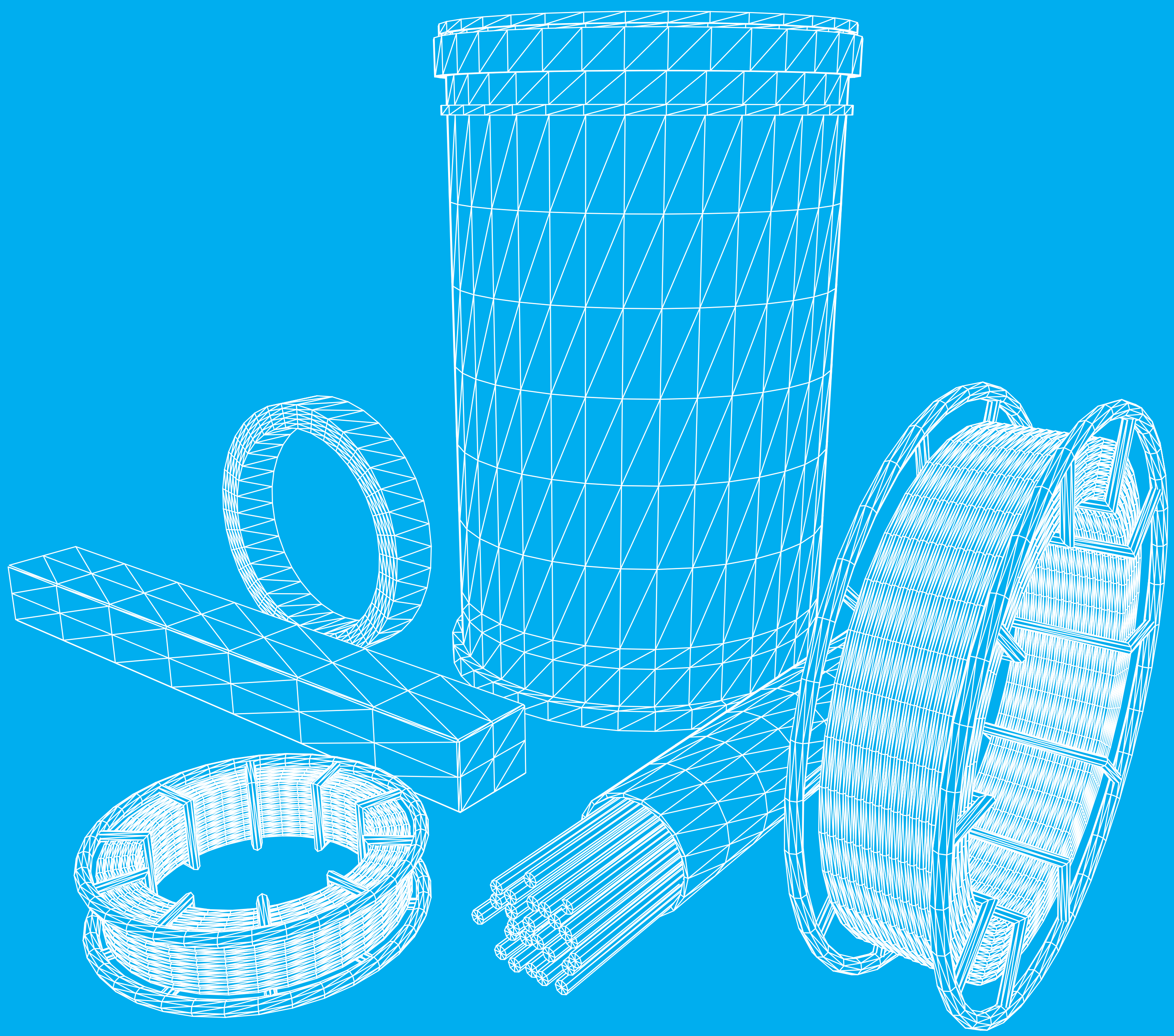
WELDING HANDBOOK



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WELCOME TO SANDVIK

At Sandvik it's innovation that makes the grade.

We are a world-class developer and manufacturer of stainless steels and special alloys for demanding environments. And for more than 80 years, we have been one of the leading global suppliers of welding materials in stainless steel and nickel alloys.

Our welding consumables guarantee;

– Safety - proven performance in demanding environments, consistent and high weld quality makes service life safe for people and the environment.
– Cost reduction - grades that reduce the number of manufacturing operations and reduce repair work. It's also safe against cracking.
– Productivity - chemistry consistent between heats and batches makes manufacturing more predictive and consistent. Consumables for high speed welding take your productivity to a new level of industry standard.

The development of welding materials always goes hand-in-hand with the development of our new steel grades.

This means that you can use our material innovations and can rest assured that the matching welding materials will maintain the required quality for both industry standards and your own company's particular needs.

Our experience in very many applications and our capable technical support is always at your disposal when you are unable to find the solution you need.

Quality Management

Sandvik Materials Technology has quality management systems approved by internationally recognized organizations. We hold, for example, the ASME Quality System Certificate as a Material Organization, approvals to ISO 9001:2008, ISO 17025:2005 and PED 97/23/EC. We also have product and/or shop approvals from bodies such as TÜV, JIS, DNV and Lloyd's Register.

Environment, health and safety

Environmental awareness, health and safety are integral parts of our business and are at the forefront of all activities within our operation. We hold ISO 14001 and OHSAS 18001 approvals.

Don't take our word for it – try our welding consumables and find out for yourself.

WELDING GUIDELINES FOR STAINLESS STEEL AND NICKEL ALLOYS

STEP 1: SELECTION OF FILLER METAL ALLOY FOR WELDING PROCESS

When both base metals are the same, use the base metal alloy as a guide. For example, if joining 316L to 316L, use 316L filler metal. Past experience may show preferential corrosion in the weld, in which case, moving up in alloy content may be required. Careful consideration regarding how far to move up is necessary, so as not to over-alloy causing galvanic corrosion.

For dissimilar joint welding (example; Stainless Steel to Carbon Steel)

Consideration: Failure can occur as a result of low alloy mixtures if the incorrect filler metal is selected, or if dilution rates are too high. The most common failure mode is cracking but weld embrittlement is also possible.

Proper alloy selection and welding technique are therefore crucial for a successful weld:

- DO NOT use low alloy electrodes to join low alloy to stainless steel. Brittle welds will result in this practice.
- DO NOT use lower alloyed stainless steel filler wire to join low alloy to stainless steel. Brittle welds will result in this practice due to martensite formation.
- DO USE over-alloyed grades such as 309 and 312 types, which are designed specifically for this purpose.

For dissimilar stainless to stainless or nickel to nickel joints see the dissimilar materials joining guide. Generally, best practice is to use the filler metal designed for the higher alloyed of the two. For example, if joining 304L to 316L base metals, use 316L filler metal.

When joining stainless steel to nickel base alloys always use nickel base filler metals.

- DO NOT use stainless steel filler metals for joining stainless steel to nickel base alloys as there is a very high risk for centerline cracking. This is due to dilution out of the nickel side of the joint. Higher nickel in the stainless weld deposit creates an imbalance in the composition increasing the sensitivity to cracking.

STEP 2: SELECTION OF WELDING PARAMETERS FOR THE WELDING PROCESS

Welding parameters should be selected to achieve as low a heat input as practical to minimize distortion. Thermal distortion can be high enough to overstrain the base materials causing stress cracking.

Heat Input = (Amps x Volts x 60)/Travel Speed. Lower amperage or voltage gives lower heat input. Faster travel speed, such as stringer beads compared to weaving, give lower heat input.

Adjust amperage or voltage to optimize:

- Arc stability
- Penetration (lower voltages tend to give lower penetration)
- Spatter (use either lower wire feed or higher voltage)
- Undercut (higher voltage tends to increase undercut. Alternatively, decrease travel speed to allow the molten weld pool to fill in the undercut)
- Dilution (lower penetration gives lower dilution)

Use welding technique with short arc lengths to minimize burn off of alloying elements.

STEP 3: PROPER JOINT PREPARATION

CONTAMINATION

- Remove or eliminate all possible sources of contamination including corrosion by products: dirt, oil, grease, scale, paints, and marking inks which may contain chlorides.
- If anti-spatter agents are used, use such materials specifically designed for stainless steels. Beware of oils in compressed air if used to cool or dry weld joints.
- Note that degreasing can add contaminants that will compromise welding as well as create dangerous poisonous gases.
- Do not mix stainless steel and carbon steel fabrications to avoid iron contamination. Iron particles serve to initiate localized corrosion.

MOISTURE AND BASE METAL TEMPERATURE

Remove condensation. Allow weldments stored outdoors to warm to ambient temperature to avoid condensation. Check for moisture contamination of shielding gases.

PLASMA CUTTING

Finish grind to clean metal, joints prepared by plasma cutting or processes using nitrogen or air in the plasma. Nitriding of the joint can result which can cause rusting in the heat affected zone of the finished joint.

Use uncontaminated abrasives designed for stainless steels.

ANTICIPATE DISTORTION

Stainless steels have a rate of thermal expansion 50% greater than carbon steels. Nickel alloys expand to a lesser degree. Use frequent tacks, or skip welding to reduce stresses. Minimize weaving techniques which result in slower travel speeds and higher heat input. Stringer beads are most desired when welding on stainless steel or nickel base alloys.

NARROW GAPS

Avoid narrow gaps. The root gap should, at a minimum, be equal to the diameter of the electrode. This is particularly important when welding duplex stainless steels and nickel base alloys, which tend to have poor weld flow characteristics, resulting in lack of fusion or undercut.

STEP 4: POST-WELD CLEANING

This is a very important step. The purpose of post weld cleaning is to ensure a properly formed chrome oxide film on the surface for optimum corrosion resistance: the smoother the finish, the higher the corrosion resistance. The heat from welding is capable of depleting chrome at the surface which can result in corrosion. To avoid rust, it is very important to remove the chrome depleted zone by chemical or mechanical post weld cleaning.

Use of stainless steel brushes and other tools are highly recommended to avoid impinging iron particles into the surface which will cause rust.

CLEANING METHODS

ELECTROLYTIC POLISHING

This is the best method but it is slow and expensive.

PICKLING

Nitric and Hydrofluoric Acid. Along with a smooth surface, this method yields optimum corrosion resistance, and removes surface blemishes. Avoid over-pickling which results in a coarse surface. Note that pickling by-products are to be properly neutralized and disposed of, in compliance with local environmental regulations. A pickled weldment is at the same time passivated. Passivation solutions are not as effective as pickling solutions for removing contamination.

GRINDING

Corrosion resistance is dependent on the fineness of the surface.

MECHANICAL POLISHING

Almost as effective to electrolytic polishing depending on the grit used: the finer the surface, the better the corrosion resistance

BRUSHING

This is a suitable method as long as uncontaminated stainless steel brushes are used.

SANDBLASTING

Use uncontaminated media. Avoid over-blasting which can result in a coarse finish.

SPECIAL CONSIDERATIONS FOR NICKEL AND SUPERAUSTENITIC ALLOYS

Standard 300 series weld deposits contain a level of ferrite which aids in the suppression of microcracks. Microcracks can propagate into continuous cracks which are normally observed in the center of the weld. Microcracking is normally caused by low melting liquid films in the grain boundaries of the solidifying weld, in combination with a high thermal expansion rate. Ferrite serves to provide more grain boundary area thus diluting the amount of low melting intermetallics.

Since nickel and super-austenitic alloys do not contain ferrite , they are more susceptible to cracking. In order to lower the risk of cracking, the following can be useful:

JOINT DESIGN

Due to the higher nickel content, weld pool flow tends to be more sluggish. To prevent lack of fusion, it is recommended to use wider joint angles and larger root openings than commonly used in stainless steels.

HEAT INPUT

The lower the heat input, the less susceptibility to cracking. Use of smaller diameter consumables which use lower current is beneficial. Typically a maximum heat input of 25 KJ/inch (1 KJ/mm) is preferred.

BEADSHAPE

Concave bead contour should be avoided. Flat to slightly convex weldbeads are preferred.

INTERPASS TEMPERATURE

When welding alloys which do not contain ferrite, a lower interpass temperature is preferred which lowers thermal stresses. A maximum interpass temperature of 300°F (150°C) is recommended.

SPECIAL CONSIDERATIONS FOR DUPLEX STAINLESS STEELS

Duplex alloys are quite different from standard stainless steels. They contain roughly 50% each of ferrite and austenite. If not properly welded, this class of alloy can be susceptible to formation of embrittled phases or formation of precipitates which are susceptible to pitting. By recognizing this, and properly following recommended procedures, mechanically sound and corrosion resistant fabrications are easily accomplished.

Sandvik provides welding guidelines to successfully join duplex base materials.

Generally speaking, the following parameters are required to be followed:

JOINT DESIGN

Due to the sluggish nature of ferritic materials, weld pool flow tends to be sluggish. To prevent lack of fusion it is recommended to use wider joint angles and larger root openings than commonly used in stainless steels. See Sandvik Welding Guidelines for more specific information.

SHIELDING AND BACKING GAS SELECTION

Due to the nature of ferritic materials, weld pool flow is sluggish. This can be compensated for by the proper shielding gas selection, which can also benefit the proper austenite and ferrite balance. The selection of backing gas can have a beneficial affect on the corrosion resistance.

See Sandvik Welding Guidelines for more specific information.

HEAT INPUT

In order to achieve the optimum ferrite to austenite ratio, the heat input must be properly controlled. The recommended heat input range is dependent on the grade of duplex stainless steel being fabricated. See Sandvik Welding Guidelines for more specific information.

INTERPASS TEMPERATURE

Duplex alloys have specific interpass temperatures recommended, in order to prevent formation of brittle intermetallic phases. The proper interpass temperature is dependent on the grade being welded and the base metal thickness. See Sandvik Welding Guidelines for more specific information.

WELDING OF FERRITIC STEELS

Ferritic stainless steel alloys, by their nature, tend to weld sluggishly due to their poor flow characteristics.

Sandvik has developed special chemistries for several grades of ferritic stainless steels to improve this condition. Contact Sandvik for more information.

WELD OVERLAY

For many industrial applications, it is necessary to contain relatively high pressures conforming to various pressure vessel codes such as ASME. At the same time, corrosion protection is required to extend the life of the vessel.

A common solution is to fabricate the vessel with a high strength, low alloy steel, and weld clad the container, with various higher alloy material, utilizing various processes. Common processes used can be MIG, TIG, SMAW, and SAW using bare wire or wire and flux combinations. In the last several decades, utilization of Strip Electrodes has become more and more common in either a submerged arc or electroslag process.

Sandvik has developed an extensive line of consumable wire, strip, and fluxes which can achieve fully alloyed weld overlays in as little as one layer with deposition rates exceeding 90 Lbs/Hr (40 Kg/Hr).

Generally, it is necessary to apply the first layer with an over-alloyed welding consumable to achieve a mechanically sound weld deposit. Subsequent layers can be achieved using a filler metal with the final deposit chemistry desired.

Contact Sandvik to find out more about the grades available in wire, strip, or flux combination.

GAS SELECTION

GAS SELECTION

TIG WELDING

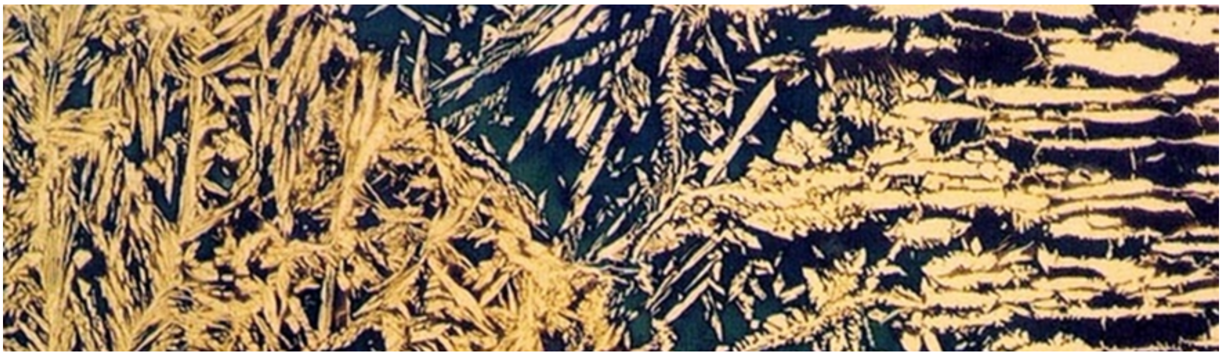
Steel type	Austenitic stainless	Duplex stainless	Super-duplex stainless	Ferritic stainless	High alloy stainless	Nickel alloy
Ar	•	•	-	•	•	•
Ar + Hea	•	•	-	•	•	•a
Ar + 2-5% H2a,b	•b	-	-	-	•b	•b
Ar + 1-2% N2	-	•	•	-	-	-
Ar + 30% He + 1-2% N2	-	•	•	-	-	-

a Improves flow compared with pure Ar.

b Preferable for automatic welding. High welding speed. Risk of porosity in multi-run welds.

COMMON PROBLEMS AND CAUSES

Problem	Cause	Solution
Cracking centerline	Excessive dilution	Add more filler metal or use technique to achieve slightly convex weldbead. Check dissimiliar joining chart to make sure correct filler material is being used
Cracking Random	Overstressed weld	Lower amperage or voltage or increase travel speed to lower heat input, which causes distortion. Use step welding technique, change joint design. Keep the interpass temperature below 150°C (300°F)
Cracking HAZ	Usually base metal related	Insure not welding with machinable grade of material containing high levels of low melting intermetallics
Porosity	Poor gas shielding, moisture, presence of excessive lubricant	Correct shielding gas selection, gas cup size, gas flow rate. Clean off lubricant. Use ceramic backup tape without foil as glue used can sometimes cause porosity
Excessive Spatter	Incorrect parameter settings or wire composition. Inconsistent cast and helix in MIG wire	Lower wire feed speed or increase voltage. Correct shielding gas selection, Look for source of moisture. Use wire with cast and helix control or remove wire straightener on wire feeder
Lack of Fusion	Joint design, too much filler metal, or excessive oxide buildup between passes	Open up weld joint by increasing bevel angle. Decrease filler metal rate by lowering wire feed speed or increase travel speed. Increase voltage to increase fusion rate into base metal. Decrease travel speed to facilitate proper fusion into weld joint. Nickel alloys may require grinding between some or all passes to remove high melting nickel oxides
Rust	Insufficient Post Weld Cleaning, joint preparation using plasma, fixturing	All welds require post weld cleaning. Insure no iron contamination from post weld cleaning technique. Proper post weld cleaning. Finish grind plasma cut joints to remove contamination by nitrogen. Avoid using contaminated or carbon steel fixturing, tooling, or hoists
Distortion	Overheating weldment	Lower heat input, use more frequent tacks, improve fixturing
Undercut	Wrong welding speed, poor weld puddle flow, incorrect grounding, base metal chemistry	Slow travel speed, use filler metal with microelement control, split grounds
Arc Blow	Incorrect grounding	Split grounds, check ground connections
Slag Inclusions	Welding technique	Use a welding technique that facilitates slag which flows towards the puddle



CHOOSING WELDING CONSUMABLES

SHIELDING THE WELD

The primary tasks of a shielding gas is to protect the weld pool from the influence of the atmosphere, i.e. from oxidation and nitrogen absorption, and to stabilize the electric arc. The choice of shielding gas can also influence the characteristics of the weld penetration profile.

SHIELDING GAS PROTECTION

Shielding gases for MIG/GMAW welding

The basic gas for MIG/MAG welding is argon (Ar). Helium (He) can be added to increase penetration and fluidity of the weld pool. Argon or argon/helium mixtures can be used for welding all grades. However, small additions of oxygen (O_2) or carbon dioxide (CO_2) are usually needed to stabilize the arc, improve the fluidity and also improve the quality of the weld deposit. For stainless steels there are also gases available containing small amounts of hydrogen (H_2).

The table indicates the appropriate choice of shielding gas for MIG/MAG welding, taking account of different types of stainless steel and arc types.

	Parent metal (type of material)					
	Austenitic stainless steel	Duplex stainless steel	Super-duplex stainless steel	Ferritic stainless steel	High-alloy austenitic stainless steel	Nickel alloys
Ar	-	-	●[a]	-	●[a]	●[a]
Ar + He	-	-	●[a]	-	●[a]	●[a]
Ar + (1-2)% O_2	●[b]	●[b]	(●)	●[b]	●[c]	-
Ar + (1-2)% CO_2 [d]	●[e]	●[e]	(●)	●[e]	●[c]	-
Ar + 30% He + (1-2)% O_2	●[f]	●[f]	●[f]	●[f]	●[c]	-
Ar + 30% He + (1-2)% CO_2[d]	●[f]	●[f]	●[f]	●[f]	●[c]	-
Ar + 30% He + (1-2)% N_2	-	-	●	-	●[g]	-

a) Preferably in pulsed MIG welding.

b) Higher fluidity of the molten pool than with CO_2 addition.

c) Except for Sandvik 22.12.HT and Sandvik 27.31.4.LCu where Ar is preferred.

d) Not to be used in spray-arc welding where extra low carbon is required.

e) Better short-arc welding and positional welding properties than with Ar + (1-2)% O_2.

f) Higher fluidity of the molten pool than with Ar. Better short-arc welding properties than with Ar + (1-2)% CO_2.

g) For nitrogen-alloyed grades.

Shielding gases for TIG/GTAW welding

The normal gas for TIG welding is argon (Ar). Helium (He) can be added to increase penetration and fluidity of the weld pool. Argon or argon/helium mixtures can be used for welding all grades. In some cases nitrogen (N_2) and/or hydrogen (H_2) can be added in order to achieve special properties. For instance, the addition of hydrogen gives a similar, but much stronger effect as adding helium. However, hydrogen additions should not be used for welding martensitic, ferritic or duplex grades.

Alternatively, if nitrogen is added, the weld deposit properties of nitrogen alloyed grades can be improved. Oxidizing additions are not used because these destroy the tungsten electrode.

Recommendations for shielding gases used in TIG welding of different stainless steels are given in the table. For plasma-arc welding, the gas types with hydrogen additions in the table are mostly used as plasma gas, and pure argon as shielding gas.

	Parent metal (type of material)					
	Austenitic stainless steel	Duplex stainless steel	Super-duplex stainless steel	Ferritic stainless steel	High-alloy austenitic stainless steel	Nickel alloys
Ar	●	●	●	●	●	
Ar + He[a]	●	●	●	●	●	●[a]
Ar + (2-5)% H_2[a,b]	●[b]	-	-	-	●[b]	●[b]
Ar + (1-2)% N_2	-	●	●	-	-	-
Ar + 30% He + (1-2)% N_2	-	●	●	-	-	-

a) Improves flow compared with pure Ar.

b) Preferably for automatic welding. High welding speed. Risk of porosity in multi-run welds.

Root protection

A perfect welding result, without impairment of corrosion resistance and mechanical properties, can only be obtained when using a backing gas with very low oxygen content. For best results, a maximum of 20 ppm O_2 at the root side can be tolerated.

This can be achieved with a purging setup and can be controlled with a modern oxygen meter. Pure argon is by far the most common gas for root protection of stainless steels. Formiergas (N_2 + 5 - 12% H_2) is an excellent alternative for conventional austenitic steels. The gas contains an active component, H_2, which brings down the oxygen level in the weld area.

Nitrogen can be used for duplex steels in order to avoid nitrogen loss in the weld metal. The purity of the gas used for root protection should be at least 99.995%. When gas purging is impractical root flux can be an alternative.

MOLTEN SLAG PROTECTION

In submerged-arc welding (SAW) and electro-slag welding (ESW), the shield is achieved by a welding flux, completely covering the consumable, the arc and the molten pool. The flux also stabilizes the electric arc. The flux is fused by the heat of the process, creating a molten slag cover that effectively shields the weld pool from the surrounding atmosphere.

WELDING WIRE AND WELDING RODS

Sandvik welding wire and rods are filler metals optimized for MIG (GMAW), TIG (GTAW), plasma-arc (PAW) and submerged-arc welding (SAW). These are available in high performance stainless steels and nickel alloys, designed to increase productivity and lower production cost.

Lower production cost and higher performance is the name of the game for corrosion resistant alloy manufacturing. Sandvik produces filler metals from melting of raw materials to finished wire and rods. Characteristics of Sandvik wire are as follows:

- Chemical composition optimized for each welding process
- Controlled ferrite content and extremely low impurity levels for resistance to hot cracking and microfissuring
- Microelement control for optimum arc stability, wetting characteristics with extremely low spatter
- Controlled wire surface for trouble-free mechanized welding
- Alloy design for the optimum corrosion resistance and mechanical properties

Welding process	ISO	AWS
Metal inert gas welding/ Metal active gas welding	MIG/MAG	GMAW
Tungsten inert gas welding	TIG	GTAW
Submerged arc welding	SAW	SAW

FORMS OF SUPPLY FOR WELDING WIRE AND RODS

Our wire for MIG/MAG/GMAW, TIG/GTAW and SAW welding of stainless steel and nickel alloys can be delivered in the following delivery forms:

Basket spool (BS 300) for MIG welding

Wire diameters 0.8, 1.0, 1.2 and 1.60 mm. Wire weight 15 kg. Precision layer wound. The highly evironmentally compatible basket spools can be treated as metal scrap when empty.

Sanpac bulk package for MIG welding

Wire diameters 0.8, 1.0, 1.2 and 1.60 mm. Outside diameter of the drum 510 mm. Height of drum 820 or 450 mm. Wire weight 300 or 150 kg.

Masonite spool (BS 300) for MIG and TIG welding

Wire diameters max 1.60 mm. Wire weight 27 kg. Precision layer wound.

Plastic spool (S 200) for TIG welding

Wire diameter max 1.2 mm. Wire weight 5 kg. Normal wound.

Plastic spool (S 100) for TIG welding

Wire diameter max. 1.0 mm. Wire weight 1 kg. Precision layer wound.

Rods for TIG welding

Wire diameters 1.0, 1.2, 1.6, 2.0, 2.4, 3.2, 4.0 and 5.0 mm. Length 1000 mm, Weight of rods 5 kg. Each rod marked for identity. Paper carton.

Basket rim (B 450) for SAW welding

Wire diameter 2.0, 2.4, 3.2, 4.0 and 5.0 mm. Wire weight 28kg. Precision layer wound. Highly environmentally compatible. Empty rims can be treated as metal scrap.

WELDING WIRE STAINLESS STEEL GRADES

The table below shows Sandvik's standard program of stainless steel welding wire grades.

GRADES

Sandvik grade	AWS* ER	ISO 14343
13.4	410NiMo	13 4
18.LNb	-	18 L Nb
18.8.Mn	(307)	18 8 Mn Si
19.9.L	308L	19 9 L
19.9.LQ	308L	19 9 L
19.9.LSi	308LSi	19 9 L Si
19.9.Nb	347	19 9 Nb
19.9.NbSi	347Si	19 9 Nb Si

Sandvik grade	AWS* ER	ISO 14343
19.9.L CRYO	308L	19 9 L
19.12.3.L CRYO	316L	19 12 3 L
19.12.3.L	316L	19 12 3 L
19.12.3.LSi	316LSi	19 12 3 L Si
19.13.4.L	317L	19 13 4 L
19.12.3.Nb	318	19 12 3 Nb
19.12.3.NbSi	318Si	19 12 3 Nb Si
Sanweld AXT	(307)	18 8 Mn Si
23.7.L	-	23 7 L N
24.13.L	309L	23 12 L
24.13.LSi	309LSi	23 12 L Si
24.13.LHF	309L	23 12 L
24.13.Si	309Si	22 12 H
24.13.LNb	"309LNb"	23 12 Nb
22.15.3.L	(309LMo)	23 12 2 L
24.16.3.L	(309LMo)	(23 12 2 L)
25.20.C	310	25 20
25.20.L	310	25 20 L
29.9	312	29 9
22.8.3.L	2209	22 9 3 N L
22.8.3.LSi	2209	22 9 3 N L
25.10.4.L	2594	25 9 4 N L
27.7.5.L	-	-
29.8.2.L	-	-
22.12.HT	-	-
25.20.L	-	-
25.22.2.LMn	(310LMo)	25 22 2 N L
20.25.5.LCu	385	20 25 5 Cu L
27.31.4.LCu	383	27 31 4 Cu L
Sandvik SX	-	-

* (xxx) = nearest equivalent; "xxx" = constructed classification, denotes the type.

NICKEL ALLOY GRADES

The table below shows Sandvik's standard program of nickel alloy welding wire grades.

GRADES

Sandvik grade	AWS* ER	ISO 18274
Sanicro 41 Cu	NiFeCr-1	Ni 8065
Sanicro 53	NiCrCoMo-1	Ni 6617
Sanicro 54	NiCrMo-10	Ni 6022

Sandvik grade	AWS* ER	ISO 18274
Sanicro 56	NiCrMo-4	Ni 6276
Sanicro 59	NiCrMo-13	Ni 6059
Sanicro 60	NiCrMo-3	Ni 6625
Sanicro 68 HP	NiCrFe-7	Ni 6052
Sanicro 72 HP	NiCr-3	Ni 6082

* (xxx) = nearest equivalent; "xxx" = constructed classification, denotes the type.

PROPERTIES AND APPLICATIONS FOR WELDING WIRE AND RODS STAINLESS STEELS

Sandvik AWS ER ISO	Suitable welding methods	Mechanical properties typical values at 20°C (68°F)		Typical applications
13.4 410NiMo 13 4	MIG TIG	$R_{p0.2}$ R_m A KV	790 MPa 990 MPa 15% 48 J	Suitable for hydroturbine components and surfacing of continuous caster rolls.
19.9.L 308L 19 9 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	390 MPa 600 MPa 34% 135 J	Joining of stainless CrNi steels, stabilized or non-stabilized, e.g. 304, 304L, 321 and 347, for service temperatures up to 350°C (662°F). Also for stainless Cr steels with max 19% Cr. Cryogenic applications down to -269°C (-452°F), depending on welding process.
19.9.LSi 308LSi 19 9 L Si	MIG TIG PAW	$R_{p0.2}$ R_m A KV	390 MPa 600 MPa 42% 120 J	Joining of stainless CrNi steels, stabilized or non- stabilized, e.g. 304, 304L, 321 and 347, for service temperatures up to 350°C (662°F). Also for stainless Cr steels with max 19% Cr. Cryogenic applications down to -269°C (-452°F), depending on welding process.
19.9.Nb 347 347	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	400 MPa 610 MPa 42% 150 J	Joining of stainless, stabilized CrNi steels, e.g. 321 and 347. Due to the strengthening effect of Nb, 19.9.Nb is recommended for weld metals subjected to temperatures above 400°C (752°F). Particularly suitable for use in the nuclear industry owing to the low cobalt and impurity levels. Also for overlay welding of pressure vessels for the petrochemical industry.
19.9.NbSi 347Si 19 9 Nb Si	MIG TIG PAW	$R_{p0.2}$ R_m A KV	400 MPa 610 MPa 35% 110 J	Joining of stainless, stabilized CrNi steels, e.g. 321 and 347. Due to the strengthening effect of Nb, 19.9.NbSi is recommended for weld metals subjected to temperatures above 400°C (752°F).
19.12.3.L 316L 19 12 3 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	410 MPa 610 MPa 35% 110 J	Joining of stainless CrNiMo and CrNi steels, stabilized or non-stabilized, e.g. 316, 316L and 316Ti as well as 304, 304L, 321 and 347, for service temperatures up to 400°C (752°F). Also for stainless Cr steels with max 19% Cr.
19.12.3.LSi 316LSi 19 12 3 L Si	MIG TIG PAW	$R_{p0.2}$ R_m A KV	400 MPa 610 MPa 37% 130 J	Joining of stainless CrNiMo and CrNi steels, stabilized or non-stabilized, e.g. 316, 316L and 316Ti as well as 304, 304L, 321 and 347, for service temperatures up to 400°C (752°F). Also for stainless Cr steels with max 19% Cr.
19.13.4.L 317L 19 13 4 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	380 MPa 600 MPa 47% 140 J	Joining of stainless CrNiMo ELC steels, e.g. 316L and 317L, for use in more severe corrosive conditions, e.g. in the petrochemical and pulp and paper industries.

Sandvik AWS ER ISO	Suitable welding methods	Mechanical properties typical values at 20ºC (68ºF)		Typical applications
19.12.3.Nb 318 19 12 3 Nb	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	400 MPa 610 MPa 36% 135 J	Joining of stainless CrNiMo and CrNi steels, stabilized or non-stabilized, e.g. 316, 316L and 316Ti as well as 304, 304L, 321 and 347, for service temperatures up to 400°C (752°F).
19.12.3.NbSi "318Si" 19 12 3 Nb Si	MIG TIG PAW	$R_{p0.2}$ R_m A KV	400 MPa 610 MPa 35% 110 J	Joining of stainless CrNiMo and CrNi steels, stabilized or non-stabilized, e.g. 316, 316L and 316Ti as well as 304, 304L, 321 and 347, for service temperatures up to 400°C (752°F).
18.8.Mn (307) 18 8 Mn Si	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	460 MPa 650 MPa 41% 140 J	Joining of work-hardenable steels, armor plates, stainless austenitic Mn steels and free-machining steels, e.g. 303. Also for stainless Cr steels with max. 18% Cr, e.g. in the automotive industry. Overlay welding of carbon and low-alloy steels.
18.8.CMn "307C" 18 8 Mn	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	460 MPa 650 MPa 42% 150 J	Joining of work-hardenable steels, armor plates, stainless austenitic Mn steels and free-machining steels, e.g. 303. Also for stainless Cr steels with max. 18% Cr. Overlay welding of carbon and low-alloy steels.
24.13.L 309L 23 12 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	400 MPa 600 MPa 40% 140 J	Joining of stainless CrNi steels of the 309 type, wrought or cast. Also for stainless Cr steels. Dissimilar steels, e.g. austenitic stainless steel to carbon or low-alloy steels for service up to 320°C (608°F). First-layer overlay welding of carbon or low-alloy steels to give a 304L deposit.
24.13.LSi 309LSi 23 12 L Si	MIG TIG PAW	$R_{p0.2}$ R_m A KV	400 MPa 600 MPa 35% 140 J	Joining of stainless CrNi steels of the 309 type, wrought or cast. Also for stainless Cr steels, e.g. in the automotive industry.
24.13.LHF 309L 23 12 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	410 MPa 600 MPa 40% 140 J	Joining of dissimilar steels, e.g. austenitic stainless steel to carbon or low-alloy steel for service temperatures up to 300°C (572°F). Stainless CrNi steels of the 309 type, wrought or cast. Problem solver when center-line cracking occurs with 24,13.L. Overlay welding of carbon or low-alloyed steels.
24.13.Si 309Si 22 12 H	MIG TIG PAW	$R_{p0.2}$ R_m A KV	400 MPa 640 MPa 35% 115 J	Joining of stainless CrNi steels of the 304 and 309 types, wrought or cast. Heat-resistant, similar steels. Dissimilar steels, e.g. austenitic stainless steel to carbon or low-alloy steel. Also for stainless Cr steels, e.g. in the automotive industry.
22.15.3.L (309LMo) 23 12 2 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	400 MPa 600 MPa 40% 140 J	Joining of stainless CrNi or CrNiMo steels 304, 309 or 316 to ensure corrosion resistance in e.g. the pulp and paper industry. For dissimilar joints when alloying with Mo is essential. Overlay applications where higher Mo content is desired in the second and third layers.
25.20.C 310 25 20	MIG TIG PAW	$R_{p0.2}$ R_m A KV	390 MPa 590 MPa 43% 175 J	Joining of heat-resistant stainless CrNi steels of the 310 type.
29.9 312 29.9	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	520 MPa 730 MPa 25% 100 J	Joining of stainless steels where high strength or wear resistance is essential. Problem solver when joining similar or dissimilar steels with limited weldability. Overlay welding of carbon and low-alloy steels.
22.8.3.L 2209	MIG TIG	$R_{p0.2}$ R_m	600 MPa 750 MPa	Joining of duplex stainless steels Sandvik 3RE60, SAF 2205 and SAF 2304 or other similar duplex steels.

Sandvik AWS ER ISO	Suitable welding methods	Mechanical properties typical values at 20°C (68°F)		Typical applications
22 9 3 N L	PAW SAW	A KV	25% 160 J	
25.10.4.L - 25 9 4 L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	650 MPa 850 MPa 25% 160 J	Joining of super-duplex stainless steel Sandvik SAF 2507 or other similar super-duplex steels. Can also be used to join Sandvik SAF 2205 and other duplex steels of the 25% Cr type when the highest possible corrosion resistance is desired.
29.8.2.L - -	MIG TIG PAW	$R_{p0.2}$ R_m A KV	700 MPa 850 MPa 25% 180 J	Joining of super-duplex stainless steel Sandvik SAF 2906 or other similar steels.
22.12.HT - -	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	400 MPa 580 MPa 35% 120 J	Joining of stainless Cr-Ni steel Sandvik 253 MA* or other similar high-temperature steels.
28.34.HT - -	MIG TIG PAW	$R_{p0.2}$ R_m A KV	410 MPa 600 MPa 30% 120 J	Joining of stainless CrNi steel Sandvik 353 MA* or other similar high-temperature steels.
25.20.L - -	MIG TIG PAW	$R_{p0.2}$ R_m A KV	380 MPa 590 MPa 37% 120 J	Joining of stainless CrNi steel Sandvik 2RE10 or other similar steels exposed to heavily oxidizing media, e.g. nitric acid.
25.22.2.LMn (310LMo) 25 22 2 N L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	335 MPa 575 MPa 42% 120 J	Joining of stainless CrNiMo steels used in the urea industry, e.g. Sandvik 2RE69 or other similar steels as well as modified type 316L. Stainless CrNi and CrNiMo steels, 304L, 304LN and 316L, 316LN, for cryogenic applications down to -269°C (-452°F) and/or applications demanding low magnetic permeability.
20.25.5.LCu 385 20 25 5 Cu L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	400 MPa 540 MPa 35% 120 J	Joining of stainless high-alloy NiCrMoCu grade 904L or other similar materials.
27.31.4.LCu 383 27 31 4 Cu L	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	360 MPa 540 MPa 35% 165 J	Joining of stainless super-austenitic grades, e.g. Sanicro 28, Alloy 825 or other similar materials.

