROPERTIES

As welded		Min. *	Typical
Tensile strength (MPa)		760	800
0.2% proof strength (MPa)		420	480
Elongation (%)	4d	30	34
	5d	27	32
Reduction of area (%)		--	30
Impact ISO-V(J)	-196°C	--	> 28
Hardness (HV)	as welded	--	250
	work-hardened	--	450

* Cannot meet TS > 827MPa required by cold rolled ASTM N06625 Grade 1, but meets PS > 414MPa and properties of hot rolled grades. Cast CW-6MC solution annealed 1175°C + WQ requires TS > 485MPa. .

TYPICAL OPERATING PARAMETERS, DC +VE OR AC (OCV: 70V)

Diameter (mm)	3.2	4.0	5.0
min. A	90	130	160
max. A	155	210	260

PACKAGING DATA

Diameter (mm)	3.2	4.0	5.0
Length (mm)	300	350	350
kg/carton	13.8	13.5	16.8
Pieces/carton	243	156	93

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m³)
1	4	9	6	1	0.1	20	0.8

NIMROD 625KS

BASIC MMA PIPE-WELDING ELECTRODE FOR 625

PRODUCT DESCRIPTION

MMA electrode with a basic flux system made on a 625 core wire. The electrode is designed to combine easy operation with the deposition of high quality, radiographically sound weld metal and a finished bead of good appearance.
Nimrod 625KS is optimised for DC+ welding in all positions including pipework qualified in the ASME 6G position.
Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrMo-3
EN ISO 14172	E Ni 6625
APPROVALS	TÜV

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Mo	Cu
Min.	--	0.5	--	--	--	20.0	55	3.15	--	8.0	--
Max.	0.10	1.0	0.75	0.015	0.020	23.0	--	4.15	2.5	10.0	0.50
Typical	0.04	0.7	0.4	0.005	0.005	22	63	3.2	< 1.5	9.3	0.01

ALL-WELD MECHANICAL PROPERTIES

As welded		Min. *	Typical	+160°C
Tensile strength (MPa)		760	800	725
0.2% proof strength (MPa)		420	500	440
Elongation (%)	4d	30	40	33
	5d	27	38	31
Reduction of area (%)		--	40	32
Impact ISO-V(J)	-196°C	--	60	--
Hardness (HV)	as welded	--	250	--
	work-hardened	--	450	--

* Cannot meet TS > 827MPa required by cold rolled ASTM N06625 Grade 1, but meets PS > 414MPa and properties of hot rolled grades. Cast CW-6MC solution annealed 1175°C + WQ requires TS > 485MPa. .

TYPICAL OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0	5.0
min. A	60	70	100	130
max. A	80	110	155	210

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0	5.0
Length (mm)	300	300	350	350
kg/carton	11.1	12.6	15.0	15.0
Pieces/carton	744	447	300	189

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m³)
1	4	9	6	1	0.1	20	0.8

62-50

SOLID WIRE FOR TIG, MIG AND SAW

PRODUCT DESCRIPTION

Solid wire for TIG, MIG and sub-arc welding.

SPECIFICATIONS

AWS A5.14M	ERNiCrMo-3
EN ISO 18274	S Ni 6625
APPROVALS	TÜV (TIG)

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Nb	Cu	Al	Ti	Fe
Min.	--	--	--	--	--	20.0	60.0	8.0	3.15	--	--	--	--
Max.	0.05	0.50	0.50	0.015	0.015	23.0	bal	10.0	4.15	0.50	0.40	0.40	1.0
Typical	0.015	0.02	0.05	0.004	0.004	22	65	9	3.5	0.05	0.2	0.2	0.2

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		TIG	SAW + NiCr	TIG +165°C
Tensile strength (MPa)		745	695	710
0.2% proof strength (MPa)		470	430	440
Elongation (%)	4d	42	50	42
	5d	40	47	40
Reduction of area (%)		100	--	--
Impact ISO-V(J)	-196°C	80	100	--
		205/225	235/255	--
Hardness cap/mid (HV)		--	250	

Cannot meet TS > 827MPa required by cold rolled ASTM N06625 Grade 1, but meets PS > 414MPa and properties of hot rolled grades. Cast CW-6MC solution annealed 1175°C + WQ requires TS > 485MPa.

TYPICAL OPERATING PARAMETERS

	Shielding	Current	Diameter (mm)	Parameters
TIG*	Argon	DC-	2.4	100A, 12V
MIG	Argon or ArHe	Pulsed	1.2	130A, 29V (mean)
SAW	NiCr flux	DC+	1.6	300A, 26V

* Also required as a purge for root runs.

PACKAGING DATA

Diameter (mm)	0.8	1.0	1.2	1.6	2.0	2.4	3.2
TIG	--	--	--	2.5 kg tube	2.5 kg tube	2.5 kg tube	2.5 kg tube
MIG	15kg spool	To order	15kg spool	--	--	--	--
SAW	--	--	--	25kg spool	--	25kg spool	--

FUME DATA

MIG fume composition (wt %)(TIG & SAW fume negligible)

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
1	1	17	50	9	< 0.5	1

SUPERCORE 625P

RUTILE ALL-POSITIONAL FLUX CORED WIRE

PRODUCT DESCRIPTION

Flux cored wire made with a nickel alloy sheath and rutile flux system.

Supercore 625P is designed for all-positional welding and combines easy operability, high deposit quality and exceptional weld bead appearance.

Metal recovery is about 90% with respect to the wire.

SPECIFICATIONS

AWS A5.34M	ENiCrMo3T1-1/4
EN ISO 12153	T Ni 6625 P M/C 2
APPROVALS	LRS

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Nb	Cu	Ti	Fe
Min.	--	--	--	--	--	20.0	58.0	8.0	3.15	--	--	--
Max.	0.10	0.50	0.50	0.015	0.02	23.0	--	10.0	4.15	0.50	0.40	5.0
Typical	0.02	0.3	0.2	0.005	0.005	21	66	8.5	3.4	0.02	0.2	1.0

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		690	770
0.2% proof strength (MPa)		420	480
Elongation (%)	4d	25	46
	5d	22	42
Reduction of area (%)		--	42
Impact ISO-V(J)	+20°C	--	95
	-196°C	--	80
Lateral expansion (mm)	-196°C	--	1.00
CTOD (mm)	-170°C	--	0.50
Hardness cap/mid (HV)		--	230/230

OPERATING PARAMETERS

Shielding gas: 80%Ar-20%CO_2 or 100% CO_2 at 20-25l/min. Proprietary gases may be used but argon should not exceed 85%.
Current: DC+ve ranges as below for Ar-20%CO_2. Welding with 100%CO_2 requires approx. 2-3V higher:

Diameter (mm)	amp-volt range	typical	stickout
1.2 (downhand)	150 – 250A, 25 – 32V	180A, 29V	15 – 20mm
1.2 (positional)	150 – 180A, 25 – 28V	160A, 26V	15 – 20mm

PACKAGING DATA

Spools vacuum-sealed in barrier foil with cardboard carton: 15kg.
The as-packed shelf life is virtually indefinite.
Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers.
Where possible, preferred storage conditions are 60% RH max, 18°C min.

FUME DATA

MIG fume composition (wt %)

Fe	Mn	Ni	Cr^3	Cr^6	Cu	F	OES (mg/m³)
1	2	10	5	5	0.1	5	1.0

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CORROSION RESISTANT ALLOY C276

ALLOY TYPE

Alloy C276 is a Ni-15%Cr-16%Mo-4%W-5%Fe nickel base alloy.

MATERIALS TO BE WELDED

	wrought	*cast*
ASTM/UNS	UNS N10276	A494 CW-12MW A743/A744 CW-12M
DIN	2.4819 (NiMo16Cr15W)	2.4883 (G-NiMo16Cr)
Proprietary alloys:	Hastelloy™ Alloy C-276 (Haynes International Inc) Inco Alloy C-276 (Special Metals) Nicrofer 5716hMoW (VDM)	

APPLICATIONS

The weld deposit composition matches parent alloy C276 with Ni-15%Cr-16%Mo-4%W-5%Fe. Carbon and silicon are controlled as close as possible to the very low levels of the wrought alloy to minimise carbide and intermetallic phase precipitates which can reduce as-welded corrosion resistance. Cast versions of the alloy typically have higher carbon and silicon (like the original wrought Hastelloy alloy C, now obsolete), but repair welds are usually solution treated for optimum corrosion resistance.