*253 MA and 353 MA are trademarks owned by Outokumpu OY

NICKEL ALLOYS

Sandvik AWS ER ISO	Suitable welding methods	Mechanical properties typical values at 20°C (68°F)		Typical applications
Sanicro 53 ERNiCrCoMo-1	MIG TIG SAW	$R_{p0.2}$ R_m A KV	510 MPa 770 MPa 37% 130 J	For joining heat resistant nickel alloys, heat resistant austenitic and cast alloys such as UNS N08810, UNS N08811 and N06617. Found in high temperature heat exchangers and valves, furnace tubing in the petrochemical industry, radiant heat tubes, gas turbines, components subjected to high temperatures in the

				chemical processing industry and components for power plants.
Sanicro 54 ERNiCrMo-10	MIG TIG SAW	$R_{p0.2}$ R_m A KV	500 MPa 780 MPa 40 % 110 J	For joining UNS N06022 (2.4602). Widely used as overmatching filler material for alloy UNS N10276 (2.4819), other nickel-chrome-molybdenum alloys and for surfacing low alloyed steels. Used in aggressively corrosive media such as chlorination systems, geothermal wells, HF furnace scrubbers, pesticide production, phosphoric acid production, SO_2 cooling towers and for weld overlays on valves.
Sanicro 56 ERNiCrMo-4	MIG TIG SAW	$R_{p0.2}$ R_m A KV	470 MPa 750 MPa 40 % 170 J	For joining of alloy UNS N06022 (2.4602) and other nickel-chrome-molybdenum alloys. Can also be used for dissimilar metal joining of nickel alloys, stainless steels, low-alloyed steels and for surfacing low alloyed steels. Found in aggressively corrosive media such as chemical processing plants, pollution control, pulp and paper production, waste treatment and for the recovery of sour natural gas.
Sanicro 59 ERNiCrMo-13	MIG TIG SAW	$R_{p0.2}$ R_m A KV	470 MPa 750 MPa 45 % 170 J	Joining of matching alloys or dissimilar joining to other nickel alloys such as UNS N10276 (2.4819), type UNS N06022 (2.4602), UNS N06625 (2.4856) and N08825 (2.4858). Nb-free weld metal for dissimilar welds in super-austenitic and super-duplex stainless steel joints or combinations of these with nickel alloys. Also used for surfacing. Found in scrubbers for flue gas desulfurisation (FGD), chemical process plants and in severe offshore and petrochemical environments.
Sanicro 60 ERNiCrMo-3	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	430 MPa 670 MPa 42% 150 J	Joining of Alloy 625, Alloy 825 and other similar materials. Dissimilar materials, e.g. austenitic stainless steels to NiCrMo grades. Steels of the 9% Ni type for cryogenic service. 254 SMO* and similar 6% MoN stainless steels. Overlay welding of carbon and low-alloy steels.
Sanicro 68HP ERNiCrFe-7 -	TIG PAW	$R_{p0.2}$ R_m A KV	420 MPa 650 MPa 38% 180 J	Joining of Alloy 690 and Alloy 600. Overlay welding in the nuclear industry.
Sanicro 72HP ERNiCr-3 -	MIG TIG PAW SAW	$R_{p0.2}$ R_m A KV	390 MPa 660 MPa 45% 245 J	Joining of Alloy 800, Alloy 800H, Alloy 600 and other similar materials. Steels of 9% Ni type used for cryogenic service. Dissimilar steels, e.g. austenitic stainless steels to carbon steels for high-temperature service, NiCu alloys to carbon steels, and NiCu alloys to nickel alloys.

* 254 SMO is a trademark owned by Outokumpu OY

WELDING WIRE FOR CRYOGENIC APPLICATIONS

For cryogenic applications, the chemical compositions in Sandvik's welding grades are optimized for Charpy-impact toughness and other characteristics which include:

– Extremely low impurity levels to reduce the risk of hot-cracking
– Controlled ferrite content for resistance to microfissuring
– A balanced content of microelements for optimum arc stability and wetting characteristics

Grade group	Alloy	Sandvik designation	AWS
Solid wire	Nickel	Sanicro 60	NiCrMo-3

Grade group	Alloy	Sandvik designation	AWS
	Nickel	Sanicro 72HP	NiCr-3
	Stainless	Sandvik 25.22.2.LMn	N/A
	Stainless	Sandvik 20.25.5.LCu	385
	Stainless	Sandvik 19.12.3.L Cryo	316L
	Stainless	Sandvik 19.9.L Cryo	308L

SANDVIK 13.4 WELDING WIRE

DATASHEET

Sandvik 13.4 is a filler material for the welding of parent metals of similar composition. The weld metal has high hardness and erosion resistance.

STANDARDS

- ISO 14343: 13 4
- AWS A5.9: 410NiMo

Product standards

- EN ISO 14343-A – (13 4)
- ASME/AWS SFA5.9 ER410NiMo

CHEMICAL COMPOSITION

Chemical composition, %

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N
0.01	0.4	0.6	0.002	0.015	12	4.5	0.5	0.3	0.015

APPLICATIONS

Sandvik 13.4 is a filler material for the welding of parent metals of similar composition with high resistance to erosion and cavitation. It is particularly suited for welding hydroturbine components and surfacing continuous caster rolls. Sandvik 13.4 is used for welding with TIG, MIG and PAW.

FORMS OF SUPPLY

Sandvik 13.4 is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 13.4 provides a martensitic-austenitic microstructure.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-20 (-4)	20 (68)[1)]
Yield strength, $R_{P0.2}$	MPa (ksi)	790 (115)	-	-
Tensile strength, R_m	MPa (ksi)	990 (144)	-	min 760 (110)
Elongation, A	%	15	-	min 15
Reduction in area, Z	%	60	-	-
Impact strength, Charpy V	J (ft lbs)	48 (35)	42 (31)	-
Hardness, Vickers	HV	320	-	-

Datasheet updated 2/22/2016 9:26:08 PM (supersedes all previous editions)

1) after heat treatment at 590-620°C (1095- 1150°F), held for 1 hour, and air cooled.

CORROSION RESISTANCE

Sandvik 13.4 has good resistance to erosion corrosion and cavitation.

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SANDVIK 18.8.MN WELDING WIRE

DATASHEET

Sandvik 18.8.Mn is a filler material is a filler metal of AWS ER 307 type with increased managanese content, reducing the risk for fissuring/hot cracking that otherwise can be a problem in fully austenitic weld metals. It is similar to ER 307 type suitable for joining work-hardenable steels, armor plate, austenitic stainless manganese steels, free-machining steels (such as ASTM 303) and stainless Cr steels with max. 18% Cr.

The grade is used, for example, in the automotive industry for joining dissimilar steels as well as tractor trailers and passenger rail cars. It is also suitable for overlay welding on carbon and low-alloy steels. Sandvik 18.8.Mn is available as wire and rods for MIG/MAG, TIG and plasma-arc welding.

STANDARDS

- AWS: - similar to ER (307)
- EN Number: 18 8 Mn

Product Standards

- EN ISO 14343

Sandvik 18.8.Mn is a modified version of ER 307 which is the closest AWS grade in AWS A5.9.

Product Approvals

- CE
- DB
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition (aim), wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
0.08	0.9	7.0	≤0.025	≤0.015	18	8	<0.3	<0.5	<0.10	<0.060

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data are typical for non heat treated weld metal made by MIG welding with a shielding gas of Ar + 2% O_2.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	N
0.07	0.8	6	0.010	0.009	18	8	0.05

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Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	N

WELD METAL CHARACTERISTICS

Fully austenitic.

MECHANICAL PROPERTIES

MIG and TIG - typical for non heat treated weld metal

Temperature	°C (°F)	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	460 (67)
Tensile strength, R_M	MPa (ksi)	650 (94)
Elongation, A_5	%	41
Reduction in area, Z	%	61
Impact strength, Charpy V	J (ft/lb)	140 (103)
Hardness, Vickers	HV	200

PHYSICAL PROPERTIES - ALL WELD METAL

Temperature, °C	20	100	300	500
Thermal conductivity, W/m	15	16	18	20

CORROSION RESISTANCE - ALL WELD METAL

Sandvik 18.8.Mn has corrosion resistance similar to that of the of the corresponding parent metal. For joints between non alloyed or low alloyed steels and stainless steels, resistance to corrosion is of secondary importance.

FABRICATION

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm (in.)	Wire feed, m/min (in./min)	Current, A	Voltage, V	Gas, l/min (CFH)
Short-arc welding				
1.0 (0.039)	4-8 (157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

– Short-arc welding is used with light gauge material of less than about 3 mm (0.118 in.), in depositing root runs, and in welding out-of-flat positions.

- The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.
- Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

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SANDVIK 18.LNB
WELDING WIRE

DATASHEET

Sandvik 18.LNb is a filler material suitable for joining Cr-steels with max 18% Cr, stabilized or non-stabilized. It is available as wire and rods for MIG/MAG, TIG and plasma-arc welding.

STANDARDS

– EN Number: 18 L Nb

Product Standards

– EN ISO 14343

FILLER METAL

Chemical composition (aim), wt%

C	Si	Mn	P	S	Cr	Nb
<0.030	0.7	0,5	<0.025	<0.015	18.5	0,5

CHEMICAL COMPOSITION- ALL-WELD METAL

The following data are typical for none heat treated all weld metal made by the MIG/MAG process using Argon + 2% O_2 as shielding gas.

C	Si	Mn	P	S	Cr	Nb
0.02	0.6	0.3	<0.030	<0.015	18.1	0.5

MICROSTRUCTURE- ALL-WELD METAL

Ferritic

CORROSION RESISTANCE

Matches the corrosion resistance of 17Cr (AISI 430-type) base metals.

RECOMMENDED WELDING DATA

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18

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Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

APPLICATIONS

Mainly used for welding of exhaust systems in the automotive industry
Continuous development may necessitate changes in technical data without notice.

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SANDVIK 19.12.3.L
WELDING WIRE

DATASHEET

Sandvik 19.12.3.L is a filler material for joining stainless CrNiMo and CrNi steels, stabilized or non-stabilized, e.g. ASTM 316, 316L and 316Ti as well as 304, 304L, 321 and 347.

Product Standards

- EN ISO 14343-A – 19 12 3 L
- ASME/AWS SFA-5.9 ER316L

APPROVALS

CE, DNV, TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition (aim), wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
<0.020	0.4	1.8	<0.025	<0.015	18.5	12.5	2.6	<0.060

APPLICATIONS

Sandvik 19.12.3.L is used for joining stainless CrNiMo and CrNi steels, stabilized or non-stabilized, e.g. ASTM 316, 316L and 316Ti as well as 304, 304L, 321 and 347, used for service temperatures up to 400°C (750°F). It is also used for Cr steels with max. 19% Cr. Sandvik 19.12.3.L is used for MIG/MAG, TIG, PAW and SAW.

FORMS OF SUPPLY

Sandvik 19.12.3.L is supplied as wire and straight rods

WELD METAL CHARACTERISTICS

Sandvik 19.12.3.L gives a microstructure with an austenitic matrix and a ferrite content of approximately 10FN according to DeLong.

Chemical composition - all-weld metal

The data below is typical for non heat treated all-weld metal made by SAW, Flux 15W.

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
0.018	0.5	1.5	0.023	0.011	18	12	2,6	0.06

MECHANICAL PROPERTIES

Datasheet updated 10/20/2015 3:10:08 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	410 (60)	290 (42)	-
Tensile strength, R_M	MPa (ksi)	610 (88)	470 (68)	-
Elongation, A_5	%	35	26	-
Reduction in area, Z	%	40	-	-
Impact strength, KV	J (ft lbs)	110 (81)	-	50 (37)
Hardness, Vickers	HV	160	-	-

SAW - typical for non heat treated weld metal using flux 15W

Temperature	°C (°F)	20 (68)
Yield strength, $R_{P0.2}$	MPa (ksi)	390 (57)
Tensile strength, R_m	MPa (ksi)	580 (84)
Elongation, A	%	35
Impact strength, KV	J (ft lbs)	60 (44)

CORROSION

Sandvik 19.12.3.L has good resistance to general corrosion and due to its low carbon content, good resistance to intercrystalline corrosion. It also has good resistance to pitting corrosion due to the balanced molybdenum content. Example: Pitting corrosion test. Three days in 1% $FeCl_3$ at 20°C (68°F), no corrosion observed.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:

– Peak current 300 - 400 A
– Background current 50 - 150 A
– Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

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– Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.
– The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.
– Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-400	28-32
3.2	300-450	29-34
4.0	350-500	30-35

Recommended flux is Sandvik 15W.

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SANDVIK 19.12.3.L CRYO WELDING WIRE

DATASHEET

Sandvik 19.12.3.L CRYO is a filler material for joining austenitic stainless steels, e.g. ASTM 316, 316L, as well as 304, 304L, for cryogenic applications and meets the requirements of ASME Section VIII, Division 1, UHA 51 ((a) (4) (-a) (-1)) and others. It is used for service temperatures down to -269ºC (-452ºF), and ferritic or martensitic stainless steels, with maximum 19% Cr. Sandvik 19.12.3.L CRYO is available as wire and rods for MIG/MAG, TIG, plasma arc and submerged arc welding (SAW). The grade has been specifically developed for welding in cryogenic applications, typically: manufacturing of dewars, containers, tanks, cryostats, and transfer systems for transportation and storage of LNG, LPG, liquid nitrogen and liquid helium.

The chemical composition is optimized for cryogenic applications in terms of impact strength and other characteristics. It has controlled chemical composition and ferrite content for resistance to microfissuring, and balanced minor additions of certain elements for optimum arc stability and wetting characteristics. Impurity levels are lower in the consumable in order to reduce the risk of hot cracking and to obtain the best arc stability, fluidity, low spatter and wetting properties.

STANDARDS

- AWS: ER316L
- EN Number: 19 12 3 L

Product Standards

- EN ISO 14343
- ASME/AWS SFA5.9

Product Approvals

- CE
- DNV
- TÜV
- CWB

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.023	0.4	1.8	≤0.025	≤0.003	18.5	13.0	2.3	0.06

CHEMICAL COMPOSITION - ALL WELD METAL

The following data is typical for non-heat treated weld metal made by MIG welding with a shielding gas of Ar + 2% O_2.

Chemical composition, wt%

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C	Si	Mn	P	S	Cr	Ni	Mo	N
0.018	0.3	1.8	0.012	0.002	18.5	12.8	2.3	0.06

The following data is typical for non-heat treated all weld metal made by SAW, Flux 15W/35W.

C	Si	Mn	P	S	Cr	Ni	Mo	N
0.021	0.5	1.5	0.023	0.003	18.0	12.8	2.3	0.06

WELD METAL CHARACTERISTICS

Austenitic-ferritic microstructure with approximately 3 FN, calculated from the WRC-92 diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-320)
Proof strength, $R_{P0.2}$	MPa (ksi)	410 (59)	290 (42)	-
Tensile strength, R_m	MPa (ksi)	610 (88)	470 (68)	-
Elongation, A	%	35	26	-
Reduction of area, Z	%	40	-	-
Impact strength, Charpy V	J (ft/lbs)	110 (81)	-	70 (52)
Hardness, Vickers	HV	160	-	-

SAW, Flux 15W

Temperature	°C (°F)	20 (68)
Proof strength, $R_{P0.2}$	MPa (ksi)	390 (57)
Tensile strength, R_m	MPa (ksi)	580 (84)
Elongation, A	%	35
Impact strength, Charpy V	J (ft/lbs)	110 (81)

PHYSICAL PROPERTIES - ALL WELD METAL

Temperature, °C (°F)	20 (68)	100 (212)	300 (572)	500 (932)
Thermal conductivity, W/m	15	16	19	20

CORROSION RESISTANCE - ALL WELD METAL

Sandvik 19.12.3.L CRYO has good resistance to general corrosion and due to its low carbon content, good resistance to intercrystalline corrosion. It also has good resistance to pitting corrosion due to the balanced molybdenum content. No corrosion was observed after pitting corrosion testing for three days in 1% $FeCl_3$ at 20°C (68°F).

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm (in.)	Wire feed, m (in.)/min	Current, A	Voltage, V	Gas, l/min (CHF)
Short-arc welding				
0.8 (0.031)	4-8 (157-315)	40-120	15-19	12 (25)

Wire diameter, mm (in.)	Wire feed, m (in.)/min	Current, A	Voltage, V	Gas, l/min (CHF)
1.0 (0.039)	4-8 (157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters:

– Peak current 300 - 400 A
– Background current 50 - 150 A
– Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

– Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.
– The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.
– Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0 (0.079)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34
4.0 (0.157)	350-500	30-35

Recommended flux is Sandvik 15W/35WF.

Datasheet updated 1/25/2016 10:15:03 AM (supersedes all previous editions)

SANDVIK 19.12.3.LSI WELDING WIRE

DATASHEET

Sandvik 19.12.3.LSi is suitable for joining stainless Cr-Ni-Mo and Cr-Ni steels, stabilized or non-stabilized, e.g. ASTM 316, 316L and 316Ti as well as 304, 304L, 321 and 347,

Product Standards

- EN ISO 14343-A – 19 12 3 L Si
- ASME/AWS SFA-5.9 ER316LSi

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
<0.025	0.9	1.8	<0.025	<0.015	18.5	12	2.6	<0.060

PRODUCT APPROVALS

CE, DB, DNV, TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

APPLICATIONS

Sandvik 19.12.3.LSi is suitable for joining stainless Cr-Ni-Mo and Cr-Ni steels, stabilized or non-stabilized, e.g. ASTM 316, 316L and 316Ti as well as 304, 304L, 321 and 347, for service temperatures up to 400°C (750°F). It is also used for welding of stainless Cr-steels with max 19% Cr. Sandvik 19.12.3.LSi is particularly suited for MIG/MAG-welding but can also be used for TIG and PAW.

FORMS OF SUPPLY

Sandvik 19.12.3.LSi is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	400 (58)	290 (42)	-
Tensile strength, R_M	MPa (ksi)	610 (88)	440 (64)	-
Elongation, A_5	%	37	29	-
Reduction in area, Z	%	68	-	-
Impact strength, Charpy V	J (ft lbs)	130 (96)	-	50 (37)
Hardness, Vickers	HV	160	-	-

Datasheet updated 10/20/2015 3:11:45 PM (supersedes all previous editions)

CORROSION

Sandvik 19.12.3LSi has good resistance to general corrosion and due to its low carbon content, good resistance to intercrystalline corrosion. It also has good resistance to pitting corrosion due to the balanced molybdenum content. Example: Pitting corrosion test. Three days in 1% $FeCl_3$ at 20°C (68°F), no corrosion observed.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current	300 - 400 A
	Background current	50 - 150 A
	Frequency	80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/20/2015 3:11:45 PM (supersedes all previous editions)

SANDVIK 19.12.3.NB WELDING WIRE

DATASHEET

Sandvik 19.12.3.Nb is suitable for joining stainless steels of the 18Cr/8Ni/Mo, 18Cr/8Ni/Mo/Ti and 18Cr/8Ni/Mo/Nb types.

Product Standards

- ASME/AWS SFA-5.9 ER318
- EN number ISO 14343-A - 19 12 3 Nb

Product Approvals

- TÜV
- UDT

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Nb	Co	Cu	N
0.04	0.4	1.5	<0.025	<0.015	18.5	11.5	2.6	>12xC <0.60	<0.20	<0.2	<0.060

APPLICATIONS

Sandvik 19.12.3.Nb is a niobium stabilised filler metal suitable for joining stainless steels of the 18Cr/8Ni/Mo, 18Cr/8Ni/Mo/Ti and 18Cr/8Ni/Mo/Nb types. Due to the strengthening effect of niobium, this grade is recommended if the weld metal will be exposed to temperatures above 400°C (750°F).

FORMS OF SUPPLY

Sandvik 19.12.3.Nb is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Gives a microstructure with austenitic matrix and a ferrite content of approximately 10FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	400 (58)	390 (57)	-
Tensile strength, R_M	MPa (ksi)	610 (88)	540 (78)	-
Elongation, A_5	%	37	29	-

Datasheet updated 10/20/2015 3:11:17 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Reduction in area, Z	%	68	-	-
Impact strength, Charpy V	J (ft lbs)	135 (100)	-	60 (44)
Hardness, Vickers	HV	220	-	-

Temperature	°C (°F)	600 (1112)	700 (1292)
Creep strength, 5 x 10^4 h	MPa (ksi)	155 (22)	45 (6)

SANDVIK 19.12.3.NBSI WELDING WIRE

DATASHEET

Sandvik 19.12.3.NbSi is suitable for joining chromium-nickel-molybdenum steels, stabilized or non-stabilized, e.g. ASTM 316Ti, 316 and 316L.

Product Standards

EN ISO 14343-A – 19 12 3 Nb Si

- ASME/AWS SFA-5.9 ER"318Si"

Product Approvals

- TÜV
- UDT

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Nb	Co	Cu	N
0.04	0.9	1.2	<0.025	<0.015	18.5	12.5	2.6	>12xC <0.60	<0.20	<0.2	<0.06

APPLICATIONS

Sandvik 19.12.3.NbSi is suitable for joining chromium-nickel-molybdenum steels, stabilized or non-stabilized, e.g. ASTM 316Ti, 316 and 316L for service temperatures up to 400°C (750°F). Sandvik 19.12.3.NbSi is used for MIG/MAG-, TIG- and plasma-arc welding.

FORMS OF SUPPLY

Sandvik 19.12.3.NbSi is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Themicrostructure has an austenitic matrix and a ferrite content of about 10FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	400 (58)	390 (57)	-
Tensile strength, R_M	MPa (ksi)	610 (88)	540 (78)	-

Datasheet updated 10/20/2015 3:13:45 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Elongation, A_5	%	35	30	-
Reduction in area, Z	%	60	-	-
Impact strength, Charpy V	J (ft lbs)	110 (81)	-	40 (30)
Hardness, Vickers	HV	160	-	-

CORROSION

Sandvik 19.12.3.NbSi has good resistance to general corrosion and due to the niobium content, good resistance to intergranular corrosion. It also has good resistance to pitting corrosion due to the balanced molybdenum content.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/20/2015 3:13:45 PM (supersedes all previous editions)

Datasheet updated 10/20/2015 3:13:45 PM (supersedes all previous editions)

SANDVIK 19.13.4.L WELDING WIRE

DATASHEET

Sandvik 19.13.4.L is suitable for joining stainless CrNiMo steels e.g. 317L or similar.

Product Standards

– EN ISO 14343-A – 19 13 4 L
– ASME/AWS SFA5.9 ER317L

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
<0.020	0.4	1.8	<0.015	<0.015	19	13.5	3.6	<0.20	<0.10	<0.060

APPLICATIONS

Sandvik 19.13.4.L is suitable for joining stainless CrNiMo steels e.g. 317L or similar. It is used for MIG/MAG-, TIG-, plasma-arc and submerged-arc welding.

FORMS OF SUPPLY

Sandvik 19.13.4.L is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 19.13.4.L gives a microstructure with austenitic matrix and a ferrite content of about 9-10FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)
Yield strength, $R_{P0.2}$	MPa (ksi)	380 (55)	290 (42)
Tensile strength, R_M	MPa (ksi)	600 (87)	460 (67)
Elongation, A_5	%	42	28
Reduction in area, Z	%	70	-
Impact strength, Charpy V	J (ft lbs)	140 (103)	-
Hardness, Vickers	HV	160	-

CORROSION RESISTANCE

Sandvik 19.13.4L has, due to the high molybdenum content, good resistance to corrosion in most inorganic and organic acids. The weld metal has good resistance to pitting corrosion in chloride containing solutions. The resistance to intergranular corrosion is also good due to the low carbon content.

Datasheet updated 10/20/2015 3:15:38 PM (supersedes all previous editions)

FABRICATION

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/20/2015 3:15:38 PM (supersedes all previous editions)

SANDVIK 19.9 WELDING WIRE

DATASHEET

Sandvik 19.9 (308/308H) is a chromium-nickel filler metal for joining austenitic stainless steels of type 18%Cr/10%Ni. The welding wire gives a high carbon deposit (minimum 0.04% carbon) for high temperature applications.

Product Standards

- AWS A5.9 ER308/308H
- ISO 14343-A 19 9 H

Product Approvals

- CE

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.05	0.4	1.8	19.8	9.2

APPLICATIONS

Sandvik 19.9 (308/308H) is used for welding steels of the following types:

ISO	1.4310, 1.4948 and 1.4303
ASTM	302, 304H and 305

Typical applications are found in high temperature service in the chemical and petrochemical industries as well as distillery, dairy and restaurant equipment.

FORMS OF SUPPLY

Sandvik 19.9 (308/308H) is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9 (308/308H) is austenitic with a ferrite content of approximately 10 FN according to WRC-92.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Datasheet updated 1/25/2016 10:15:47 AM (supersedes all previous editions)

Wire diameter, mm (in.)	Wire feed, m (in.)/min	Current, A	Voltage, V	Gas, l/min (CHF)
Short-arc welding				
0.8 (0.031)	4-8 (157-315)	40-120	15-19	12 (25)
1.0 (0.039)	4-8 (157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)] Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

- Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.
- The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.
- Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0 (0.079)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34
4.0 (0.157)	350-500	30-35

Recommended flux is Sandvik 15W/35WF.

SANDVIK 19.9.L
WELDING WIRE
DATASHEET

Sandvik 19.9.L is used for welding stainless steels of the 18Cr/8Ni/ELC and 18Cr/8Ni/Nb types.

Product Standards
- EN ISO 14343-A - 19 9 L
- ASME/AWS SFA-5.9 ER308L

Product Approvals
- CE
- DB
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION (AIM), %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
<0.025	0.4	1.8	<0.025	<0.015	20	10	<0.5	<0.20	<0.2	<0.06

APPLICATIONS
Sandvik 19.9.L is used for MIG/MAG, TIG, plasma arc welding and submerged arc welding. It is suitable for joining stainless steels of the 18Cr/8Ni/ELC and 18Cr/8Ni/Nb types for service temperatures up to 350°C (660°F). Sandvik 19.9.L is approved by TÜV-Rheinland for use at cryogenic temperatures down to 4°K (-269°C).

FORMS OF SUPPLY
Sandvik 19.9.L is supplied in wire and straight rods.

WELD METAL CHARACTERISTICS
Austenitic microstructure with ferrite number 10FN according to the DeLong diagram (based on aim analysis).

CHEMICAL COMPOSITION - ALL-WELD METAL, %
The data below is typical for non heat treated all-weld metal made by SAW, Flux 15W.

C	Si	Mn	P	S	Cr	Ni	N
0.02	0.6	1.2	0.025	0.012	19,5	10	0.05

MECHANICAL PROPERTIES
MIG TIG - typical for non heat treated weld metal

Datasheet updated 10/20/2015 3:16:03 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	390 (57)	290 (42)	-
Tensile strength, R_m	MPa (ksi)	600 (87)	440 (64)	-
Elongation, A	%	35	25	-
Reduction in area, Z	%	56	-	-
Impact strength, Charpy V	J (ft lbs)	135 (100)	-	60 (44)
Hardness, Vickers	HV	160	-	-

SAW - typical for non heat treated weld metal using flux 15W

Temperature	°C (°F)	20 (68)
Yield strength, $R_{P0.2}$	MPa (ksi)	390 (57)
Tensile strength, R_m	MPa (ksi)	560 (81)
Elongation, A	%	35
Impact strength, Charpy V	J (ft*lbs)	90 (66)

CORROSION PROPERTIES

Sandvik 19.9.L has good resistance to general corrosion and due to its low carbon content, good resistance to intercrystalline corrosion. It also has good resistance to oxidizing agents. Example: Huey test for MIG weld metal (5 x 48 hours in boiling 65% HNO_3). Rate of corrosion mean value, 0.11 mm/year.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-400	28-32
3.2	300-450	29-34
4.0	350-500	30-35

Recommended flux is Sandvik 15W.

Datasheet updated 10/20/2015 3:16:03 PM (supersedes all previous editions)

SANDVIK 19.9.L CRYO WELDING WIRE

DATASHEET

Sandvik 19.9.L CRYO is a filler material for joining austenitic stainless steels, e.g. ASTM 304, 304L (18Cr/8Ni/ELC), for cryogenic applications and meets the requirements of ASME Section VIII, Division 1, UHA 51 ((a) (4) (-a) (-1)) and others. It is also used for service temperatures down to -269°C (-452°F), and ferritic or martensitic stainless steels with maximum 19% Cr. Sandvik 19.9.L Cryo is approved by TÜV Rheinland for use at cryogenic temperatures down to 4K (-269°C (-452°F)). It is suitable for joining stainless steels of 18Cr/8Ni/Nb types, e.g. ASTM 347, for service temperatures up to 350°C (660°F).

Sandvik 19.9.L CRYO is available as wire and rods for MIG/MAG, TIG, plasma arc, and submerged arc welding (SAW). Specifically developed for welding in cryogenic applications, typically: manufacturing of dewars, containers, tanks, cryostats, and transfer systems for transportation and storage of LNG, LPG, liquid nitrogen and liquid helium.

The chemical composition is optimized for cryogenic applications in terms of impact strength and other characteristics. It has a controlled chemical composition and ferrite content for resistance to microfissuring, and balanced minor additions of certain elements for optimum arc stability, fluidity and low spatter.

STANDARDS

- AWS: ER308L
- EN Number: 19 9 L

Product Standards

- EN ISO 14343
- ASME/AWS SFA5.9

Product Approvals

- CE
- DNV
- TÜV
- CWB

CHEMICAL COMPOSITION - FILLER METAL, %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.023	0.4	1.8	≤0.025	≤0.014	19.8	10.6	≤0.3	≤0.10

CHEMICAL COMPOSITION, ALL-WELD METAL, %

The following data is typical for non-heat treated weld metal made by MIG welding with a shielding gas of Ar + 2% O_2.

Datasheet updated 10/29/2015 9:10:55 AM (supersedes all previous editions)

C	Si	Mn	P	S	Cr	Ni	Mo	N
0.02	0.3	1.7	0.020	0.010	19.8	10	0.15	0.08

The following data is typical for non-heat treated all weld metal made by SAW, Flux 15W/35W.

C	Si	Mn	P	S	Cr	Ni	Mo	N
0.02	0.6	1.2	0.025	0.011	19.3	10	0.15	0.09

WELD METAL CHARACTERISTICS

Austenitic-ferritic microstructure of about 6, calculated from the WRC-92 diagram

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature,	°C (°F)	20 (68)	400 (752)	-196 (-320)
Proof strength, $R_{P0.2}$	MPa (ksi)	390 (57)	290 (42)	-
Tensile strength, R_m	MPa (ksi)	600 (87)	440 (64)	-
Elongation, A	%	35	25	-
Reduction in area, Z	%	56	-	-
Impact strength, Charpy V	J (ft/lbs)	135 (100)	-	60 (44)
Hardness, Vickers	HV	160	-	-

SAW - typical for non-heat treated weld metal using flux 15W.

Temperature, °C (°F)		20 (68)
Proof strength, $R_{P0.2}$	MPa (ksi)	390 (57)
Tensile strength, R_m	MPa (ksi)	560 (81)
Elongation, A	%	35
Impact strength, Charpy V	J (ft/lbs)	90 (66)

PHYSICAL PROPERTIES - ALL-WELD METAL

Temperature °C (°F)	20 (68)	100 (212)	300 (572)	500 (932)
Thermal conductivity, W/m	15	16	19	21

CORROSION RESISTANCE - ALL-WELD METAL

Sandvik 19.9.L CRYO has good resistance to general corrosion and due to its low carbon content, good resistance to intercrystalline corrosion. It also has good resistance to oxidizing agents. Huey testing of MIG weld metal (5 x 48 hours in boiling 65% HNO_3) resulted in a low mean corrosion rate of 0.11 mm/year.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm (in.)	Wire feed, m (in.)/min	Current, A	Voltage, V	Gas, l/min (CHF)
Short-arc welding				
0.8 (0.031)	4-8(157-315)	40-120	15-19	12 (25)

Wire diameter, mm (in.)	Wire feed, m (in.)/min	Current, A	Voltage, V	Gas, l/min (CHF)
1.0 (0.039)	4-8(157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12(236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0 (0.079)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34
4.0 (0.157)	350-500	30-35

Recommended flux is Sandvik 15W.

Datasheet updated 10/29/2015 9:10:55 AM (supersedes all previous editions)

![SANDVIK]

SANDVIK 19.9.LQ WELDING WIRE

DATASHEET

Sandvik 19.9.LQ is particularly suited for welding in the nuclear industry. It is used for MIG-, TIG-, plasma-arc and submerged-arc welding.

STANDARDS

- AWS: ER308L
- EN Number: 19 9 L

Product Standards

- EN ISO 14343
- ASME/AWS SFA5.9

FILLER METAL

Chemical composition (aim), wt%

C	Si	Mn	P	S	Cr	Ni	Co	Cu	N
<0.025	0.4	1.8	<0.025	<0.015	19.5	10	<0,05	<0,10	<0.06

CHEMICAL COMPOSITION- ALL-WELD METAL

The data below is typical for non heat treated all-weld metal made by TIG-welding with a shielding gas of Ar.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Co	Cu	N
0.02	0.3	1.7	0.020	0.011	19.5	10	0.04	0.06	0.05

The data below is typical for non heat treated all-weld metal made by SAW, Flux 15W.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Co	Cu	N
0.02	0.6	1.4	0.025	0.012	19.5	10	0.04	0.07	0.05

MICROSTRUCTURE- ALL-WELD METAL

Austenitic matrix with 9 FN WRC.

MECHANICAL PROPERTIES- ALL-WELD METAL

TIG - typical for non heat treated weld metal

Temperature	° C	20	350

Datasheet updated 10/20/2015 3:16:58 PM (supersedes all previous editions)

Temperature	°C	20	350
Yield strength, $R_{P0.2}$	MPa	420	270
Tensile strength, R_M	MPa	630	390
Elongation, A_5	%	38	33
Reduction in area, Z	%	60	-
Impact strength, Charpy V	J	140	-
Hardness, Vickers	HV	160	-

SAW - typical for non heat treated weld metal using flux 15W

Temperature	°C	20	350
Yield strength, $R_{P0.2}$	MPa	350	250
Tensile strength, R_m	MPa	540	360
Elongation, A	%	40	33
Impact strength, Charpy V	J	885	-

CORROSION PROPERTIES- ALL-WELD METAL

Resistant to intergranular corrosion according to ASTM A262 Practice E in as welded condition and after post weld heat treatment.

Datasheet updated 10/20/2015 3:16:58 PM (supersedes all previous editions)

SANDVIK 19.9.LSI
WELDING WIRE

DATASHEET

Sandvik 19.9.LSi is suitable for joining stainless steels of the 18Cr/8Ni ELC-type and 18Cr/8Ni/Nb type.

STANDARDS

– AWS:

Product Standards

– ISO 14343-A - 19 9 L Si
– ASME/AWS SFA5.9 ER308LSi

Product Approvals

– CE
– DB
– TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
<0.025	0.9	1.8	<0.025	<0.015	20	10.5	<0.3	<0.06

APPLICATIONS

Sandvik 19.9.LSi is a filler metal particularly suited for MIG welding but can also be used for TIG and plasma arc welding. It is suitable for joining stainless steels of the 18Cr/8Ni ELC-type and 18Cr/8Ni/Nb type for service temperatures up to 350°C (660°F).

FORMS OF SUPPLY

Sandvik 19.9.LSi is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Austenitic matrix with a ferrite content of about 12FN according to DeLong diagram.

MECHANICAL PROPERTIES

MIG TIG - typical for non heat treated weld metal

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)

Datasheet updated 10/20/2015 3:17:23 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	390 (57)	290 (42)	-
Tensile strength, R_M	MPa (ksi)	600 (87)	440 (64)	-
Elongation, A_5	%	42	24	-
Reduction in area, Z	%	60	-	-
Impact strength, Charpy V	J (ft lbs)	120 (88)	-	50 (37
Hardness, Vickers	HV	160	-	-

CORROSION RESISTANCE

Sandvik 19.9.LSi has good resistance to general corrosion and due to its low carbon content, good resistance to intergranular corrosion. Example: Huey test for MIG weld metal (5 x 48 hours in boiling 65% HNO_3). Rate of corrosion mean value, 0.13 mm/year.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

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Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

SANDVIK

SANDVIK 19.9.NB WELDING WIRE

DATASHEET

Filler metal Sandvik 19.9.Nb is suitable for joining stainless steels of the 18Cr/8Ni/Nb and 18Cr/8Ni/Ti types.

Product Standards

- EN ISO 14343-A – 19 9 Nb
- ASME/AWS SFA-5.9 ER347

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	Nb	N
0.03	0.4	1.3	<0.025	<0.015	19.5	9.5	<0.3	<0.05	<0.10	>12xC <0.7	<0.07

PRODUCT APPROVALS

CE, DB, TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

APPLICATIONS

Filler metal Sandvik 19.9.Nb is suitable for joining stainless steels of the 18Cr/8Ni/Nb and 18Cr/8Ni/Ti types. Due to the strenghtening effect of niobium, this grade is recommended if the weld metal will be exposed to temperatures above 400°C (750oF). It is used for MIG/MAG-, TIG-, plasma-arc and submerged-arc welding.

FORMS OF SUPPLY

Sandvik 19.9.Nb is supplied in wire and straight rods.

WELD METAL CHARACTERISTICS

The weld metal has an austenitic matrix with a ferrite number of 8-10FN according to the DeLong diagram.

The following data are typical for weld metal made by SAW using the flux 15W.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Nb	N
0.03	0.5	0,9	0.02	0.013	19	9.5	0.5	0.05

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)

Datasheet updated 10/20/2015 3:17:47 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	400 (58)	340 (49)	-
Tensile strength, R_M	MPa (ksi)	610 (88)	560 (81)	-
Elongation, A_5	%	42	28	-
Reduction in area, Z	%	73	-	-
Impact strength, Charpy V	J (ft lbs)	150 (111)	-	50 (37)
Hardness, Vickers	HV	160	-	-

Temperature	°C (°F)	600 (1112)	700 (1292)
Creep strength, 5 x 10^4 h	MPa (ksi)	135 (20)	50 (7)

SAW with flux Sandvik 15W - typical for non heat treated weld metal:

Temperature	°C (°F)	20 (68)
Yield strength, RP0.2	MPa (ksi)	400 (58)
Tensile strength, RM	MPa (ksi)	600 (87)
Elongation, A5	%	35
Reduction in area, Z	%	73
Impact strength, Charpy V	J (ft*lbs)	80 (59)

CORROSION PROPERTIES- ALL-WELD METAL

Sandvik 19.9.Nb has good resistance to general corrosion and due to its niobium content, good resistance to intercrystalline corrosion.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Datasheet updated 10/20/2015 3:17:47 PM (supersedes all previous editions)

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-400	28-32
3.2	300-450	29-34
4.0	350-500	30-35

Recommended welding flux is Sandvik 15W.

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SANDVIK 19.9.NBSI WELDING WIRE

DATASHEET

Sandvik 19.9.NbSi is a filler metal mainly suited for MIG welding of stainless steels of the 18Cr/8Ni/Nb and 18Cr/8Ni/Ti types.

STANDARDS

- AWS: ER347Si
- EN Number: 19 9 Nb Si

Product Standards

- EN ISO 14343-A – 19 9 Nb Si
- ASME/AWS SFA5.9

Product Approvals

- CE
- DB
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	Nb	N
0.04	1.0	1.3	<0.025	<0.015	19.5	10	<0.3	<0.2	<0.2	>12xC <0.75	<0.050

PRODUCT APPROVALS

- CE
- DB
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

APPLICATIONS

Sandvik 19.9.NbSi is particularly suited for MIG welding. It can also be used for TIG and plasma arc welding. It is suitable for joining stainless steels of the 18Cr/8Ni/Nb and 18Cr/8Ni/Ti types. Due to the strengthening effect of niobium, this grade is recommended if the weld metal is exposed to temperatures above 400°C (750°F).

Datasheet updated 10/27/2015 12:51:44 PM (supersedes all previous editions)

FORMS OF SUPPLY

Sandvik 19.9.NbSi is supplied as wire and straight rods

WELD METAL CHARACTERISTICS

Sandvik 19.9.NbSi gives an austenitic microstructure with approximately 8-9FN according to the WRC-92 diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	400 (58)	320 (46)	-
Tensile strength, R_M	MPa (ksi)	610 (88)	470 (68)	-
Elongation, A_5	%	35	23	-
Reduction in area, Z	%	61	50	-
Impact strength, Charpy V	J (ft lbs)	110 (81)	-	60 (44)
Hardness, Vickers	HV	225	-	-

CORROSION RESISTANCE

Sandvik 19.9.NbSi has good resistance to general corrosion and due to its niobium content, good resistance to intercrystalline corrosion.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

Datasheet updated 10/27/2015 12:51:44 PM (supersedes all previous editions)

SANDVIK 19.LNBTI WELDING WIRE

DATASHEET

Sandvik 19.LNbTi welding wire has excellent resistance to oxidation in air and in sulphur containing combustion gases. Its strength at high temperatures is enhanced by the addition of Ti and Nb. It is suitable for joining base metals such as 409, 430L, and 439. The high silicon content of this grade improves weld metal flow characteristics over conventional ferritic welding consumables.

It is suitable for joining similar parent metals in, for example, the high temperature sections of exhaust systems for the automotive industry such as manifolds, catalytic converters, and diesel exhaust systems. It is also suitable for overlay welding where oxidation resistance is required.

STANDARDS

- AWS: - similar to AWS ER 430LCbTi
- EN Number: 19 L Nb Ti

Sandvik 19.LNbTi is a modified version of ER 439 which is the closest grade in AWS A5.9.

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Nb	Ti
≤0.025	0.8	0.5	≤0.030	≤0.015	19	0.4	0.5

WELD METAL CHARACTERISTICS

Fully ferritic.

CORROSION RESISTANCE - ALL WELD METAL

Sandvik 19.LnbTi has corrosion resistance comparable to other 18% chromium extra low carbon stainless steels.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm (in.)	m/min (in./min)	A	V	l/min (CFH)
Short-arc welding				
1.0 (0.039)	4-8 (157-315)	60-140	15-21	12 (25)
Spray-arc welding				

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Wire diameter	Wire feed	Current	Voltage	Gas
mm (in.)	m/min (in./min)	A	V	l/min (CFH)
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

- Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.
- The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.
- Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

SANDVIK 20.25.5.LCU WELDING WIRE

DATASHEET

Sandvik 20.25.5.LCu welding wire is suitable for joining steels of the 20Cr/25Ni/4.5Mo/1.5Cu type - for example Sandvik 2RK65 used in many areas of the process industry, such as in the production of acetic acid, sulphuric acid, terephthalic or tartaric acid and vinyl chloride. It is also suitable for use in cooling operations involving sea water or heavily polluted river water.

This grade can be used for MIG, TIG, plasma-arc and submerged-arc welding.

STANDARDS

- AWS: ER385
- EN Number: 20 25 5 Cu L

Products Standards

- EN ISO 14343
- ASME/AWS A5.9

Product Approvals

- CE
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.020	0.4	1.8	≤0.015	≤0.015	20	25	4.5	1.5

CHEMICAL COMPOSITION- ALL WELD METAL

The following data is typical for non heat treated all-weld metal made by MIG welding with argon shielding gas.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.020	0.4	1.5	≤0.015	≤0.015	19.5	25	4.5	1.5

WELD METAL CHARACTERISTICS

Fully austenitic matrix.

Datasheet updated 1/25/2016 10:19:02 AM (supersedes all previous editions)

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-320)
Yield strength, $R_{p0.2}$	MPa (ksi)	320 (46)	250 (36)	-
Tensile strength, R_m	MPa (ksi)	540 (78)	410 (59)	-
Elongation, A	%	37	29	-
Reduction in area, Z	%	60	-	-
Impact strength, Charpy V	J (ft/lb)	120 (89)	-	100 (74)
Hardness, Vickers	HV	160	-	-

PHYSICAL PROPERTIES - ALL WELD METAL

Thermal conductivity, W/m °C, at 20°C	13
Thermal expansion per °C, from 20° to 400°C	$17x10^{-6}$
Density, g/cm^3, at 20°C	8.1

CORROSION RESISTANCE - ALL WELD METAL

Sandvik 20.25.5.LCu shows very good resistance to stress corrosion cracking, intercrystalline corrosion and to attack in acidic, non-oxidizing environments, such as sulphuric, phosphoric and acetic acid. The resistance to pitting corrosion and crevice corrosion is significantly better than that of ordinary 18Cr/8Ni and 18Cr/8Ni/Mo steels.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm (in.)	m/min (in./min)	A	V	l/min (CFH)
Short-arc welding				
0.8 (0.031)	4-8 (157-315)	50-140	16-25	12 (25)
1.0 (0.039)	4-8 (157-315)	70-160	16-25	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	150-230	26-31	18 (38)
1.2 (0.047)	5-9 (197-354)	170-280	27-32	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)] Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

- Short-arc welding is used for thin gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.
- The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Datasheet updated 1/25/2016 10:19:02 AM (supersedes all previous editions)

– Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.078)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34
4.0 (0.157)	350-500	30-35

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.078)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34

Recommended welding flux is Sandvik 15W.

Datasheet updated 1/25/2016 10:19:02 AM (supersedes all previous editions)

SANDVIK 22.12.HT WELDING WIRE

DATASHEET

Sandvik 22.12.HT is an austenitic filler material for welding the high temperature steel grade Sandvik 253 MA*, UNS S30815. It is characterized by high creep strength, good resistance to oxidation and good weldability.

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N	Ce
0.08	1.6	0.5	≤0.025	≤0.015	21	10	≤0.3	0.17	0.06

WELD METAL CHARACTERISTICS

Austenitic matrix with a ferrite content of 6FN according to the WRC-92 diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	600 (1112)	800 (1472)	1000 (1832)
Yield strength, $R_{p0,2}$	MPa (ksi)	360 (52)	-	-	-
Tensile strength, R_m	MPa (ksi)	580 (84)	-	-	-
Elongation, A	%	40	-	-	-
Impact strength, Charpy V	J (ft/lb)	120 (89)	-	-	-
Hardness, Vickers	HV	180	-	-	-
Creep rupture strength, 5×10^5h	.	.	100	15	5

PHYSICAL PROPERTIES - ALL WELD METAL

Temperature °C	20	100	300	500
Thermal conductivity, W/m	14.5	16	17.5	21

– Thermal expansion per °C, from 20 °C (68°F) to 400°C (750°F) 17.6×10^{-6}

– Density, g/cm^3, at 20°C (68°F), 7.8

CORROSION RESISTANCE - ALL WELD METAL

Sandvik 22.12.HT has good resistance to oxidation and can be used in air up to 1150°C (2100°F).

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common

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conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm (in.)	m/min (in./min)	A	V	l/min (CFH)
Short-arc welding				
0.8 (0.031)	4-8 (157-315)	40-120	15-19	12 (25)
1.0 (0.039)	4-8 (157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding of argon or helium should be used to prevent oxidation of the weld metal.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.078)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34
4.0 (0.157)	350-500	30-35

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.078)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34

Recommended welding flux is Sandvik 15W.

* 253 MA is a trademark owned by Outokumpu OY.

SANDVIK 22.15.3.L WELDING WIRE

DATASHEET

Sandvik 22.15.3.L is an austenitic filler material for joining stainless steels to carbon steels or low-alloy steels and for overlay welding.

Product Standards

– EN ISO 14343-A – 23 12 2 L
– ASME/AWS SFA5.9 ER(309LMo)

CHEMICAL COMPOSITION

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Mo
≤0.025	0.4	1.5	≤0.025	≤0.015	21.5	15	2.7

WELD METAL CHARACTERISTICS

Sandvik 22.15.3.L gives a microstructure with an austenitic matrix and a ferrite content of about 12FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	400 (58)
Tensile strength, R_m	MPa (ksi)	600 (87)
Elongation, A	%	40
Reduction in area, Z	%	60
Impact strength, Charpy V	J (ft lbs)	140 (103)
Hardness, Vickers	HV	180

CORROSION RESISTANCE

Sandvik 22.15.3.L is normally used for joints between non alloyed or low alloyed steels and stainless steels, where resistance to corrosion is of secondary importance.

FABRICATION

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				

Datasheet updated 10/27/2015 1:32:37 PM (supersedes all previous editions)

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding
The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding
Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-350	28-32
2.4	250-450	28-32
3.2	300-500	29-34
4.0	400-600	30-35

Recommended welding flux is Sandvik 15W.

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SANDVIK 22.8.3.L WELDING WIRE

DATASHEET

Sandvik 22.8.3.L is a duplex stainless filler metal for welding duplex stainless steels. Weldability as well as properties of the all-weld metal is excellent. Corrosion resistance is equal to 904L in most applications.

Product Standards

– EN ISO 14343-A – 22 9 3 N L
– ASME/AWS SFA5.9 ER2209

Product Approvals

– CE
– DNV
– TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.5	1.6	≤0.020	≤0.015	23	9	3.2	0.16

APPLICATIONS

Sandvik 22.8.3.L is used for welding of duplex stainless steels such as Sandvik SAF 2205 and SAF 2304. It can also be used for welding of duplex stainless steels to carbon steel. Sandvik 22.8.3.L is used for joint welding and cladding with TIG, MIG, SAW, PAW and laser welding.

FORMS OF SUPPLY

Sandvik 22.8.3.L is supplied as wire and straight rods.

WELD METAL CHARACTERSTICS

Sandvik 22.8.3.L gives an austenitic-ferritic (duplex) microstructure with approximately 50 FN, calculated from the WRC-92 diagram.

Chemical composition - all-weld metal

The data below is typical for non heat treated all-weld metal made by SAW, Flux 15W.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.7	1.2	≤0.025	≤0.015	22.5	9	3	0.15

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Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N

MECHANICAL PROPERTIES

MIG and TIG

Temperature	°C (°F)	20 (68)	-20 (-4)
Yield strength, $R_{p0.2}$	MPa (ksi)	600 (87)	-
Tensile strength, R_m	MPa (ksi)	750 (109)	-
Elongation, A	%	25	-
Impact strength, Charpy V	J (ft lbs)	160 (118)	100 (74)
Hardness, Vickers	HV	240	-

SAW, Flux 15W

Temperature	°C (°F)	20 (68)	-40 (-40)
Yield strength, $R_{p0.2}$	MPa (ksi)	650 (94)	-
Tensile strength, R_m	MPa (ksi)	770 (112)	-
Elongation, A	%	33	
Impact strength, Charpy V	J (ft lbs)	90 (66)	85 (63)

CORROSION RESISTANCE

Sandvik 22.8.3.L is resistant to intergranular corrosion and pitting. It also has good resistance to stress corrosion cracking, especially in environments containing H_2S.

FABRICATION

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

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Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-400	28-32
3.2	300-450	29-34
4.0	350-500	30-35

Recommended welding flux is Sandvik 15W.

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SANDVIK

SANDVIK 22.8.3.LSI WELDING WIRE

DATASHEET

Sandvik 22.8.3.LSi is a duplex stainless filler metal for welding of duplex stainless steels, such as Sandvik SAF 2205 and Sandvik SAF 2304.

Product Standards

- EN ISO 14343-A 22 9 3 N L Si
- ASME/AWS SFA5.9 ER2209

Product Approvals

- CE
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.8	1.6	≤0.025	≤0.015	23	9	3.2	0.16

APPLICATIONS

Sandvik 22.8.3.LSi is designed for gas shielded arc welding and particularly MIG welding of duplex stainless steels, such as Sandvik SAF 2205 and Sandvik SAF 2304. Its corrosion resistance is equal to 904L in most applications. It combines high strength with excellent ductility. Sandvik 22.8.3.LSi can also be used for joining Sandvik SAF 2205 or Sandvik SAF 2304 to carbon steel or low-alloy steels.

FORMS OF SUPPLY

Sandvik 22.8.3.LSi is supplied as wire and straight rods.

WELD METAL CHARACTERSTICS

Sandvik 22.8.3.LSi gives an austenitic-ferritic (duplex) microstructure with approximately 50FN according to the WRC-92 diagram.

MECHANICAL PROPERTIES

MIG and TIG

Temperature	°C (°F)	20 (68)	-40 (-40)
Yield strength, RP0.2	MPa (ksi)	600 (87)	-
Tensile strength, Rm	MPa (ksi)	750 (109)	-

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Temperature	°C (°F)	20 (68)	-40 (-40)
Elongation, A	%	25	-
Impact strength, Charpy V	J (ft lbs)	130 (96)	110 (81)
Hardness, Vickers	HV	240	-

CORROSION RESISTANCE

Sandvik 22.8.3.LSi is resistant to intergranular and pitting corrosion. It also has good resistance to stress corrosion cracking, especially in environments containing H_2S.

FABRICATION

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm	m/min	A	V	l/min
Short-arc welding				
0.8	4-8	40-120	16-20	12
1.0	4-8	60-140	16-22	12
Spray-arc welding				
1.0	6-12	140-220	24-29	18
1.2	5-9	180-260	25-30	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Recommended thermal data

The interpass temperature should be kept below 250°C (482°F) and the heat input between 0.5 and 2.5kJ/mm for joint welding. Preheating is normally not recommended. In case post weld heat treatment is needed from a construction point of view, contact Sandvik for support

Datasheet updated 10/20/2015 3:19:52 PM (supersedes all previous editions)

Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

SANDVIK 23.7.L WELDING WIRE

DATASHEET

Sandvik 23.7.L is a duplex stainless filler metal for welding lean duplex stainless steels such as Sandvik SAF 2304, LDX 2101* and similar. Corrosion resistance is equal to 316L in most applications. This alloy is not alloyed with molybdenum and has found applications for production of Nitric Acid in the fertilizer industry.

STANDARDS

– EN Number: 23 7 L N

Product Standards

– EN ISO 14343

CHEMICAL COMPOSITION- FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	≤0.7	1.7	≤0.025	≤0.005	23	7	0.3	0.14

WELD METAL CHARACTERISTICS

Austenitic-ferritic microstructure with approximately 50 FN, calculated from the WRC-92 diagram.

MECHANICAL PROPERTIES

TIG (GTAW)

Temperature	°C (°F)	20 (68)	-20 (-4)
Yield strength, $R_{p0.2}$	MPa (ksi)	525 (76)	-
Tensile strength, R_m	MPa (ksi)	710 (103)	-
Elongation, A	%	25	-
Impact strength, Charpy V	J (ft/lb)	170 (125)	150 (110)
Hardness, Vickers	HV	230	-

SAW, Flux 15W

Temperature	°C (°F)	20 (68)	-20 (-4)
Yield strength, $R_{p0.2}$	MPa (ksi)	500 (72.5)	-
Tensile strength, R_m	MPa (ksi)	600 (87)	-
Elongation, A	%	30	-
Impact strength, Charpy V	J (ft/lb)	100 (74)	90 (66)

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PHYSICAL PROPERTIES - ALL WELD METAL

Thermal conductivity, W/m °C, at 20°C (68°F)	16
Thermal expansion per °C, from 20 to 400°C (68 to 752°F)	$14.5x10^{-6}$
Density, g/cm^3 (lb/in.^{3}), at 20°C (68°F)	7.9 (0.285)

CORROSION RESISTANCE - ALL WELD METAL

Sandvik 23.7.L is resistant to intergranular and pitting corrosion at the same level as 316L. Resistance to stress corrosion cracking is better than 316L

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm (in.)	m/min (in./min)	A	V	l/min (CFH)
Short-arc welding				
0.8 (0.031)	4-8 (157-315)	40-120	15-19	12 (25)
1.0 (0.039)	4-8(157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding of argon or helium should be used to prevent oxidation of the weld metal.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.078)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34

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Wire diameter	Current	Voltage
mm (in.)	A	V
4.0 (0.157)	350-500	30-35

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.078)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.126)	300-450	29-34

Recommended welding flux is Sandvik 15W.

* LDX 2101 is a trademark owned by Outokumpu OY.

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SANDVIK 24.13.L WELDING WIRE

DATASHEET

Sandvik 24.13.L is suitable for joining stainless Cr-Ni steels of the 309 type, Cr-steels and dissimilar steels.

Product Standards

- EN ISO 14343-A – 23 12 L
- ASME/AWS SFA-5.9 ER309L

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu
<0.02	0.4	1.8	<0.02	<0.015	23.5	13.5	<0.3	<0.1	<0.2

APPLICATIONS

Sandvik 24.13.L is suitable for joining stainless Cr-Ni steels of the 309 type, Cr-steels and dissimilar steels e.g. austenitic stainless steel to carbon or low-alloyed steels for service up to 320°C (610°F). It is used for MIG/MAG-, TIG-, plasma-arc and submerged-arc welding. Widely used as barrier layer between carbon/low alloy steel and different stainless grades in cladding operations.

FORMS OF SUPPLY

Sandvik 24.13.L is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 24.13.L gives a microstructure with an austenitic matrix and a ferrite cintent of about 10FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, RP0.2	MPa (ksi)	400 (58)
Tensile strength, Rm	MPa (ksi)	600 (87)
Elongation, A	%	40
Reduction in area, Z	%	60
Impact strength, Charpy V	J (ft lbs)	140 (103)
Hardness, Vickers	HV	160

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CORROSION RESISTANCE

Sandvik 24.13.L is normally used for joints between non alloyed or low alloyed steels and stainless steels where resistance to corrosion is of secondary importance.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-350	28-32
2.4	250-450	28-32
3.2	300-500	29-34
4.0	400-600	30-35

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Recommended welding flux is Sandvik 15W.

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SANDVIK 24.13.LHF WELDING WIRE

DATASHEET

Sandvik 24.13.LHF welding wire is particularly suitable for overlay welding and joining of dissimilar steels.

Product Standards

- EN ISO 14343-A – 23 12 L
- ASME/AWS SFA5.9 ER309L

Product Approvals

- CE
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
≤0.015	0.3	1.8	≤0.015	≤0.015	24	13	≤0.3	≤0.05	≤0.10	≤0.05

APPLICATIONS

Sandvik 24.13.LHF welding wire is used for TIG, plasma-arc, MIG and submerged-arc welding. It is particularly suitable for overlay welding and joining dissimilar steels, for example austenitic stainless steels to low alloyed or non alloyed steels. It has excellent resistance to hot cracking due to its enhanced ferrite content.

FORMS OF SUPPLY

Sandvik 24.13.LHF is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 24.13.LHF gives a microstructure with an austenitic matrix and a ferrite content of 15-16FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, RP0.2	MPa (ksi)	410 (60)
Tensile strength, Rm	MPa (ksi)	(87)
Elongation, A	%	41
Reduction in area, Z	%	71

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Temperature	°C (°F)	20 (68)
Impact strength, Charpy V	J (ft lbs)	140 (103)
Hardness, Vickers	HV	160

CORROSION RESISTANCE

Sandvik 24.13.LHF is normally used for joints between non alloyed or low alloyed steels and stainless steels, where resistance to corrosion is of secondary importance.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm	m/min	A	V	l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm	A	V
2.0	200-350	28-32

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Wire diameter	Current	Voltage
mm	A	V
2.4	250-450	28-32
3.2	300-500	29-34
4.0	400-600	30-35

Recommended welding flux is Sandvik 15W.

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SANDVIK 24.13.LNB
WELDING WIRE

DATASHEET

Sandvik 24.13.LNb is a niobium-stabilized filler metal for overlay welding of carbon and low-alloy steels, where a type 347 of overlay is required.

Product Standards

- EN ISO 14343-A – 23 12 Nb
- ASME/AWS SFA5.9 ER"309LNb"

CHEMICAL COMPOSITION

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Nb
≤0.020	0.3	2.0	≤0.020	≤0.015	24	12.5	0.8

APPLICATIONS

Sandvik 24.13.LNb is a niobium-stabilized overalloyed filler metal suitable for overlay welding of carbon and low-alloy steels, where a type 347 of overlay is required. It is used for MIG/MAG, TIG and SAW.

FORMS OF SUPPLY

Sandvik 24.13.LNb is supplied as wire and straight rod.

WELD METAL CHARACTERISTICS

Sandvik 24.13.LNb gives a microstructure with an austenitic matrix and a ferrite content of about 13FN according to the DeLong diagram.

Chemical composition - all-weld metal

The data below is typical for non heat treated all-weld metal made by SAW, Flux 15W.

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Nb
≤0.020	0.7	1.2	≤0.025	≤0.015	23.5	12	0.7

MECHANICAL PROPERTIES

MIG and TIG

Temperature	°C (°F)	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	400 (58)
Tensile strength, R_m	MPa (ksi)	600 (87)
Elongation, A_5	%	35

Datasheet updated 10/27/2015 1:37:53 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)
Impact strength, Charpy V	J (ft lbs)	110 (81)
Hardness, Vickers	HV	180

SAW, flux 15W

Temperature	°C (°F)	20 (68)
Yield strength, $R_{P0.2}$	MPa (ksi)	400 (58)
Tensile strength, R_m	MPa (ksi)	600 (87)
Elongation, A	%	35
Impact strength, Charpy V	J (ft lbs)	90 (66)

CORROSION RESISTANCE

Overlay welds using Sandvik 24.13.LNb have similar corrosion resistance to type 347, EN 1.4550, base material.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm	m/min	A	V	l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm	A	V
2.0	200-350	28-32
2.4	250-450	28-32
3.2	300-500	29-34
4.0	400-600	30-35

Recommended welding flux is Sandvik 15W.

Datasheet updated 10/27/2015 1:37:53 PM (supersedes all previous editions)

SANDVIK 24.13.LSI WELDING WIRE

DATASHEET

Sandvik 24.13.LSi is a filler material suitable for joining stainless chromium-nickel steels of the ASTM 309 type, chromium steels and dissimilar metals.

Product Standards

- EN ISO 14343 A – 23 12 L Si
- ASME/AWS SFA5.9 ER309LSi

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
<0.025	0.9	1.8	<0.025	<0.015	23.5	13.5	<0.4	0.10

APPLICATIONS

Sandvik 24.13.LSi is suitable for joining stainless chromium-nickel steels of the ASTM 309 type, chromium steels and dissimilar metals e.g. austemitic stainless steel to carbon or low-alloyed steel. It is used for MIG/MAG-, TIG- and plasma-arc welding.

FORMS OF SUPPLY

Sandvik 24.13.LSi is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 24.13.LSi gives a microstrucrure with an austenitic matrix and a ferrite content of about 10FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, RP0.2	MPa (ksi)	400 (58)
Tensile strength, Rm	MPa (ksi)	600 (87)
Elongation, A	%	35
Reduction in area, Z	%	55
Impact strength, Charpy V	J (ft lbs)	140 (103)
Hardness, Vickers	HV	160

CORROSION RESISTANCE

Sandvik 24.13.LSi is normally used for joints between non alloyed or low alloyed steels and stainless steels where resistance to corrosion is of secondary importance.

Datasheet updated 10/21/2015 2:18:56 PM (supersedes all previous editions)

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/21/2015 2:18:56 PM (supersedes all previous editions)

SANDVIK

SANDVIK 24.13.SI WELDING WIRE

DATASHEET

Sandvik 24.13.Si is a filler metal for joining stainless steels of the 18Cr/8Ni type and for dissimilar joints, e.g. austenitic steels to low alloyed steels.

Product Standards

- EN ISO 14343-A – 22 12 H
- ASME/AWS SFA5.9 ER309Si

APPLICATIONS

Sandvik 24.13.Si is particularly suited for MIG welding but can also be used for TIG and PAW. It can be used for joining stainless steels of the 18Cr/8Ni type when higher corrosion resistance is desired in the weld metal. It can also be used for dissimilar joints, e.g. austenitic steels to low alloyed steels.

FORMS OF SUPPLY

Sandvik 24.13.Si is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 24.13.Si gives a microstructure with an austenitic matrix and a ferrite content of about 10FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, RP0.2	MPa (ksi)	420 (61)
Tensile strength, Rm	MPa (ksi)	640 (93)
Elongation, A	%	35
Reduction in area, Z	%	60
Impact strength, Charpy V	J (ft lbs)	110 (81)
Hardness, Vickers	HV	180

CORROSION RESISTANCE

Sandvik 24.13.Si is normally used for joints between non alloyed or low alloyed steels and stainless steels where resistance to corrosion is of secondary importance.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Datasheet updated 1/13/2016 2:09:47 PM (supersedes all previous editions)

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding1)				
1.2	3-10	150-250	23-31	18

1)Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

SANDVIK 24.16.3.L WELDING WIRE

DATASHEET

Sandvik 24.16.3.L is a filler material for overlay welding on carbon and low-alloy steels where a 316L weld deposit is specified.

Product Standards

- EN ISO 14343-A – (23 12 2 L)
- ASME/AWS SFA5.9 ER(309LMo)

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.4	1.5	≤0.025	≤0.015	24.5	17	2.8	0.13

APPLICATIONS

Sandvik 24.16.3.L is particularly suitable for overlay welding on carbon and low-alloy steels, including seam closing of clad plate, where a 316L weld deposit is specified. Sandvik 24.16.3.L is used for TIG, plasma-arc, MIG and submerged-arc welding.

FORMS OF SUPPLY

Sandvik 24.16.3.L is supplied as wire and straight rods.

WELD METAL CHARACTERSTICS

Sandvik 24.16.3.L gives a microstructure with an austenitic matrix and a ferrite content of about 11FN according to the DeLong diagram.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	450 (65)
Tensile strength, R_m	MPa (ksi)	650 (94)
Elongation, A	%	30
Reduction in area, Z	%	60
Impact strength, Charpy V	J (ft*lbs)	70 (52)

CORROSION RESISTANCE

The corrosion resistance of Sandvik 24.16.3.L weld overlays are at the level of the 316L base metal.

FABRICATION

Datasheet updated 10/27/2015 1:38:41 PM (supersedes all previous editions)

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm	m/min	A	V	l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm	A	V
2.0	200-350	28-32
2.4	250-450	28-32
3.2	300-500	29-34
4.0	400-600	30-35

Recommended welding flux is Sandvik 15W.

Datasheet updated 10/27/2015 1:38:41 PM (supersedes all previous editions)

Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

SANDVIK 25.10.4.L WELDING WIRE

DATASHEET

Sandvik 25.10.4.L welding wire has been specially developed for welding Sandvik SAF 2507 and other super-duplex steels.

Product Standards

- ISO 14343-A: 25 9 4 N L
- ASME/AWS SFA5.9 ER2594

Product Approvals

- CE
- DNV
- TÜV

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.3	0.4	≤0.020	≤0.015	25	9.5	4	0.25

APPLICATIONS

Sandvik 25.10.4.L is used for welding of Sandvik SAF 2507 and other super-duplex steels. The grade is characterized by excellent resistance to stress corrosion in chloride-bearing environments and excellent resistance to pitting and crevice corrosion.

Sandvik 25.10.4.L can also be used for welding Sandvik SAF 2205 and corresponding duplex steels when the highest possible corrosion resistance is required.

FORMS OF SUPPLY

Sandvik 25.10.4.L is supplied as wire and straight rod.

WELD METAL CHARACTERISTICS

Sandvik 25.10.4.L gives an austenitic-ferritic (duplex) microstructure with approximately 40 FN, calculated from the WRC-92 diagram

Chemical composition - all-weld metal

The following data is typical for non heat treated weld metal made by SAW and flux 15W.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.6	0.3	≤0.020	≤0.015	24.5	9.6	4	0.21

Datasheet updated 11/16/2015 12:42:09 PM (supersedes all previous editions)

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N

MECHANICAL PROPERTIES - ALL-WELD METAL

TIG

Temperature	°C (°F)	20 (68)	-40 (-40)	-46 (-51)	-50 (-58)
Yield strength, $R_{p0.2}$	MPa (ksi)	650 (94)	-	-	-
Tensile strength, R_m	MPa (ksi)	850 (123)	-	-	-
Elongation, A	%	25	-	-	-
Impact strength, Charpy V	J (ft lbs)	210 (155)	170 (125)	150 (111)	140 (103)

SAW

Temperature	°C (°F)	20 (68)	-40 (-40)
Yield strength, $R_{p0.2}$	MPa (ksi)	690 (100)	-
Tensile strength, R_m	MPa (ksi)	880 (128)	-
Elongation, A	%	25	-
Impact strength, Charpy V	J (ft lbs)	90 (66)	60 (44)

CORROSION RESISTANCE

Sandvik 25.10.4.L has a high resistance to intergranular corrosion and pitting. Nominal CPT in the ASTM G48 test is 40°C (105 ^{o}F). The filler also has good resistance to stress corrosion cracking, especially in environments containing H_2S or chlorides.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter	Wire feed	Current	Voltage	Gas
mm (in.)	m/min	A	V	l/min (CFH)
Short-arc welding				
0.8 (0.031)	4-8 (157-315)	40-120	15-19	12 (25)
1.0 (0.039)	4-8 (157-315)	60-140	15-21	12 (25)
Spray-arc welding				
1.0 (0.039)	6-12 (236-472)	140-220	23-28	18 (38)
1.2 (0.047)	5-9 (197-354)	180-260	24-29	18 (38)
1.6 (0.063)	3-5 (118-197)	230-350	25-30	18 (38)
Pulsed-arc welding[1)]				
1.2 (0.047)	3-10 (118-394)	150-250	23-31	18 (38)

[1)]Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Datasheet updated 11/16/2015 12:42:09 PM (supersedes all previous editions)

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter	Current	Voltage
mm (in.)	A	V
2.0 (0.079)	200-300	28-32
2.4 (0.094)	250-450	28-32
3.2 (0.0126)	300-500	29-34

Recommended flux is Sandvik 15W.

Recommended thermal data

The interpass temperature should be kept below 150°C (302°F) and the heat input between 0.2 and 1.5kJ/mm for joint welding. Preheating is normally not recommended. In case post weld heat treatment is needed from a construction point of view, contact Sandvik for support.

Datasheet updated 11/16/2015 12:42:09 PM (supersedes all previous editions)

SANDVIK

SANDVIK 25.20.C WELDING WIRE

DATASHEET

Sandvik 25.20.C is a filler material for joining heat resistant austenitic steels of the 25 Cr/20 Ni type.

Product Standards

- EN ISO 14343
- ASME/AWS SFA5.9

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N
0.12	0.3	1.8	<0.015	<0.015	26	21	<0.3	<0.3	<0.06

APPLICATIONS

Sandvik 25.20.C is suitable for joining heat resistant austenitic steels of the 25 Cr/20 Ni type. It can be used in air up to about 1100°C (2010°F), in oxidizing sulphurous atmospheres up to 1050°C (1920°F) and in reducing sulphurous atmospheres up to 650°C (1200°F). Sandvik 25.20.C has moderate creep strength and structure stability.

FORMS OF SUPPLY

Sandvik 25.20.C is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 25.20.C gives a fully austenitic microstructure.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{P0.2}$	MPa (ksi)	390 (57)	250 (36)	-
Tensile strength, R_m	MPa (ksi)	590 (86)	490 (71)	-
Elongation, A	%	40	-	-
Reduction in area, Z	%	60	-	-
Impact strength, Charpy V	J (ft lbs)	130 (96)	-	60 (44)
Hardness, Vickers	HV	160	-	-

CORROSION RESISTANCE

Sandvik 25.20.C has a high scaling temperature, 1100°C (2010 °F) and, therefore, good oxidation resistance at high temperatures.

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FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/21/2015 2:16:42 PM (supersedes all previous editions)

SANDVIK

SANDVIK 25.20.L WELDING WIRE

DATASHEET

Sandvik 25.20.L is a filler wire for joining Sandvik 2RE10 (UNS S31002) and similar grades used in heavily oxidizing media such as pipes in preheaters, coolers and condensers in the chemical industry. Sandvik 25.20.L can used for gas-shielded arc and gas-tungsten arc welding.

STANDARDS

- AWS: Similar to ER 310 low carbon
- EN Number: Z 25 20 L

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu
≤0.020	0.2	1.8	≤0.020	≤0.015	24	20	≤0.30	≤0.20	≤0.10

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data is typical for non heat treated all-weld metal made by TIG welding with argon shielding gas.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni
≤0.020	0.2	1.6	≤0.020	≤0.015	24	20

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic matrix.

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature	°C	20	-196
Yield strength, $R_{p0.2}$	MPa	380	-
Tensile strength, R_m	MPa	590	-
Elongation, A	%	37	-
Reduction in area, Z	%	57	-
Impact strength, Charpy V	J	-	150
Hardness, Vickers	HV	170	-

PHYSICAL PROPERTIES - ALL-WELD METAL

Temperature, °C	20	100	300	400

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Temperature, °C	20	100	300	400
Thermal conductivity, W/m	14	15	17	19

Thermal expansion per °C, from 20°C (68°F) to 400°C (750°F) 16.7×10^{-6}
Density, g/cm^3, at 20°C (68°F) 8.0

CORROSION RESISTANCE - ALL-WELD METAL

Sandvik 25.20.L has very good resistance to intergranular corrosion, pitting and stress corrosion cracking due to its high chromium and nickel contents. As an example, the mean value corrosion rate in a Huey test for MIG weld metal (5 x 48 hours in boiling 65% HNO_3) after 1 h sensitization at 675°C (1245 °F), is 0.35 mm/year.

RECOMMENDED WELDING DATA

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	V Gas, l/min
Short-arc welding				
0.8	4-9	70-140	16-25	15
1.0	4-9	80-160	13-25	15
Spray-arc welding				
1.0	6-12	150-230	24-31	22
1.2	5-9	170-280	25-32	22
1.6	3-5	250-370	29-33	22
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)] Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Because of the fully austenitic structure Sandvik 25.20.L is not recommended for SAW welding. Instead Sandvik 25.22.2.LMn is recommended which is more resistance to hot cracking, due to its higher content of Manganese.

Datasheet updated 10/21/2015 2:16:19 PM (supersedes all previous editions)

Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

Datasheet updated 10/21/2015 2:16:19 PM (supersedes all previous editions)

SANDVIK 25.22.2.LMN WELDING WIRE

DATASHEET

Sandvik 25.22.2.LMn is a manganese alloyed chromium-nickel-molybdenum filler material used for welding Sandvik 2RE69 (UNS S31050, 1.4466), Sandvik 3R60 U.G. (UNS S31603, 1.4435). The weld deposit has excellent low temperature toughness that makes it suitable for joining stainless steels for cryogenic service.

STANDARDS

- AWS: ER "310LMo"
- EN Number: 25 22 2 N L

Product Standards

- AWS A5.9 ER "310LMo"
- ISO 14343 25 22 2 N L

Product Approvals

- CE
- TÜV

Contact your nearest sales office for details.

CHEMICAL COMPOSITION

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	≤0.2	4.5	≤0.015	≤0.015	25.0	22.0	2.1	0.13

APPLICATIONS

Sandvik 25.22.2.LMn has extensively been used successfully in all critical high-pressure units of modern urea processes, such as:

Stripper tubes	Stamicarbon, Montedison IDR
Outerlayer of bimetallic (stripper tubes)	Saipem
Ferrules	All processes
Carbamate condensers	All processes
Decomposers	Montedison
Reactor coils	UTI

Sandvik 25.22.2.LMn has also found extensive use in other corrosive environments in fertilizer plants, such as:

- Nitric acid cooler/condensers cooled with polluted cooling water

Datasheet updated 1/25/2016 10:23:36 AM (supersedes all previous editions)

- Heating coils and pipe in NPK plants – Norsk Hydro process

WELD METAL CHARACTERISTICS

Fully austenitic.

MECHANICAL PROPERTIES

Temperature	°C	20 (68)	400 (752)	-196 (-321)
Yield strength, $R_{p0.2}$	MPa	335 (49)	225 (33)	-
Tensile strength, R_m	MPa	575 (83)	410 (59)	-
Elongation, A	%	42	29	-
Reduction in area, Z	%	58		-
Impact strength, Charpy V	J	120 (89)		100 (74)
Hardness, Vickers	HV	170		-

CORROSION RESISTANCE

Sandvik 25.22.2.LMn has been developed primarily to cope with the severe corrosion conditions existing in the urea industry. Therefore, this filler has excellent resistance to corrosion in ammonium carbamate and nitric acid. Sandvik 25.22.2.2LMn also exhibits excellent resistance to intregranular corrosion. As an example, the corrosion rate in a Huey test for TIG weld metal, (5 x 48 hours in boiling 65% HNO_3), is below 0.12 mm/year.