Alloy C276 has high resistance to corrosion in a wide range of acids and salts under oxidising and especially reducing conditions. These include hydrochloric and hydrofluoric acids, hypochlorites, chlorides and wet chlorine gas, sulphuric, phosphoric and many organic acids. Exceptional resistance to crevice corrosion and pitting in seawater and chloride-induced stress-corrosion cracking (superior to alloy 625). High temperature stability is limited by intermetallic phase formation.

In addition to fabrication welds in alloy C276, these consumables have good tolerance to dilution by most ferrous and high nickel alloys, and are suitable for surfacing and dissimilar welds which exploit the corrosion resistance, strength and toughness. Excellent properties to below -196°C allow its use for welding 5-9%Ni cryogenic installations.

Applications include **pumps, valves, pipework and vessels** for use in aggressive environments in **chemical process plants**; also in equipment for **flue gas desulphurisation** and critical equipment in **offshore oil** and **gas production**.

MICROSTRUCTURE

In the as-welded condition the weld metal consists of austenite with some carbides.

WELDING GUIDELINES

Preheat is not required, interpass temperature should preferably be kept below 100°C and heat input restricted to 1.5kJ/mm.

RELATED ALLOY GROUPS

Alloy 59 (D-31) and alloy C22 (D-32) are also NiCrMo alloys but with higher Cr for improved corrosion resistance.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod C276KS**	AWS ENiCrMo-4
TIG/MIG	**HAS C276**	AWS ERNiCrMo-4
SAW	**HAS C276**	AWS ERNiCrMo-4
	NiCr flux	BS EN SA FB2

NIMROD C276KS

ALL-POSITIONAL PIPE WELDING MMA ELECTRODE FOR ALLOY C276

PRODUCT DESCRIPTION

MMA electrode with special basic flux coating on matching nickel-chromium-molybdenum core wire to provide clean and homogenous weld metal. Nimrod C276KS has exceptional operability, optimised for DC+ welding in all positions including fixed pipework qualified in the ASME 6G (inclined overhead) position.
Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrMo-4
BS EN ISO 14172	E Ni 6276

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	Fe	V	Cu	Co
min.	--	--	--	--	--	14.5	50.0	15.0	3.0	4.0	--	--	--
max.	0.02	1.0	0.2	0.015	0.02	16.5	--	17.0	4.5	7.0	0.35	0.50	2.5
Typical	0.02	0.3	0.20	0.01	0.01	15.0	58.0	16.0	4.0	5.0	0.1	0.05	0.05

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		700	780
0.2% proof strength (MPa)		400	520
Elongation (%)	4d	25	30
	5d	25	28
Impact ISO-V(J)	-50°C	--	65
	-196°C	--	55
Hardness* (HV)		--	240

* Work hardens to about 450HV.

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	60	75	100
max. A	80	110	155

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	300	350
kg/carton	13.5	13.5	15.0
Pieces/carton	789	435	294

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m³)
1	4	10	5	5	0.2	16	1

HAS C276

SOLID WIRES FOR TIG/MIG/SAW

PRODUCT DESCRIPTION

Solid wire for TIG, MIG and sub-arc welding.

SPECIFICATIONS

AWS A5.14M	ERNiCrMo-4
BS EN ISO 18274	S Ni 6276
UNS	N10276

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	Fe	V	Cu	Co
min.	--	--	--	--	--	14.5	bal	15.0	3.0	4.0	--	--	--
max.	0.02	1.0	0.08	0.015	0.020	16.5	--	17.0	4.5	7.0	0.3	0.50	2.50
Typical	0.005	0.5	0.05	0.005	0.01	16	58	16	3.5	6	0.2	0.05	0.50

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		Min.	TIG	SAW
Tensile strength (MPa)		700	740	710
0.2% proof strength (MPa)		400	500	470
Elongation (%)	4d	--	46	38
	5d	30	43	36
Reduction of area (%)		--	50	48

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon or Ar-He	Pulsed	1.2	160A, 28V (mean)
SAW	Nicr Flux			

* Also required as a purge for root runs.

PACKAGING DATA

Diameter (mm)	0.9	1.0	1.2	1.6	2.0	2.4	3.2
TIG	--	--	--	2.5kg tube	To order	2.5kg tube	2.5kg tube
MIG	12.5kg spool	15kg spool	15kg spool (to order)	--	--	--	--
SAW			--	--	--	25kg spool	--

FUME DATA

MIG fume composition (wt %) (TIG & SAW fume negligible)

Fe	Mn	Cr[3]	Ni	Mo	Cu	OES (mg/m³)
14	3	10	28	11	1	1.8

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CORROSION RESISTANT ALLOY 59

ALLOY TYPE

Ni-23%Cr-16%Mo alloy commonly known as alloy 59.

MATERIALS TO BE WELDED

ALLOY 59 AND SIMILAR:

ASTM/UNS

N06059

DIN

2.4605 (NiCr23Mo16Al)

Proprietary

Nicrofer 5923hMo (Krupp VDM).
Inconel™ Alloy 686 (Special Metals) +W.
Hastelloy™ Alloy C-2000™ (Haynes International Inc) +Cu.

ALLOY C22 AND SIMILAR:

ASTM/UNS

N06022
A494 Grade CX2MW (cast)

DIN

2.4602 (NiCr21Mo14W)
2.4811, 2.4836 (NiCr20Mo15)
2.4697 (G-NiCr20Mo15) (cast)

Proprietary

Hastelloy™ Alloy C-22™ (Haynes International Inc)
Nicrofer 5621hMoW (Krupp VDM)

SUPERAUSTENITICS INCLUDING:

ASTM/UNS

S32654, S31254, S34565

Proprietary

654SMO (Avesta Polarit)
Uranus B66 (Usinor Industeel)

Also dissimilar joints between any combination of the above and dissimilar joints between them and superduplex stainless steels.

APPLICATIONS

The weld deposit composition of 59%Ni-23%Cr-16%Mo is designed to match the nickel base corrosion resistant alloy commonly known as alloy 59. The high level of Mo is similar to alloys C276 and C4 but performance in a wide range of more oxidising media is significantly enhanced by increasing Cr to 23% in alloy 59. Total alloying exceeds the level typically present in alloy C22; it is therefore considered suitable for welding this group of alloys.

Alloy 59 consumables also provide strong, tough Nb-free weld metal for dissimilar welds in superaustenitic and superduplex stainless steels or combinations of these with nickel base alloys.

Some authorities do not allow or have discontinued use of 625 type consumables for such applications, where deleterious Nb-rich precipitates may form in diluted or partially mixed regions around the fusion boundary. Alloy C276 is possibly a more economic alternative depending on the required properties in this situation.

Applications of alloy 59 in aggressively corrosive media include **scrubbers** for **flue gas desulphurisation (FGD), digesters and papermaking equipment**, **chemical process plants, corrosion resistant overlays and in severe offshore and petrochemical** environments.

MICROSTRUCTURE

Solid-solution strengthened high nickel austenite, with some microsegregation typical of as-deposited weld metal.

WELDING GUIDELINES

No preheat required, heat input <1kJ/mm and interpass temperature 100°C maximum are desirable to minimise precipitates which may reduce corrosion resistance and ductility of the weld metal.

RELATED ALLOY GROUPS

The alloy C22 is related and covers many of the same applications and base materials.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 59KS**	AWS ENiCrMo-13
TIG/MIG	**HAS 59**	AWS ERNiCrMo-13

NIMROD 59KS

BASIC ALL-POSITIONAL PIPE-WELDING MMA ELECTRODE FOR ALLOY 59

PRODUCT DESCRIPTION

MMA electrode with special basic flux covering on high purity NiCrMo core wire to give clean homogenous weld metal.
Very low levels of C and Si minimise the occurrence of deleterious precipitates in the as-welded condition. The special flux coating provides exceptional operability, optimised for DC+ welding in all positions including fixed pipework in the ASME 5G/6G positions. The electrode is equally suitable for general fabrication welds.
Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrMo-13
BS EN ISO 14172	E Ni 6059

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

PA/1G **PB/2F** **PC/2G** **PF/3Gu** **PE/4G**

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Fe	Cu
min.	--	--	--	--	--	22.0	57.0	15.0	--	--
max.	0.02	1.0	0.2	0.010	0.015	24.0	bal	16.5	1.5	0.50
Typical	0.01	0.5	0.15	0.006	0.01	23	60	15.5	1	0.01

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		690	750
0.2% proof strength (MPa)		350	520
Elongation (%)	4d	30	32
	5d	25	30
Reduction of area (%)		--	30
Impact ISO-V(J)	-50°C	--	50

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	60	75	100
max. A	80	120	155

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	300	350
kg/carton	10.5	13.5	15.0
Pieces/carton	714	480	297

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical:

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m³)
1	4	10	5	6	0.2	16	1

HAS 59

SOLID WIRES FOR TIG AND MIG

PRODUCT DESCRIPTION

Solid wire for TIG and MIG welding.