FABRICATION

Recommended welding data MIG/GTAW welding

Electrode positive is used to give good penetration in all types of welding joint. The following table shows common conditions for MIG welding.

Wire diameter,mm (in.)	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min. (CFH)
Short-arc welding				
0.8 (0.	5-9	50-140	16-25	15 (31)
1.0	5-9	70-160	16-25	15 (31)
Spray-arc welding				
1.0	6-12	150-230	26-31	22 (46)
1.2	5-9	170-280	27-32	22 (46)
Pulsed arc welding 1)				
1.2	3-10	150-250	23-31	18 (38)

1) Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

- Short-arc welding is used with thin gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.
- The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.
- Spray-arc welding is normally used for heavier gauge material.

Datasheet updated 1/25/2016 10:23:36 AM (supersedes all previous editions)

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm (in.)	Current, A	Voltage, V
2.0 (0.079)	200-300	28-32
2.4 (0.094)	250-400	28-32
3.2 (0.125)	300-450	29-34

Recommended welding flux is Sandvik 31S.

Datasheet updated 1/25/2016 10:23:36 AM (supersedes all previous editions)

SANDVIK 27.31.4.LCU WELDING WIRE

DATASHEET

Sandvik 27.31.4.LCu is a copper alloyed chromium-nickel-molybdenum filler material for welding of high-alloy austenitic stainless steels such as Sanicro 28 (UNS S08028, 1.4363) type. It is also suitable for joining Sanicro 41 (UNS N08825, 2.4858) and other similar materials.

Product Standards

- ISO 14343 27 31 4 Cu L
- ASME/AWS SFA5.9 ER383

Product Approvals

- CE
- TÜV

Contact your nearest sales office for details.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.020	≤0.2	1.7	≤0.015	≤0.010	27.0	31.0	3.5	1.0

APPLICATIONS

Due to its outstanding corrosion properties, Sandvik 27.31.4.LCu can be used in the most diverse environments, such as phosphoric and sulphuric acid, sour gas service in the oil & gas industry and chloride bearing seawater. Typical applications are found in heat exchangers, evaporators and transport piping.

WELD METAL CHARACTERISTICS

Fully austenitic.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Yield strength, $RP_{0.2}$	MPa (ksi)	360 (52)
Tensile strength, R_m	MPa (ksi)	540 (78)
Elongation, A	%	35
Reduction in area, Z	%	65
Hardness, Vickers	HV10	160

CORROSION RESISTANCE

Datasheet updated 11/13/2015 9:34:19 AM (supersedes all previous editions)

Sandvik 27.31.4.LCu has high resistance to general corrosion, particularly in contaminated technical phosphoric acid. It has also very good resistance to intergranular corrosion and stress corrosion cracking. For example in 50% sulphuric acid at 80 °C for 1+3+3 days, the corrosion rate is about 0.23 mm/year.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welding joint. The following table shows common conditions for MIG welding.

Wire diameter,mm	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min. (CFH)
Short-arc welding				
0.8	5-9	50-140	16-25	15 (31)
1.0	5-9	70-160	16-25	15 (31)
Spray-arc welding				
1.0	6-12	150-230	26-31	22 (46)
1.2	5-9	170-280	27-32	22 (46)
Pulsed-arc welding1)				
1.2	3-10	150-250	23-31	18 (38)

1) Pulse parameters:

– Peak current 300–400 A
– Background current 50–150 A
– Frequency 80–120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used for thin gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-400	28-32
3.2	300-450	29-34

Recommended welding flux is Sandvik 15W.

Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

SANDVIK 27.7.5.L WELDING WIRE

DATASHEET

Sandvik 27.7.5.L is a filler material of hyper-duplex (austenitic-ferritic) stainless steel that has been specially developed for welding of the hyper-duplex steel Sandvik SAF 2707HD.

STANDARDS

– UNS: S32707

CHEMICAL COMPOSITION

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	N
≤0.02	0.3	1.0	≤0.020	≤0.015	27	6.5	5	1	0.4

APPLICATIONS

Sandvik 27.7.5.L is a hyper-duplex (austenitic-ferritic) filler metal with improved yield strength and better pitting and crevice corrosion resistance compared to super-duplex stainless steels (UNS S32750 and S32760). It also has higher HISC (hydrogen induced stress cracking) resistance compared to super-duplex stainless steels and higher resistance to aggressively sour environments.

Sandvik 27.7.5.L can be advantageously used for welding 13% Cr flow pipes, as its high strength enables reduction of repair rates during pipeline production, because finite element analysis is not required for weld metal of matching strength and the acceptance criteria can be less conservative.

The high pitting resistance of Sandvik 27.7.5.L makes it suitable for root pass welding in Sandvik SAF 2507 and other super-duplex stainless steels (UNS S32750 and S32760) when the risk of pitting corrosion is critical, or when mixed shielding gases cannot be used.

Sandvik 27.7.5.L can also be used for overlay welding on e.g. tube sheets in heat-exchangers or for joint welding of hyper-duplex (UNS S32707) pipe with wall thickness < 13 mm.

FORMS OF SUPPLY

Sandvik 27.7.5.L is supplied as wire and rod.

WELD METAL CHARACTERISTICS

Sandvik 27.7.5.L gives an austenitic-ferritic (duplex) microstructure with approximately 60-70% ferrite measured according to ASTM E562.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-30 (-22)	--50 (-58)	-60 (-76)
Yield strength, $R_{P0.2}$	MPa (ksi)	690 (100)	-	-	-

Datasheet updated 2/10/2016 3:03:47 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	-30 (-22)	--50 (-58)	-60 (-76)
Tensile strength, R_m	MPa (ksi)	890 (129)	-	-	-
Elongation, A	%	25	-	-	-
Hardness	HV10	300	-	-	-
Impact strength, Charpy V	J (ft lbs)	190 (140)	106 (78)	58 (43)	47 (35)

a) $R_{p0.2}$ corresponds to 0.2% offset yield strength.

CORROSION PROPERTIES

Sandvik 27.7.5.L has excellent resistance to intergranular corrosion and pitting. Nominal CPT in the ASTM G48 test is 57.5°C. The filler also excellent resistance to stress corrosion cracking, especially in environments containing H_2S or chlorides.

FABRICATION

Recommended welding data

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon+3%N_2 should be used to prevent oxidation and to maintain nitrogen in the weld metal.

Recommended thermal data

Heat-input is restricted to 0.2-1.0 kJ/mm and maximum interpass temperature is 100°C (212°F).

Datasheet updated 2/10/2016 3:03:47 PM (supersedes all previous editions)

SANDVIK 29.8.2.L WELDING WIRE

DATASHEET

Sandvik 29.8.2.L is a filler material suitable for welding the super-duplex grade Sandvik SAF 2906.

STANDARDS

– UNS: S32906

CHEMICAL COMPOSITION

Chemical composition, wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.025	0.4	1.0	≤0.020	≤0.015	29	7	2.4	0.36

APPLICATIONS

Sandvik 29.8.2.L is used for TIG and SAW welding of the super-duplex grade Sandvik SAF 2906. Typical applications are welding of piping systems in Caustic soda production as well as welding of pipes and heat exchangers in Alumina production.

FORMS OF SUPPLY

Sandvik 29.8.2.L is available as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 29.8.2.L gives an austenitic-ferritic (duplex) microstructure with approximately 50 FN, calculated from the WRC-92 diagram.

Chemical composition - all-weld metal, wt %

C	Si	Mn	P	S	Cr	Ni	Mo	N
0.02	0.6	0.8	≤0.020	≤0.015	28.5	6.8	2.3	0.32

MECHANICAL PROPERTIES

TIG

Temperature	°C (°F)	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	670 (97)
Tensile strength, R_m	MPa (ksi)	880 (128)
Elongation, A	%	25
Impact strength, Charpy V	J (ft lbs)	150 (111)

SAW

Datasheet updated 10/21/2015 2:11:28 PM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	660 (96)
Tensile strength, R_m	MPa (ksi)	860 (125)
Elongation, A	%	25
Impact strength, Charpy V	J (ft lbs)	115 (85)

CORROSION RESISTANCE

Sandvik 29.8.2.L has a very high resistance to pitting and crevice corrosion. Intergranular corrosion resistance is also good. Typical value for testing according to ASTM A262 Pr. B is 0.15mm/year.

FABRICATION

Recommended welding data

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding of Argon+2%N_2.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-450	28-32
3.2	300-500	29-34

Recommended flux is Sandvik 15W.

Recommended thermal data

Welding should be conducted within the heat input range of 0.2-1.5 kJ/mm, and an interpass temperature of maximum 150°C (302°F).

Datasheet updated 10/21/2015 2:11:28 PM (supersedes all previous editions)

SANDVIK 29.9 WELDING WIRE

DATASHEET

Sandvik 29.9 is a filler material suitable for joining dissimilar steels and for overlay welding of carbon and low-alloy steels. It gives a ferritic-austenitic structure with a high ferrite content.

Product Standards

- EN ISO 14343-A – 29 9
- ASME/AWS SFA-5.9 ER312

CHEMICAL COMPOSITION

Chemical composition (aim), wt %

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
0.10	0.4	1.8	<0.025	<0.015	30.5	9	<0.40	<0.20	<0.20	<0.060

APPLICATIONS

Sandvik 29.9 is suitable for joining dissimilar steels and for overlay welding of carbon and low-alloy steels with MIG/MAG-, TIG-, plasma-arc or submerged-arc welding. It gives a ferritic-austenitic structure with a high ferrite content.

Even with considerable dilution by austenite forming elements such as nickel, the micro structure remains ferritic-austenitic and thus highly resistant to weld metal cracks and fissures.

FORMS OF SUPPLY

Sandvik 29.9 is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sandvik 29.9 gives a microstructure with a ferrite content of about 70-75FN according to WRC-92.

MECHANICAL PROPERTIES (ALL-WELD METAL)

Temperature	°C°F	20 (68)
Yield strength, $R_{p0.2}$	MPa (ksi)	520 (75)
Tensile strength, R_m	MPa (ksi)	730 (106)
Elongation, A_5	%	25
Reduction in area, Z	%	30
Impact strength, Charpy V	J (ft lbs)	100
Hardness, Vickers	HV	200-250

CORROSION RESISTANCE

Datasheet updated 10/27/2015 1:46:15 PM (supersedes all previous editions)

The high chromium content gives Sandvik 29.9 high oxidation resistance up to 1100°C (2010°F).

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	4-8	40-120	15-19	12
1.0	4-8	60-140	15-21	12
Spray-arc welding				
1.0	6-12	140-220	23-28	18
1.2	5-9	180-260	24-29	18
1.6	3-5	230-350	25-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)]Pulse parameters:	Peak current Background current Frequency	300 - 400 A 50 - 150 A 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-350	28-32
2.4	250-450	28-32
3.2	300-500	29-34
4.0	400-600	30-35

Recommended flux is Sandvik 15W.

Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

SANDVIK SX WELDING WIRE

DATASHEET

Sandvik SX is a filler wire for joining Sandvik SX steel (UNS S32615, ASME Code Case 2029-3) used in concentrated sulphuric acid. Sandvik SX wire can be used for MIG-, TIG- and PAW welding.

CHEMICAL COMPOSITION (FILLER METAL)

C	Si	Mn	P	S	Cr	Ni	Cu
≤ 0.018	5.0	1.7	≤0.015	≤0.005	18.5	13.5	2.0

MICROSTRUCTURE (ALL-WELD METAL)

Austenitic matrix with a ferrite content of about 16FN according to DeLong.

MECHANICAL PROPERTIES (ALL-WELD METAL)

Temperature	°C	20
Yield strength, $R_{p0.2}$	MPa	327
Tensile strength, R_m	MPa	668
Elongation, A	%	55

CORROSION RESISTANCE (ALL-WELD METAL)

Sandvik SX has excellent corrosion resistance in concentrated sulphuric acid, both in static and dynamic conditions. The corrosion resistance is close to that of the parent material.

RECOMMENDED WELDING DATA

Always weld with as low heat input as possible (max 1,0 kJ/mm). Keep interpass temperature below 60°C (140°F). Clean joints before welding and use pickling paste for post weld cleaning.

MIG WELDING

No weaving except for vertical up position. Recommended shielding gas: pure Argon or Argon/Helium mixture (20-30% He).

TIG WELDING

Always weld Sandvik SX tube and plate with filler metal. Recommended shielding gas: pure Argon or Argon/Helium mixture (20-30% He).

Datasheet updated 6/8/2015 1:01:59 PM (supersedes all previous editions)

SANICRO 41CU WELDING WIRE

DATASHEET

Sanicro 41Cu welding wire is suitable for overlay welding when a deposit with chemistry corresponding to UNS N08825 is required. The weld deposit is a nickel-iron-chromium-molybdenum-copper alloy suitable for use in extremely corrosive environments.

Sanicro 41Cu has very good resistance to stress corrosion cracking (SCC) in chloride containing environments and is particularly suited for use in reducing environments such as those containing sulphuric and phosphoric acids. Sanicro 41Cu is available as wire and rods.

Product Standards

- EN ISO 18274 Ni8065
- ASME/AWS SFA5.14 ERNiFeCr-1

Product Approvals

Contact your nearest sales office for details.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Cu
≤0.025	≤0.3	1.0	≤0.025	≤0.010	23.0	≥42.0	3.0	≥22.0	2.3

APPLICATIONS

Sanicro 41Cu is used for corrosion resistant alloy surfacing of components in the chemical, pollution control, oil & gas and petrochemical industries and often in connection with sour gas service. Typical components are tanks, heat exchangers, evaporators, transport pipes and scrubbers etc.

FORMS OF SUPPLY

Sanicro 41Cu is available in wire and rods.

WELD METAL CHARACTERISTICS

The following data is typical for two layer deposits made by the TIG, MIG, or PAW methods using argon as shielding gas, or SAW using flux Sandvik 50SW.

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Cu
≤0.030	0.3	0.8	≤0.02	≤0.010	21.5	40.0	2.8	30.0	2.1

The microstructure is fully austenitic.

MECHANICAL PROPERTIES

Datasheet updated 11/13/2015 9:45:07 AM (supersedes all previous editions)

Overlays made with Sanicro 41Cu passed side bend testing.

CORROSION RESISTANCE

Sanicro 41Cu shows very good resistance to pitting corrosion and stress corrosion cracking (SCC) in chloride-containing environments. Nickel, together with molybdenum and copper, also gives excellent resistance to reducing environments such as those containing sulfuric and phosphoric acids. The alloy's chromium content gives good resistance in oxidizing environments such as nitric acid.

FABRICATION

Recommended welding data

MIG/GTAW welding

Electrode positive is used to give good penetration in all types of welding joint. The following table shows common conditions for MIG welding.

Pulsed-arc welding1)

Wire diameter,mm	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min. (CFH)
1.2	3-10	130-230	23-27	20 (42)

1) Pulse parameters:Peak current 300–400 A
Background current 50–130 A
Frequency 80–120 Hz

TIG welding

Wire diameter,mm	Current, A	Voltage, V	Gas, l/min. (CFH)
2.4 (manual)	100-200	9-12	9-12 (19-25)
1.2 (mechanized)	180-220	10-12	9-12 (19-25)

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V	Travelspeed,mm/min
2.4	250-400	28-34	250-450

Recommended welding flux is Sandvik 50SW.

Datasheet updated 11/13/2015 9:45:07 AM (supersedes all previous editions)

SANICRO 53
WELDING WIRE

DATASHEET

Sanicro 53 is a nickel-chrome-cobalt-molybdenum alloy of type alloy 617. It has an excellent resistance to high temperature corrosion such as oxidation and carburization. The weld metal provides a combination of excellent metallurgical stability and strength in short and long term exposure to temperatures up to 1100°C (2012°F).

Applications for Sanicro 53 are found in high temperature heat exchangers and valves, furnace tubing in the petrochemical industry, radiant heat tubes, gas turbines, components subjected to high temperatures in the chemical processing industry and components for power plants.

Sanicro 53 is suitable for joining heat resistant nickel alloys, heat resistant austenitic and cast alloys such as:

– UNS N08810 (1.4958)

– UNS N08811 (1.4959)

– UNS N06617 (2.4663)

Sanicro 53 can also be used for surfacing.

Product Standards

- ASME/AWS A5.14 ERNiCrCoMo-1/UNS N06617
- ISO 18274 NiCr22Co12Mo9/Ni 6617

Product Approvals

- CE

Contact your nearest sales office for details.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	W	Co	Ti	Al	Fe
0.08	≤1.0	≤1.0	≤0.010	≤0.010	22.5	53	9	≤0.5	12	≤0.6	1	≤1.0

APPLICATIONS

Applications for Sanicro 53 are found in high temperature heat exchangers and valves, furnace tubing in the petrochemical industry, radiant heat tubes, gas turbines, components subjected to high temperatures in the chemical processing industry and components for power plants.

Datasheet updated 1/25/2016 10:24:39 AM (supersedes all previous editions)

FORMS OF SUPPLY

Sanicro 53 is available in wire and rods.

WELD METAL CHARACTERISTICS

The following data is typical for non heat treated all-weld metal made by the TIG, MIG or PAW methods using argon as shielding gas.

C	Si	Mn	Cr	Ni	Mo	W	Co	Fe
0.06	0.20	0.04	22.5	55	9.0	≤0.1	11.5	0.5

The microstructure is fully austenitic.

MECHANICAL PROPERTIES

Temperature	°C	20 (68)	-196 (-321)
Yield strength, $R_{p0.2}$	MPa	510 (74)	-
Tensile strength, R_m	MPa	770 (112)	-
Elongation, A	%	37	-
Reduction in area, Z	%	42	-
Impact strength, KV	J (ft/lb)	130 (96)	105 (77)
Hardness, Vickers	HV10	260	-

Mechanical properties of all-weld metal in as welded condition after TIG or MIG welding.

FABRICATION

Recommended welding data

MIG/GTAW welding

Electrode positive is used to give good penetration in all types of welding joint. The table shows common conditions for MIG welding.

Wire diameter,mm (in.)	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min. (CFH)
Spray arc welding				
1.0 (0.039)	6 - 12	150-230	26-31	22 (46)
1.2 (0.047)	5 - 9	170-280	27-32	22 (46)
1.6 (0.063)	3 - 5	230-370	29-33	22 (46)
Pulsed arc welding 1)				
1.2 (0.047)	3 - 10	150-250	23-31	20 (42)

1)Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Shielding gases are used for sufficient protection of the weld pool.

TIG/GTAW welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Datasheet updated 1/25/2016 10:24:39 AM (supersedes all previous editions)

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 1/25/2016 10:24:39 AM (supersedes all previous editions)

SANDVIK

SANICRO 54 WELDING WIRE

DATASHEET

Sanicro 54 is a nickel-chrome-molybdenum alloy of type alloy C-22. It is a versatile alloy with excellent wet corrosion resistance in oxidizing and reducing media. It has better overall corrosion resistance than other Ni-Cr-Mo alloys such as alloy UNS N10276 (2.4819) and alloy UNS N06626 (2.4856). However, in severely reducing media alloy UNS N10276 is preferred while Sanicro 56 is a better matching consumable. Applications for Sanicro 54 are found in aggressively corrosive media such as chlorination systems, geothermal wells, HF furnace scrubbers, pesticide production, phosphoric acid production, SO_2 cooling towers and for weld overlays on valves.

Sanicro 54 is used for joining alloy UNS N06022 (2.4602) and is widely used as overmatching filler material for alloy UNS N10276 (2.4819) and other nickel-chrome-molybdenum alloys for better weld metal properties. It is used for surfacing low alloyed steels.

STANDARDS

- ISO: NiCr21Mo13Fe4W3/Ni 6022
- AWS: ERNiCrMo-10 / UNS N06022

Product Standards

- EN ISO 18274
- ASME/AWS SFA5.14

APPROVALS

CE

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	W	Co	V	Fe
≤0.015	≤0.08	≤0.50	≤0.020	≤0.010	21.5	56	13.5	3.0	≤2.5	≤0.35	4

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data is typical for non heat treated all-weld metal made by the TIG, MIG or PAW methods using argon as shielding gas.

Chemical composition, wt%

C	Si	Mn	Cr	Ni	Mo	W	Fe
0.008	0.05	0.1	22	57.5	14	3	3

MECHANICAL PROPERTIES - ALL-WELD METAL

Datasheet updated 10/20/2015 3:28:41 PM (supersedes all previous editions)

Temperature	°C	20	-196
Yield strength, $R_{p0.2}$	MPa	500	-
Tensile strength, R_m	MPa	780	-
Elongation, A	%	40	-
Reduction in area, Z	%	45	-
Impact strength, Charpy V	J	110	80
Hardness, Vickers	HV10	250	-

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic.

RECOMMENDED WELDING DATA

MIG/MAG welding

Electrode positive is used to give good penetration in all types of welding joint. The table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min.
Spray arc welding				
1.0	6 - 12	150 - 230	26 - 31	22
1.2	5 - 9	170 - 280	27 - 32	22
1.6	3 - 5	230 - 370	29 - 33	22
Pulsed arc welding [1)]				
1.2	3 - 10	150 - 250	23 - 31	20

[1)] Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Shielding gases are used for sufficient protection of the weld pool.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/20/2015 3:28:41 PM (supersedes all previous editions)

SANICRO 56
WELDING WIRE

DATASHEET

Sanicro 56 is a low carbon nickel-chrome-molybdenum alloy of type alloy C-276. It is a versatile alloy with excellent wet corrosion resistance in oxidizing and especially in reducing media. However, in oxidizing chloride containing environments alloy UNS N06022 (2.4602) is preferred while Sanicro 54 is a better matching welding consumable. Applications for Sanicro 56 are found in aggressively corrosive media such as chemical processing plants, pollution control, pulp and paper production, waste treatment and for the recovery of sour natural gas.

Sanicro 56 is used for joining alloy UNS N10276 (2.4819) and other nickel-chrome-molybdenum alloys. It can also be used for dissimilar metal joining of nickel alloys, stainless steels and low-alloy steels. Sanicro 56 can be used for surfacing low alloyed steels.

STANDARDS

- ISO: NiCr15Mo16Fe6W4/Ni 6276
- AWS: ERNiCrMo-4 / UNS N10276

Product Standards

- EN ISO 18274
- ASME/AWS SFA5.14

APPROVALS

CE

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	W	Co	V	Fe
≤0.02	≤0.08	≤1.0	≤0.030	≤0.030	16	56	16	3.5	≤2.5	<0.35	5

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data is typical for non heat treated all-weld metal made by the TIG, MIG or PAW methods using argon as shielding gas.

Chemical composition, wt%

C	Si	Mn	Cr	Ni	Mo	W
0.005	0.04	0.3	16	56.5	15.5	3.5

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature	°C	20	-196

Datasheet updated 10/20/2015 3:29:22 PM (supersedes all previous editions)

Temperature	°C	20	-196
Yield strength, $R_{p0.2}$	MPa	470	-
Tensile strength, R_m	MPa	750	-
Elongation, A	%	40	-
Reduction in area, Z	%	45	-
Impact strength, Charpy V	J	170	130
Hardness, Vickers	HV10	250	-

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic.

RECOMMENDED WELDING DATA

MIG/MAG welding

Electrode positive is used to give good penetration in all types of welding joint. The table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min.
Spray arc welding				
1.0	6 - 12	150 - 230	26 - 31	22
1.2	5 - 9	170 - 280	27 - 32	22
1.6	3 - 5	230 - 370	29 - 33	22
Pulsed arc welding [1]				
1.2	3 - 10	150 - 250	23 - 31	20

[1] Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Shielding gases are used for sufficient protection of the weld pool.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

SANICRO 59
WELDING WIRE

DATASHEET

Sanicro 59 is a nickel-chrome-molybdenum alloy of type alloy 59. It is a versatile alloy with excellent wet corrosion resistance for the most demanding applications. It combines excellent corrosion resistance in oxidizing and reducing media, has excellent resistance in chloride containing media and to localized corrosion environments. Sanicro 59 has excellent thermal stability compared to other common nickel alloys and has therefore outstanding resistance to intermetallic precipitation during welding. Applications for Sanicro 59 are found in aggressive and contaminated corrosive media including scrubbers for flue gas desulfurisation (FGD), chemical process plants and in severe offshore and petrochemical environments.

Sanicro 59 is used for joining matching alloys or dissimilar joining to other nickel alloys such as UNS N10276 (2.4819), type UNS N06022 (2.4602), UNS N06625 (2.4856) and N08825 (2.4858). It provides strong, tough, Nb-free weld metal for dissimilar welds in super-austenitic and super-duplex stainless steel joints or combinations of these with nickel alloys. Sanicro 59 can be used for surfacing.

STANDARDS

- ISO: NiCr23Mo16/Ni 6059
- AWS: ERNiCrMo-13

Product Standards

- EN ISO 18274
- ASME/AWS SFA5.14
- ISO 15156/NACE MR0175

APPROVALS

CE, TüV

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Al	Fe
≤0.010	≤0.10	≤0.5	≤0.015	≤0.010	23	59	15.5	≤0.3	0.3	≤1.5

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data is typical for non heat treated all-weld metal made by the TIG, MIG or PAW methods using argon as shielding gas.

Chemical composition, wt%

C	Si	Mn	Cr	Ni	Mo
0.002	0.02	0.2	23	60	15.5

Datasheet updated 10/27/2015 1:48:32 PM (supersedes all previous editions)

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature	°C	20	-196
Yield strength, $R_{p0.2}$	MPa	470	-
Tensile strength, R_m	MPa	750	-
Elongation, A	%	40	-
Reduction in area, Z	%	45	-
Impact strength, Charpy V	J	170	130
Hardness, Vickers	HV10	250	-

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic.

RECOMMENDED WELDING DATA

MIG/MAG welding

Electrode positive is used to give good penetration in all types of welding joint. The table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/mm	Current, A	Voltage, V	Gas, l/min.
Spray arc welding				
1.0	6 - 12	150 - 230	26 - 31	22
1.2	5 - 9	170 - 280	27 - 32	22
1.6	3 - 5	230 - 370	29 - 33	22
Pulsed arc welding 1)				
1.2	3 - 10	150 - 250	23 - 31	20

1) Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Shielding gases are used for sufficient protection of the weld pool.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Datasheet updated 10/27/2015 1:48:32 PM (supersedes all previous editions)

SANICRO 60
WELDING WIRE

DATASHEET

Sanicro 60 welding wire is suitable for joining nickel-chromium-molybdenum nickel alloys and chromium-nickel-molybdenum steels with very high corrosion resistance in oxidizing, aqueous and high temperature environments such as 6Mo-steels, UNS N06625 (2.4856) and corresponding grades. It is also suitable for joining stainless steels and nickel alloys for high-temperature service.

Sanicro 60 can also be used for dissimilar joining of stainless steels to nickel alloys, for overlay welding and is available as both wire and rod.

STANDARDS

- ISO: NiCr22Mo9Nb/Ni 6625
- AWS: ERNiCrMo-3/UNS N06625

Product Standards

- EN ISO 18274
- ASME/AWS SFA5.14
- ISO 15156/NACE MR0175

Product Approvals

- CE

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Nb
≤0.03	0.2	0.2	≤0.015	≤0.010	22	≥60	9	≤1	3.5

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data is typical for non heat treated all-weld metal made by the TIG, MIG or PAW methods using argon as shielding gas.

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Nb
≤0.030	0.2	0.2	≤0.015	≤0.010	22	60	9	0.5	3.4

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic.

Datasheet updated 10/20/2015 3:31:02 PM (supersedes all previous editions)

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature	°C	20	-196
Yield strength, $R_{p0.2}$	MPa	510	-
Tensile strength, R_m	MPa	770	-
Elongation, A	%	42	-
Reduction in area, Z	%	51	-
Impact strength, Charpy V	J	150	70
Hardness, Vickers	HV	220	-

PHYSICAL PROPERTIES - ALL-WELD METAL

Temperature, °C	20	100	300	500	700
Thermal conductivity, W/m	15	16	18	22	25

Thermal expansion per °C, from 20°C to 400°C: 12×10^{-6}

Density, at 20°C: 8.3 g/cm^3

CORROSION RESISTANCE - ALL-WELD METAL

Sanicro 60 shows very good resistance to pitting corrosion, intergranular corrosion (corrosion rate <0.4 mm/year when tested acc. to ASTM G28 A) and is almost immune to stress corrosion cracking in chloride-containing environments.

RECOMMENDED WELDING DATA

MIG/MAG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Spray-arc welding				
1.0	6-12	150-230	26-31	22
1.2	5-9	170-280	27-32	22
1.6	3-5	230-370	29-33	22
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	20

[1)] Pulse parameters: Peak current 300 - 400 A
Background current 50 - 150 A
Frequency 80 - 120 Hz

Short-arc welding is used with thin gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Datasheet updated 10/20/2015 3:31:02 PM (supersedes all previous editions)

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	30-33
2.4	250-400	30-33
3.2	300-450	30-33

Recommended flux is Sandvik 50SW.

* 254 SMO is a trademark owned by Outokumpu OY.

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SANDVIK

SANICRO 68HP WELDING WIRE

DATASHEET

Sanicro 68HP is a filler material for welding Sanicro 69, i.e. alloy 690, and similar alloys. It produces corrosion resistant overlays on most low-alloy and stainless steels. Sanicro 68HP can also be used for dissimilar joints between the common nickel alloys and carbon, low-alloy and stainless steels. Sanicro 68HP is available as wire and rods.

STANDARDS

- ISO: NiCr30Fe9/Ni 6052
- AWS: ERNiCrFe-7/UNS N06052

Product Standards

- EN ISO 18274
- ASME/AWS SFA5.14

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Nb	Ti	Al
≤0.03	0.2	0.9	≤0.01	≤0.01	30	60	≤0.10	9	≤0.10	0.5	0.5

CHEMICAL COMPOSITION - ALL-WELD METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Nb	Ti	Al
≤0.03	0.1	0.9	≤0.01	≤0.01	29.5	58.5	≤0.10	9	≤0.10	0.5	0.5

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic.

MECHANICAL PROPERTIES - ALL-WELD METAL

Mechanical properties after PWHT1) at 610°C (1130 °F) for 24 hours

Temperature	°C	20	360	400
Yield strength, $R_{p0.2}$	MPa	410	350	330
Tensile strength, R_m	MPa	650	550	520
Elongation, A	%	37	37	37
Reduction in area, Z	%	43	48	48
Impact strength, Charpy V (KV)	J	180	-	-

Datasheet updated 10/27/2015 1:49:06 PM (supersedes all previous editions)

Mechanical properties after PWHT1) at 610°C (1130 °F) for 24 hours

Temperature	°C	20	360	400
Impact strength, U-notch (KU)	J	75	-	-

Mechanical properties after PWHT1) at 610°C (1130 °F) for 40 hours

Temperature	°C	20	360
Yield strength, $R_{p0.2}$	MPa	460	380
Tensile strength, R_m	MPa	690	565
Elongation, A	%	32	34
Reduction in area, Z	%	38	40

1) Post Weld Heat Treatment

PHYSICAL PROPERTIES - ALL-WELD METAL

Temperature, °C	20	100	300	500
Thermal conductivity, W/m	11	16	16	19

Thermal expansion per °C, from 30°C to 400°C	15×10^{-6}
Density, g/cm^3, at 20°C	8.1

CORROSION RESISTANCE - ALL-WELD METAL

Sanicro 68HP shows very good resistance to stress corrosion cracking in nuclear pure water environments. The alloy has also good resistance to high temperature oxidation.

RECOMMENDED WELDING DATA

MIG/MAG welding

Electrode positive is used to give good penetration in all types of welded joints. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	5-9	50-140	16-25	15
1.0	5-9	70-160	16-25	15
Spray-arc welding				
1.0	6-12	150-230	22-27	18
1.2	5-9	170-280	23-28	18
1.6	3-5	230-370	24-30	18
Pulsed-arc welding1)				
1.2	3-10	150-250	23-31	18

1) Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Datasheet updated 10/27/2015 1:49:06 PM (supersedes all previous editions)

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with thin gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

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SANICRO 72HP WELDING WIRE

DATASHEET

Sanicro 72HP is filler material for joining NiCrFe alloys, 9% Ni steels used at cryogenic temperatures, stainless steels to carbon steels, high service temperature NiCu alloys to carbon steels and NiCu alloys to nickel alloys. Sanicro 72HP can be used in air up to 1175°C (2145°F) and in sulphur dioxide atmospheres up to 800°C (1470°F).

Sanicro 72HP is suitable for MIG, TIG, PAW and SAW and available as wire and rods.

STANDARDS

- ISO: NiCr20Mn3Nb / Ni 6082
- AWS: ERNiCr-3/UNS N06082

Product Standards

- EN ISO 18274
- ASME/AWS SFA5.14

Product Approvals

- CE
- TÜV

Certificates of approval, including Declaration of Performance, can be found in the Materials Center, Welding materials - approvals.

CHEMICAL COMPOSITION - FILLER METAL

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N	Ti	Nb	Fe
≤0.03	0.1	3.0	≤0.010	≤0.010	20.0	72.5	≤0.2	≤0.10	≤0.05	≤0.05	0.4	2.6	≤1.0

CHEMICAL COMPOSITION - ALL-WELD METAL

The following data is typical for non heat treated all-weld metal made by MIG welding with argon shielding gas.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Ti	Fe	Nb
≤0.03	0.1	3	≤0.010	≤0.010	20.5	72	0.2	0.5	2.5

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic

MECHANICAL PROPERTIES- ALL-WELD METAL

Datasheet updated 10/27/2015 1:49:50 PM (supersedes all previous editions)

Temperature	°C	20	400	600	700	800	-196
Yield strength, $R_{p0.2}$	MPa	390	240	-	-	-	-
Tensile strength, R_m	MPa	660	540	-	-	-	-
Elongation, A	%	45	.	-	-	-	-
Reduction in area, Z	%	50	-	-	-	-	-
Impact strength, Charpy V	J	245	-	-	-	-	150
Hardness, Vickers	HV	180	--	-	-	-	-
Creep rupture strength 5 x 10^5 h	MPa.		-	180	53	20	-

PHYSICAL PROPERTIES - ALL-WELD METAL

Temperature, °C	20	100	300	500	700
Thermal conductivity, W/m	15	16	18	22	25.5

Thermal expansion per °C, from 20°C (68°F) to 400°C (750°F) 12 x 10^{-6}
Density, g/cm^3, at 20°C (68°F) 8.3.

CORROSION RESISTANCE - ALL-WELD METAL

Sanicro 72HP has very good resistance to general corrosion, stress corrosion cracking, and due to its low carbon and high chromium contents, good resistance to intergranular corrosion.

RECOMMENDED WELDING DATA

MIG/MAG welding

Electrode positive is used to give good penetration in all types of welded joints. The following table shows common conditions for MIG welding.

Wire diameter, mm	Wire feed, m/min	Current, A	Voltage, V	Gas, l/min
Short-arc welding				
0.8	5-9	50-140	16-25	15
1.0	5-9	70-160	16-25	15
Spray-arc welding				
1.0	6-12	150-230	22-27	18
1.2	5-9	170-280	23-28	18
1.6	3-5	230-370	24-30	18
Pulsed-arc welding[1)]				
1.2	3-10	150-250	23-31	18

[1)] Pulse parameters:

- Peak current 300 - 400 A
- Background current 50 - 150 A
- Frequency 80 - 120 Hz

Sandvik can provide recommendations for shielding gases.

Short-arc welding is used with thin gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions.

The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application.

Electrode negative and a shielding gas of argon or helium should be used to prevent oxidation of the weld metal.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm	Current, A	Voltage, V
2.0	200-300	28-32
2.4	250-400	28-32
3.2	300-450	29-34

Recommended welding flux is Sandvik 50SW.

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SANDVIK

SANWELD AXT WELDING WIRE

DATASHEET

Sanweld AXT is a filler metal of AWS ER 307 type with increased managanese content, reducing the risk for fissuring/hot cracking that otherwise can be a problem in fully austenitic weld metals. It is suitable for joining work-hardenable steels, armor plates, austenitic stainless manganese steels and free-machining steels (such as ASTM 303) and stainless Cr steels with max. 18% Cr.

Product Standards

- EN ISO 14343-A – 18 8 Mn
- ASME/AWS SFA-5.9 ER(307)

Product Approvals

- CE
- DB
- TÜV
- CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N
0.08	0.9	0.7	≤0.025	≤0.015	18.0	8.0	≤0.3	≤0.1	≤0.06

CHEMICAL COMPOSITION

C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
0.08	0.9	7.0	≤0.025	≤0.015	18	8	≤0.3	≤0.5	≤0.10	≤0.060

APPLICATIONS

Typical applications for Sandweld AXT are welding of work-hardenable steels, armor plate and austenitic stainless manganese steels. It can also be used for welding stainless chromium steels with max. 18% Cr as well as for overlay welding of carbon and low-alloy steels.

FORMS OF SUPPLY

Sanweld AXT is supplied as wire and straight rods.

WELD METAL CHARACTERISTICS

Sanweld AXT gives a fully austenitic microstructure.

MECHANICAL PROPERTIES

At 20°C (68°F), typical values

Datasheet updated 1/7/2016 9:57:47 AM (supersedes all previous editions)

Metric units

Proof strength R_{p02}, MPa	Tensile strength R_m, MPa	Elong. A, %	Hardness HV
460	650	41	200

Imperial units

Proof strength $R_{p0.2}$, ksi	Tensile strength R_m, ksi	Elong. A, %	Hardness HV
67	94	41	200

Impact strength, Charpy V, typical values

Temperature, °C	Impact strength, J	Temperature, °F	Impact strength, ft lbf
20	140	68	103
-196	27	-321	20

CORROSION RESISTANCE

Sanweld AXT has corrosion resistance similar to that of the of the corresponding parent metal. For joints between non-alloyed or low-alloy steels and stainless steels, resistance to corrosion is of secondary importance.

FABRICATION

Recommended welding data

MIG welding

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for MIG welding.

Wire diameter, mm (in.)	Wire feed, m/min	Wire feed, in./min	Current, A	Voltage, V	Gas, l/min	Gas, CFH
Short-arc welding						
0.9 (0.035)	4-8	150-300	40-120	14-18	12	25
1.0 (0.039)	4-8	150-300	60-140	15-21	12	25
Spray-arc welding						
1.0 (0.039)	6-12	225-450	140-220	23-28	18	35
1.2 (0.045)	5-9	200-350	180-260	24-29	18	35
1.6 (0.063)	3-10	115-400	230-350	24-29	18	35
Pulsed-arc welding[1)]						
1.2 (0.045)	3-10	115-400	150-250	23-31	18	35

[1)]Pulse parameters:

- Peak current: 300-400 A
- Background current: 50-150 A
- Frequency: 80-120 Hz

Recommended shielding gases; Ar+(1-3)% O_2, Ar+(1-3)%CO_2, Ar+He+(1-3)%O_2, Ar+He+(1-3)%CO_2

Short-arc welding is used with light gauge material of less than about 3 mm, in depositing root runs, and in welding out-of-flat positions. The higher the inductance in short-arc welding, the higher the fluidity of the molten pool.

Datasheet updated 1/7/2016 9:57:47 AM (supersedes all previous editions)

Spray-arc welding is normally used for heavier gauge material.

TIG welding

The parameters for TIG welding depend largely upon the base metal thickness and the welding application. Electrode negative and a shielding of argon or helium should be used to prevent oxidation of the weld metal. Contact us for more information.

Submerged-arc welding

Electrode positive is suggested for joint welding to give good penetration.

Wire diameter, mm (in.)	Current, A	Voltage, V
1.6 (0.063)	200-300	28-32
2.4 (0.093)	250-400	28-32
3.2 (0.125)	300-350	29-34
4.0 (0.156)	350-500	30-35

Recommended welding fluxes are Sandvik 15W, Sandvik 34WF or Sandvik 35WF.

WELDING STRIP ELECTRODES

Sandvik has been a world leading company in corrosion resistant alloys for surfacing of carbon steels and low alloyed steels for more than 50 years. We have unique industrial experience ranging from nuclear power generation through the chemical and petrochemical industries to the oil & gas and metallurgical industries. The extensive product range of surfacing alloys consists of austenitic, duplex and superduplex stainless steels, high alloy austenitics and nickel alloys.

Strip electrodes are used in electro-slag welding (ESW) and submerged arc welding (SAW). With a world leading metallurgy in our surfacing alloys, we have developed strip electrodes for controlled ferrite (±2 FN) and extremely low impurity levels. The properties are consistent and guarantee very high resistance to cracking and microfissuring in high alloyed austenitics and nickel alloys.

Sandvik strip electrodes have low carbon and high alloy content, therefore the desired properties in the weld metal can be achieved with non-alloying flux even when dilution is high. With non-alloying flux, extremely robust welding is possible with very high productivity levels. With ESW, extra low carbon (ELC) deposits can be attained in a single layer and with non-alloying fluxes extra high speed welding is also possible.

FORMS OF SUPPLY FOR WELDING STRIP ELECTRODES

The welding strip is delivered in coils with inner diameter 305 mm in the cold-rolled condition with a dry, bright surface and deburred edges. The standard strip thickness is 0.4 and 0.5 mm.

Maximum coil weight, for thickness 0.5 mm

Strip width, mm	Coil weight, kg
30	170
60	350
90	525
120	700

STAINLESS STEEL GRADES FOR STRIP ELECTRODES

Welding strip standard program

Sandvik grade	AWS, A5.9	ISO 14343
19.9.L	308L	19 9 L
19.9.LNb	347	19 9 Nb

Sandvik grade	AWS, A5.9	ISO 14343
19.12.3.L	316L	19 12 3 L
19.13.4.L	317L	19 13 4 L
24.13.L	309L	23 12 L
23.12.L*	(309L)	23 12 L
22.11.L	(309L)	22 11 L
24.13.LNb	"309LNb"	23 12 Nb
23.11.LNb	"309LNb"	23 12 Nb
21.11.LNb	"309LNb"	22 12 L Nb
21.13.3.L	(309LMo)	21 13 3 L
22.8.3.L	2209	22 9 3 N L
25.10.4.L	2594	25 9 4 N L
29.8.2.L*	-	-
25.22.2.LMn	"310LMo"	25 22 2 N L
20.25.5.LCu	385	20 25 5 Cu L
24.29.5.LCu	(385)	-

NICKEL ALLOY GRADES FOR STRIP ELECTRODES

Sandvik grade	AWS, A5.14	ISO 18274
Sanicro 60	NiCrMo-3	Ni 6625
Sanicro 69HP	NiCrFe-14	Ni 6043
Sanicro 72HP	NiCr-3	Ni 6082
Sanicro 41Cu	NiFeCr-1	Ni 8065

PROPERTIES AND APPLICATIONS FOR STRIP ELECTRODES

Type ASTM/UNS ISO	Typical procedures	Properties	Applications
18/8 304 1.4301	1 layer 24.13.L + SAW Cr comp. flux 1 layer 23.12.L + ESW flux, high speed 1 layer 24.13.L + ESW flux, high speed	Good resistance to general corrosion, limited resistance to pitting. Resistance to intergranular corrosion (IGC) in Strauss testing good if not PWHT.	General purpose austenitic weld overlay for mildly corrosive media. Low cost overlay as only one layer is necessary. Usually not post-weld heat treated (PWHT) as C content is >0.03%
18/8/ELC 304L 1.4306	2 layers 24.13.L/19.9.L + SAW Cr comp. flux 1 layer 22.11.L + ESW flux 1 layer 23.12.L + ESW flux, moderate speed	Same resistance to general and pitting corrosion as 18/8. Good resistance to IGC, even after PWHT (Strauss/Huey). Ferrite content for SAW can be controlled by the choice of flux.	General purpose austenitic weld overlay for mildly corrosive media. In principle same applications as 18/8. The most common weld metal. Required properties can be reached in one layer with ESW.

Type ASTM/UNS ISO	Typical procedures	Properties	Applications
18/8/Nb 347 1.4550	1 layer 24.13.LNb + AW Cr comp. flux 2 layers 24.13.L/19.9.LNb + SAW Cr comp. flux 1 layer 21.11.LNb + ESW flux 1 layer 23.11.LNb + ESW flux, moderate speed 1 layer 24.13.LNb + ESW flux, high speed	Same resistance to general and pitting corrosion as 18/8/ELC. Very good resistance to IGC, even after PWHT up to 690°C (1274°F).	General purpose austenitic weld overlay for mildly corrosive media, also at elevated temperatures. Often the preferred choice if service temperature is above 400°C (752°F)
19/12/3/ELC 316L 1.4435	2 layers 21.13.3.L/19.12.3.L + SAW Cr comp. flux 2 layers 24.13.L/19.12.3.L + SAW Cr comp. flux 1 layer 21.13.3.L + ESW flux	Better resistance to pitting than the 18/8 types and to all acids, except nitric acid. Almost equal resistance to IGC as 18/8/Nb after PWHT.	Used where better resistance to corrosion in acids or pitting is required. Common choice for heat exchangers, e.g. in the petrochemical industry or offshore. The Mo content, which is important for corrosion resistance, varies with the procedure. For higher corrosion resistance requirements use 20/25/5/Cu/ELC.
25/22/2/ELC s31050 1.4466	2 layers 25.22.2.LMn v+ SAW flux 31S 2 layers 25.22.2.LMn + ESW flux 37S	Very good resistance in ammonium carbamate and nitric acid. Huey testing is commonly used for qualification. The overlay will pass max. 1 µm/48 hours and max. 70µm selective attack. Fully austenitic.	One of the most commonly used weld overlays in urea plants, where austenitic overlays are required.
20/25/5/Cu/ELC 904L 1.4539	2-3 layers 20.25.5.LCu + SAW Cr comp. flux 2-3 layers 20.25.5.LCu + ESW flux	Very good resistance to pitting and acidic corrosion. Good resistance to stress corrosion cracking due to the high Ni content. Strauss testing satisfactory after PWHT up to 5 hours at 600°C (1112°F). CPT is 30°C (86°F).	Used in the chemical, pertochemical, pulp and paper and metallurgical industries, often in connection with seawater cooling. This grade is used where fully austenitic overlays are required.
22/8/3/ELC N31803 1.4462	2-3 layers 22.8.3.L + SAW Cr comp. flux 2-3 layers 22.8.3.L + ESW flux	Good resistance to IGC. CPT is 25°C (77°F). Good resistance to stress corrosion owing to its ferritic-austenitic microstructure.	Used in the process industry to solve problems of stress corrosion cracking (SCC) and pitting. Its high strength makes it very resistant to erosion and therefore suitable, for example, for valve seats, especially in seawater. Cost effective alternative to fully austenitic overlays.

Type ASTM/UNS ISO	Typical procedures	Properties	Applications
25/10/4/L S32750	2 - 3 layers 25.10.4.L + ESW flux 47S	Excellent resistance to stress corrosion cracking. Excellent resistance to pitting and crevice corrosion. CPT 45ºC	Used in chloride-containing bleaching environments in the pulp and paper industry, seawater applications and the chemical industry.
20/70/Nb/ELC N06600 -	2-3 layers Sanicro 72HP + SAW flux 50SW 2-3 layers Sanicro 72HP + ESW flux	Good resistance to IGC also after PWHT. Good resistance to stress corrosion cracking (SCC).	High nickel alloy mostly used in the nuclear industry, e.g. for tube sheets and outlets. For higher corrosion resistance requirements use 30/60/Nb/ELC.
30/60/Nb/ELC N06690 -	2-3 layers Sanicro 69HP + SAW flux 50SW 2-3 layers Sanicro 69HP + ESW flux	Better resistance to IGC than N06600. Good resistance to stress corrosion cracking.	High nickel alloy for nuclear steam generators, e.g. for tube sheets and outlets.

SANDVIK 19.12.3.L WELDING STRIP

DATASHEET

Sandvik 19.12.3.L is a chromium-nickel-molybdenum strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW) to deposit a second layer corrosion resistant alloy of 19%Cr/12%N/3%Mo composition on carbon- and low alloyed steels.

The buffer layer is deposited using an over-alloyed consumable, such as Sandvik 21.13.3.L, Sandvik 22.11.L or Sandvik 24.13.L.

Product standards

- ISO 14343 B 19 12 3 L
- ASME/AWS SFA 5.9

Product Approvals

- Contact your nearest sales office for details.

APPLICATIONS

Sandvik 19.12.3.L is used for weld surfacing of components in the chemical, petrochemical and marine industries where corrosion resistance matching with 316L is required. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.020	0.4	1.8	≤0.020	≤0.020	18.5	13	2.9	≤0.3

The ferrite content is nominally FN 8 according to WRC-92.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

WELD METAL CHARACTERISTICS

Typical chemical compositions in the second layer obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

Datasheet updated 1/25/2016 10:26:14 AM (supersedes all previous editions)

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Mo	FN, WRC
SAW 24.13.L+19.12.3.L/10SW	E316L	≤0,04	18-19,5	11-12,5	2,0-2,5	3-8
SAW 21.13.3.L+19.12.3.L/10SW	E316L	≤0,04	17,5-19	11,5-12,5	2,5-3	3-8
ESW 22.11.L+19.12.3.L/47S	316L,E316L	≤0,03	17,5-19	11,5-12,5	2,0-2,7	3-8
ESW 24.13.L+19.12.3.L/49S	316L,E316L	≤0,03	17-18,5	11,5-12,5	2,0-2,5	3-8

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

On par with the base metal 316L. The resistance to pitting corrosion is better than for 304L. The resistance to acids, except nitric acid, is also better than for 304L.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 19.12.3.L

Flux	Welding method
Sandvik 47S	ESW
Sandvik 49S	ESW-High speed
Sandvik 10SW	SAW

Datasheet updated 1/25/2016 10:26:14 AM (supersedes all previous editions)

SANDVIK 19.13.4.L WELDING STRIP

DATASHEET

Sandvik 19.13.4.L is a chromium-nickel-molybdenum strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW) to deposit a second layer corrosion resistant alloy of 19%Cr/13%Ni/4%Mo composition on carbon- and low alloyed steels. The buffer layer is deposited using an over-alloyed consumable, such as Sandvik 21.13.3.L, Sandvik 22.11.L or Sandvik 24.13.L

The buffer layer is deposited using an over-alloyed consumable, such as Sandvik 21.13.3.L, Sandvik 22.11.L or Sandvik 24.13.L.

Product standards

- ASME/AWS SFA5.9 EQ317L
- ISO 14343 B 19 13 4 L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 19.13.4.L is used for weld surfacing of components in the chemical, petrochemical, marine industries where corrosion resistance on a par with 317L is required. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.02	0.4	1.5	≤0.020	≤0.020	19	14	3.6	≤0.3

The ferrite content is nominally FN 7 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical compositions in the second layer obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

Datasheet updated 1/25/2016 10:27:08 AM (supersedes all previous editions)

	Type of overlay	C	Cr	Ni	Mo	FN, WRC
SAW 21.13.3.L+19.13.4.L/10SW	317L, E317L	≤0,04	18-19	12,5-13,5	3,1-3,5	3-8
ESW 21.13.3.L+19.13.4.L/47S	317L, E317L	≤0,03	18-19	12,5-14	3,3-3,6	3-8
ESW 22.11.L+19.13.4.L/47S	317L, E317L	≤0,03	18-19	12,5-13,5	3,0-3,5	3-8
ESW 24.13.L+19.13.4.L/49S	E316L, EN1.4435	≤0,03	18-19	12,5-13,5	2,5-3,0	3-8

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

- On a par with base metal 317L
- The resistance to pitting corrosion is better than for 316L

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 19.13.4.L

Flux	Welding method
Sandvik 47S	ESW
Sandvik 49S	ESW-High speed
Sandvik 10SW	SAW

Datasheet updated 1/25/2016 10:27:08 AM (supersedes all previous editions)

SANDVIK 19.9.L WELDING STRIP

DATASHEET

Sandvik 19.9.L is a chromium-nickel strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW) to deposit a second layer corrosion resistant alloy of 18%Cr/8%Ni composition on carbon- and low alloyed steels. The buffer layer is deposited using an over-alloyed consumable, such as Sandvik 22.11.L or Sandvik 24.13.L.

Product standards

- ASME/AWS SFA5.9 EQ308L
- ISO 14343 B 19 9 L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 19.9.L is used for weld surfacing of components in the chemical, petrochemical, nuclear, marine industries where corrosion resistance on par with 304L is needed. Typical components are pressure vessels, heat exchangers, shafts, indiustrial piping etc.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.015	0.35	1.8	≤0.015	≤0.015	20	10	≤0.3	≤0.1

The ferrite content is nominally FN 12 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical compositions in the second layer obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	FN, WRC
SAW 24.13.L+19.9.L/10SW	E308L	≤0,03	19-20,5	9,5-10,5	5-10

Datasheet updated 1/25/2016 10:28:10 AM (supersedes all previous editions)

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	FN, WRC
SAW 24.13.L+19.9.L/10S	E308L	≤0,03	18-19,5	9,5-10,5	3-8
ESW 22.11.L+19.9.L/47S	E308L	≤0,030	19-20	9,5-10,5	5-10
ESW 24.13.L+19.9.L/49S	304L,E308L	≤0,03	18,5-20	9,5-10,5	5-10

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

On par with the base metal 304L. The weld deposit is resistant to intergarnular corrosion in Strauss testing (ASTM A262 Practice E) also after the commonly applied post-weld heat treatment specified for C, CMn and low-alloyed steels.

In pitting corrosion applications Mo-alloyed strip electrodes shall be selected. Contact Sandvik for more information.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 19.9.L

Flux	Welding method
Sandvik 47S	ESW
Sandvik 49S	ESW-High speed
Sandvik 10SW	SAW

Datasheet updated 1/25/2016 10:28:10 AM (supersedes all previous editions)

SANDVIK 19.9.LNB
WELDING STRIP

DATASHEET

Sandvik 19.9.LNb is a niobium stabilized chromium-nickel strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW) to deposit a second layer corrosion resistant alloy of stabilized 19%Cr/9%Ni composition on carbon- and low alloyed steels.

The buffer layer is deposited using an over-alloyed consumable, such as Sandvik 21.11.LNb or Sandvik 24.13.LNb.

Product standards

- ASME/AWS SFA5.9 EQ347
- ISO 14343 B 19 9 Nb

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 19.9.LNb is most commonly used for weld surfacing of components petrochemical industries at service temperatures up to 850°C but are also found in the chemical and nuclear industries where corrosion resistance on level with 347 is needed. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb
≤0.02	0.4	1.8	≤0.02	≤0.02	20	10.5	≤0.3	≤0.3	0.5

The ferrite content is nominally FN 11 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical compositions in the second layer obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

Datasheet updated 1/25/2016 10:29:07 AM (supersedes all previous editions)

	Type of overlay	C	Cr	Ni	Nb/C	FN, WRC
SAW 24.13.LNb+19.9.LNb/10SW	E347	≤0,04	19-20	9,5-10,5	8-20	5-10
SAW 24.13.LNb+19.9.LNb/10S	E347	≤0,04	18-19,5	9,5-10,5	8-20	3-8
ESW 21.11.LNb+19.9.LNb/47S	E347	≤0,03	18,5-19,5	9,5-10,5	10-30	4-9
ESW 24.13.LNb+19.9.LNb/49S	E347	≤0,04	18,5-19,5	10-11	10-30	3-8
SAW 24.13.L+19.9.LNb/10SW	E347	≤0,04	19-20	10-11	8-15	3-8
ESW 22.11.L+19.9.LNb/47S	E347	≤0,03	18,5-19,5	10-11	10-20	3-8
ESW 24.13.L+19.9.LNb/49S	E347	≤0,04	18,5-19,5	10-11	10-20	3-8

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

- On a par with base metal 347
- The weld overlay is resistant to intergranular corrosion in Strauss testing (ASTM A262 Practice E) also after the commonly applied post weld heat treatments specified for C-, CMn- and low-alloyed steels
- Better corrosion resistance at elevated temperature than 304/304L

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 19.9.LNb

Flux	Welding method
Sandvik 47S	ESW
Sandvik 49S	ESW-High speed
Sandvik 10SW	SAW

SANDVIK 20.25.5.LCU
WELDING STRIP

DATASHEET

Sandvik 20.25.5.5.LCu is a copper alloyed chromium-nickel-molybdenum strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW) to deposit a second and third layer corrosion resistant alloy of 20%Cr/25%Ni/5%Mo/Cu composition on carbon- and low alloyed steels.

The buffer layer can be deposited using Sandvik 20.25.5.LCu, but also strip electrodes such as Sandvik 21.12.3.L or Sandvik 22.11.L can be used. When the over-alloyed electrode Sandvik 24.29.5.L is used, only one second layer is required to achieve the 904L/E385 composition.

Product Standards

- ASME/AWS SFA5.9 EQ385
- ISO 14343 B 20 25 5 Cu L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 20.25.5.LCu is used for weld surfacing of components in the chemical, petrochemical, marine industry where corrosion resistance equal to UNS N08904 is required. Typical components are heat exchangers, pressure vessels, shafts etc.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.020	0.4	1.8	≤0.015	≤0.015	20	25	4.5	1.5

Fully austenitic microstructure.

WELD METAL CHARACTERISTICS

Typical chemical composition of overlays obtained on C-Mn steel and low-alloy steel.

Two layer welding procedures are also possible. Contact Sandvik for details and guidelines.

Datasheet updated 1/25/2016 10:30:03 AM (supersedes all previous editions)

Chemicalcomposition,wt%

	Type of overlay	C	Cr	Ni	Mo	Cu
SAW 10SW 20.25.5.LCu+20.25.5.LCu+20.25.5.LCu	904L, E385	≤0,03	19,5-20,5	24-25	4,2-4,5	1,2-1,6
SAW 10SW 21.13.3.L+20.25.5.LCu+20.25.5.LCu	904L, E385	≤0,03	19,5-20,5	23,5-24,5	4-4,5	1,2-1,5
ESW 47S 20.25.5.LCu+20.25.5.LCu+20.25.5.LCu	904L	≤0,02	19-20	24-25	4,2-4,5	1,2-1,6
ESW 47S 22.11.L+20.25.5.LCu+20.25.5.LCu	904L	≤0,02	19-20	24-25	4-4,5	1,2-1,6
ESW 47S 21.13.3.L+20.25.5.LCu+20.25.5.LCu	904L	≤0,02	19-20	24-25	4,2-4,5	1,2-1,6
ESW 47S 24.29.5.LCu+20.25.5.LCu	904	≤0,02	19-20	24-25	4,2-4,5	1,2-1,6

The micro structure of the weld overlay is fully austenitic.

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

On a par with base metal 904L (UNS N08904). The resistance to pitting corrosion is better than for 317L. Good resistance to stress corrosion cracking.

The resistance to intergranular corrosion is good.

In constructions that have to be post-weld heat treated for longer periods, Sandvik 22.11.L or Sandvik 21.13.3.L should be used for the first layer and the heat treatment should be carried out before welding the subsequent layer(s).

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 20.25.5.LCu

Flux	Welding method
Sandvik 47S	ESW
Sandvik 10SW	SAW

Datasheet updated 1/25/2016 10:30:03 AM (supersedes all previous editions)

Datasheet updated 1/25/2016 10:30:03 AM (supersedes all previous editions)

SANDVIK 21.11.LNB WELDING STRIP

DATASHEET

Sandvik21.11.LNb is a niobium stabilized chromium-nickel strip electrode used for electro-slag welding (ESW) to deposit a single layer overlay of stabilized corrosion resistant alloy of 19%Cr/9%Ni composition on carbon- and low alloyed steels.

It can also be combined with Sandvik 19.9.LNb for surfacing of two layer overlays.

STANDARDS

- AWS: 'EQ309LNb'
- EN Number: (B 22 11 L Nb)

Product standards

- ASME/AWS SFA5.9 EQ"309LNb"
- ISO 14343 B 22 11 L Nb

Product approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 21.11.LNb is mostly used for corrosion resistant weld surfacing of components in the petrochemical industry at service temperatures up to 850°C but is also used in the chemical and nuclear industries. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

It is often used as transition layer on which a second layer is welded, using 19.9.LNb for better corrosion resistance.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb
≤0.015	0.2	1.8	≤0.020	≤0.020	21	11	≤0.3	≤0.3	0.55

The ferrite content is nominally FN 14 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

Welding process and consumable	Type of overlay	C	Cr	Ni	FN, WRC
ESW Sandvik 21.11.LNb/47S	347, E347	≤0.06	17.5-19.5	9-10.5	3-8

Datasheet updated 1/25/2016 10:30:47 AM (supersedes all previous editions)

Consider the figures as examples. Parameters selected and conditions influence the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

The resistance to general corrosion is good. It is a general purpose overlay for mildly corrosive media, also at elevated temperatures for example in the petrochemical industry.

The resistance to intergranular corrosion in Strauss testing (ASTM A262 Practice E) is good also after post-weld heat-treatment.

FABRICATION

Recommended fluxes for Sandvik 21.11.LNb

Flux	Welding method
Sandvik 47S	ESW
Sandvik 49S	ESW-High speed

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SANDVIK 21.13.3.L
WELDING STRIP

DATASHEET

Sandvik 21.13.3.L is a chromium-nickel-molybdenum strip electrode used for corrosion resistant alloy surfacing with electro-slag welding (ESW) or with submerged arc welding (SAW). In ESW, single layer overlays on carbon- and low alloyed steels of 316/316L composition can be deposited. In SAW, buffer layers of 18%Cr/8%Ni/2%Mo composition can be deposited on carbon- and low alloyed steels before surfacing of second layers with molybdenum containing alloys.

- Combined with Sandvik 19.13.4.L for the second layer it will give 317L weld deposit
- Combined with Sandvik 20.25.5.LCu for the second layer it will give 385 weld deposit
- Other combinations and conditions are possible

STANDARDS

- AWS: (EQ309LMo)
- EN Number: (B 23 12 2 L)

Product standards

- ASME/AWS SFA5.9 EQ(309LMo)
- ISO 14343 B 23 12 2 L

Product approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 21.13.3.L is used for corrosion resistant alloy surfacing, in particular where pitting corrosion is involved, of components in the chemical, petrochemical and marine industries. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

It is used in applications where corrosion resistance similar to 316/316L is required.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu

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≤0.015	0.2	1.8	≤0.020	≤0.015	20.5	13.5	2.9	≤0.3

The ferrite content is nominally FN 13 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloyed steel.

Chemical composition, wt%

Welding process and consumable	Type of overlay	C	Cr	Ni	FN, WRC
ESW21.13.L/47S	316, 316L, E316, E316L	≤0.06	16.5-18.5	10.5-12.5	3-8

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

The resistance to pitting corrosion and corrosion in acids is on par with the base metal 316L. The resistance to intergranular corrosion in Strauss testing (ASTM A262 Practice E) is good.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 21.13.3.L.

Flux	Welding method
Sandvik 47S	ESW
Sandvik 10SW	SAW

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SANDVIK 22.11.L WELDING STRIP

DATASHEET

Sandvik 22.11.L is a chromium-nickel strip electrode used for electro-slag welding (ESW) to deposit a single layer overlay of corrosion resistant alloy of 19%Cr/9%Ni composition on carbon- and low alloyed steels. It can also be combined with Sandvik 19.9.L for surfacing of two layer overlays.

STANDARDS

– AWS: (EQ309L)
– EN Number: (B 22 11 L)

Product Standards

– ASME/AWS SFA5.9 EQ(309L)

– ISO 14343 B 22 11 L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 22.11.L is a multi purpose grade used for corrosion resistant weld surfacing of components in the chemical, petrochemical, nuclear and marine industries. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

It is often used as transition layer on which a second layer is welded, using for example Sandvik 19.9.L, 19.9.LNb, 19.12.3.L or 22.8.3.L, for better corrosion resistance.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.015	0.2	1.8	≤0.020	≤0.020	21	11.5	≤0.3	≤0.1

The ferrite content is nominally FN 13 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloyed steel.

Chemical composition, wt%

Welding process and consumable	Type of overlay	C	Cr	Ni	FN, WRC
ESW22.11.L/47S	304, 304L, E308, E308L	≤0.06	17.5-19.5	9-10.5	3-8

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Consider the figures as examples. Parameters selected and conditions influence the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

- The resistance to general corrosion is good in many mildly corrosive media
- The resistance to intergranular corrosion in Strauss testing (ASTM A262 Practice E) is good if the overlay is not post-weld heat-treated - unless the carbon content is maximum 0,03 %
- In pitting corrosion applications Mo-alloyed strip electrodes shall be selected

Contact Sandvik for more information.

FABRICATION

Recommended fluxes for Sandvik 22.11.L

Flux	Welding method
Sandvik 47S	ESW
Sandvik 49S	ESW-High speed

Datasheet updated 1/25/2016 10:32:31 AM (supersedes all previous editions)

SANDVIK 22.8.3.L WELDING STRIP

DATASHEET

Sandvik 22.8.3.L is a strip electrodes used to obtain a 2209 (SAF 2205) corrosion resistant overlay weld deposit on carbon, carbon-manganese and low-alloy steels using submerged-arc welding (SAW) with Sandvik 10SW flux or electroslag welding (ESW) with Sandvik 47S flux. Other combinations and conditions are possible.

STANDARDS

- AWS: EQ2209
- EN Number: B 22 9 3 N L

Product standards

- EN ISO 14343
- ASME/AWS SFA5.9

CHEMICAL COMPOSITION - STRIP ELECTRODE

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.5	1,6	≤0.020	≤0.015	23	9	3,1	0.15

Ferrite content

The ferrite is nominally 50 FN WRC.

CHEMICAL COMPOSITION OF OVERLAY

Typical chemical composition of overlay in three layers obtained on C-Mn steel and low-alloy steel.

Two layer welding procedures are also possible. Contact Sandvik for details and guidelines.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Mo	N	FN, WRC
SAW 10SW 22.8.3.L+22.8.3.L+22.8.3.L	ER2209	≤0,03	22-23,5	7,5-8,5	2,8-3,3	0,15-0,20	35-55
SAW 10SW 24.13.L+22.8.3.L+22.8.3.L	ER2209,E2209	≤0,03	22-23,5	8-9	2,7-3,2	0,14-0,19	30-50
ESW 47S 22.8.3.L+22.8.3.L+22.8.3.L	ER2209, E2209	≤0,02	22-23	8-9	2,9-3,3	0,14-0,18	35-55
ESW 47S 22.11.L+22.8.3.L+22.8.3.L	ER2209,E2209	≤0,02	22-23	8-9	2,8-3,2	0,13-0,18	35-55

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact

Datasheet updated 5/28/2015 7:48:00 PM (supersedes all previous editions)

Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION PROPERTIES OF OVERLAY

Equal to the base metal UNS S31803 and to UNS S32205, provided a welding procedure resulting in a PRE value exceeding 34 is selected.

Good resistance to stress corrosion cracking.

The resistance to intergranular corrosion is good.

In constructions that have to be post-weld-heat-treated Sandvik 22.11.L or 24.13.L should be used for the first layer and the heat treatment be carried out before welding the subsequent layer(s).

WELDING DATA

Process/Flux	Size	Current, A	Voltage, V	Travel speed, mm/min
SAW/10SW	30 x 0.5 mm	300 - 425	28-30	80 - 160
SAW/10SW	60 x 0.5 mm	650 - 850	28-30	80 - 160
SAW/10SW	90 x 0.5 mm	975 - 1275	28-30	80 - 160
ESW/47S	60 x 0.5 mm	1100 - 1400	23 - 26	130 - 220
ESW/47S	90 x 0.5 mm	1650 - 2100	23 - 26	130 - 220

Direct current, with electrode positive is normally used.

The welding data in the table represent the operation capability of the flux. The desired properties of the overlay are obtained by proper selection of the settings within the ranges.

APPLICATIONS

Sandvik 22.8.3.L is used for weld surfacing of components in the chemical, petrochemical, marine idustries where corrosion resistance on level with the duplex stainless steel UNS S31803 or UNS S32205 (Sandvik SAF 2205) is required. Typical components are pressure vesels, heat exchangers, shafts, idustrial piping etc.

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SANDVIK 23.11.LNB
WELDING STRIP

DATASHEET

Sandvik 23.11.LNb is a niobium stabilized chromium-nickel strip electrode particularly suited for high speed electro-slag welding (ESW) to deposit a single layer overlay of stabilized corrosion resistant alloy of 19%Cr/9%Ni composition on carbon- and low alloyed steels. It can also be combined with Sandvik 19.9.LNb for surfacing of two layer overlays.

Product Standards

– ASME/AWS SFA5.9 EQ"309LNb"
– ISO 14343 B 23 12 L Nb

Product Approvals

Contact your nearest sales office for details,

APPLICATIONS

Sandvik 21.11.LNb is mostly used for corrosion resistant weld surfacing of components petrochemical industries at service temperatures up to 850°C but is also used in the chemical and nuclear industries. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

It is often used as transition layer on which a second layer is welded, using 19.9.LNb for better corrosion resistance.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb
≤0.02	0.2	2.0	≤0.020	≤0.015	23	12	≤0.2	≤0.2	0.75

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

Welding process and consumable	Type of overlay	C	Cr	Ni	FN, WRC
SAW Sandvik 23.11.LNb/Sandvik10SW	E347	≤0.06	18.0-20.0	9-10.5	5-8
ESW Sandvik 23.11.LNb/Sandvik 49S	347, E347	≤0.05	18.0-20.0	9-10.5	5-8

Consider the figures as examples. Parameters selected and conditions influence the result. Contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

Datasheet updated 1/25/2016 10:37:04 AM (supersedes all previous editions)

CORROSION RESISTANCE

- The resistance to general corrosion is good. It is a general purpose overlay for mildly corrosive media, also at elevated temperatures in, for example, the petrochemical industry
- The resistance to intergranular corrosion in Strauss testing (ASTM A262 Practice E) is good also after post-weld-heat-treatment (PWHT)
- In pitting corrosion applications Mo-alloyed strip electrodes shall be selected

Contact Sandvik for more information.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 23.11.LNb

Flux	Welding method
Sandvik 49S	ESW-High speed
Sandvik 10SW	SAW

SANDVIK 24.13.L WELDING STRIP

DATASHEET

Sandvik 24.13.L is a chromium-nickel strip electrode used for submerged arc welding (SAW) and high speed electro-slag welding (ESW) to deposit a buffer overlay of corrosion resistant alloy of 19%Cr/9%Ni composition on carbon- and low alloyed steels. It is combined with Sandvik 19.9.L for surfacing of two layer overlays.

Product standards

- ASME/AWS SFA5.9 EQ309L
- ISO 14343 B 23 12 L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 24.13.L is a multi purpose grade for corrosion resistant weld surfacing of components in the chemical, petrochemical, nuclear, marine industries. Typical components are pressure vessels, heat exchangers, shafts, indiustrial piping etc. It is often used as transition layer on which a second layer is welded, using for example Sandvik 19.9.L, 19.9.LNb, 19.12.3.L, 22.8.3.L, for better corrosion resistance.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.015	0.35	1.8	≤0.015	≤0.015	23.5	13	≤0.3	≤0.1

Ferrite content

The ferrite content is nominally FN 15 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloyed steel.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	FN, WRC
SAW 24.13.L/10SW	304, E308	≤0.07	18.5-20	10-11	3-8
ESW 24.13.L/49S	304, E308, E308L	≤0.07	18-20	9.5-11	3-8

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

Datasheet updated 1/25/2016 10:37:54 AM (supersedes all previous editions)

CORROSION RESISTANCE

- The resistance to general corrosion is good in mildly corrosive media
- The resistance to intergranular corrosion in Strauss testing (ASTM A262 Practice E) is good if the overlay is not post-weld heat treated – unless the carbon content is less than 0.03%
- In pitting corrosion applications Mo-alloyed strip electrode shall be selected

Contact Sandvik for more information.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 24.13.L

Flux	Welding method
Sandvik 10SW	SAW
Sandvik 49S	ESW-High speed

Datasheet updated 1/25/2016 10:37:54 AM (supersedes all previous editions)

SANDVIK

SANDVIK 24.13.LNB
WELDING STRIP

DATASHEET

Sandvik 24.13.LNb is a niobium stabilized chromium-nickel strip electrode used for submerged arc welding (SAW) to deposit a buffer layer of stabilized corrosion resistant alloy of 19%Cr/9%Ni composition on carbon- and low alloyed steels. In high speed electro-slag welding (ESW) it can be used for single layer deposits of 347 composition on carbon- and low alloyed steels. It can also be combined with Sandvik 19.9.LNb for surfacing of two layer overlays.

Product standards

- ASME/AWS SFA5.9 EQ"309LNb"
- ISO 14343 B 23 12 Nb

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 24.13.LNb is used for corrosion resistant weld surfacing of components in the chemical, petrochemical, nuclear industry. Typical components are pressure vessels, heat exchangers, shafts, industrial piping etc.

It is often used as buffer layer on which a second layer is welded, using 19.9.LNb for better corrosion resistance.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb
≤0.02	0.3	2	≤0.020	≤0.020	24	12.5	≤0.3	≤0.3	0.75

Ferrite content

The ferrite content is nominally FN 22 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloyed steel.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	FN, WRC
SAW 24.13.LNb/10SW	E347	≤0,06	18,5-20	9-10,5	3-8
ESW 24.13.LNb/49S	347, E347	≤0,06	17,5-19,5	9-10,5	3-8

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

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MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

- The resistance to general corrosion is good. It is a general purpose overlay for midly corrosive media, also at elevated temperatures, for example in the petrochemical industry
- The resistance to intergranular corrosion in Strauss testing (ASTM A262 Practice E) is good also after post-weld heat treatment
- In pitting corrosion applications Mo-alloyed strip electrodes shall be selected

Contact Sandvik for more information

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 24.13.LNb

Flux	Welding method
Sandvik 10SW	SAW
Sandvik 49S	ESW-High speed

SANDVIK 24.29.5.LCU WELDING STRIP

DATASHEET

Sandvik 24.29.5.LCu is a copper alloyed chromium-nickel-molybdenum strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW).

In ESW, single layer overlays on carbon- and low alloyed steels of E385 composition can be deposited. In SAW, buffer layers of 20%Cr/25%Ni/5%Mo/Cu composition can be deposited on carbon- and low alloyed steels before surfacing of second layers of 904/385 composition using Sandvik 20.25.5.LCu.

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

24.29.5.LCu is used for corrosion resistant weld surfacing, in particular where pitting corrosion is involved, of components in the chemical, petrochemical industries often in connection with sea-water cooling. Typical components are pressure vessels, heat exchangers etc.

It is used where fully austenitic overlays are required and where corrosion properties exceeding those of 317L are needed.

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
≤0.020	0.4	2	≤0.015	≤0.015	23.5	29	5.4	1.8

Ferrite content

Fully austenitic microstructure.

WELD METAL CHARACTERISTICS

Typical chemical composition of single layer obtained on C-Mn steel and low-alloyed steel.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Mo	Cu
ESW 24.29.5.LCu/47S	E385	≤0,03	19,5-21	24-26	4,3-5	1,2-1,7

The microstructure is fully austenitic.

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

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MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

- On par with the base metal 904L (UNS N08904). The resistance to pitting corrosion is better than for 317L
- Good resistance to stress corrosion cracking
- Good resistance to stress corrosion cracking
- The resistance to intergranaular corrosion is good

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 24.29.5.LCu

Flux	Welding method
Sandvik 10SW	SAW
Sandvik 49S	ESW-High speed

Datasheet updated 1/25/2016 10:39:38 AM (supersedes all previous editions)

SANDVIK 25.10.4.L WELDING STRIP

DATASHEET

Sandvik 25.10.4.L is a nitrogen alloyed duplex chromium-nickel-molybdenum strip electrode used in electro-slag welding (ESW) to deposit a second and third layer corrosion resistant alloy of 25%Cr/10%Ni/4%Mo/N composition on carbon- and low alloyed steels.

The buffer layer can be deposited using Sandvik 25.10.4.L, but when the carbon- or low alloyed steel component require post weld heat treatment the buffer layer is welded using Sandvik 24.13.L with heat treatment before subsequent layers.