SPECIFICATIONS

AWS A5.14M	ERNiCrMo-13
BS EN ISO 18274	SNi6059

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Fe	Co	Al
Min.	--	--	--	--	--	22.0	56.0	15.0	--	--	0.1
Max.	0.010	0.5	0.10	0.005	0.015	24.0	Bal	16.5	1.5	0.3	0.4
Typical	0.003	0.2	0.03	0.003	0.003	23	60	15.6	0.4	0.1	0.3

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		TIG
Tensile strength (MPa)		730
0.2% proof strength (MPa)		510
Elongation (%)	4d	34
	5d	32
Impact ISO-V(J)	+20°C	140
Hardness	HV	240

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon or Ar-He	Pulsed	1.2	160A, 28V (mean)

* Also required as a purge for root runs.

PACKAGING DATA

Diameter (mm)	1.0	1.2	1.6	2.0	2.4	3.2
TIG	--	--	To order	2.5 kg tube	2.5 kg tube	2.5 kg tube
MIG	15 kg spool	15 kg spool	--	--	--	--

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr[3]	Ni	Mo	Cu	OES (mg/m³)
1	1	17	50	11	<0.5	1

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CORROSION RESISTANT ALLOY C22

ALLOY TYPE

Nickel base 22%Cr-13.5%Mo-3%W, alloy C22.

MATERIALS TO BE WELDED

MATCHING ALLOY C22:

ASTM

A494 CX2MW (cast)
UNS N06022

DIN

2.4602 (NiCr21Mo14W)
2.4811, 2.4836 (NiCr20Mo15)
2.4697 (G-NiCr20Mo15) (cast)

Proprietary

Hastelloy™ Alloy C-22™ (Haynes International Inc)
Nicrofer™ 5621hMoW (VDM)
Inconel™ 622 (Special Metals)

OTHER ALLOYS:

Alloy C4

ASTM UNS N06455
DIN 2.4610 (NiMo16Cr16Ti)
Hastelloy™ Alloy C-4 (Haynes International Inc)

Superaustenitics

UNS S31254, S31266, S32654, S34565.
N08367, N08925, N08926.
1.4529, 1.4565, 1.4575, 1.4652.
254SMO and 654SMO (Outokumpu).
Uranus B66 (Usinor Industeel).

APPLICATIONS

The weld deposit composition of Ni-22Cr-13.5Mo-3W is designed to match the nickel base alloy commonly known as alloy C22. The high level of molybdenum is similar to alloys C276 and C4 but performance in a wide range of more oxidising media is significantly enhanced in alloy C22 by increasing chromium to 22%.

Alloy C22 also provides a tough Nb-free weld metal for dissimilar welds in superaustenitic and superduplex stainless steels or combinations of these with nickel base alloys. Some authorities do not allow or have discontinued using alloy 625 consumables for such applications, where deleterious Nb-rich precipitates may form in diluted or partially mixed regions around the fusion boundary.

Applications of alloy C22 in aggressively corrosive media include **scrubbers** for **flue gas desulphurisation (FGD), digesters and papermaking equipment**, **chemical process plants, corrosion resistant overlays and in severe offshore and petrochemical** environments.

MICROSTRUCTURE

Solid solution strengthened high nickel austenite, with some microsegregation typical of as-deposited weld metal.

WELDING GUIDELINES

Preheat not normally required, interpass temperature restricted to 100°C and heat inputs below 1kJ/mm are desirable.

RELATED ALLOY GROUPS

Alloy 59 is similar but with slightly higher Cr and Mo for similar or more severe applications – see data sheet D-31.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	Nimrod C22KS	AWS ENiCrMo-10
TIG/MIG	HAS C22	AWS ERNiCrMo-10

NIMROD C22KS

ALL-POSITIONAL MMA ELECTRODE FOR ALLOY C22

PRODUCT DESCRIPTION

Basic flux covered electrode with exceptional operability optimised for DC+ welding in all positions including fixed pipework qualified in the ASME 5G/6G positions. It is equally suitable for general fabrication welds.
Special basic flux covering on matching high purity nickel alloy core wire to give clean and homogenous weld metal. Very low levels of carbon and silicon minimise the occurrence of deleterious precipitates in the as-welded condition.
Recovery is approx 110% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrMo-10
BS EN ISO 14172	E Ni 6022

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

PA/1G **PB/2F** **PC/2G** **PF/3Gu** **PE/4G**

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	V	Co	Cu	Fe
min.	--	--	--	--	--	20.0	49.0	12.5	2.5	--	--	--	2.0
max.	0.02	1.0	0.2	0.015	0.02	22.5	--	14.5	3.5	0.35	2.5	0.50	6.0
Typical	0.01	0.5	0.15	0.008	0.008	21	58	14	3	0.05	0.05	0.05	4

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		690	760
0.2% proof strength (MPa)		350	510
Elongation (%)	4d	25	36
	5d	22	35
Reduction of area (%)		--	33
Impact ISO-V(J)	-196°C	--	45
Hardness, cap/mid (HV)		--	245/275

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	60	75	100
max. A	80	120	155

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	300	350
kg/carton	13.5	13.5	15.6
Pieces/carton	780	486	306

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for much longer than an 8h working shift.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase risk of porosity.
For electrodes that have been exposed:
Redry 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350°C, 3 cycles, 10h total.
Storage of redried electrodes at 100 – 200°C in holding oven, or 50 – 150°C in heated quivers: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): <60%RH, >18°C.

FUME DATA

Fume composition, wt % typical:

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m³)
1	4	10	5	6	0.2	16	1

HAS C22

SOLID WIRES FOR TIG AND MIG

PRODUCT DESCRIPTION

Solid wire for TIG and MIG welding.

SPECIFICATIONS

AWS A5.14M	ERNiCrMo-10
BS EN ISO 18274	S Ni 6022

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	V	Co	Cu	Fe
Min.	--	--	--	--	--	20.0	49.0	12.5	2.5	--	--	--	2.0
Max.	0.01	0.50	0.08	0.010	0.02	22.5	--	14.5	3.5	0.3	2.5	0.50	6.0
Typical	0.003	0.2	0.03	0.002	0.01	21	56	13.5	3	0.15	1.5	0.1	4

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		TIG
Tensile strength (MPa)		740
0.2% proof strength (MPa)		500
Elongation (%)	4d	44
	5d	42
Impact ISO-V(J)	-196°C	130
Hardness (HV)		220

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon or Ar-He	Pulsed	1.2	160A, 28V (mean)

* Also required as a purge for root runs.

PACKAGING DATA

Diameter (mm)	1.0	1.2	1.6	2.0	2.4	3.2
TIG	--	--	2.5 kg tube	2.5 kg tube	2.5 kg tube	2.5 kg tube
MIG	To order	To order	--	--	--	--

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr[3]	Ni	Mo	Cu	OES (mg/m³)
14	1	17	30	10	<0.5	1.7

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9% NICKEL STEEL CONSUMABLES

ALLOY TYPE

NiCrMo-6 type nickel base consumables for welding 9% Nickel steels.