The grade is characterized by:

- Excellent resistance to stress corrosion cracking (SCC) in chloride-bearing environments
- Excellent resistance to pitting and crevice corrosion
- High resistance to general corrosion
- High resistance to erosion corrosion and corrosion fatigue

Product standards

- ASME/AWS SFA5.9 EQ 2594
- ISO 14343 B 25 9 4 N L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

The high corrosion resistance of overlays using SANDVIK 25.10.4.L, makes it suitable for use in aggressive environments such as chlorinated seawater and acidic, chloride containing media up to temperatures of 280°C.

Typically the grade is found in found in seawater applications, chloride-containing bleaching environments in the pulp and paper industry and the chemical industry.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

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C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	0.3	0.4	≤0.020	≤0.015	25	9.5	4	0.25

The ferrite is nominally FN 50 according to WRC-92.

WELD METAL CHARACTERISTICS

Typical chemical composition of overlay in two layers without heat-treatment, and three layers including intermediate heat-treatment after buffer layer welding.

Chemical composition, wt%

Sandvik	Type of overlay	C	Cr	Ni	Mo	N	FN, WRC	PRE*
1st: 25.10.4.L 2nd: 25.10.4.L	S32750	≤0.03	24.0-25.5	9.0-10.0	3.7-4.2	0.20-0.25	50-60	41
1st: 24.13.L 2nd: 25.10.4.L 3rd: 25.10.4.L	S32750	≤0.03	24.0-25.5	9.0-10.0	3.7-4.2	0.20-0.25	50-60	41

The figures for overlay chemical composition are given as examples. The weld parameters selected and conditions under which welding is carried out may influence the result obtained. Please contact Sandvik for details and guidelines.

*) PRE = %Cr + 3.3 x %Mo + 16 x %N

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

The corrosion resistance of a milled cladding surface meets the following criteria:

- The overlay obtained meets 40°C in ASTM G48A testing
- CPT value of 45°C according to ASTM G48E

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 25.10.4.L

Flux	Welding method
Sandvik 47S	ESW

Datasheet updated 1/25/2016 10:40:57 AM (supersedes all previous editions)

SANDVIK 25.22.2.LMN WELDING STRIP

DATASHEET

Sandvik 25.22.2.LMn is a chromium-nickel-molybdenum strip electrode used for electro-slag welding (ESW) or submerged arc welding (SAW) to deposit a second layer corrosion resistant alloy of 25%Cr/22%Ni/2%Mo composition on carbon- and low alloyed steels. It can also be used as buffer layer before depositing second layers.

Product standards

- ASME/AWS SFA5.9 EQ"310LMo"
- ISO 14343 B 25 22 2 N L

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sandvik 25.22.2.LMn is used for corrosion resistant weld surfacing of components in urea plants. Typical components are pressure vessels, heat exchangers and over-head condensers.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.020	≤0.2	4,5	≤0.015	≤0.015	25	22	2,1	0.13

Fully austenitic microstructure.

WELD METAL CHARACTERISTICS

Typical chemical composition of overlay obtained on C-Mn steel.

Two layer welding procedures are also possible. Contact Sandvik for details and guidelines.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Mo

Datasheet updated 1/25/2016 10:41:54 AM (supersedes all previous editions)

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Mo
SAW 3 layer 25.22.2.LMn/31S	25Cr-22Ni-2Mo	0,03	24,0- 24,5	21-22	2,0-2,1
ESW 2 layer 25.22.2.LMn/37S	25Cr-22Ni-2Mo	0,02	24,0-25,0	21,5-22	2,0-2,1

The ferrite content of the overlay is max 0,5 %.

Consider the figures as examples. Many parameters influence the result. Please consult Sandvik for details guidelines.

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

– Meets the commonly specified corrosion rates in Huey testing (ASTM A262 Practice C). Typical corrosion rate 0,10 mm/year.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended fluxes for Sandvik 25.22.2.LMn

Flux	Welding method
Sandvik 37S	ESW
Sandvik 31S	SAW

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SANDVIK

SANICRO 41CU
WELDING STRIP

DATASHEET

Sanicro 41Cu is a nickel-iron-chromium strip electrode used for electro-slag welding (ESW) to deposit single layer or second layer corrosion resistant alloy overlays of Ni8065/UNS N08825 composition on carbon- and low alloyed steels using non-alloying flux.

The grade has very good resistance to stress corrosion cracking (SCC) in chloride containing environments and is particularly suited for use in reducing environments such as those containing sulphuric and phosphoric acids.

Product standards

- ASME/AWS SFA5.14 EQNiFeCr-1
- ISO 18274 B Ni 8065

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sanicro 41Cu is used for corrosion resistant alloy surfacing of components in the chemical, pollution control, oil & gas and petrochemical industries and often in connection with sour gas service. Typical components are tanks, heat exchangers, evaporators and scrubbers etc.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION - FILLER METAL

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Cu
≤0.025	0.3	1.0	≤0.025	≤0.010	23	≥42	3.0	≥22	2.3

WELD METAL CHARACTERISTICS

The following data is typical for single layer deposits made by the ESW method using the non-alloying flux Sandvik 57S.

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Cu
≤0.05	0.4	0.9	≤0.03	≤0.01	20	39	2.6	34	2

Datasheet updated 1/25/2016 10:42:56 AM (supersedes all previous editions)

The figures for overlay chemical composition are given as examples. The weld parameters selected and conditions under which welding is carried out may influence the result obtained.

Fully austenitic microstructure.

CORROSION RESISTANCE

Sanicro 41Cu shows very good corrosion resistance in both reducing and oxidicing media, and has good resistance to general corrosion, pitting, crevice corrosion and stress corrosion cracking. It is particularly useful in environments such as sulfuric acid, phosphoric acid, sulfur-containing flue gases, sour oil and gas wells, and sea water.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended flux for Sandvik Sanicro 41Cu

Flux	Welding method
Sandvik 57S	ESW

Datasheet updated 1/25/2016 10:42:56 AM (supersedes all previous editions)

SANICRO 60 WELDING STRIP

DATASHEET

Sanicro 60 is a nickel-chromium-molybdenum strip electrode used for electro-slag welding (ESW) to deposit a second layer corrosion resistant alloy of Ni6625/UNS N06625 composition on carbon- and low alloyed steels.

It can also be used as buffer layer before depositing second layers. Due to the low carbon content of the strip Sanicro 60 is often used for single layer deposits when the required Fe content in the overlay is less than 10%.

The grade is characterized by:

- Excellent resistance to stress corrosion cracking in chlorides
- Very good resistance to pitting and intergranular corrosion

Product standards

- ASME/AWS SFA 5.14 EQNiCrMo-3
- ISO 18274 B NiCr22Mo9Nb/Ni 6625

Product Approvals

Contact your nearest sales office for details.

APPLICATIONS

Sanicro 60 is used for corrosion resistant weld surfacing of components in the chemical and petrochemical industries and often in connection with sea-water cooling where pitting corrosion and stress corrosion cracking are a risk. Typical components are pressure vessels, heat exchangers etc.

FORMS OF SUPPLY

Strip electrodes are delivered in coils with internal diameter 305 mm.

Standard dimensions	0.5 x 30, 60, 90, 120 mm
	0.4 x 50, 75, 150 mm
Max coil weight	700 kg

CHEMICAL COMPOSITION

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	Fe	Nb
≤0.03	0.2	0.2	≤0.015	≤0.010	22	≥60	9	≤1	3.5

WELD METAL CHARACTERISTICS

Typical chemical composition of overlays in two layers obtained on C-Mn steel and low-alloy steel.

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Chemical composition (nominal) %

	Type of overlay	C	Cr	Ni	Mo	Fe	Nb
ESW 57S Sanicro 60 (2 layers)	ERNiCrMo-3	0.02	21.5	≥60	8-9	≤4	3

The figures for overlay chemical composition are given as examples. The weld parameters selected and conditions under which welding is carried out may influence the result obtained.

MECHANICAL PROPERTIES

Passes side bend testing according to ASME Section IX.

CORROSION RESISTANCE

Sanicro 60 shows very good resistance to pitting corrosion and intergranular corrosion and has excellent resistance to stress corrosion cracking in chloride containing environments.

FABRICATION

For electro-slag welding (ESW) and submerged arc welding (SAW), weld fluxes are used for protective shielding of the weld metal.

Recommended flux for Sandvik Sanicro 60

Flux	Welding method
Sandvik 57S	ESW

SANICRO 69HP WELDING STRIP

DATASHEET

Sanicro 69HP is a strip electrode used mainly in the nuclear industry to obtain a ENiCrFe-7 (UNS N06690) corrosion resistant overlay weld deposit on carbon, carbon-manganese and low-alloy steels using electroslag welding (ESW) with Sandvik 59S flux. Other combinations and conditions are possible.

STANDARDS

– AWS: EQNiCrFe-14

Product standards

– ASME/AWS SFA5.14

CHEMICAL COMPOSITION - STRIP ELECTRODE

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Fe	Nb
≤0.025	0.1	1.3	≤0.01	≤0.01	30	57	≤9	1.8

CHEMICAL COMPOSITION OF OVERLAY

Typical chemical composition of overlays in three layers obtained on C-Mn steel and low-alloy steel.

Two layer welding procedures are also possible. Contact Sandvik for details and guidelines.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Fe	Nb
ESW 59S Sanicro 69HP+Sanicro 69HP+Sanicro 69HP	ENiCrFe-7	≤0,03	28,5-30	57-59	8-10	1,2-1,7

The micro structure of the weld overlay is fully austenitic.

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION PROPERTIES OF OVERLAY

Better resistance to intergranular corrosion than N06600. Good resistance to stress corrosion cracking.

WELDING DATA

Datasheet updated 6/8/2015 12:57:58 PM (supersedes all previous editions)

Process/Flux	Size	Current, A	Voltage, V	Travel speed, mm/min
ESW/59S	30 x 0.5 mm	500 - 700	24-28	140 - 180
ESW/59S	60 x 0.5 mm	1100 - 1300	24-28	140 - 180

APPLICATIONS

Sandvik Sanicro 69HP is used for corrosion resistant weld surfacing of components in the nuclear industry - for example tube sheets and closure heads of steam generators.

Datasheet updated 6/8/2015 12:57:58 PM (supersedes all previous editions)

SANDVIK

SANICRO 72HP WELDING STRIP

DATASHEET

Sanicro 72HP is a strip electrode used to obtain a ERNiCr-3 (UNS N06600) corrosion resistant overlay weld deposit on C-, CMn- and low-alloy steels using electroslag welding (ESW) with Sandvik 57S flux. Other combinations and conditions are possible.

STANDARDS

– AWS: EQ NiCr-3

Product standard

– ASME/AWS SFA 5.14 EQNiCr-3

CHEMICAL COMPOSITION - STRIP ELECTRODE

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Fe	Nb
≤0.030	0.1	3	≤0.01	≤0.01	20	72	≤1	2.6

CHEMICAL COMPOSITION OF OVERLAY

Typical chemical composition of overlays in three layers obtained on C-Mn steel and low-alloy steel.

Chemical composition, wt%

	Type of overlay	C	Cr	Ni	Fe	Nb
ESW 57S Sanicro 72HP+Sanicro 72HP+Sanicro 72HP	ERNiCr-3	≤0,03	19-20	≥70	≤1,5	2-2,5

The micro structure of the weld overlay is fully austenitic.

Consider the figures as examples. Parameters selected and conditions influence on the result. Please contact Sandvik for details and guidelines.

MECHANICAL PROPERTIES OF OVERLAY

Passes side bend testing according to ASME Section IX.

CORROSION PROPERTIES OF OVERLAY

Good resistance to intergranular corrosion also after PWHT. Good resistance to stress corrosion cracking.

WELDING DATA

Process/Flux	Size	Current, A	Voltage, V	Travel speed, mm/min
ESW/57S	30 x 0.5 mm	500 - 700	24-28	140 - 180

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Process/Flux	Size	Current, A	Voltage, V	Travel speed, mm/min
ESW/57S	60 x 0.5 mm	1100 - 1300	24-28	140 - 180

APPLICATIONS

Sandvik Sanicro 72HP is mostly used for corrosion resistant weld surfacing of components in the nuclear industry – for example, tube sheets and closure heads of steam generators.

WELDING FLUX

Sandvik provides welding fluxes for joint welding and surfacing with stainless steel and nickel alloys. They are used in combination with wire and strip electrodes in submerged arc welding (SAW) and strip electrodes in submerged arc (SAW) or electro-slag welding (ESW).

Welding fluxes protect the weld pool and enable high productive and robust welding conditions for manufacturing industries. Sandvik welding fluxes have non-alloying characteristics for optimized welding performance and consistent weld metallurgy.

All welding fluxes are agglomerated and packed in hermetically sealed metallic containers. Sandvik welding fluxes can be used directly from unopened containers, without re-baking, up to five years after the manufacturing date.

OUR WELDING FLUXES

Flux for submerged-arc welding (SAW)

Flux	Characteristics	Applications
Sandvik 10SW	Cr compensated Basicity 1.0	General purpose flux for both strip and wire electrodes of CrNi and CrNiMo steels, stabilized or non-stabilized. Good slag removal. Gives about 2% higher ferrite content than 10S.
Sandvik 15W	Non-Cr compensated Basicity 1.7	Special purpose flux for wire electrodes of Cr-Ni and CrNiMo steels, stabilized or non-stabilized as well as duplex, super-duplex and fully austenitic grades, e.g. 20.25.5.LCu. Good slag removal. Gives good impact properties. The Nb burn-off is very small when using stabilized electrodes, such as 19.9.Nb.
Sandvik 31S	Non-Cr compensated Basicity 1.1	Single purpose flux for both strip and wire electrodes of 25.22.2.LMn, intended for urea applications. Good slag removal.
Sandvik 50SW	Non-Cr compensated Basicity 2.4	General flux for strip and wire electrodes of nickel alloys. Good slag removal.

Flux for electroslag welding (ESW)

Flux	Characteristics	Applications
Sandvik 37S	Non-Cr compensated Basicity 3.8	General purpose flux for strip electrodes of CrNi and CrNiMo steels, stabilized or non-stabilized, duplex and fully austenitic grades, e.g. 25.22.2.LMn. Excellent slag removal and bead appearance.

Flux for electroslag welding (ESW)

Flux	Characteristics	Applications
Sandvik 47S	Non-Cr compensated Basicity 4.0	General purpose flux for strip electrodes of CrNi and CrNiMo steels, stabilized or non-stabilized as well as duplex and fully austenitic CrNiMo grades, e.g. 20.25.5.LCu. Excellent slag removal and bead appearance. Low Si pick up.
Sandvik 48S[1)]	Non-Cr compensated Ni alloying Basicity 4.0	Special nickel alloying flux for strip electrodes of mainly super-duplex type.
Sandvik 49S	Non-Cr compensated Basicity 4.4	High speed flux for strip electrodes of CrNi and CrNiMo steels, stabilized or non-stabilized. Excellent slag removal and bead appearance.
Sandvik 57S	Basicity 4.0	Flux for strip electrodes of nickel alloy type giving excellent slag removal and bead appearance.
Sandvik 59S	Non-Cr compensated Basicity 5.0	Flux for strip electrodes of nickel alloy type. Excellent slag removal and bead appearance. Gives good safety against micro cracking.

1) Contact us for more information.

WELDING FLUX BASICITY INDEX

Basicity is commonly used to describe the metallurgical behaviour of a welding flux. The basicity index is a ratio between basic and acid compounds (oxides and flourides) of which the flux is composed.

There are several ways of calculating basicity and in welding Boniszewski's formula has become the predominant way of calculating basicity.

Welding fluxes can be divided into three groups:

Type of welding flux	Basicity
Acid fluxes	<0.9
Neutral fluxes	0.9 - 1.2
Basic fluxes	>1.2

Basicity has great influence on impact toughness of the weld metal. Increasing basicity brings down the oxygen content and hence the inclusion level in the weld metal. Consequently, the impact toughness will increase and also, to a limited extent, the ductility of the weld metal.

The relation between basicity and impact toughness is particularly important for high alloyed grades, such as duplex steels.

HANDLING AND STORAGE OF WELDING FLUXES

By carefully selecting raw materials and optimizing manufacturing conditions the Sandvik fluxes have guaranteed as-delivered moisture content from the factory.

Normally, the fluxes are delivered in steel drums, each containing 25 kg (55 lbs). Each pallet has a net weight of 500–1000 kg (1100–2200 lbs) and is shrink wrapped in plastic or packed in wooden crates before delivery from the factory.

To maintain the as-delivered moisture content, as long as possible, the handling and storage of the flux must be done according to the following requirements.

TRANSPORT

Transportation of the flux must be done in covered vehicles.

- Unbroken pallets must be shrink wrapped in plastic or kept in wooden crates.
- Unprotected containers must be repacked within one hour, otherwise they must be scrapped.
- Maximal two pallets may be stapled on each other.

STORAGE

Unopened flux drums must be kept under properly maintained storage conditions as follows:

- Temperature: 20 ± 10°C.
- Relative humidity: as low as possible, not exceeding 70%.
- Flux stored according to these conditions has a lifetime of max 5 years.
- The content of unprotected flux hoppers must, after an 8 hours' shift, be placed in drying cabinet or heated flux hopper at a temperature of 150 ± 25°C.
- Remaining flux from opened drums must also be placed at a temperature of 150 ± 25°C.

RECYCLING

- Moisture and oil must, in a suitable way, be removed from the compressed air used in the recirculation system.
- Addition of new flux must be done with the proportion of at least one part new flux to three parts recycled flux.
- Foreign material such as millscale, dross et cetera, should be removed by a suitable sieving.

REBAKING

When handled and stored as above, the Sandvik fluxes can normally be used as they are. If, however, a severe application is considered, as given by the material specification, rebaking of flux is recommended.

Furthermore, if flux, due to unfavourable handling or storage, has picked-up moisture, rebaking can return the flux to its original state.

Rebaking shall be performed as follows:

- 350 ± 25°C for minimum 4 hours.
- Rebaking must be done on shallow plates with a flux height not exceeding 50 mm.
- Rebaked flux, not immediately used, must be kept at 150 ± 25°C before use.

SANDVIK 10SW WELDING FLUX

DATASHEET

Sandvik 10SW is a chromium-compensating agglomerated flux giving good slag removal and a fine bead appearance. It is suitable for welding with wire and strip electrodes of the chromium, chromium-nickel and chromium-nickel-molybdenum steel types either with or without niobium.

Sandvik 10SW is an allround flux which can be used for many applications varying from surfacing continuous caster rolls to large componens in chemical plants. Sandvik 10SW gives about 2% higher ferrite content than flux Sandvik 10S.

Product standard

– EN ISO 14174 S A CS 2 Cr

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

SiO_2	MgO	AL_2O_3	CaF_2	Cr
35.0	30.0	15.0	7.0	5.0

APPLICATIONS

Sandvik 10SW is an all-round flux which can be used for many applications varying from surfacing continuous caster rolls to large components in chemical plants. Sandvik 10SW gives about 2% higher ferrite content than flux Sandvik 10S.

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERISTICS

Surfacing – strip welding

Chemical composition (nominal) %

The chemical compositions below are typical results after weld surfacing on 2¼ Cr1Mo steel.

Alloy type	ASTM 347	ASTM 347	ASTM 316L
Layer 1	Sandvik 24.13.LNb	Sandvik 24.13.L	Sandvik 24.13.L
Layer 2	Sandvik 19.9.LNb	Sandvik 19.9.LNb	Sandvik 19.12.3.L
C	0.02	0.02	0.02
Si	0.6	0.8	0.7
Mn	0.8	0.7	0.8

Datasheet updated 2/22/2016 2:49:33 PM (supersedes all previous editions)

Alloy type	ASTM 347	ASTM 347	ASTM 316L
Layer 1	Sandvik 24.13.LNb	Sandvik 24.13.L	Sandvik 24.13.L
Layer 2	Sandvik 19.9.LNb	Sandvik 19.9.LNb	Sandvik 19.12.3.L
Cr	21.0	19.5	19.0
Ni	10.4	10.1	11.5
Mo	0	0.2	2.2
Nb	0.3	0.3	0
N	0.05	0.05	0.06

Mechanical properties

All three surfacings have passed side bend testing (ASME IX) after heat treatment at for 690°C 15 hours.

Corrosion resistance

All three surfacings above have been intergranular corrosion tested (ASTM A262 E) after heat treatment at 690°C for 15 hours, and passed.

Surfacing - wire welding

Chemical composition (nominal) %

The chemical compositions below are typical results after weld surfacing on 2¼ Cr1Mo steel.

Alloy type	ASTM 347	ASTM 316L
Layer 1	Sandvik 24.13.LHF	Sandvik 24.13.LHF
Layer 2	Sandvik 19.9.Nb	Sandvik 19.12.3.L
Layer 3	Sandvik 19.9.Nb	Sandvik 19.12.3.L
C	0.04	0.02
Si	1.0	1.0
Mn	0.6	0.8
Cr	19.0	18.5
Ni	9.2	11.4
Mo	0	2.1
Nb	0.3	0
N	0.06	0.06

Joining

Mechanical properties

Sandvik 10SW gives the following typical mechanical properties of all-weld metal for the wire electrodes below.

	$R_{P0.2}$ MPa	R_m MPa	A %	KV J		
Sandvik wire				20°C	-40°C	-196°C
19.9.L	400	580	38	69	59	40

	$R_{P0.2}$ MPa	R_m MPa	A %	KV J		
Sandvik wire				20°C	-40°C	-196°C
19.9.Nb	440	625	38	72	61	34
19.12.3.L	355	555	33	69	60	66

FABRICATION

Fabrication

Welding data

Direct current with electrode positive is normally used.

Strip dimensions, mm	Current, A	Voltage, V	Travel speed, mm/mm
20 x 0.50	200-275	28-30	80-160
30 x 0.50	300-425	28-30	80-160
60 x 0.50	650-850	28-30	80-160
90 x 0.50	975-1275	28-30	80-160

Wire diameter, mm	Current, A	Voltage, V	Travel speed, mm/mm
2.4	250-400	26-32	300-500
3.2	300-550	26-32	300-600
4.0	400-700	26-32	300-600

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	1.0
Current capacity using 60 x 0.5 mm strip electrode	1200 A
Flux consumption	0.7 kg/kg strip electrode 0.7 kg/kg wire electrode at 30 V 1.0 kg/kg wire electrode at 35 V

Datasheet updated 2/22/2016 2:49:33 PM (supersedes all previous editions)

SANDVIK 15W WELDING FLUX

DATASHEET

Sandvik 15W is a basic welding flux for submerged arc welding giving good slag removal and a fine bead appearance. Its relatively high basicity makes it suitable for joining of the austenitic and duplex stainless steel when high impact strength is desired. Due to its low niobium content burn-off it can be used advantageously with stabilized wire electrodes.

STANDARDS

– ISO: 14174 S A AF 2

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

SiO_2	CaF_2	Al_2O_3
7.0	50.0	40.0

APPLICATIONS

Sandvik 15W is a high performance welding flux in many joining applications in the chemical, petrochemical and oil&gas industry. It is particularly suited for Sandvik's range of duplex wire electrodes (e.g. Sandvik 22.8.3.L/25.10.4.L) due to the highly neutral behaviour, which ensures an optimal balanced microstructure.

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERISTICS

Chemical composition (nominal) %

The chemical compositions are typical all-weld metal results for the Sandvik wire listed.

Element	19.12.3.L	20.25.5.LCu	22.8.3.L	25.10.4.L
C	0.01	0.01	0.01	0.01
Si	0.5	0.5	0.7	0.5
Mn	1.5	1.4	1.2	0.3
Cr	18.1	19.6	22.6	24.5
Ni	12.3	25.0	8.6	9.5
Mo	2.6	4.5	3.1	4.0
Nb	-	-	-	-
N	-	-	0.15	0.22

Mechanical properties

Datasheet updated 1/8/2016 1:54:53 PM (supersedes all previous editions)

Sandvik 15W gives the following mechanical properties for the filler wires below.

Sandvik wire	$R_{p0.2}$ MPa	R_m MPa	A %	KV J		
				20°C	-40°C	-196°C
19.12.3.L	390	530	41	100	85	40
20.25.5.LCu	345	550	40	125	-	100
22.8.3.L	620	790	29	115	85	-
25.10.4.L						

FABRICATION

Fabrication

Welding data

Direct current with electrode positive is normally used.

Wire diameter, mm	Current, A	Voltage, V	Travel speed, mm/mm
1.2	**250-450**	**28-32**	**200-400**
2.4	300-500	29-34	250-500
3.2	400-600	30-35	250-600
4.0	500-700	30-35	250-600

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	1.9
Current capacity using 60 x 0.5 mm wire electrode	1200 A
Flux consumption	0.5 kg/kg wire electrode at 28 V 0.6 kg/kg wire electrode at 31 V 0.8 kg/kg wire electrode at 34 V

Datasheet updated 1/8/2016 1:54:53 PM (supersedes all previous editions)

SANDVIK

SANDVIK 31S WELDING FLUX

DATASHEET

Sandvik 31S is a neutral welding flux for submerged arc welding giving good slag removal and fine bead appearance. It is suitable for surfacing with strip and wire electrodes and can also be used for joining.

Product standard

– ISO 14174 S A AB 2

APPLICATIONS

Sandvik 31S is intended primarily for welding with strip or wire electrodes of the 310LMo type, such as Sandvik 25.22.2.LMn, for urea applications.

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERISTICS

Chemical composition (nominal), %

The chemical compositions are typical all weld metal results for the below strip and wire electrodes.

Sandvik 25.22.2.LMn	C	Si	Mn	Cr	Ni	Mo	N
Strip electrode	0.02	0.6	3.6	24.2	22	2.0	0.13
Wire electrode	0.02	0.6	3.8	24.5	22	2.0	0.12

MECHANICAL PROPERTIES

Sandvik flux 31S gives the following mechanical properties in combination with Sandvik 25.22.2.LMn strip and wire electrodes.

Sandvik 25.22.2.L	$R_{p0.2}$ MPa	R_m MPa	A %	KV J		
				20°C	-40°C	-196°C
Strip electrode	320	560	50	125	115	65
Wire electrode	380	570	40	75	-	40

FABRICATION

Welding data

Direct current, with electrode positive is normally used for joint welding to give good penetration.

Strip dimensions, mm	Current, A	Voltage,V	Travel speed, mm/min
30 x 0.5	400-500	26-30	100-180
60 x 0.5	700-900	26-30	100-160

Datasheet updated 1/8/2016 1:56:39 PM (supersedes all previous editions)

Strip dimensions, mm	Current, A	Voltage,V	Travel speed, mm/min
90 x 0.5	1100-1500	26-30	100-160

Wire diameter, mm	Current, A	Voltage,V	Travel speed, mm/min
1.6	250-450	28-32	200-400
2.4	300-500	29-34	250-500
3.2	400-600	30-35	250-600
4.0	500-700	30-35	250-600

FLUX DATA

Bulk weight	0.9 kg/l
Basicity (Boniszewski)	1.0
Current capacity using 60 x 0.5 mm strip electrode	1200 A
Flux consumption	0.7 kg/kg strip electrode

Datasheet updated 1/8/2016 1:56:39 PM (supersedes all previous editions)

SANDVIK 34S
WELDING FLUX

DATASHEET

Sandvik 34S is a neutral slightly chromium compensating welding flux for submerged arc welding giving good slag removal and fine bead appearance. It is suitable for surfacing with strip and wire electrodes and can also be used for joining.

Product standard

– ISO 14174 S A AB 2 Cr

APPLICATIONS

Sandvik 34S is intended primarily for welding with strip or wire electrodes of austenitic types, such as Sandvik 19.9.LQ and Sandvik 24.13.LQ, for nuclear and chemical applications.

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERISTICS

The chemical compositions are typical all-weld metal results for the strip electrodes below.

Strip electrode	C	Si	Mn	Cr	Ni	Mo
Sandvik 19.9.LQ	0.02	0.8	1.3	20.5	9.2	0.1
Sandvik 24.13.LQ	0.02	0.8	1.3	23.5	12.1	0.1

MECHANICAL PROPERTIES

Sandvik flux 34S gives the following mechanical properties in combination with Sandvik strip electrodes below.

Strip electrode	$R_{p0.2}$ MPa (ksi)	R_m MPa (ksi)	A5, %
Sandvik 19.9.LQ	420 (61)	600 (87)	47
Sandvik 24.13.LQ	430 (62)	580 (84)	43

CORROSION RESISTANCE

The all-weld metal of both above electrodes have been tested for intergranular corrosion (ASTM A262 E) in as welded and PWHT condition (608°C ± 10°C 40 h), and passed.

FABRICATION

Welding data

Direct current, with electrode positive is normally used for joint welding to give good penetration.

Strip dimensions, mm	Current, A	Voltage, V	Travel speed, mm/min

Datasheet updated 1/18/2016 2:27:04 PM (supersedes all previous editions)

30 x 0.5	400-500	26-30	100-180
60 x 0.5	700-900	26-30	100-160
90 x 0.5	1100-1500	26-30	100-160

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	0.85
Current capacity using 60 x 0.5 mm wire electrode	1200 A
Flux consumption	0.7 kg/kg strip electrode

Datasheet updated 1/18/2016 2:27:04 PM (supersedes all previous editions)

SANDVIK 37S
WELDING FLUX

DATASHEET

Sandvik 37S is a highly basic welding flux for electroslag strip surfacing. It gives excellent slag removal and bead appearance also for niobium-alloyed strip electrodes.

Flux Sandvik 37S is used together with strip electrodes of chromium, chromium-nickel and chromium-nickel-molybdenum steel types with or without niobium.

Product standard

– ISO 14174 (E) SA FB 2

CHEMICAL COMPOSITION (NOMINAL), %

CaF_2	Al_2O_3	SiO_2+MgO
63	25	8

APPLICATIONS

Sandvik 37S is intended primarily for welding with fully austenitic strip electrodes, such as the Sandvik 25.22.2.LMn for urea applications.

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERSTICS

Chemical composition (nominal) %

The chemical compositions below are typical results after weld surfacing on 2¼ Cr1Mo steel.

Layer 1	Sandvik 25.22.2.LMn
Layer 2	Sandvik 25.22.2.LMn
C	0.02
Si	0.04
Mn	3.4
Cr	24.2
Ni	21.8
Mo	2.1
N	0.12

Mechanical properties

The above surfacing has passed side bend testing (ASME IX) after heat treatment at 690°C for 15 hours.

Datasheet updated 10/7/2015 4:34:14 PM (supersedes all previous editions)

Disbonding results are available on request.

Corrosion resistance

The above surfacing has been intergranular corrosion tested (ASTM A262 C) after heat treatment at 690°C for 15 hours, with corrosion rate <0.12 mm/year.

FABRICATION

Welding data

Direct current, with electrode positive is normally used.

Strip electrode	Current, A	Voltage, V	Travel speed, mm/min
60x0.50	1100-1400	23-26	130-220
90x0.50	1650-2100	23-26	130-220

FLUX DATA

Bulk weight	0.8 kg/l
Basicity (Boniszewski)	3.8
Current capacity using 60 x 0.5 mm strip electrode	1800 A
Flux consumption	0.7 kg/kg strip electrode

Datasheet updated 10/7/2015 4:34:14 PM (supersedes all previous editions)

SANDVIK 47S
WELDING FLUX

DATASHEET

Sandvik 47S is a highly basic welding flux for electroslag strip surfacing. It gives excellent slag removal and bead appearance also for niobium-alloyed strip electrodes. Flux Sandvik 47S is used together with strip electrodes of steel types chromium, chromium-nickel and chromium-nickel-molybdenum with or without niobium.

STANDARDS

– ISO: 14174 (E) SA FB 2

APPLICATIONS

The high basicity of flux Sandvik 47S makes it especially suitable for duplex, super-duplex and fully austenitic stainless steel surfacings.

CHEMICAL COMPOSITION (NOMINAL), %

CaF_2	Al_2O_3	SiO_2+MgO
63	25	8

FABRICATION

Welding data

Direct current, with electrode positive is normally used.

Strip electrode	Current, A	Voltage, V	Travel speed, mm/min
60x0.50	1100-1400	23-26	130-220
90x0.50	1650-2100	23-26	130-220

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	4.04.04.
Current capacity using 60 x 0.5 mm wire electrode	1700 A
Flux consumption	0.6 kg/kg strip electrode

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERISTICS

Datasheet updated 1/25/2016 10:45:28 AM (supersedes all previous editions)

Chemical composition (nominal) %

The chemical compositions below are typical results after weld surfacing on 2¼Cr1Mo steel.

Alloy type	ASTM 347	ASTM 310MoLN
Layer 1	Sandvik 22.11.L	Sandvik 25.22.2.LMn
Layer 2	Sandvik 19.9.LNb	Sandvik 25.22.2.LMn
C	0.01	0.02
Si	0.4	0.4
Mn	1.2	3.5
Cr	19.2	24.6
Ni	10.5	22.0
Mo	0.1	2.0
Nb	0.3	-
N	0.03	0.14

Alloy type	ASTM 347	ASTM 347	ASTM 316
Layer 1	Sandvik 22.11.LNb	Sandvik 24.13.LNb	Sandvik 21.13.3.L
C	0.02	0.03	0.02
Si	0.5	0.4	0.4
Mn	1.3	1.5	1.1
Cr	19.3	20.8	18.7
Ni	10.1	10.7	12.5
Mo	0.1	0.2	2.7
Nb	0.5	0.6	-
N	0.05	0.04	0.03

Mechanical properties

All five surfacings have passed side bend testing (ASME IX) after heat treatment at 690°C for 15 hours. Disbonding results are available on request.

Corrosion resistance

All five surfacings above have been intergranular corrosion tested (ASTM A262 E) after heat treatment at 690°C for 15 hours, and passed.

SANDVIK 49S
WELDING FLUX

DATASHEET

Sandvik 49S is a basic, agglomerated flux for electroslag strip surfacing. This flux is particularly intended for high-speed welding. In spite of high welding speed, flux Sandvik 49S gives excellent slag removal and bead appearance, also for niobium-alloyed strip electrodes. It is used together with strip electrodes of the chromium, chromium-nickel and chromium-nickel-molybdenum steel types with or without niobium.

ALLOYING VECTOR

The alloying vector describes the difference in chemical composition between the filler metal and the undiluted all-weld metal due to the influence of the flux. Welding speed: 350mm/min.

Element	Sandvik strip electrode		
	19.9.LNb	24.13.LNb	19.12.3.L
C	-0.001	0	-0.001
Si	+0.2	+0.2	+0.2
Mn	-0.4	-0.4	-0,4
Cr	-0.4	-0.4	-0.3
Ni	-0.1	-0.1	0
Mo	0	0	0
Nb	-0.1	-0.1	-
N	0	0	0

CHEMICAL COMPOSITION (NOMINAL), %

Al_2O_3	CaF_2	SiO_2+MgO
20	70	10

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	4.4
Current capacity using 60 x 0.5 mm strip electrode	2200 A
Flux consumption	0.6 kg/kg strip electrode

SURFACING

The chemical compositions below are typical results after weld surfacing on 2¼Cr1Mo steel.

Datasheet updated 1/18/2016 2:44:14 PM (supersedes all previous editions)

Alloy type	347	347	347
Welding speed	350 mm/min	350 mm/min	250 mm/min
Layer 1	Sandvik 24.13.LNb	Sandvik 24.13.L	Sandvik 21.11.LNb
Layer 2	Sandvik 19.9.LNb	Sandvik 19.9.LNb	-
C	0.02	0.02	0.02
Si	0.3	0.3	0.4
Mn	1.4	1.3	1.4
Cr	19.6	19.5	18.9
Ni	105	10.6	9.7
Mo	0.1	0.1	0.1
Nb	0.4	0.3	0.5
N	0.03	0.03	0.05

Intergranular corrosion – All three surfacings above have been IGC tested (ASTM A262, Pr.E, Strauss) after heat treatment at 690°C for 15 hours, and passed.

Bend testing – All three surfacings have passed side bend testing (ASME IX) after heat treatment at 690°C for 15 hours. Disbonding results are available on request.

WELDING PARAMETERS

Direct current, with electrode positive is normally used.

Strip electrode	Current, A	Voltage, V	Travel speed, mm/min
60x0.50	1600-2200	23-26	250-450
90x0.50	2400-2800	23-26	250-350

SANDVIK 50SW WELDING FLUX

DATASHEET

Sandvik 50SW is a basic agglomerated flux with low silicon pickup. It gives good slag removal, good tie-ins and a finely rippled surface. It is suitable for welding with either wire or strip electrodes of nickel alloy type. It is particularly suitable for surfacing with Sanicro 72HP strip electrodes (ERNiCr-3 type).

Typical applications for flux Sandvik 50SW are found in nuclear and chemical equipment fields. It is also suitable for dissimilar material welding of nickel alloy grades to stainless steel grades.

STANDARDS

– EN Number: 760 S A AF 2

ALLOYING VECTOR

The alloying vector describes the difference in chemical composition between the filler metal and the undiluted all-weld metal due to the influence of the flux. The following table presents data for flux Sandvik 50SW in combination with strip and wire electrodes.

Element	Strip electrode	Wire electrode
	Sanicro 72HP	Sanicro 72HP
C	+0.003	+0.003
Si	+0.2	+0.1
Mn	±0	±0
Cr	-0.9	-0.8
Ni	±0	±0
Nb	-0.2	-0.2
Fe	±0	±0

CHEMICAL COMPOSITION (NOMINAL), %

SiO_2+TiO_2	CaF_2	Al_2O_3+MnO
14	52	30

FLUX DATA

Bulk weight	1.2 kg/l
Basicity (Boniszewski)	2.4
Current capacity using 60 x 0.5 mm strip electrode	900 A
Flux consumption	0.7-0.8 kg/kg strip electrode

Datasheet updated 6/8/2015 12:59:13 PM (supersedes all previous editions)

WELDING PARAMETERS

Direct current, with electrode positive is normally used.

Strip dimensions, mm	Current, A	Voltage, V	Travel speed, mm/min
60x0.5	700	29	130

Wire diameter, mm	Current, A	Voltage, V	Travel speed, mm/min
3.25	400	30	400

SANDVIK 57S WELDING FLUX

DATASHEET

Sandvik 57S is a highly basic welding flux for electroslag strip surfacing. It gives excellent slag removal and bead appearance also for niobium-alloyed strip electrodes. It gives excellent slag removal and bead appearance. Flux Sandvik 57S is used together with strip electrodes of nickel alloy type, such as EQNiFeCr-1, EQNiCr-3, EQNiCrMo-3 or similar.

STANDARDS

– ISO: 14174 (E) SA FB 2

CHEMICAL COMPOSITION

CaF_2	Al_2O_3	SiO_2+MgO
75	20	5

APPLICATIONS

Sandvik 57S is used for single and double layer surfacing with nickel alloys for sour service environments, chemical, petrochemical and oil and gas industries.

FORMS OF SUPPLY

Agglomerated non-alloying welding flux.

WELD METAL CHARACTERISTICS

Chemical composition (nominal) %

The chemical compositions below are typical results after weld surfacing on 2¼Cr1Mo steel.

Alloy type	825	625
No. of layers	1	2
Strip electrode	Sanicro 41Cu	Sanicro 60
C	0.02	0.02
Si	0.4	0.5
Mn	0.5	0.03
Cr	20.5	21.5
Cu	1.8	-
Mo	2.8	8.0
Nb + Ta	-	3.2
Fe	32	4.0

Datasheet updated 9/7/2015 3:24:11 PM (supersedes all previous editions)

FABRICATION

Welding data

Direct current, with electrode positive is normally used.

Strip electrode	Current, A	Voltage, V	Travel speed, mm/min
30x0.50	500-700	24-28	140-180
60x0.50	1100-1300	24-28	140-180
90x0.50	1650-1800	24-28	140-180

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	4.0
Current capacityusing 60 x 0.5 mm wire electrode	2500 A
Flux consumption	0.6 kg/kg electrode

Datasheet updated 9/7/2015 3:24:11 PM (supersedes all previous editions)

SANDVIK 59S
WELDING FLUX

DATASHEET

Sandvik 59S is a highly basic, agglomerated flux for electroslag strip surfacing. It gives excellent slag removal and bead appearance. Flux Sandvik 59S is used together with strip electrodes of nickel alloy type, such as ERNiCr-3, ERNiCrMo-3, ERNiCu7 and ERNiCrFe-7 or similar.

CHEMICAL COMPOSITION (NOMINAL), %

SiO_2	Al_2O_3+TiO_2	CaO+MgO
5	20	50

FLUX DATA

Bulk weight	1.0 kg/l
Basicity (Boniszewski)	5.0
Current capacity using 60 x 0.5 mm strip electrode	3000 A
Flux consumption	0.6 kg/kg strip electrode
Redrying, when necessary	350°C, 4 h

STRIP WELDING

ALLOYING VECTOR

The alloying vector describes the difference in chemical composition between the filler metal and the undiluted all-weld metal due to the influnce of the flux.

Element	Sandvik strip electrode	
	Sanicro 72HP ERNiCr-3	Sanicro 69HP (ERNiCrFe-7)
C	0	0.003
Si	0	+0.1
Mn	-0.35	-0.1
Cr	-0.2	-0.7
Ni	+1.5	+1.3
N	+0.001	+0.001
Nb	-0.35	-0.15

WELDING PARAMETERS

Direct current, with electrode positive is normally used.

Datasheet updated 10/7/2015 9:29:20 AM (supersedes all previous editions)

Strip electrode	Current, A	Voltage, V	Travel speed, mm/min
30x0.50	500-700	24-28	140-180
60x0.50	1100-1300	24-28	140-180
90x0.50	1650-1800	24-28	140-180

SURFACING

The chemical compositions below are typical results after weld surfacing on A508 class 3.

Alloy type	600	690
No. of layers	2	2
Strip electrode	Sanicro 72HP	Sanicro 69HP
C	0.01	0.01
Si	0.3	0.3
Mn	2.7	1.2
Cr	19.6	29.3
Ni	71.9	56.6
Mo	0.1	0
Nb	2.5	1.8
N	0.02	0.03
Fe	2.9	10.5

Alloy type	600	690
No of layers	3	3
Strip electrodes	Sanicro 72HP	Sanicro 69HP
C	0.01	0.01
Si	0.3	0.3
Mn	2.7	1.2
Cr	19.7	29.7
Ni	72.0	57.3
Mo	0.1	0
Nb	2.5	1.8
N	0.02	0.04
Fe	2.5	9.3

All four surfacings have passed side bend testing (ASME IX) after heat treatment at 610°C for 24 hours.

WIRE WELDING

ALLOYING VECTOR

The alloying vector describes the difference in chemical composition between the filler metal and the undiluted all-weld metal due to the influnce of the flux.

Element	Sandvik wire electrode	
	Sanicro 72HP	Sanicro 69HP

	ERNiCr-3	(ERNiCrFe-7)
C	0	0.003
Si	0	+0.1
Mn	-0.35	-0.1
Cr	-0.2	-0.7
Ni	+1.5	+1.3
N	+0.001	+0.001
Nb	-0.35	-0.15

FLUX CORED WIRE ELECTRODES

Flux cored arc welding (FCAW) is a fast and versatile welding method, which is an important complement to other welding processes. Sandvik has a wide range of flux cored electrodes for welding stainless steels designed to increase productivity and lower production cost.

The FCAW deposit is a combination of the metal sheath and the flux ingredients and both are closely monitored for size and chemical composition during production. The tight controls during manufacture yield an electrode with a stable arc, welds with a minimum of spatter, easy slag removal, and a weld that has smooth transition to the base material.

Sandvik flux cored electrodes have predominantly rutile characteristics. These electrodes provide high productivity with a minimum of repair work. We have developed flux cored electrodes adapted to match the base material and design for the optimum corrosion resistance and mechanical properties. The electrodes are easy to weld and consistently ensure the desired weld properties with excellent resistance to hot cracking.

OUR FCAW WIRE ELECTRODES

Flux cored welding electrodes in a variety of grades and sizes for flat, horizontal or all-position welding.

Sandvik grade	AWS A5.22	EN ISO 17633-A
19.9.L T0	E308LT0-1/T0-4	T 19 9 L R C 3/T 19 9 L R M 3
19.9.L T1	E308LT1-1/T1-4	T 19 9 L P M 1
19.9.H T1	E308HT1-1/T1-4	-
19.9.Nb T1	E347T1-1/T1-4	-
19.12.3.L T0	E316T0-1/T0-4	T 19 12 3 L R C 3/T 19 12 3 L R M 3
19.12.3.L T1	E316T1-1/T1-4	T 19 12 3 L P M 2
19.13.4.L T0	E317T0-1/T0-4	-
19.13.4.L T1	E317T1-1/T1-4	-
22.9.3.L T1	E2209T1-1/T1-4	T 22 9 3 N L P C M 2
23.12.2.L T0	E309LMoT0-1/T0-4	T 23 12 2 L R C M 3
23.12.2.L T1	E309LMoT1-1/T1-4	T 23 12 2 L R C M 1
24.13.L T0	E309LT0-1/T0-4	T 23 12 L R C 3/T 23 12 L R M 3
24.13.L T1	E309LT1-1/T1-4	T 23 12 L R C 2/T 23 12 L P M 2

Sandvik grade	AWS A5.22	EN ISO 17633-A
25.10.4.L T1	E2594T1-1/T1-4	-
29.9. T1	E312T1-1/T1-4	-

SANDVIK 19.9.H T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.9.H–T1 (308/308L-T1) is a chromium-nickel flux core electrode for welding of low carbon 18% Cr/10% Ni austenitic stainless steels.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.9.H-T1 (308/308L-T1) gives smooth uniform beads and works in any standard weld position.

Product Standards

- AWS/ASME A5.22: E308H-T1-1/T1-4

Product Approvals

- AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.55	0.85	1.15	19.4	9.7

APPLICATIONS

Sandvik 19.9.H-T1 (308/308L-T1) is used for welding steels of the following types:

ISO	1.4301, 1.4307
UNS	S30400, S32100, S32109, S34700, S34709
ASTM	304, 304H, 321, 321H, 347, 347H

In cases where creep strength is of secondary importance Sandvik 19.9.H-T1 (308/308L-T1) is suitable for welding stabilized austenitic steels, e.g. ASTM 321 and 347.

FORMS OF SUPPLY

Sandvik 19.9.H-T1 (308/308L-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9.H-T1 (308/308L-T1) is an austenitic matrix with a ferrite content of about 10FN according to DeLong.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Datasheet updated 1/25/2016 10:48:28 AM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	430 (62)
Tensile strength, R_m	MPa (ksi)	600 (87)
Elongation, A	%	42

Using CO_2 100%

Temperature	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	392 (57)
Tensile strength, R_m	MPa (ksi)	578 (84)
Elongation, A	%	44

CORROSION RESISTANCE

Sandvik 19.9.H-T1 (308/308L-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding Data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-25.4 mm (1/2-3/4 in.). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	170-300	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

SANDVIK 19.9.L T0

FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.9.L–T0 (308/308L) is a chromium-nickel flux core electrode for welding of low carbon 18% Cr/10% Ni austenitic stainless steels.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.9.L-T0 (308/308L) gives smooth uniform beads and works in the flat and horizontal fillet weld positions.

Product Standards

- ISO T 19 9 L R C 3 / T 19 9 L R M 3
- AWS/ASME A5.22: E308LT0-1/T0-4

Product Approvals

- AWS
- CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.03	0.48	1.3	19.4	9.9

APPLICATIONS

Sandvik 19.9.L-T0 (308/308L-T0) is used for welding steels of the following types:

ISO	1.4301, 1.4307
UNS	S30400, S32100, S32109, S34700, S34709
ASTM	304, 304H, 321, 321H, 347, 347H

In cases where creep strength is of secondary importance Sandvik 19.9.L-T0 (308/308L-T0) is suitable for welding stabilizedaustenitic steels, e.g. ASTM 321 and 347. When a weld metal similar to the parent metal is not required Sandvik 19.9.L-T0 (308/308L-T0) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.9.L-T0 (308/308L-T0) is supplied in wire of diameters 1.2, 1.6 mm (0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9.L-T0 (308/308L-T0) is an austenitic matrix with a ferrite content of about 10FN according to DeLong.

Datasheet updated 1/25/2016 10:50:08 AM (supersedes all previous editions)

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)
Proof strength, $R_{P0.2}$	MPa (ksi)	410 (60)
Tensile strength, R_m	MPa (ksi)	580 (85)
Elongation, A	%	40

Using CO_2 100%

Temperature	°C (°F)	20 (68)
Proof strength, $R_{P0.2}$	MPa (ksi)	409 (59)
Tensile strength, R_m	MPa (ksi)	550 (79)
Elongation, A	%	55

CORROSION RESISTANCE

Sandvik 19.9.L-T0 (308/308L-T0) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding Data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-25.4 mm (1/2-3/4 in.). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min(in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
1.2 (0.047)	8-18 (315-710)	150-300	25-32	12 (25)
1.6 (1/16)	4-11 (155-435)	200-350	26-34	18 (38)

Datasheet updated 1/25/2016 10:50:08 AM (supersedes all previous editions)

SANDVIK 19.9.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.9.L–T1 (308/308L-T1) is a chromium-nickel flux core electrode for welding low carbon 18% Cr/10% Ni austenitic stainless steels.

Product Standards

- ISO T 19 9 L P M 2
- AWS/ASME A5.22: E308L-T1-1/T1-4

Product Approvals

- AWS
- CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.028	0.8	1.15	19.2	10.1

APPLICATIONS

Sandvik 19.9.L-T1 (308/308L-T1) is used for welding steels of the following types:

ISO	1.4301, 1.4307
ASTM	301, 304L, 304LN, 304 and 302

In cases where creep strength is of secondary importance Sandvik 19.9.L-T1 (308/308L-T1) is suitable for welding stabilized austenitic steels, e.g. ASTM 321 and 347. When a weld metal similar to the parent metal is not required Sandvik 19.9.L-T1 (308/308L-T1) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.9.L-T1 (308/308L-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9.L-T1 (308/308L-T1)is Austenitic matrix with a ferrite content of about 10FN according to DeLong.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{P0.2}$	MPa (ksi)	410 (60)	

Datasheet updated 1/25/2016 10:51:26 AM (supersedes all previous editions)

Tensile strength, R_m	MPa (ksi)	580 (85)	
Elongation, A	%	44	
Impact strength, Charpy V	J (ft/lb)		55 (40)

Using CO_2 100%

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	372 (54)	
Tensile strength, R_m	MPa (ksi)	568 (82)	
Elongation, A	%	61	
Impact strength, Charpy V	J (ft/lb)		55 (40)

CORROSION RESISTANCE

Sandvik 19.9.L-T1 (308/308L-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding Data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-25.4 mm (1/2-3/4 in.). These parameters are for CO_2 shielding. If using Ar-CO_2 mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	170-300	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 10:51:26 AM (supersedes all previous editions)

SANDVIK 19.9.NB T1

FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.9.Nb–T1 (347-T1) is a niobium-stabilized chromium-nickel flux core electrode for welding of ASTM 321 and 347 types as well as overlays. It is used in structural applications up to 400ºC.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.9.Nb-T1 (347-T1) gives smooth uniform beads and works in any standard weld position.

Product Standards

– AWS A5.22: E347T1-1/T1-4

Product Approvals

– AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.038	0.85	1.15	19.2	10.1

APPLICATIONS

Sandvik 19.9.Nb-T1 (347-T1) is used for welding steels of the following types:

UNS	S32100, S32109, S34700 and S34709
ASTM	321, 321H, 347 and 347H

When a weld metal similar to the parent metal is not required Sandvik 19.9.Nb-T1 (347-T1) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.9.Nb-T1 (347-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9.Nb-T1 (347-T1) is austenitic matrix with a ferrite content of about 10FN according to DeLong.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)	-20 (-4)

Datasheet updated 1/25/2016 10:54:11 AM (supersedes all previous editions)

Proof strength, $R_{p0.2}$	MPa (ksi)	520 (75)	
Tensile strength, R_m	MPa (ksi)	650 (94)	
Elongation, A	%	35	
Impact strength, Charpy V	J (ft/lb)		67 (49)

Using CO_2 100%

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	433 (63)	
Tensile strength, R_m	MPa (ksi)	622 (90)	
Elongation, A	%	47	
Impact strength, Charpy V	J (ft/lb)		67 (49)

CORROSION RESISTANCE

Sandvik 19.9.Nb-T1 (347-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-25.4 mm (1/2-3/4 in.). These parameters are for CO_2 shielding. If using Ar-CO_2 mixture, decrease voltage by up to 2V.

Wire diameter, mm(in)	Wire feed, m/min(in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	130-220	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 10:54:11 AM (supersedes all previous editions)

SANDVIK 19.12.3.L T0
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.12.3.L T0 (Sandvik 316/316L) is a chromium-nickel-molybdenum flux core electrode for welding of low carbon 18% Cr/10% Ni/ 2%Mo austenitic stainless steels of type 316.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.12.3.L T0 gives smooth uniform beads and works in the flat and horizontal fillet weld positions.

Product Standards

- T 19 12 3 L R C 3 / T 19 12 3 L R M 3
- AWS/ASME A5.22: E316T0-1/T0-4

Product Approvals

- AWS
- CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
≤0.03	≤0.52	1.39	18.8	12.0	2.7

APPLICATIONS

Sandvik 19.12.3.L T0 (Sandvik 316/316L) is used for welding steels of the following types:

UNS	S31600, S31603, S31653, S31609 and S31635
ASTM	316, 316L, 316LN, 316H and 316Ti

In cases where creep strength is of secondary importance Sandvik 19.12.3.L T0 is suitable for welding corresponding stabilized austenitic steels. When a weld metal similar to the parent metal is not required, Sandvik 19.12.3.L T0 can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.12.3.L T0 is supplied in wire of diameters 1.2, 1.6 mm (0.45, 1/16 in.)

WELD METAL CHARACTERSTICS

The all weld metal for Sandvik 19.12.3.L T0 is austenitic matrix with a ferrite content of 4–10 FN according to WRC-92.

MECHANICAL PROPERTIES

Datasheet updated 1/25/2016 10:55:38 AM (supersedes all previous editions)

Mechanical properties using Ar 75%/CO_2 5%

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{P0.2}$	MPa (ksi)	450 (65)	-
Tensile strength, R_m	MPa (ksi)	580 (84)	-
Elongation, A	%	36	-
Impact strength, Charpy V	J (ft lbs)	-	57(42)

Mechanical properties using CO_2 100%

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, RP0.2	MPa (ksi)	430 (62)	-
Tensile strength, Rm	MPa (ksi)	565 (82)	-
Elongation, A	%	37	-
Impact strength, Charpy V	J (ft lbs)	-	57(42)

CORROSION RESISTANCE

Sandvik 19.12.3.L T0 is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding Data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5 - 19 mm (1/2 - 3/4 in.). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire Diameter, mm (in)	Wire Feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min
1.2 (0.045)	8-18 (315-710)	150-300	25-32	12
1.6 (1/16)	4-11 (155-435)	200-350	26-34	18

Datasheet updated 1/25/2016 10:55:38 AM (supersedes all previous editions)

SANDVIK 19.12.3.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.12.3.L–T1 (316/316L-T1) is a chromium-nickel-molybdenum flux core electrode for welding of low carbon 18% Cr/10% Ni/ 2%Mo austenitic stainless steels of type 316.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.12.3.L–T1 (316/316L-T1) gives smooth uniform beads and works in any standard weld position.

Product Standards

– T 19 12 3 L P M 2
– AWS/ASME A5.22: E316-T1-1/T1-4

Product Approvals

– AWS
– CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.029	0.85	1.15	18.5	11.9	2.6

APPLICATIONS

Sandvik 19.12.3.L-T1-1/T1-4 (316/316L-T1) is used for welding steels of the following types:

UNS S31600, S31603, S31653, S31609 and S31635

ASTM 316, 316L, 316LN, 316H and 316Ti

In cases where creep strength is of secondary importance Sandvik 19.12.3.L–T1 (316/316L-T1) is suitable for welding of corresponding stabilized austenitic steels. When a weld metal similar to the parent metal is not required, Sandvik 19.12.3.L-T1 (316/316L-T1) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.12.3.L-T1 (316/316L-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.)

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.12.3.L-T1 (316/316L-T1) is austenitic matrix with a ferrite content of 4–10 FN according to WRC-92.

MECHANICAL PROPERTIES

Datasheet updated 1/25/2016 10:57:07 AM (supersedes all previous editions)

Using Ar 75%/CO_2 25%

Temperature,	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	450 (65)	
Tensile strength, R_m	MPa (ksi)	580 (84)	
Elongation, A	%	40	
Impact strength, Charpy V	J (ft/lb)		69 (51)

Using CO_2 100%

Temperature,	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	442 (64)	
Tensile strength, R_m	MPa (ksi)	570 (83)	
Elongation, A	%	53	
Impact strength, Charpy V	J (ft/lb)		69 (51)

CORROSION RESISTANCE

Sandvik 19.12.3.L-T1 (316/316L-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	130-220	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 10:57:07 AM (supersedes all previous editions)

SANDVIK 19.13.4.L T0
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.13.4.L–T0 (317/317L-T0) is a chromium-nickel-molybdenum flux core electrode for welding of low carbon 18% Cr/10% Ni/ 3%Mo austenitic stainless steels of type 317.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.13.4.L–T0 (317/317L-T0) gives smooth uniform beads and works in the flat and horizontal fillet weld positions.

Product Standards

- AWS/ASME A5.22: E317-T0-1/T0-4

Product Approvals

- AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.03	0.52	1.39	18.8	12.0	2.7

APPLICATIONS

Sandvik 19.13.4.L-T0 (317/317L-T0) is used for welding steels of the following types:

UNS S31700, and S31703

ASTM 317 and 317L

In cases where creep strength is of secondary importance Sandvik 19.13.4.L–T0 (317/317L-T0)is suitable for welding of corresponding stabilized austenitic steels. When a weld metal similar to the parent metal is not required, Sandvik 19.13.4.L-T0 (317/317L-T0) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.13.4.L-T0 (317/317L-T0) is supplied in wire of diameters 1.2, 1.6 mm (0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.13.4.L-T0 (317/317L-T0) is austenitic matrix with a ferrite content of 4–10 FN according to WRC-92.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature,	°C (°F)	20 (68)	-20 (-4)

Datasheet updated 1/25/2016 10:58:37 AM (supersedes all previous editions)

Proof strength, $R_{p0.2}$	MPa (ksi)	450 (65)	
Tensile strength, R_m	MPa (ksi)	580 (84)	
Elongation, A	%	36	
Impact strength, Charpy V	J (ft/lb)		57 (42)

Using CO_2 100%

Temperature,	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	430 (62)	
Tensile strength, R_m	MPa (ksi)	565 (82)	
Elongation, A	%	37	
Impact strength, Charpy V	J (ft/lb)		57 (42)

CORROSION RESISTANCE

Sandvik 19.13.4.L-T0 (317/317L-T0) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2”-3/4”). These parameters are for CO_2 shielding. If using Ar-CO_2 mixture, decrease voltage by up to 2V.

Wire diameter, mm(in)	Wire feed, m/min(in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
1.2 (0.047)	8-18 (315-710)	150-300	25-32	12 (25)
1.6 (1/16)	4-11 (155-435)	200-350	26-34	18 (38)

Datasheet updated 1/25/2016 10:58:37 AM (supersedes all previous editions)

SANDVIK 19.13.4.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 19.13.4.L–T1 (317/317L-T1) is a chromium-nickel-molybdenum flux core electrode for welding of low carbon 18% Cr/10% Ni/ 3%Mo austenitic stainless steels of type 317.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.13.4.L–T1 (317/317L-T1) gives smooth uniform beads and works in any standard weld position.

Product Standards

– AWS/ASME A5.22: E317-T1-1/T1-4

Product Approvals

– AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.028	0.82	1.2	19.0	12.8	3.45

APPLICATIONS

Sandvik 19.13.4.L-T1 (317/317L-T1) is used for welding steels of the following types:

UNS S31700, and S31703

ASTM 317 and 317L

In cases where creep strength is of secondary importance Sandvik 19.13.4.L–T1 (317/317L-T1) is suitable for welding of corresponding stabilized austenitic steels. When a weld metal similar to the parent metal is not required, Sandvik 19.13.4.L-T1 (317/317L-T1) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Sandvik 19.13.4.L-T1 (317/317L-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.13.4.L-T1 (317/317L-T1) is austenitic matrix with a ferrite content of 4–10 FN according to WRC-92.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature,	°C (°F)	20 (68)

Datasheet updated 1/25/2016 11:00:14 AM (supersedes all previous editions)

Proof strength, $R_{p0.2}$	MPa (ksi)	480 (69)
Tensile strength, R_m	MPa (ksi)	620 (90)
Elongation, A	%	35

Using CO_2 100%

Temperature,	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	460 (67)
Tensile strength, R_m	MPa (ksi)	600 (87)
Elongation, A	%	34

CORROSION RESISTANCE

Sandvik 19.13.4.L-T1 (317/317L-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm(in.)	Wire feed, m/min(in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	130-220	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

SANDVIK 22.9.3.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 22.9.3.L–T1 (2209L-T1) is a chromium-nickel-molybdenum-nitrogen flux core electrode for welding of for welding of 22-23%Cr duplex (ferritic-austenitic) stainless steels (e.g. Sandvik SAF 2205).

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 22.9.3.L–T1 (2209L-T1) gives smooth uniform beads and works in any standard weld position.

Product Standards

- T 22 9 3 N L P C M 2
- AWS/ASME A5.22: E2209-T1-1/T1-4

Product Approvals

- AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo	N
0.03	0.47	1.15	22.9	9.0	3.2	0.16

APPLICATIONS

Sandvik 22.9.3.L-T1 (2209-T1) is used for welding steels of the following types:

ISO	1.4462, 1.4362, 1.4162, 1.4662, 1.4460, 1.4417
ASTM	UNS S32205, S31803, S32304, S32101, S82441

Sandvik 22.9.3-T1 (2209-T1) is used for welding duplex and lean duplex stainless steels in service temperatures up to 280°C (536°F).

FORMS OF SUPPLY

Sandvik 22.9.3.L-T1 (2209-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 22.9.3.L-T1 (2209L-T1) is ferritic-austenitic with a ferrite content of approximately 45 FN according to WRC-92.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature,	°C (°F)	20 (68)	-40 (-40)

Datasheet updated 1/25/2016 11:02:52 AM (supersedes all previous editions)

Proof strength, $R_{P0.2}$	MPa (ksi)	650 (94)	
Tensile strength, R_m	MPa (ksi)	820 (119)	
Elongation, A	%	25	
Impact strength, Charpy V	J (ft/lb)		49 (36)

Using CO_2 100%

Temperature,	°C (°F)	20 (68)	-40 (-40)
Proof strength, $R_{P0.2}$	MPa (ksi)	614 (89)	
Tensile strength, R_m	MPa (ksi)	825 (120)	
Elongation, A	%	32	
Impact strength, Charpy V	J (ft/lb)		49 (36)

CORROSION RESISTANCE

Sandvik 22.9.3.L-T1 (2209L-T1) meets pitting resistance of 22°C according to ASTM G48 A, and resistance to intermetallic formation as defined by ASTM A 923 C with weight loss less than 10 mdd.

Intergranular corrosion

Huey test, ASTM A262 Practice C	0.25 $g/m^2/h$
Strauss test, ASTM A262 Practice E	Resistant to intergranular corrosion

Stress corrosion cracking, NACE TM 0177

Applied stress	Time to fracture
650 MPa	65.6 h
520 Mpa	>720 h (no fracture)

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for CO_2 shielding. If using Ar-CO_2 mixture, decrease voltage by up to 2V.

Wire diameter, mm(in)	Wire feed, m/min(in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	130-220	25-30	12 (38)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 11:02:52 AM (supersedes all previous editions)

SANDVIK 23.12.2.L T0
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 23.12.2.L–T0 (309LMo-T0) is a high alloyed chromium-nickel-molybdenum flux core electrode for welding of dissimilar joints between stainless steel and mild or low alloyed steels. It is also used to create buffer layers with a composition of 18%Cr/8%Ni/2%Mo before overlay alloys are deposited.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 23.12.2.L–T0 (309LMo-T0) gives smooth uniform beads and works in the flat and horizontal fillet weld positions.

STANDARDS

- AWS: A5.22: E309LMoT0-1/T0-4
- EN Number: T 23 12 2 L R C M 3

Product Standards

- AWS/ASME A5.22: E309Lmo-T0-1/T0-4

Product Approvals

- AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.027	0.59	1.57	23.8	13.5	2.4

APPLICATIONS

Sandvik 23.12.2.L (309LMo-T0) is used for welding steels of the following types:

- Welding of stainless steels to mild or low alloy steels
- Buffer layers on low alloy steels before overlays of 316 composition
- Welding of medium carbon hardenable steels, e.g. armour plate
- When a weld metal similar to the parent metal is not required, Sandvik 23.12.2.L-T0 (309LMo-T0) can be used for welding ferritic and martensitic steels

FORMS OF SUPPLY

Sandvik 23.12.2.L-T0 (309LMo-T0) is supplied in wire of diameters 1.2, 1.6 mm (0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 23.12.2.L-T0 (309LMo-T0) is austenitic matrix with a ferrite content of 14–20 FN according to WRC-92.

Datasheet updated 1/25/2016 11:03:59 AM (supersedes all previous editions)

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	550 (79)	
Tensile strength, R_m	MPa (ksi)	690 (100)	
Elongation, A	%	30	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		57 (42)

Using CO_2 100%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	525 (76)	
Tensile strength, R_m	MPa (ksi)	660 (95)	
Elongation, A	%	33	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		57 (42)

CORROSION RESISTANCE

Sandvik 23.12.2.L-T0 (309LMo-T0) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for CO_2 shielding. If using Ar-CO_2 mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
1.2 (0.047)	8-18 (315-710)	150-300	25-32	12 (25)
1.6 (1/16)	4-11 (155-435)	200-350	26-34	18 (38)

Datasheet updated 1/25/2016 11:03:59 AM (supersedes all previous editions)

SANDVIK

SANDVIK 23.12.2.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 23.12.2.L–T1 (309LMo-T1) is a high alloyed chromium-nickel-molybdenum flux core electrode for welding of dissimilar joints between stainless steel and mild or low alloyed steels. It is also used to create buffer layers with a composition of 18%Cr/8%Ni/2%Mo before overlay alloys are deposited.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 23.12.2.L–T1 (309LMo-T1) gives smooth, uniform beads and works in any standard weld position.

Product Standards

- T 23 12 2 L R C M 1
- AWS/ASME A5.22: E309LMo-T1-1/T1-4

Product Approvals

- AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.029	0.73	1.1	23.3	12.9	2.6

APPLICATIONS

Sandvik 23.12.2.L (309LMo-T1) is used for welding steels of the following types:

- Welding of stainless steels to mild or low alloy steels
- Buffer layers on low alloy steels before overlays of 316 composition
- Welding of medium carbon hardenable steels, e.g. armour plate
- When a weld metal similar to the parent metal is not required, Sandvik 23.12.2.L-T1 (309LMo-T1) can be used for welding ferritic and martensitic steels

FORMS OF SUPPLY

Sandvik 23.12.2.L-T1 (309LMo-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 23.12.2.L-T1 (309LMo-T1) is austenitic matrix with a ferrite content of 14–20 FN according to WRC-92.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Datasheet updated 1/25/2016 11:05:38 AM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	570 (79)	
Tensile strength, R_m	MPa (ksi)	750 (109)	
Elongation, A	%	30	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		52 (38)

Using CO_2 100%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	550 (78)	
Tensile strength, R_m	MPa (ksi)	715 (104)	
Elongation, A	%	35	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		52 (38)

CORROSION RESISTANCE

Sandvik 23.12.2.L-T1 (309LMo-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	170-300	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 11:05:38 AM (supersedes all previous editions)

SANDVIK 24.13.L T0
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 24.13.L–T0 (309/309L) is a high alloyed chromium-nickel-molybdenum flux core electrode for welding of dissimilar joints between stainless steel and mild or low alloyed steels. It is also used to create buffer layers with a composition of 18%Cr/8%Ni before overlay alloys are deposited.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 24.13.L–T0 (309/309L) gives smooth, uniform beads and works in the flat and horizontal fillet weld positions.

Product Standards

- T 23 12 L R C 3 / T 23 12 L R M 3
- AWS/ASME A5.22: E309/309LT0-1/T0-4

Product Approvals

- AWS
- CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.031	0.72	1.45	24.5	12.9

APPLICATIONS

Sandvik E317TO-1/T0-4 (309/309L) is used for welding steels of the following types:

- Welding of stainless steels to mild or low alloy steels
- Buffer layers on low alloy steels before overlays of 304 composition
- Welding of stainless steels of 23%Cr/12%Ni (309) type
- Welding of medium carbon hardenable steels, e.g. armour plate
- When a weld metal similar to the parent metal is not required, Sandvik 24.13.L-T0 (309/309L) can be used for welding ferritic and martensitic steels

FORMS OF SUPPLY

Sandvik 24.13.L-T0 (309/309L) is supplied in wire of diameters 1.2, 1.6 mm (0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 24.13.L-T0 (309/309L) is an austenitic matrix with a ferrite content of 14-20FN according to WRC-92.

Datasheet updated 1/25/2016 11:07:25 AM (supersedes all previous editions)

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	480 (70)	
Tensile strength, R_m	MPa (ksi)	600 (87)	
Elongation, A	%	35	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		57 (42)

Using CO_2 100%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	410 (59)	
Tensile strength, R_m	MPa (ksi)	545 (79)	
Elongation, A	%	38	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		57 (42)

CORROSION RESISTANCE

Sandvik 24.13.L-T0 (309/309L) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in./min)	Current, A	Voltage, V	Gas, l/min (CFH)
1.2 (0.047)	8-18 (315-710)	150-300	25-32	12 (25)
1.6 (1/16)	4-11 (155-435)	200-350	26-34	18 (38)

Datasheet updated 1/25/2016 11:07:25 AM (supersedes all previous editions)

SANDVIK 24.13.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 24.13.L–T1 (309/309L-T1) is a high alloyed chromium-nickel-molybdenum flux core electrode for welding of dissimilar joints between stainless steel and mild or low alloyed steels. It is also used to create buffer layers with a composition of 18%Cr/8%Ni before overlay alloys are deposited.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 24.13.L–T1 (309/309L-T1) gives smooth uniform beads and works in any standard weld position.

Product Standards

- T 23 12 L P C 2 / T 23 12 L P M 2
- AWS/ASME A5.22: E309/309L-T1-1/T1-4

Product Approvals

- AWS
- CWB

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.031	0.85	1.2	23.3	12.5

APPLICATIONS

Sandvik 24.13.L (309/309L-T1) is used for welding steels of the following types:

- Welding of stainless steels to mild or low alloy steels
- Buffer layers on low alloy steels before overlays of 304 composition
- Welding of stainless steels of 23%Cr/12%Ni (309) type
- Welding of medium carbon hardenable steels, e.g. armour plate
- When a weld metal similar to the parent metal is not required, Sandvik 24.13.L-T1 (309/309L-T1) can be used for welding ferritic and martensitic steels

FORMS OF SUPPLY

Sandvik 24.13.L-T1 (309/309L-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 inch).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 24.13.L-T1 (309/309L-T1) is austenitic matrix with a ferrite content of 14–20 FN according to WRC-92.

Datasheet updated 1/25/2016 11:08:13 AM (supersedes all previous editions)

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	480 (70)	
Tensile strength, R_m	MPa (ksi)	600 (87)	
Elongation, A	%	35	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		57 (42)

Using CO_2 100%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{p0.2}$	MPa (ksi)	392 (57)	
Tensile strength, R_m	MPa (ksi)	539 (78)	
Elongation, A	%	51	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		57 (42)

CORROSION RESISTANCE

Sandvik 24.13.L-T1 (309/309L-T1) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2”-3/4”). These parameters are for $C0_2$ shielding. If using Ar-$C0_2$ mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	170-300	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 11:08:13 AM (supersedes all previous editions)

SANDVIK 25.10.4.L T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 25.10.4.L–T1 (2594L-T1) is a high alloyed chromium-nickel-molybdenum-nitrogen flux core electrode for welding of for welding of 25%Cr super duplex (ferritic-austenitic) stainless steels (e.g. Sandvik SAF 2507 and Zeron* 100).

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 25.10.4.L–T1 (2594L-T1) gives smooth, uniform beads and works in any standard weld position.

Product Standards

– AWS/ASME A5.22: E2594-T1-1/T1-4

Product Approvals

– AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo	N
0.03	0.6	0.9	25.0	9.7	4.0	0.25

APPLICATIONS

Sandvik 25.10.4.L-T (2594-T1) is used for welding steels of the following types:

ISO	1.4410, 1.4501, 1.4507
ASTM	UNS S32750, S32760, S31260, S32550

Sandvik 25.10.4-T1 (2594-T1) is used for welding of super duplex stainless steels in service temperatures up to 280°C (536°F). It can also be used as overmatching consumable for 21-23%Cr duplex stainless steels.

FORMS OF SUPPLY

Sandvik 25.10.4.L-T1 (2594-T1) is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.035, 0.047, 1/16 in.).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 25.10.4.L-T1 (2594-T1) is ferritic-austenitic with a ferrite content of approximately 45 FN according to WRC-92.

MECHANICAL PROPERTIES

Using Ar 75%/CO_2 25%

Temperature	°C (°F)	20 (68)	-20

Datasheet updated 1/25/2016 11:09:30 AM (supersedes all previous editions)

Proof strength, $R_{p0.2}$	MPa (ksi)	690 (100)	
Tensile strength, R_m	MPa (ksi)	900 (130)	
Elongation, A	%	25	
Hardness	HB		
Impact strength, Charpy V	J (ft/lb)		42 (31)

CORROSION RESISTANCE

Sandvik 25.10.4.L-T1 (2594-T1) meets pitting resistance of 40°C according to ASTM G48 A, and resistance to intermetallic formation as defined by ASTM A 923 C with weight loss less than 10 mdd.

Intergranular corrosion

Strauss test, ASTM A262 Practice E	–	Resistant to intergranular corrosion

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19 mm (1/2"-3/4"). These parameters are for CO_2 shielding. If using Ar-CO_2 mixture, decrease voltage by up to 2V.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.035)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.047)	5.8-14.4 (225-570)	170-300	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 11:09:30 AM (supersedes all previous editions)

SANDVIK 29.9 T1
FLUX CORED WIRE ELECTRODES

DATASHEET

Sandvik 29.9–T1 (Sandvik 312-T1) is a chromium-nickel flux core electrode giving a duplex (ferritic-austenitic) all weld metal. It is used for welding of dissimilar materials, high carbon and manganese steels like tool steels as well as surfacing. Sandvik 29.9-T1 is also used for overlays on hot forming steels and as a universal electrode for repair and maintenance work.

The electrode has excellent arc stability, low spatter and fast burn off rate. It is also characterized by improved moisture resistance, self peeling slag, easy post weld finishing. Sandvik 29.9-T1 gives smooth uniform beads and works in any standard weld position.

STANDARDS

– AWS: A5.22: E312T1-1/T1-4

Product Standards

– AWS/ASME A5.22: E312-T1-1/T1-4

Product Approvals

– AWS

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.1	0.72	1.25	28.7	9.6

APPLICATIONS

Sandvik 29.9-T1 (Sandvik 312-T1) is maintenance and repair alloy used for welding of dissimilar materials, high carbon and manganese steels as well as surfacing and is used for universal repair and maintenance work. Even with high dilution by austenitizers such as nickel and manganese, the weld metal remains highly resistant to cracking. To avoid embrittlement by formation of secondary phases, the service temperature should be limited to a maximum of 420 °C (800 °F).

FORMS OF SUPPLY

Sandvik 29.9-T1 is supplied in wire of diameters 0.9, 1.2, 1.6 mm (0.35, 0.45, 1/16 inch).

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 29.9-T1 is austenitic matrix with a ferrite content of about 50FN according to WRC-92.