MATERIALS TO BE WELDED

9% NICKEL STEELS, INCLUDING:

ASTM	*UNS*
A353 / A353M	K81340
A553 / A553M Type I	K71340
A553 / A553M Type II	

BS

1501 510 and 510N, 1502 and 1503 509-690

DIN

1.5662 X8Ni9 (wrought) and G-X8Ni9 (cast)

5% AND 3.5% NICKEL STEELS, INCLUDING:

ASTM	*UNS*
A645	K41583
A352 LC4 (cast)	
A333 Grade 3	
A202 Grade E	

DIN

1.5680 X12Ni (12Ni19)
1.5637 10Ni14 (3.5%Ni), 1.5637 12Ni14 (3.5%Ni)

APPLICATIONS

Metrode Supercore 620P all-positional flux cored wire is specifically designed for welding 9% Ni steels used in the fabrication of cryogenic containment plant demanding good properties down to -196°C. The typical application is the welding of 9% Ni steels for LNG storage tanks.
Supercore 620P deposits a controlled carbon and solid solution strengthened alloy with high strength and toughness in the as-welded condition. To satisfy procedural and property requirements in aimed applications, Supercore 620P meets the following criteria:

- All-positional operation, including full-automated 3G butt weld of 9%Ni steels for LNG storage tanks.
- Good welding operability with 80%Ar-20%CO2 mix gas; For less demanding welding positions, useful performance can also be achieved with 100% CO2 shield.
- Operates on power source polarity of DC+.
- High deposition efficiency.
- Proof stress of weld metal exceeds 400MPa (typically >420MPa) with UTS above 700MPa.
- Nickel-base alloy weld metal with excellent impact toughness at -196°C independent from procedure.
- Similar thermal expansion coefficient to 9% Ni steels.

Supercore 620P can also be used for welding 5% Ni and 3.5% Ni steels with satisfactory weld metal mechanical properties including excellent cryogenic impact toughness.

This wire is equally suitable for welding other low alloy and hardenable steels, including applications where PWHT is required, and for dissimilar welds between these and austenitic steels or high nickel alloys.

MICROSTRUCTURE

In the as-welded condition the weld metal consists of high alloy nickel base solid-solution strengthened austenite with some carbides.

WELDING GUIDELINES

No preheat required and maximum interpass of 250°C.

RELATED ALLOY GROUPS

For welding 9% Ni steels of LNG storage tanks, Metrode also manufactures an all positional 625 type flux cored wire, Supercore 625P. Please refer to data sheet D-20 for details.

For other consumables for welding 9% Ni steels, 625 (D-20) and C276 (D-30) can also be considered.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nyloid 2***	AWS ENiCrMo-6
	Nyloid 4*	AWS ENiCrMo-6
FCW	**Supercore 620P**	(AWS ENiCrMo6T1-4)

* : Lincoln group products which have been widely used in the construction of 9% Ni LNG storage tanks (project reference list available).
For reference, please refer to Lincoln Electric Europe "Welding Consumable Product Catalogue"..

SUPERCORE 620P

RUTILE ALL-POSITIONAL FLUX CORED WIRE

PRODUCT DESCRIPTION

Flux cored wire made with a nickel alloy sheath and rutile flux system.
Supercore 620P is specifically designed for all-positional welding of 9% Ni steels.
It combines easy operability, high deposit quality and exceptional weld bead appearance.
Metal recovery is about 90% with respect to the wire.

SPECIFICATIONS

AWS A5.34M --

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Nb	W	Fe	Cu
Min.	--	2.0	--	--	--	12.0	58.0	5.0	0.5	1.0	--	--
Max.	0.08	4.0	1.0	0.015	0.02	17.0	--	8.0	2.0	2.0	10.0	0.50
Typical	0.04	3.0	0.4	0.008	0.008	16.0	66	6.0	1.5	1.5	4.0	0.05

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		690	710
0.2% proof strength (MPa)		430	450
Elongation (%)	4d	25	40
	5d	--	38
Reduction of area (%)		--	40
Impact ISO-V(J)	+20°C	--	90
	-100°C	--	80
	-196°C	47	75
Lateral expansion (mm)	-196°C	0.38	>1.20
Hardness cap/mid (HV)		--	190/200

OPERATING PARAMETERS

Shielding gas: 80%Ar-20%CO_2 or 100%CO_2 at 20-25l/min. Proprietary gases may be used but argon should not exceed 85%.
Current: DC+ve ranges as below for Ar-20%CO_2. Welding with 100%CO_2 requires approx. 2-3V higher:

Diameter (mm)	amp-volt range	typical	stickout
1.2 (downhand)	150 – 250A, 25 – 32V	180A, 29V	15 – 20mm
1.2 (positional)	150 – 180A, 25 – 28V	160A, 26V	15 – 20mm

PACKAGING DATA

Spools vacuum-sealed in barrier foil with cardboard carton: 15kg.
The as-packed shelf life is virtually indefinite.
Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers.
Where possible, preferred storage conditions are 60% RH max, 18°C min.

FUME DATA

MIG fume composition (wt %)

Fe	Mn	Ni	Cr^3	Cr^6	Cu	F	OES (mg/m^3)
2	13	10	5	5	<0.5	5	1.0

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HIGH TEMPERATURE ALLOY 617

ALLOY TYPE

Nickel base alloy of nominally Ni-24%Cr-12%Co-9%Mo designed for high temperature service.

MATERIALS TO BE WELDED

MATCHING ALLOY 617:

ASTM

UNS N06617

DIN

2.4663 (NiCr23Co12Mo)

Proprietary

Inconel alloy 617 (Special Metals)
Nicrofer 5520Co (Krupp VDM)

OTHER ALLOYS:

Alloys 800H and 800HT

ASTM UNS N08810, N08811
BS NA15H
DIN 1.4876 (X10NiCrAlTi 32 20)
Incoloy 800H and 800HT (Special Metals)
Nicrofer 3220H (Krupp VDM)

Alloy 601 & other oxidation resistant alloys

ASTM UNS N06601
DIN 2.4851
Inconel alloy 601 (Special Metals)
Nicrofer 6023 (Krupp VDM)
ASTM UNS N06333
RA333 (Rolled Alloys)

High Carbon Austenitic Alloy

Cast HK40, HP40Nb, etc

Also dissimilar welds between above.

APPLICATIONS

Nimrod 617KS is primarily intended for high temperature applications up to about 1100°C. It provides good microstructural stability, high creep strength and excellent resistance to oxidation and carburisation. In a variety of aqueous media, the alloy also has useful resistance to general corrosion, pitting and stress-corrosion cracking.

The electrode is optimised for DC+ welding in all positions including fixed pipework qualified in the ASME 5G/6G positions.

In addition to welding the parent alloy 617, some authorities specify it in preference to other nickel-base filler metals for welding alloys 800H and 800HT for service above 760°C. It is also suitable for the heat-resistant alloy 601 (usually above 900°C) and **dissimilar welds** including high carbon heat resistant cast alloys and any combination of those mentioned.

Applications include **combustion, pyrolysis, heat treatment and furnace components, flare tips, ducting and gas turbine parts**.

MICROSTRUCTURE

High nickel alloy austenite with carbides.

WELDING GUIDELINES

Normally no preheat required, interpass temperature generally limited to 150°C maximum.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 617KS**	AWS ENiCrCoMo-1
TIG/MIG	**61-70**	AWS ERNiCrCoMo-1

NIMROD 617KS

617 MMA ELECTRODE FOR HIGH TEMPERATURE APPLICATIONS

PRODUCT DESCRIPTION

Special basic flux on matching nickel alloy core wire. The chromium range of the weld metal is higher than the parent material to maintain oxidation resistance at a lower aluminium level.
The electrode is optimised for DC+ welding in all positions including fixed pipework qualified in the ASME 5G/6G positions.
Recovery is about 105% with respect to core wire, 65% with respect to whole electrode.

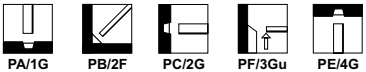
SPECIFICATIONS

AWS A5.11M	ENiCrCoMo-1
BS EN ISO 14172	E Ni 6117

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)



CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Co	Mo	Nb	Cu	Fe	Al	Ti
min.	0.05	0.3	--	--	--	21.0	45.0	9.0	8.0	--	--	--	--	--
max.	0.15	2.5	0.75	0.015	0.020	26.0	bal	15.0	10.0	1.0	0.50	5.0	1.5	0.6
Typical	0.07	1.0	0.4	0.003	<0.01	24	52	12	9	<0.5	0.05	1	0.15	0.2

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		700	760
0.2% proof strength (MPa)		400	520
Elongation (%)	4d	25	43
	5d	25	40
Reduction of area (%)		--	40
Impact ISO-V(J)	+20°C	--	70
Hardness, cap/mid (HV)		--	230/245

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	60	75	100
max. A	80	110	155

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	300	350
kg/carton	12.0	15.0	15.0
Pieces/carton	738	459	273

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 300°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical:

Fe	Mn	Ni	Co	Cr[6]	Mo	Cu	F	OES (mg/m³)
1	4	9	2.5	6	1	0.2	20	0.8

61-70

SOLID WIRES FOR TIG AND MIG

PRODUCT DESCRIPTION

Solid wires for TIG and MIG welding alloy 617.

SPECIFICATIONS

AWS A5.14M	ERNiCrCoMo-1
BS EN ISO 18274	S Ni 6617

ASME IX QUALIFICATION

QW432	F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Co	Mo	Cu	Fe	Al	Ti
Min.	0.05	--	--	--	--	20.0	44.0	10.0	8.0	--	--	0.80	--
Max.	0.15	1.0	0.5	0.015	0.020	24.0	bal	15.0	10.0	0.5	3.0	1.50	0.60
Typical	0.08	0.1	0.1	0.002	<0.01	22	55	12	9	<0.2	0.5	1	0.3

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		Min.	TIG typical	MIG typical
Tensile strength (MPa)		700	750	710
0.2% proof strength (MPa)		400	500	450
Elongation (%)	4d	25	43	42
	5d	30	41	40
Impact ISO-V(J)	+20°C	--	230	>100
Hardness cap/mid (HV)		--	200/225	

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon **	DC+ ***	1.2	220A, 30V

* Also required as a purge for root runs.
** Proprietary Ar/He mixtures also suitable.
*** Pulsed current may provide benefits with respect to operability and arc transfer characteristics.

PACKAGING DATA

Diameter (mm)	0.8	1.0	1.2	1.6	2.4
TIG	--	--	--	2.5 kg tube	2.5 kg tube
MIG	15kg spool	15kg spool	15kg spool	--	--

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr^3	Ni	Mo	Co	OES (mg/m^3)
1	1	17	45	9	11	0.9

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ALLOY 690

ALLOY TYPE

Ni-30%Cr-10%Fe alloy commonly known as alloy 690.

MATERIALS TO BE WELDED

ASTM
B163, B166-8

DIN
2.4642 (NiCr29Fe)

UNS
N06690

Proprietary
Inconel 690 (Special Metals)
Nicrofer 6030 (Krupp VDM)

APPLICATIONS

The consumables are designed to match alloy 690, which is finding increasing use in place of alloy 600 for high temperature corrosion applications, especially in the nuclear industry. The high chromium content provides good elevated temperature corrosion resistance in oxidising and sulphidising atmospheres.

In addition to joining matching base materials, the consumables can also be used for surfacing applications on CMn and low alloy steels.

Applications include **nuclear engineering; sulphuric, nitric and hydrofluoric acid processing equipment**

MICROSTRUCTURE

High alloy nickel base austenite.

WELDING GUIDELINES

Preheat and PWHT is not generally required.

RELATED ALLOY GROUPS

There are no directly related alloys.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 690KS**	AWS ENiCrFe-7
TIG/MIG	**ER690**	AWS ERNiCrFe-7

NIMROD 690KS

BASIC ALL-POSITIONAL PIPE-WELDING MMA ELECTRODE FOR ALLOY 690

PRODUCT DESCRIPTION

Nickel base MMA electrode designed for welding matching base materials, and for surfacing CMn and low alloy steels.
Special basic flux coating on a nickel alloy core wire optimised for DC+ welding in all positions including pipework in the ASME 5G/6G positions.
Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCrFe-7
BS EN ISO 14172	E Ni 6152

ASME IX QUALIFICATION

QW432 F-No 43

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Mo	Ti	Al	Cu	Co
min.	--	3.0	--	--	--	28.0	50.0	1.2	8.0	--	--	--	--	--
max.	0.045	5.0	0.65	0.008	0.02	31.5	bal	2.2	12.0	0.5	0.5	0.5	0.5	0.10
Typical	0.04	3.6	0.3	0.005	0.007	29	55	1.6	8.5	0.1	0.05	0.05	0.05	0.02

ALL-WELD MECHANICAL PROPERTIES

		As welded		PWHT 610°C/40h	
		Min.	Typical	RT	+360°C
Tensile strength (MPa)		552	660	661	532
0.2% proof strength (MPa)		360	430	414	325
Elongation (%)	4d	30	40	42	45
	5d	27	38	38	42
Reduction of area (%)		--	45	60	46
Impact ISO, KCV (J)	- 50°C	--	>50	--	--
Impact energy, KCU (J/cm²)	+20°C	--	--	84	--

OPERATING PARAMETERS, DC +VE

Diameter (mm)	**2.5**	**3.2**	**4.0**
min. A	60	70	100
max. A	80	110	155

PACKAGING DATA

Diameter (mm)	**2.5**	**3.2**	**4.0**
Length (mm)	300	300	350
kg/carton	11.7	12.9	15.0
Pieces/carton	672	408	294

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200–250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical:

Fe	Mn	Ni	Cr	Cu	Mo	F	OES (mg/m³)
2	13	10	8	0.2	0.1	16	0.6

ER690

SOLID WIRE FOR TIG WELDING OF ALLOY 690

PRODUCT DESCRIPTION

Solid wires for TIG.

SPECIFICATIONS

AWS A5.14M	ERNiCrFe-7
BS EN ISO 18274	S Ni6052

ASME IX QUALIFICATION

QW432 F-No 43

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	Mo	Ti	Al	Cu	Al+Ti
Min.	--	--	--	--	--	28.0	54.0	--	7.0	--	--	--	--	--
Max.	0.04	1.0	0.50	0.015	0.020	31.5	--	0.10	11.0	0.50	1.0	1.10	0.30	1.5
Typical	0.03	0.7	0.2	0.005	0.010	29	60	0.03	8.5	0.05	0.6	0.6	0.05	1.2

ALL-WELD MECHANICAL PROPERTIES

		As welded typical, RT	As welded typical, +360°C	PWHT 610°C/40h typical
Tensile strength (MPa)		720	520	--
0.2% proof strength (MPa)		430	320	--
Elongation (%)	4d	43	40	--
	5d	40	--	--
Reduction of area (%)		60	50	--
Impact ISO, KCV (J)	- 50°C	200	--	145
Impact energy, KCU (J/cm²)	+ 20°C	160	--	130

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V

* Also required as a purge for root runs.

PACKAGING DATA

Diameter (mm)	0.9	2.4
TIG	0.7 or 5kg spool	2.5kg tube

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr³	Ni	Mo	Cu	OES (mg/m³)
10	3	20	50	<1	<1	0.9

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PURE NICKEL CONSUMABLES

ALLOY TYPE

Low carbon pure nickel weld metal with titanium de-oxidation.

MATERIALS TO BE WELDED

ASTM-ASME

UNS N02200
UNS N02201

BS

NA11
NA12

DIN

2.4066
2.4068
2.4061

Proprietary alloys

Nickel 200 and 201 (Special Metals)
Nickel 99.6 and 99.2 (VDM)

APPLICATIONS

These consumables give low carbon pure nickel with the addition of titanium for refinement and de-oxidation. They are used for joining pure nickel to itself, for buffer layers, and for cladding joint faces and flanges. The solid wire is also useful for welding **cast iron** to give soft low strength deposit.

Applications include **tanks and vessels, process pipework and heat exchangers, in chemical plant for salt production, chlorination and evaporation of caustic soda**. Also used for handling c**orrosive alkalis and halides.**

MICROSTRUCTURE

In the as-welded condition the microstructure consists of almost pure nickel austenite. It is strongly ferromagnetic at room temperature.

WELDING GUIDELINES

Pure nickel weld metals are sluggish and can lead to irregular weld beads which may require inter-run dressing.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 200Ti**	AWS ENi-1
TIG/MIG	**Nickel 2Ti**	AWS ERNi-1

NIMROD 200Ti

ALL-POSITIONAL PURE NICKEL MMA ELECTRODE

PRODUCT DESCRIPTION

MMA electrode with special carbonate-fluoride-rutile flux system on matching core wire.
Smaller diameters offer excellent all-positional operability.
Recovery is about 100% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENi-1
BS EN ISO 14172	E Ni 2061

ASME IX QUALIFICATION

QW432 F-No 41

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Ni	Ti	Al	Fe	Cu	Nb
min.	--	--	--	--	--	92.0	1.0	--	--	--	--
max.	0.10	0.7	1.2	0.015	0.02	bal	4.0	1.0	0.7	0.2	0.5
Typical	0.04	0.5	0.6	0.005	0.005	97	1.5	0.1	0.3	0.1	<0.1

NICKEL BASE ALLOYS

ALL-WELD MECHANICAL PROPERTIES

As welded	Min.	Typical
Tensile strength (MPa)	410	450
0.2% proof strength (MPa)	200	295
Elongation (%) 4d	20	22
5d	18	20
Reduction of area %	--	40
Impact ISO-V(J) -30°C	--	160
Hardness (HV)	--	160

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	60	70	90
max. A	80	110	145

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	350	350
kg/carton	12.3	13.5	14.4
Pieces/carton	720	414	300

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical:

Fe	Mn	Ni	Cu	F	OES (mg/m³)
<1	1	10	0.2	10	5

NICKEL 2Ti

SOLID WIRES FOR TIG AND MIG

PRODUCT DESCRIPTION

Solid wire for TIG and MIG welding.

SPECIFICATIONS

AWS A5.14M	ERNi-1
BS EN ISO 18274	S Ni 2061
UNS	N02061

Also known generically as filler metal 61 (FM61)

ASME IX QUALIFICATION

QW432 F-No 41

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Ni	Ti	Al	Cu	Fe
Min.	--	--	--	--	--	93.0	2.0	--	--	--
Max.	0.15	1.0	0.7	0.015	0.020	bal	3.5	1.5	0.2	1.0
Typical	<0.02	0.4	<0.3	0.005	0.005	96	3	0.1	<0.02	0.1

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		Min.	TIG
Tensile strength (MPa)		410	585
0.2% proof strength (MPa)		200	335
Elongation (%)	4d	--	35
	5d	25	31
Reduction of area (%)		--	65
Hardness, cap/mid (HV)		--	155/185

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon or Ar-He	Pulsed	1.2	150A, 29V (mean)

* Ar + 1-5%H_2 also suitable.

PACKAGING DATA

Diameter (mm)	1.2	1.6	2.0	2.4
TIG	--	2.5 kg tube	2.5 kg tube	2.5 kg tube
MIG	15kg spool	--	--	--

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
2	2	<0.1	68	0.1	<0.5	0.7

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NICKEL-COPPER ALLOY 400

ALLOY TYPE

Nickel-copper alloy based on alloy 400 with raised levels of manganese and titanium to suppress hot cracking and porosity.

MATERIALS TO BE WELDED

ASTM-ASME	*BS*	*DIN*
UNS N04400	NA13	2.4360
UNS N04405	NA1 (cast)	2.4361
UNS N05500		2.4365 (cast)
A494 M-35-1 (cast)		
A494 M-35-2 (cast)		

Proprietary

Monel alloy 400, R405, K500 (Special Metals)
Nicorros (VDM)

APPLICATIONS

Nimrod 190 deposits 65%Ni-30%Cu weld metal based on Monel alloy 400 with raised levels of manganese and titanium to suppress hot cracking and porosity. It is optimised to give the highest as-welded ductility and strength attainable in weld metal of this type.

For welding alloy 400 and similar parent material to itself and to others in the Ni-Cu alloy system, such as pure nickel and cupronickel. Welds in alloy K500 are satisfactory, but cannot match the strength of this precipitation-hardened alloy. Castings of alloy 400 with up to about 1.5%Si are welded with Nimrod 190, but higher silicon grades such as BS3071 NA2 and ASTM A743 M35-2 are virtually unweldable because of HAZ cracking.

For dissimilar joints between alloy 400 and other alloys or steels, sensitivity to dilution by Fe (20-30%) or Cr (3-6%) can lead to low ductility (or bend-test fissuring) in weld metal close to the fusion boundary. Direct welds to mild or low alloy steels are satisfactory with dilution control, although ENiCrFe-X (ERNiCr-3 wire) is preferable and necessary for stainless and higher chromium alloys (see data sheets D-10 and D-11). Alternatively, the steel or alloy can be buttered with pure nickel (see data sheet D-50) and this procedure is also useful when **surfacing** with alloy 400 consumables.

Alloy 400 has a useful combination of strength, thermal conductivity and resistance to corrosion by seawater, inorganic salts, sulphuric and hydrofluoric acids, hydrogen fluoride and alkalis. Applications include **heat exchangers, piping, vessels and evaporators** in the **offshore, marine, chemical, petrochemical and power engineering** industries.

MICROSTRUCTURE

Solid solution, single phase alloy, slightly ferromagnetic near room temperature.

WELDING GUIDELINES

No preheat required, maximum interpass temperature 150°C and no PWHT required.

ADDITIONAL INFORMATION

Alloy 400 parent material is noted for its good resistance to both hydrofluoric acid and hydrogen fluoride vapour. However, weld metal compositions within standard specification limits have inferior resistance to these media. A fully optimised composition for this specific application is not currently available. Contact Metrode for guidance.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimrod 190**	AWS ENiCu-7
TIG/MIG/SAW	**65NiCu**	AWS ERNiCu-7

NIMROD 190

NICKEL-COPPER MMA ELECTRODE FOR MONEL ALLOY 400

PRODUCT DESCRIPTION

Special basic carbonate-fluoride-rutile flux system on matching 400 core wire to give low levels of residuals.
Deoxidation system designed to ensure sound deposits.
The raised levels of manganese and titanium help suppress hot cracking and porosity.
Analysis is optimised to give the highest as-welded ductility and strength attainable in weld metal of this type.
The smaller electrode sizes are particularly suitable for fixed pipework welds demanding qualification in the ASME 6G position.
Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiCu-7
BS EN ISO 14172	E Ni 4060

ASME IX QUALIFICATION

QW432 F-No 42

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si *	S	P	Ni	Cu	Ti	Fe	Al
min.	--	1.0	--	--	--	62.0	27.0	--	0.5	--
max.	0.15	4.0	1.5	0.015	0.02	69.0	34.0	1.0	2.5	0.5
Typical	0.08	3.5	1.2	0.005	0.01	63	30	0.9	1	0.03

* DIN maximum 1.0% Si

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		480	520
0.2% proof strength (MPa)		200	320
Elongation (%)	4d	30	40
	5d	27	35
Reduction of area (%)		--	40
Impact ISO-V(J)	-30°C	--	110
Hardness (HV)		--	160-180

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0	5.0
min. A	60	70	90	120
max. A	80	110	145	190

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0	5.0
Length (mm)	300	350	350	350
kg/carton	12.6	13.5	15.0	15.0
Pieces/carton	612	417	294	189

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 200 – 250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical:

Fe	Mn	Ni	Cu	F	OES (mg/m³)
1	7	4	16	8	1.2

65NiCu

SOLID WIRES FOR TIG, MIG & SAW TO MATCH MONEL ALLOYS

PRODUCT DESCRIPTION

Solid wire for TIG, MIG and sub-arc welding.

SPECIFICATIONS

AWS A5.14M	ERNiCu-7
BS EN ISO 18274	S Ni 4060

Also known generically as filler metal 60 (FM60)

ASME IX QUALIFICATION

QW432 F-No 42

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Ni	Cu	Ti	Fe	Al
Min.	--	3.0	--	--	--	62.0	28.0	1.5	--	--
Max.	0.15	4.0	1.2	0.015	0.020	69.0	32.0	3.0	2.5	1.2
Typical	0.03	3.2	0.2	0.005	0.005	64	29	2.2	<1	0.1

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded		Min.	TIG
Tensile strength (MPa)		460	525
0.2% proof strength (MPa)		200	280
Elongation (%)	4d	--	41
	5d	25	38
Impact ISO-V(J)	-30°C	--	120

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon*	DC-	2.4	100A, 12V
MIG	Argon or Ar-He	Pulsed	1.2	150A, 29V (mean)
SAW	NiCu	DC+	2.4	300A, 28V

* Ar + 1-5%H_2 also suitable.

PACKAGING DATA

Diameter (mm)	1.2	1.6	2.4
TIG	--	2.5 kg tube	2.5 kg tube
MIG	15kg spool	--	--
SAW	--	--	25kg reel

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
2	2	<0.1	68	0.1	<0.5	0.7

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CUPRONICKEL ALLOYS

ALLOY TYPE

70/30 and 90/10 copper-nickel alloys.

MATERIALS TO BE WELDED

	70/30	*90/10*
ASTM/UNS	C71500 C96400 (cast)	C70600 C96200 (cast)
DIN	2.0882 2.0883	2.0872
BS	CN106 CN107 CN108	CN102
CDA	CA715	CA706
Proprietary	Kunifer 30 (IMI) Cunifer 30 (Krupp VDM)	Kunifer 10 (IMI) Cunifer 10 (Krupp VDM)

The Cupromet N30 and 70CuNi can be used for welding the 70/30 and 90/10 base materials; the 90CuNi is only suitable for the 90/10 alloys.

APPLICATIONS

These consumables deposit a copper-nickel weld metal; the MMA electrode and 70CuNi solid wire are both nominally 67%Cu and 30%Ni, whereas the 90CuNi solid wire is nominally 86%Cu and 10.5%Ni. The 70/30 consumables are suitable for welding 70/30, 80/20 and 90/10 base materials. The 70/30 consumables match the 70/30 base materials for strength and colour and overmatch the 90/10 alloys for strength.

The consumables are suitable for surfacing and cladding provided the need for an appropriate buttering layer is addressed, normally either alloy 400 (D-60) or pure nickel (D-50).

Applications include **offshore** construction, **desalination plant, evaporators, condensers** etc, in **salt** and **sea water** processing systems.

MICROSTRUCTURE

Solid solution, single phase alloy.

WELDING GUIDELINES

Preheating not normally required, maximum interpass temperature 150°C and no PWHT. Contamination of the weld zone with foreign material, particularly any source of lead, tin or zinc (eg. Gun metals) must be scrupulously avoided to prevent weld metal cracking.

RELATED ALLOY GROUPS

No closely related alloys but the alloy 400 (D-60) or pure nickel (D-50) consumables may be required as a buffer layer for cladding applications.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Cupromet N30**	AWS ECuNi
TIG/MIG	**70CuNi**	AWS ERCuNi
TIG	**90CuNi**	BS C16

CUPROMET N30

ALL-POSITIONAL MMA ELECTRODE FOR CUPRONICKEL

PRODUCT DESCRIPTION

MMA electrode made on matching 70/30 core wire with a special basic flux system giving very low residuals (S, P, Pb, Sn, Zn etc) and hence maximum crack resistance. Suitable for all-positional welding.
Recovery is about 105% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.6M ECuNi

ASME IX QUALIFICATION

QW432 F-No 34

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	Cu	Mn	Si	S	P	Ni	Fe	Ti	Pb
min.	bal	1.00	--	--	--	29.0	0.40	--	--
max.	--	2.50	0.50	0.015	0.020	33.0	0.75	0.50	0.02
Typical	67	1.8	0.2	0.005	0.010	30	0.6	0.15	0.002

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		350	400
0.2% proof strength (MPa)		--	260
Elongation (%)	4d	20	38
	5d	--	36
Reduction of area (%)		--	60
Impact ISO-V(J)	+20°C	--	120
Hardness, mid (HV)		--	130

OPERATING PARAMETERS, DC +VE OR AC (OCV: 70V MIN)

Diameter (mm)	2.5	3.2	4.0	5.0
min. A	60	75	100	130
max. A	90	120	155	210

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0	5.0
Length (mm)	300	300	350	350
kg/carton	12.6	15.0	15.0	15.0
Pieces/carton	684	450	297	198

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Ni	Cu	F	OES (mg/m³)
< 1	2	3	16	15	1.2

70CuNi

SOLID 70/30 CUPRONICKEL WIRES FOR TIG AND MIG

PRODUCT DESCRIPTION

Solid wire for TIG and MIG welding.

SPECIFICATIONS

AWS A5.7M	ERCuNi
BS EN ISO 24373	S Cu 7158 / CuNi30Mn1FeTi

Also known generically as filler metal 67 (FM67)

ASME IX QUALIFICATION

QW432 F-No 34

CHEMICAL COMPOSITION (WIRE WT %)

	Mn	Si	S	P	Cu	Ni	Fe	Ti	Pb	C
Min.	0.5	--	--	--	bal	29.0	0.40	0.20	--	--
Max.	1.0	0.25	0.01	0.02	--	32.0	0.7	0.50	0.02	0.04
Typical	0.8	0.01	0.005	0.003	67	31	0.5	0.3	0.001	0.03

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded	TIG
Tensile strength (MPa)	365
0.2% proof strength (MPa)	200
Elongation (%) 5d	40
Hardness (HV)	105

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon or Ar + 1-5%H_2	DC-	2.4	100A, 12V
MIG	Argon or Ar-He	Pulsed	1.2	160A, 28V

PACKAGING DATA

Diameter (mm)	1.2	1.6	2.0	2.4
TIG	--	2.5kg tube	2.5kg tube	2.5kg tube
MIG	15kg spool	--	--	--

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr[3]	Ni	Mo	Cu	OES (mg/m³)
<1	5	<0.1	22	<0.1	72	0.3

90CuNi

SOLID 90/10 CUPRONICKEL WIRE FOR TIG

PRODUCT DESCRIPTION

Solid wire for TIG welding

SPECIFICATIONS

BS EN ISO 24373 S Cu 7061 / CuNi10

ASME IX QUALIFICATION

QW432 F-No 34

CHEMICAL COMPOSITION (WIRE WT %)

	Mn	Si	S	P	Cu	Ni	Fe	Ti	Pb	C
min.	0.5	--	--	--	bal	9.0	0.5	0.1	--	--
max.	1.5	0.2	0.02	0.02	--	11.0	2.0	0.5	0.02	0.05
Typical	0.8	0.02	0.001	0.002	86	10.5	1.2	0.3	0.001	0.01

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded	TIG
Tensile strength (MPa)	365
0.2% proof strength (MPa)	200
Elongation (%) 5d	40
Hardness cap/mid (HV)	105

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon or Ar + 1-5%H_2	DC-	2.4	100A, 12V

PACKAGING DATA

Diameter (mm)	1.6	2.0	2.4	3.2
TIG	2.5kg tube	2.5kg tube	2.5kg tube	2.5kg tube

FUME DATA

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
2	5	<0.1	8	<0.1	80	0.3

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NICKEL-MOLYBDENUM ALLOY B2

ALLOY TYPE

Ni-28%Mo consumables to match alloy B2.

MATERIALS TO BE WELDED

	wrought	*cast*
ASTM/UNS	B333, B335, B619, B626	A494: N-7M
	UNS N10001 (alloy B)	A743: N-12M
	UNS N10665 (alloy B2)	A744: N-12M
DIN	2.4617	2.4685, 2.4882
BS		3146: ANC 15
Proprietary	Hastelloy alloy B-2 (Haynes)	NB (Paralloy)
	Nimofer 6928 (VDM)	Langalloy B (Meighs)
		AR5 (LaBour/Darwins)

Similar alloys:

UNS N10675, Hastelloy Alloy B-3 (Haynes).

UNS N10629, DIN 2.4600, Nimofer 6629 (VDM), alloy B-4.

APPLICATIONS

These consumables deposit nickel-molybdenum weld metal with very low carbon and silicon levels appropriate for alloy B-2, although it is equally suitable for the original alloy B, now obsolete in wrought form. In addition, specially controlled levels of iron and chromium ensure good as-welded ductility in multipass deposits.

These modifications bring the composition close to the more recent alloys B-3 and B-4 which have better microstructural stability and weldability than alloy B-2. There are no electrode specifications for these alloys at present, and these consumables are therefore offered as an acceptable candidate within current specification limits. These alloys are designed to resist hydrochloric acid at all concentrations and temperatures up to boiling point under non-oxidising conditions. They are also resistant to hydrogen chloride gas, sulphuric and acetic acids under certain conditions. The newer alloys B-3 and B-4 with additional Fe and Cr have improved SCC resistance in chloride media. Contamination of acid media with oxidising ferric or cupric salts must be avoided. Alloys with much higher chromium (C-4 or C-276 etc.) are superior under oxidising conditions.

Applications include **pumps, valves and process equipment operating in aggressive environments in chemical plant**.

MICROSTRUCTURE

Solid solution alloy, high nickel austenite with some microsegregation typical of as-deposited weld metal (homogenised by solution treatment around 1150°C and rapidly cooled for casting repairs).

WELDING GUIDELINES

No preheat and maximum interpass of 150°C for wrought alloys.
For castings of low ductility a preheat-interpass of up to 200-300°C may be required on sections above 15mm. In this case a post-weld solution treatment must be applied to restore satisfactory weld area properties.

ADDITIONAL INFORMATION

Alloy B-2 was introduced to suppress the formation of carbides and silicon-rich intermetallic phases which occur in the original alloy B during processing and welding. However, experience has revealed that elimination of Fe promoted sensitivity to another intermetallic, beta phase Ni_4Mo. This can be limited significantly by controlled Fe (and Cr) additions within the B-2 specification, and this modification is extended in the new alloys B-3 (1.5%Fe, 1.5%Cr) and B-4 (3%Fe, 1.3%Cr). Intermetallics reduce ductility and corrosion resistance.
If PWHT is required to restore maximum corrosion resistance of casting repairs, castings should be solution treated at about 1150°C followed by a rapid cool.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**Nimax B2L**	AWS ENiMo-7

NIMAX B2L

HIGH MOLYBDENUM NICKEL BASE MMA ELECTRODE TO MATCH ALLOY B-2

PRODUCT DESCRIPTION

MMA electrode made on pure nickel core wire with a special basic flux coating to give low levels of impurities.
Sizes above 3.2mm are not suitable for positional welding.
Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

AWS A5.11M	ENiMo-7
BS EN ISO 14172	E Ni 1066

ASME IX QUALIFICATION

QW432 F-No 44

WELDING POSITIONS (ISO/ASME)

CHEMICAL COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	Cu	Fe	Co	V
min.	--	--	--	--	--	0.3	64.5	26	--	--	1.0	--	--
max.	0.02	1.75	0.2	0.015	0.02	1.0	bal	30	1.0	0.50	2.0	1.0	0.4
Typical	0.018	1.3	0.1	0.005	0.01	0.7	68	28	0.1	0.01	1.5	0.04	0.1

ALL-WELD MECHANICAL PROPERTIES

As welded		Min.	Typical
Tensile strength (MPa)		760	775
0.2% proof strength (MPa)		400	525
Elongation (%)	4d	25	31
	5d	22	30
Reduction of area (%)		--	25
Hardness (HV)		--	260

ASTM A494 castings require elongation >6% (N-12MV) or >20% (N-7M) after solution treatment.

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	70	90	130
max. A	115	155	210

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	350	350
kg/carton	12.6	15.0	14.1
Pieces/carton	447	300	183

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for longer than a working shift of 8h.
Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.
For electrodes that have been exposed:
Redry 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.
Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.

FUME DATA

Fume composition, wt % typical

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m³)
1	2	10	0.2	15	0.2	16	5

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EPRI P87

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

ALLOY TYPE

EPRI P87 is a Ni-Fe weld metal covered by U.S.Patent 7,562,807 «Weld Filler For Welding Dissimilar Alloy Steels and Method Using Same,» July 21, 2009.

MATERIALS TO BE WELDED

Designed for dissimilar joints between austenitic stainless steels (eg. 304H) and creep resisting CrMo (eg. P91).

Suitable for as-welded, PWHT or N+T joints in CrMo steels.

APPLICATIONS

EPRI P87 consumables are designed for welding high temperature creep resisting CrMo steels, including P91. The consumables can be used for dissimilar applications between CrMo creep resisting steels and austenitic stainless steels. The EPRI P87 consumables are also suitable for joining CrMo steels to themselves.

The EPRI P87 weld metal is also proposed for N+T joints in P91. The weld metal will allow joints to be buttered in the workshop and then subjected to a full N+T heat treatment; joints on the buttered faces can then be completed in the field without the need for PWHT.

The all-weld metal strength at ambient temperature may not meet that of P91 but transverse tests have shown strengths above the P91 base material requirement, and elevated temperature strength exceeds the minimum base material requirement.

MICROSTRUCTURE

High alloy austenite.

WELDING GUIDELINES

Preheat and PWHT requirements will be determined by the base material being welded. For example P91 is normally preheated to 200°C and PWHT at 760°C for 2 hours (or time appropriate to material thickness). Alternatively if P91 is subjected to a full N+T the heat treatment would typically be 1060°C/1 hour + 760°C/2 hours.

ADDITIONAL INFORMATION

The alloy is balanced to provide excellent resistance to carbide formation at the fusion boundary.

The thermal expansion coefficient is also closer to the base material than with standard nickel base weld metals.

PRODUCTS AVAILABLE

Process	Product	Specification
MMA	**EPRI P87**	--
TIG/MIG	**EPRI P87**	--

EPRI P87

BASIC MMA ELECTRODE FOR HIGH TEMPERATURE APPLICATIONS

PRODUCT DESCRIPTION

MMA electrode with a special basic flux covering on a nickel-iron alloy core wire.
The electrode is optimised for DC+ welding in all positions including fixed pipework in the ASME 5G/6G positions.
Recovery about 115% with respect to core wire, 65% with respect to whole electrode.

SPECIFICATIONS

No current national standards but covered by U.S Patent 7,562,807.

ASME IX QUALIFICATION

QW432 F-No --

WELDING POSITIONS (ISO/ASME)

COMPOSITION (WELD METAL WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Nb	Fe
Typical	0.1	1.5	0.3	0.008	0.008	9	Bal	2	1	38

ALL-WELD MECHANICAL PROPERTIES

Typical values	Ambient	Hot strength 593°C	
	as-welded	as-welded	N+T
Tensile strength (MPa)	575	530	440
0.2% proof strength (MPa)	375	340	225
Elongation (%) 4d	28	21	25
Reduction of area (%)	30	24	33
Impact ISO (J) +20°C	80	--	--

OPERATING PARAMETERS, DC +VE

Diameter (mm)	2.5	3.2	4.0
min. A	60	70	90
max. A	80	110	150

PACKAGING DATA

Diameter (mm)	2.5	3.2	4.0
Length (mm)	300	350	350
kg/carton	12.6	15.0	14.7
Pieces/carton	684	420	264

STORAGE

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life.
Direct use from tin is satisfactory for much longer than an 8h working shift.
For electrodes that have been exposed:
Redry 200-250°C/1-2h to restore to as-packed condition. Maximum 350°C, 3 cycles, 10h total.
Storage of redried electrodes at 100-200°C in holding oven or 50-150°C in heated quiver: no limit, but maximum 6 weeks recommended.
Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, >18°C.

FUME DATA

Fume composition (wt %) typical

Fe	Mn	Ni	Cr	Cu	F	OES (mg/m³)
9	5	6	2.5	<0.5	12	2

EPRI P87

SOLID WIRE FOR TIG AND MIG

PRODUCT DESCRIPTION

Solid wire for TIG and MIG welding.

SPECIFICATIONS

No current national standards but covered by U.S Patent 7,562,807.

ASME IX QUALIFICATION

QW432 F-No --

CHEMICAL COMPOSITION (WIRE WT %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Nb	Fe
Typical	0.1	1.5	0.3	0.008	0.008	9	Bal	2	1	38

ALL-WELD MECHANICAL PROPERTIES

Typical values as welded	
Tensile strength (MPa)	560
0.2% proof strength (MPa)	360
Elongation (%) 4d	32
Impact ISO (J)	150

TYPICAL OPERATING PARAMETERS

	Shielding gas	Current	Diameter (mm)	Parameters
TIG	Argon	DC-	2.4	100A, 12V

PACKAGING DATA

Diameter (mm)	0.9	2.4	3.2
TIG	--	2.5kg tube	2.5kg tube
MIG	12.5kg spool	--	--

FUME DATA

Fume composition (wt %) (TIG fume negligible)

Fe	Mn	Ni	Cr	Cu	F	OES (mg/m³)
9	5	6	2.5	<0.5	12	2