MECHANICAL PROPERTIES

Using Ar 75%/CO25%

Datasheet updated 1/25/2016 11:10:03 AM (supersedes all previous editions)

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{P0.2}$	MPa (ksi)	630 (91)	
Tensile strength, R_m	MPa (ksi)	830 (120)	
Elongation, A	%	24	

Using CO2 -100%

Temperature	°C (°F)	20 (68)	-20
Proof strength, $R_{P0.2}$	MPa (ksi)	620 (910	
Tensile strength, R_m	MPa (ksi)	810 (117)	
Elongation, A	%	24	

CORROSION RESISTANCE

Sandvik 29.9-T1 is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Electrode positive is used to give good penetration in all types of welded joint. The following table shows common conditions for FCAW welding. Electrode extension is 12.5-19mm(1/2”-3/4”). These parameters are for C02 shielding. If using Ar-C02 mixture, decrease voltage by up to 2.

Wire diameter, mm (in)	Wire feed, m/min (in/min)	Current, A	Voltage, V	Gas, l/min (CFH)
0.9 (0.35)	6.7-13.5 (265-530)	100-170	23-26	12 (25)
1.2 (0.45	5.8-14.4 (225-570)	170-300	25-30	12 (25)
1.6 (1/16)	3.9-8.2 (150-320)	170-300	25-29	18 (38)

Datasheet updated 1/25/2016 11:10:03 AM (supersedes all previous editions)

COVERED ELECTRODES

Shielded metal arc welding (SMAW), or manual metal arc welding (MMA) is a slow but versatile welding method, and is therefore an important complement to other welding processes. We have a wide range of covered electrodes for welding stainless steels and nickel alloys.

SMAW is often the most suitable process for field installations and repair work. It is also the only welding method that can be used outdoors without taking special weld protective measures.
We have developed electrodes adapted for the base material and the electrodes are easy to weld and consistently ensure the desired weld properties, with excellent resistance to hot cracking.

Sandvik electrodes have predominantly rutile characteristics and rutile electrodes have high productivity with a minimum of repair work needed. They give stable arcs that are easy to strike, welds with a minimum of spatter and easy slag removal, and the welds have smooth transition to the base material.

Sandvik electrodes that are used in low temperatures applications, or with base materials that are more crack sensitive, such as pure austenitic stainless steel and nickel alloys, have more basic characteristics. These electrodes give cleaner weld metallurgy with low levels of non-metallic inclusions and impurities. Basic electrodes give a slightly convex bead shape and deeper penetration than rutile electrodes, though striking the arc and slag removal can be more difficult.

OUR STAINLESS STEEL GRADES FOR COVERED ELECTRODES

Sandvik	AWS* A5.4	ISO 3581
19.9.LR	308L-17	19 9 L R
19.9.LR Cryo	308L-16	19 9 L R
19.9.NbR	347-17	19 9 Nb R
19.12.3.LR	316L-17	19 12 3 L R
19.12.3.LR Cryo	316L-16	19 12 3 L R
22.12.HTR	-	-
23.12.2.LR	309LMo-17	23 12 2 L R
24.13.LR	309L-17	23 12 L R
29.9.R	312-16	29 9 R
22.9.3.LR	2209-17	22 9 3 N L R
22.9.3.LB	2209-15	22 9 3 N L B

Sandvik	AWS* A5.4	ISO 3581
25.10.4.LR	2594-16	25 9 4 N L R
25.10.4.LB	2594-15	25 9 4 N L B
22.12.HTR	-	-
25.22.2.LMnB	(310LMo-15)*	25 22 2 N L B
20.25.5.LCuR	385-16	20 25 5 Cu N L R
27.31.4.LCuR	(383-16)*	27 31 4 Cu L R

* nearest equivalent.

OUR NICKEL ALLOY GRADES FOR COVERED ELECTRODES

Sandvik	AWS A5.11	ISO 14172
Sanicro 60	NiCrMo-3	Ni 6625
Sanicro 69	NiCrFe-7	Ni 6152
Sanicro 71	NiCrFe-3	Ni 6182
AquaSan Ni50	A5.35 (pending initial publication)	-

PROPERTIES AND APPLICATIONS FOR COVERED ELECTRODES

Sandvik AWS E ISO	Mechanical properties: typical values at 20°C (68°F)		Typical applications
22.9.3.LR 2209-17 22 9 3 N L R	$R_{p.02}$ R_m A KV	600 MPa 750 MPa 25% 50 J	Rutile-basic electrode for joining of duplex stainless steels such as Sandvik 3RE60, SAF 2205 and SAF 2304.
22.9.3.LB 2209-15 22 9 3 N L B	$R_{p.02}$ R_m A KV	510 MPa 730 MPa 25% 93 J	Rutile-basic electrode for welding of duplex (ferritic-austenitic) stainless steels of UNS S31803/S32205 type (e.g. Sandvik SAF 2205).
25.10.4.LR - 25 9 4 N L R	$R_{p.02}$ R_m A KV	650 MPa 850 MPa 25% 50 J	Rutile-basic electrode for joining of super-duplex stainless steels such as Sandvik SAF 2507. Can also be used to join Sandvik SAF 2205 and other duplex steels of the 25% Cr type when the highest possible corrosion resistance is required.
22.12.HTR - -	$R_{p.02}$ R_m A KV	500 MPa 650 MPa 35% 85 J	Rutile-basic electrode for joining of stainless CrNi steel Sandvik 253 MA* or other similar high-temperature steels.
25.22.2.LMnB 310LMo-15 25 22 2 N L B	$R_{p.02}$ R_m A KV	380 MPa 600 MPa 40% 80 J	Basic electrode for joining of stainless CrNiMo steels used in the urea industry, such as Sandvik 2RE69 as well as modified type 316L. Stainless CrNi and CrNiMo steels, 204L, 304LN and 316L, 316NL, for cryogenic applications down to -196°C (-321°F) and/or applications demanding low magnetic permeability.
20.25.5.LCuR 385-16 20 25 5 CU L R	$R_{p.02}$ R_m A KV	400 MPa 540 MPa 35% 80 J	Rutile-basic electrode for joining of stainless high-alloy NiCrMoCu grade Sandvik 2RK65 ('904L') or other similar materials.
27.31.4.LCuR (383-16)	$R_{p.02}$ R_m	400 MPa 580 Mpa	Rutile-basic electrode for joining of stainless superaustenitic grades, such as Sanicro 28, Alloy 825.

Sandvik AWS E ISO	Mechanical properties: typical values at 20ºC (68ºF)		Typical applications
27 31 4 Cu L R	A KV	35% 80 J	

*253 MA and 353 MA are trademarks owned by Outokumpu OY

Sandvik AWS ER ISO	Mechanical properties typical values at 20ºC (68ºF)		Typical applications
Sanicro 60 NiCrMo-3 -	$R_{p0.2}$ R_m A KV	430 MPa 670 MPa 35% 65 J	Basic electrodes for joining of Alloy 625, Alloy 825 and other similar materials. Dissimilar materials, such as austenitic stainless steels to NiCrMo grades. Steels of the 9% Ni type for cryogenic service. 254 SMO* and similar 6% MoN stainless steels. Overlay welding of carbon and low-alloy steels.
Sanicro 69 NiCrFe-7 -	$R_{p0.2}$ R_m A KV	400 MPa 620 MPa 35% 100 J	Basic electrode for joining of Alloy 690 and Alloy 600. Overlay welding in the nuclear industry.
Sanicro 71 NiCrFe-3 -	$R_{p0.2}$ R_m A KV	390 MPa 620 MPa 35% 80 J	Basic electrode for joining of Alloy 800, Alloy 800H, Alloy 600 and other similar materials. Steels of 9% Ni type used for cryogenic service. Dissimilar materials, such as austenitic stainless steels to carbon steels for high-temperature service, as well as Ni-Cu alloys to nickel alloys.

*254 SMO is a trademark owned by Outokumpu OY

Sandvik AWS A5.35 (pending initial publication)	Mechanical properties typical values at 20ºC (68ºF)		Typical applications
AquaSan Ni50	Rp0.2 Rm A	524 MPa 648 MPa 14%	Qualified for underwater welding of the following steel types to a maximum depth of 50 ft (15 m): Grades: HY 80, HY 100, 204B, A36, 300 series stainless steels.

STORAGE AND RE-DRYING INSTRUCTIONS FOR COVERED ELECTRODES

STORAGE

During manufacture, covered electrodes are dried before packing in sealed plastic capsules. The plastic capsules provide firm protection against mechanical damage and protection against moisture in the atmosphere. If the electrodes are stored under normal conditions they can be stored for one year.

If covered electrodes are stored in the following normal conditions, moisture is picked up very slowly:

- 5-15°C (41-59°F): Relative humidity ≤ 60%
- 15-25°C (59-77°F): Relative humidity ≤ 50%
- > 25°C (> 77°F): Relative humidity ≤ 40%

If covered electrodes are stored in cold locations, the package should be acclimatized by reaching the surrounding temperature before the package is unwrapped.

Covered electrodes should be removed from the plastic capsules and stored in heated cabinets of 120-150°C (248-302°F) when:

1. The electrodes have been re-dried
2. The electrodes have been removed from the hermetically sealed capsules

At the workplace, the electrodes should be removed from the plastic capsules and kept in an electrically heated compartment of minimum 70°C (158°F).

RE-DRYING OF COVERED ELECTRODES

When covered electrodes leave the factory, the humidity level has been checked. If, however, the electrode has picked up humidity, it can easily be reconditioned. Temperature and holding time depend on the type of electrode (recommendations are given on each pack). Note that the specified time begins when the covered electrodes have reached the furnace temperature. For best drying results no more than four layers of electrodes at a time should be dried.

SANDVIK 19.9.LR CRYO
COVERED ELECTRODES

DATASHEET

Sandvik 19.9.LR CRYO (308L-16 CRYO) is a covered chromium nickel electrode with a rutile-basic coating for welding of steels of ASTM 304L base materials for cryogenic applications. Ferrite is controlled within a range of 2-5 FN according to WRC92. The low carbon content reduces the susceptibility to intergranular carbide precipitation and intergranular corrosion without the use of stabilizers such as niobium or titanium.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag and easy post weld finishing. Sandvik 19.9.LR CRYO (308L-16 CRYO) gives smooth uniform beads and works in any standard weld position.

Product Standards

- ISO 3581 E 19 9 L R
- AWS/ASME A5.4/SFA-5.4 E308L-16

Product Approvals

- AWS
- ASME
- CWB
- ISO 3581

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.025	0.6	1.0	18.5	10.0

APPLICATIONS

Sandvik 19.9.LR CRYO (308L-16 CRYO) is used for welding steels of the following types:

UNS	S30100	S30403	S30453	S30400	-	-
ASTM	301	304L	304LN	304	CF3	CF8

Suitable for welding 18/8 stainless steels with service temperatures down to -196°C (-320°F) such as cryogenic piping systems and LNG vessels.

These electrodes have a controlled ferrite content designed for cryogenic applications and meet the requirements of ASME UHA-51.

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FORMS OF SUPPLY

Deposition and working data

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	450	~3/16	~14

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9.LR CRYO (308L-16 CRYO)is austenitic with a ferrite content of 2-5 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Mechanical properties (nominal), at 20°C

Temperature	°C (°F)	20 (68)	-100 (-150)	-196 (-320)
Proof strength, $R_{P0.2}$	MPa (ksi)	440 (64)		
Tensile strength, R_m	MPa (ksi)	600 (87)		
Elongation, A	%	45		
Hardness; Brinell (Rockwell B)	HB (HRB)	200 (93)		
Impact strength, Charpy V	J (ft/lb)		45 (33)	35 (26)
Lateral expansion, mm (in.)				0.50 (0.020)

CORROSION RESISTANCE

Sandvik 19.9.LR CRYO (308L-16 CRYO) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench annealed condition.

FABRICATION

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	
Diameter, mm (in.)		Current, A
2.50 (~3/32)		60-90
3.25 (~1/8)		75-120
4.00 (~5/32)		100-155
5.00 (~3/16)		130-210

Thermal data

Interpass temperature: 150°C (300°F)

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				

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kg weld metal/h (approx.)	1	1.5	2.0	2.8
lb weld metal/h (approx.)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

SANDVIK 19.9.LR (308/308L-17)
COVERED ELECTRODES

DATASHEET

Sandvik 19.9.LR (308/308L-17) is a chromium-nickel covered electrode with rutile coating for welding of low carbon 18% Cr/10% Ni austenitic stainless steels.

The electrode has excellent arc stability, low spatter and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self peeling slag, easy post weld finishing. Sandvik 19.9.LR (308/308L-17) gives smooth uniform beads and works in any standard weld position.

Product Standards

- AWS A5.4 E308/308L-17
- ISO 3581-A E 19 9 L R

Product Approvals

- CE

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.025	0.95	0.75	19.0	9.5

APPLICATIONS

Sandvik 19.9.LR (308/308L-17) is used for welding steels of the following types:

ISO	1.4301, 1.4307
ASTM	301, 304L, 304LN, 304 and 302

In cases where creep strength is of secondary importance Sandvik 19.9.LR (308/308L-17) is suitable for welding stabilizedaustenitic steels, e.g. ASTM 321 and 347. When a weld metal similar to the parent metal is not required Sandvik19.9.LR (Sandvik 308/308L-17) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350 or 450	~5/32	~14 or ~18

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5.00	450	~3/16	~18

The electrodes are delivered in hermetically sealed metal cans.

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.9.LR (308/308L-17) is austenitic with a ferrite content of approximately 4-10 FN according to WRC-92.

MECHANICAL PROPERTIES - ALL WELD METAL

The following data are valid for as welded all-weld metal.

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	440 (64)	
Tensile strength, R_m	MPa (ksi)	600 (87)	
Elongation, A	%	40	
Hardness	HB	200	
Impact strength (KV)	J (ft lbs)	75 (55)	60 (44)

CORROSION RESISTANCE

Sandvik 19.9.LR (308/308L-17) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Diameter, mm (in.)	Current, A
2.50 (~3/32)	45–80
3.25 (~1/8)	80–115
4.00 (~5/32)	100–155
5.00 (~3/16)	150–220

Thermal data

Interpass Temperature	≤250°C (500°F)
Heat input	≤2.0 kJ/mm
Post weld heat treatment	None

Welding data

Welding positions	Diameter ≤3.25 mm (~1/8 in.)	All except vertical down
	Diameter ≤4.00 mm (~5/32 in.)	Horizontal
Current/polarity	DC+ or AC	

Redrying of the electrodes when necessary: 300°C (570°F)/2h

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm in.	300 (~12)	350 (~14)	450 (~18)	450 (~18)

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Deposition rate				
kg weld metal/h (approx)	1	1.5	2.0	2.7
lb weld metal/h (approx)	2.2	3.3	4.4	6.0
Effective value				
kg weld metal/kg electrodes	0.57	0.61	0.61	0.60
lb weld metal/lb electrodes	0.57	0.61	0.61	0.60
Change value				
Electrodes/kg weld metal	94	48	24	16
Electrodes/ lb weld metal	43	22	11	7
Burn-off time per electrode at max current, s	44	57	83	85
Weight/1000 pcs, kg (lb)	18.6 (41.0)	34.3 (75.6)	68.0 (149.9)	106.2 (234.1)

SANDVIK 19.12.3.R
COVERED ELECTRODES

DATASHEET

Sandvik 19.12.3.R (316/316H-16) is a covered chromium-nickel-molybdenum electrode with rutile-basic coating used for welding of steels of 316 types as well as overlays giving 316 type composition. This electrode has the same composition as type 316 except the carbon restriction eliminates carbon content below 0.04%. Carbon content in the range 0.04-0.08 facilitates higher tensile and creep strengths at elevated temperatures. The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 19.12.3.R (316/316H-16) gives smooth uniform beads and works in any standard weld position.

Product Standards

– ISO 3581 E 19 12 3 R
– AWS/ASME A5.4/SFA-5.4 E316-16

Product Approvals

– AWS, ASME, ISO 3581

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.06	0.6	2.0	19.5	11.5	2.5

APPLICATIONS

Sandvik 19.12.3.R (316/316H-16) is used for welding steels of 316H composition intended for high temperature service. The presence of molybdenum provides creep resistance and increased ductility at elevated temperatures.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	350	~3/16	~14

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WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.12.3.R (316/316L-16) is austenitic with a ferrite content of 4–12 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	406 (59)
Tensile strength, R_m	MPa (ksi)	607 (88)
Elongation, A	%	35
Hardness	HB	180
Impact strength (KV)	J (ft/lb)	61 (45)

CORROSION RESISTANCE

Due to the higher carbon content, Sandvik 19.12.3.R (316/316L-16) is not resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	
Diameter, mm (in.)		Current, A
2.50 (~3/32)		60-90
3.25 (~1/8)		75-120
4.00 (~5/32)		100-155
5.00 (~3/16)		130-210

Thermal data

Interpass temperature: 150°C (300°F)

Heat input: As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx.)	1	1.5	2.0	2.8
lb weld metal/h (approx.)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14	30.4	45	65

	(30)	(67)	(100)	(143)

SANDVIK 19.12.3.LR
COVERED ELECTRODES

DATASHEET

Sandvik 19.12.3.LR (316/316L-17) is a chromium-nickel-molybdenum covered electrode with rutile coating for welding of low carbon, molybdenum alloyed, austenitic stainless steels of 316L (1.4436) type.

Product Standards

- AWS A5.4 E316/316-17
- ISO 3581-A E 19 12 3 L R

Product Approvals

- CE
- CWB

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.02	1.0	0.8	18.5	12.0	2.8

APPLICATIONS

Sandvik 19.12.3.LR (316/316L-17) is used for welding steels of the following types:

ISO	1.4401, 1,4404, 1.4435, 1.4436, 1.4571
ASTM	316, 316L, 316LN, 316H and 316Ti

In cases where creep strength is of secondary importance, Sandvik 19.12.3.LR (316/316L-17) is suitable for welding of corresponding stabilized austenitic steels. When a weld metal similar to the parent metal is not required, Sandvik 19.12.3.LR (316/316L-17) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350 or 450	~5/32	~14 or ~18
5.00	450	~3/16	~18

The electrodes are delivered in hermetically sealed metal cans.

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WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.12.3.LR (316/316L-17) is austenitic with a ferrite content of approximately 4-10 FN according to WRC-92.

MECHANICAL PROPERTIES ALL-WELD METAL

The following data are valid for as welded all-weld metal.

Mechanical properties (nominal), at 20°C (68°F)

Proof strength $R_{p0.2}$	MPa (ksi)	470 (59)
Tensile strength R_m	MPa (ksi)	590 (85)
Elongation, A	%	35
Hardness	HB	210

Impact strength (nominal), Charpy V

Temperature, °C (°F)	20 (68)	-20 (04)	-105 (-157)
KV, J/ft-lbs	70 (52)	60 (44)	40 (30)

CORROSION RESISTANCE - ALL-WELD METAL

Sandvik 19.12.3.LR (316/316L-17) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and solution annealed and quenched condition.

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	45–80
3.25 (~1/8)	80–120
4.00 (~5/32)	100–160
5.00 (~3/16)	160–220

Thermal data

Intepass temperature	Max 200°C (300°F)
Heat input	Max 2.0 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Welding positions, mm (in.)	diameter ≤3.25 (~1/8)	all except vertical down
	diameter ≥4.00 (~5/32)	preferably flat position
Current/polarity DC+ or AC		

Redrying of the electrodes when necessary 300°C (570°F)/2h

Electrode and deposition data

Electrodediameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm	300	350	350-450	450

(in.)	(~12)	(~14)	(~14-18)	(~18)
Max deposition rate				
kg weld metal/h (approx)	1.0	1.5	2.0	2.8
lb weld metal/lb (approx)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.56	0.59	0.59	0.59
lb weld metal/lb electrodes	0.56	0.59	0.59	0.59
Change value				
kg weld metal/kg electrodes	71	48	24	16
lb weld metal/lb electrodes	32	22	11	7
Burn-off time per electrode at max current, s	37	49	73	84
Weight/1000 pcs, kg (lb)	18.5 (40.8)	35.3 (77.8)	69.2 (152.6)	107.8 (237.7)

SANDVIK 19.12.3.LR-16 (316/316L-16) COVERED ELECTRODES

DATASHEET

Sandvik 19.12.3.LR-16 (316/316L-16) is a covered chromium-nickel-molybdenum electrode with rutile-basic coating welding of steels of 316 types as well as overlays giving 316 type composition.

The low carbon content reduces the susceptibility to intergranular carbide precipitation and intergranular corrosion without the use of stabilizers such as niobium or titanium. For cryogenic applications down to -196°C (-452°F) use of Sandvik 19.12.3.LR-16 (316L-16) CRYO is recommended. The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 19.12.3.LR-16 (316/316L-16) gives smooth uniform beads and works in any standard weld position.

Product Standards

- ISO 3581 E 19 12 3 L R
- AWS/ASME A5.4/SFA-5.4 E316L-16

Product Approvals

- AWS, ASME, CWB, ISO 3581

Contact your nearest sales office for full details

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.02	0.6	2.0	18.5	12.0	2.8

APPLICATIONS

Sandvik 19.12.3.LR-16 (316/316L-16) is used for welding steels of the following types:

UNS	s31600, s31603, s31653, s31609 and s31635
ASTM	316, 316L, 316LN, 316H and 316Ti

The molybdenum content of this filler metal reduces the risk of pitting where exposure to chlorides is expected such as coastal areas and food processing equipment cleaned with chloride solutions.

In cases where creep strength is of secondary importance, Sandvik 19.12.3.LR-16 (316/316L-16) is suitable for welding of corresponding stabilized austenitic steels. When a weld metal similar to the parent metal is not required, Sandvik 19.12.3.LR-16 (316/316L-16) can be used for welding ferritic and martensitic steels.

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FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	350	~3/16	~14

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 19.12.3.LR-16 (316/316L-16) is austenitic with a ferrite content of 4–10 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-20 (-4)	-105 (-157)
Yield strength, $R_{p0.2}$	MPa (ksi)	470 (68)		
Tensile strength, R_m	MPa (ksi)	690 (86)		
Elongation, A	%	35		
Hardness	HB	210		
Impact toughness (KV)	J (ft lbs)	70 (52)	60 (44)	40 (29)

$R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE

Sandvik 19.12.3.LR-16 (316/316L-16) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	

Diameter, mm (in.)	**Current, A**
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

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PRODUCTIVITY DATA

Diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx)	1	1.5	2.0	2.8
lb weld metal/h (approx)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg Weight/1000 pcs, lbs	14.0 30.0	30.4 67.0	45.0 100.0	65.0 143.0

SANDVIK 19.12.3.LR CRYO
COVERED ELECTRODES

DATASHEET

Sandvik 19.12.3.LR CRYO (316L-16 CRYO) is a covered chromium-nickel-molybdenum electrode with rutile-basic coating for welding of steels of ASTM 316L base materials for cryogenic applications. The low carbon content reduces the susceptibility to intergranular carbide precipitation and intergranular corrosion without the use of stabilizers such as niobium or titanium.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, high resistance to porosity, self-peeling slag and easy post weld finishing. Sandvik 19.12.3.LR CRYO (316L-16 CRYO) gives smooth uniform beads and works in any standard weld position.

Product Standards

– ISO 3581 E 19 12 3 L R
– AWS/ASME A5.4/SFA-5.4 E316L-16

Product Approvals

– AWS
– ASME
– CWB
– ISO 3581

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo*
0.025	0.6	1.0	18.0	12.0	2.2

* Does not meet the DIN and EN requirement of Mo 2.5-3.0%

APPLICATIONS

Sandvik 19.12.3.LR CRYO (316L-16 CRYO) is used for welding steels of the following types:

UNS	S30100	S30400	S30403	S30453	S31600	S31603	S31653	S31609	S32635	-	-	-	-
ASTM	301	304	304L	304LN	316	316L	316LN	316H	316Ti	CF3	CF8	CF3M	CF8M

Sandvik 19.12.3.LR CRYO (316L-16 CRYO) produces a weld metal with low ferrite or a fully austenitic structure, crack susceptibility may result. To reduce crack susceptibility use as low heat input as practical, a flat to convex bead shape, and maintain an interpass temperature of 150°C (300°F).

FORMS OF SUPPLY

Diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length mm (in.)	300 (11.8)	350 (13.8)	350 (13.8)	350 (13.8)
kg (lb)/carton	11.4 (25.1)	13.5 (29.7)	13.5 (29.7)	13.5 (29.7)

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Pieces (lb)/carton	618	296	261	159

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.12.3.LR CRYO (316L-16 CRYO) is austenitic with a ferrite content of 2-5 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Mechanical properties (nominal)

Temperature,	°C (°F)	20 (68)	-100 (-150)	-196 (-320)
Proof strength, $R_{p0.2}$	MPa (ksi)	440 (64)		
Tensile strength, R_m	MPa (ksi)	600 (87)		
Elongation, A	%	45		
Hardness Brinell Rockwell B	 HB HRB	 230 98		
Impact strength (KV)	J (ft/lb)		50 (37)	30 (32)
Lateral expansion, mm (in.)				0.45 (0.018)

1 MPa = 1 N/mm^2

CORROSION RESISTANCE

Sandvik 19.12.3.LR CRYO (316L-16 CRYO) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	

Diameter, mm (in.)	Current, A
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130-210

Thermal data

Interpass temperature, °C (°F)	150 (300)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode and deposition data

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx.)	1	1.5	2.0	2.8
lb weld metal/h (approx.)	2.2	3.3	4.4	6.2
Effective value				

kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

Datasheet updated 1/25/2016 11:14:06 AM (supersedes all previous editions)

SANDVIK 19.9.LR-16
COVERED ELECTRODES

DATASHEET

Sandvik 19.9.LR-16 (308/308L-16) is a covered chromium-nickel electrode with rutile-basic coating for welding of steels of ASTM 304 types as well as overlays giving 308 type composition.

The low carbon content reduces the susceptibility to intergranular carbide precipitation and intergranular corrosion without the use of stabilizers such as niobium or titanium. Due to the low carbon content, the high temperature strength will not be as high as 308H or 347 grades. For cryogenic applications down to -196°C (-452°F) use of Sandvik 19.9.LR-16 (308/308L-16) CRYO is recommended.

The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry.
The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, easy post weld finishing. Sandvik 19.9.LR-16 (308/308L-16) gives smooth uniform beads and works in any standard weld position.

Product Standards

- ISO 3581 E 19 9 L R
- AWS/ASME A5.4/SFA-5.4 E308L-16

Product Approvals

- AWS
- ASME
- CWB
- ISO 3581

Contact your nearest sales office for full details

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.025	0.6	2.0	20.5	10.0

APPLICATIONS

Sandvik 19.9.LR-16 (308/308L-16) is used for welding steels of the following types:

UNS	S30400, S30403, S30409 and S30453
ASTM	301, 304L, 304LN, 304 and 302

In cases where creep strength is of secondary importance Sandvik 19.9.LR-16 (308/308L-16) is suitable for

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welding stabilized austenitic steels, e.g. ASTM 321 and 347. When a weld metal similar to the parent metal is not required Sandvik 19.9.LR-16 (308/308L-16) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	350	~3/16	~14

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.9.LR-16 (308/308L-16) is austenitic with a ferrite content of 4–12 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	440 (64)	
Tensile strength, R_m	MPa (ksi)	600 (87)	
Elongation, A	%	40	
Hardness	HB	200	
Impact strength (KV)	J (ft lbs)	75 (55)	60 (44)

CORROSION RESISTANCE

Sandvik 19.9.LR-16 (308/308L-16) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	

Diameter, mm (in.)	**Current, A**
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)

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Deposition rate				
kg weld metal/h (approx.)	1	1.5	2.0	2.8
lb weld metal/h (approx.)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

SANDVIK

SANDVIK 19.9.NBR-16 (347-16)
COVERED ELECTRODES

DATASHEET

Sandvik 19.9.NbR-16 (347-16) is a covered niobium-stabilized chromium-nickel electrode with rutile-acid coating for welding of steels of ASTM 321 and 347 types as well as overlays. It is used in structural applications over 400ºC (752°F) and up to 850°C (1562°F). The coating for this electrode is of the American rutile type with a faster freezing rate over -17 type of the same weld deposit chemistry.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 19.9.NbR-16 (347-16) gives smooth uniform beads and works in any standard weld position.

Product Standards

- ISO 3581 E 19 9 Nb R
- AWS/ASME A5.4/SFA-5.4 E347-16

Product Approvals

- AWS
- ASME
- CWB
- ISO 3581

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.03	0.6	2.0	20.0	10.0

Nb = 8xC-1.0

APPLICATIONS

Sandvik 19.9.NbR-16 (347-16) is used for welding steels of the following types:

UNS	S32100, S32109, S34700 and S34709
ASTM	321, 321H, 347 and 347H

If dilution with the base metal produces a weld metal with low ferrite or a fully austenitic structure, crack susceptibility may result.

When a weld metal similar to the parent metal is not required Sandvik 19.9.NbR-16 (347-16) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Datasheet updated 1/28/2016 9:02:58 AM (supersedes all previous editions)

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~ 12
3.25	350	~1/8	~ 14
4.00	350	~5/32	~ 14
5.00	350	~3/16	~ 14

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.9.NbR-16 (347-16) is austenitic with a ferrite content of 6–12 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-20 (-4)	-60 (-76)
Proof strength, $R_{P0.2}$	MPa (ksi)	450 (65)		
Tensile strength, R_m	MPa (ksi)	620 (90)		
Elongation, A	%	35		
Hardness	HB	215		
Impact strength (KV)	J (ft lbs)	55 (41)	50 (37)	35 (26)

CORROSION RESISTANCE

Sandvik 19.9.NbR-16 (347-16) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions		All except vertical down
Current/polarity	DC+ or AC	

Diameter, mm (in.)	**Current, A**
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	450 (~18)	450 (~18)
Deposition rate				
kg weld metal/h (approx)	1	1.5	2.0	2.8
lb weld metal/h (approx)	2.2	3.3	4.4	6.2

Datasheet updated 1/28/2016 9:02:58 AM (supersedes all previous editions)

Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

SANDVIK 19.9.NBR
COVERED ELECTRODES

DATASHEET

Sandvik 19.9.NbR (347-17) is a niobium-stabilized chromium-nickel covered electrode with rutile coating for welding of Nb (Cb) or Ti stabilized 18% Cr/10% Ni austenitic stainless steels. It is used in applications with temperatures up to 850°C (1562°F).

The electrode has excellent arc stability, low spatter and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self peeling slag, high resistance to porosity and easy post weld finishing.

Sandvik 19.9.NbR (347-17) gives smooth uniform beads and works in any standard weld position.

Product Standards

- AWS A5.4 347-17
- ISO 3581-A E 19 9 Nb R

Product Approvals

- CE

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.03	0.9	0.8	20.0	10.0

Nb = 8xC-1.00

APPLICATIONS

Sandvik 19.9.NbR (347-17) is used for welding steels of the following types:

ISO	1.4550, 1.4912
ASTM	321, 321H, 347 and 347H

When a weld metal similar to the parent metal is not required, Sandvik 19.9.NbR (347-17) can be used for welding ferritic and martensitic steels.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~ 12

Datasheet updated 1/7/2016 11:35:46 AM (supersedes all previous editions)

3.25	350	~1/8	~ 14
4.00	350 or 450	~5/32	~ 14 or 18
5.00	450	~3/16	~ 18

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.9.NbR (347-17) is austenitic with a ferrite content of approximately 6-10 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal

Mechanical properties (nominal)

Temperature,	°C (°F)	20 (68)	-20 (-4)	-60 (-76)
Proof strength, $R_{p0.2}$	MPa (ksi)	450 (65)		
Tensile strength, R_m	MPa (ksi)	620 (90)		
Elongation, A	%	35		
Impact toughness (KV)	J (ft lbs)	55 (41)	50 (37)	35 (26)

CORROSION RESISTANCE

Sandvik 19.9.NbR (347-17) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	Diameter ≤3.25 mm (~1/8 in.)	All except vertical down
	Diameter ≥4.00 mm (~5/32 in.)	Horizontal
Current/polarity	DC+ or AC	

Redrying of the electrodes when necessary .... 300°C (570°F)/2h

Diameter, mm (in.)	Current, A
2.50 (~3/32)	50-80
3.25 (~1/8)	80-110
4.00 (~5/32)	110-160
5.00 (~3/16)	160-220

Thermal data

Interpass Temperature	250°C (500°F)
Heat input	≤ 2.0 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)

Datasheet updated 1/7/2016 11:35:46 AM (supersedes all previous editions)

Length, mm (in.)	300 (~12)	350 (~14)	450 (~18)	450 (~18)
Deposition rate				
kg weld metal/h (approx)	1	1.5	2.0	2.8
lb weld metal/h (approx)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg Weight/1000 pcs, lb	14 30	30.4 67	45 100	65 143

SANDVIK 19.9.R-16
COVERED ELECTRODES

DATASHEET

Sandvik 19.9.R-16 (308/308H-16) is a covered chromium-nickel electrode with rutile-basic coating for welding of steels of ASTM 304 types as well as overlays giving 308 type composition. This electrode has the same composition as type 308 except the carbon restriction eliminates carbon content below 0.04%. Carbon content in the range 0.04-0.08 facilitates higher tensile and creep strengths at elevated temperatures. The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, easy post weld finishing. Sandvik 19.9.R-16 (308/308H-16) gives smooth uniform beads and works in any standard weld position.

Product Standards
- ISO 3581 E 19 9 R
- AWS/ASME A5.4/SFA-5.4 E308H-16

Product approvals
- AWS
- ASME
- ISO 3581

Contact your nearest sales office for full details

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.06	0.6	2.0	20.5	9.5

APPLICATIONS
Sandvik 19.9.R-16 (308/308H-16) is used for welding steels of the following types:

UNS	S30400, S30409, S30100 and S30200
ASTM	304, 304H, 301 and 302

In cases where creep strength is important, Sandvik 19.9.R-16 (308/308H-16) is suitable.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.

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2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	350	~3/16	~14

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 19.9.R-16 (308/308H-16) is austenitic with a ferrite content of 4–12 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$ [1)]	MPa (ksi)	441 (64)
Tensile strength, R_m	MPa (ksi)	620 (90)
Elongation, A	%	41
Hardness	HB	200
Impact strength (KV)	J (ft lb)	122 (90)

1) $R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE

Due to the higher carbon content, Sandvik 19.9.R-16 (308/308H-16) is not resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	

Diameter, mm (in.)	**Current, A**
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~ 12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx)	1	1.5	2.0	2.8

lb weld metal/h (approx)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

Datasheet updated 1/7/2016 11:37:54 AM (supersedes all previous editions)

SANDVIK

SANDVIK 20.25.5.LCUR COVERED ELECTRODES

DATASHEET

Sandvik 20.25.5.LCuR (385-16) is a covered electrode with type with rutile-basic coating and normal recovery, used for welding of high-alloy austenitic stainless of UNS N08904 type, also known as 904L (e.g. Sandvik 2RK65).

Sandvik 20.25.5.LCuR (385-16) gives a fully austenitic chromium-nickel-molybdenum weld metal with especially low carbon content and copper addition. Spray transfer gives a bead with a finely rippled surface, little spatter and good slag removal.

Product Standards

- ISO 3581 E 20 25 5 Cu N L R
- AWS/ASME A5.4/SFA-5.4 E385-16

Product Approvals

- AWS
- ASME
- ISO 1600

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
≤0.025	0.9	1.0	20.0	25.0	4.7

APPLICATIONS

Sandvik 20.25.5.LCuR (385-16) is suitable for joining steels of the 20Cr/25Ni/4.5Mo/1.5Cu type such as 2RK65 and 904L used in many areas of the process industry, such as in the production of acetic acid, sulfuric acid, terephthalic or tartaric acid and vinyl chloride as well as other chloride containing media. It is also suitable for use in cooling operations involving sea water or heavily polluted river water.

Sandvik 20.25.5.LCuR (385-16) may also be used to join 317L where improved corrosion resistance in specific media is required.

These electrodes may be used to join 2RK65, 904L, and 317L to other grades of stainless steel.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12

Datasheet updated 1/7/2016 11:43:40 AM (supersedes all previous editions)

3.25	350	~1/8	~14
4.00	350	~5/32	~14

WELD METAL CHARACTERISTICS

Fully austenitic.

MECHANICAL PROPERTIES

Temperature,	°C (°F)	20 (68)
Proof strength, $R_{P0.2}$	MPa (ksi)	350 (51)
Tensile strength, R_m	MPa (ksi)	550 (80)
Elongation, A	%	35
Hardness	HV10	160
Impact strength (KV)	J (ft/lb)	65 (50)

CORROSION PROPERTIES

Resistant to intergranular corrosion according to DIN50914 and ASTM A262 practice E.

FABRICATION

Welding data

Welding positions	Diameter <3.25 mm (~1/8 in.)	All except vertical down
	Diameter >3.25 mm (~1/8 in.)	Preferably flat position
Current/polarity	Direct current/electrode positive or alternating current at an open circuit voltage of at least 70V	
Diameter, mm (in.)		Current, A
2.50 (~3/32)		40-75
3.25 (~1/8)		60-110
4.00 (~5/32)		80-140

Redrying electrodes when necessary: 300°C (570°F)/2h

Thermal data

- Interpass Temperature: 150°C (300°F)
- Heat input: 1.0 kJ/mm (25 kJ/in.) max

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)
Deposition rate			
kg weld metal/h (approx.)	0.6	1.2	1.8
lb weld metal/h (approx.)	1.30	2.6	4.0
Effective value			
kg weld metal/kg electrodes	0.63	0.60	0.65
lb weld metal/lb electrodes	0.63	0.60	0.65

Datasheet updated 1/7/2016 11:43:40 AM (supersedes all previous editions)

Change value			
Electrodes/kg weld metal	80	51	32
Electrodes/lb weld metal	36	23	15
Burn-off time per electrode at max current, s	79	53	60
Weight/1000 pcs, kg (lb)	21 (46)	31 (68)	47 (103)

SANDVIK

SANDVIK 22.12.HTR COVERED ELECTRODES

DATASHEET

Sandvik 22.12.HTR is a covered electrode with rutile-acid coating and about 110% metal recovery. It is used for welding of austenitic stainless steels of UNS S30815 type (e.g. Sandvik 253 MA) and similar high-temperature steels, such as ASTM 309 and 309S.

Sandvik 22.12.HTR gives a chromium-nickel weld metal that is scaling resistant in air up to 1150°C (2102°F). Spray transfer gives a bead with a finely rippled surface. There is little spatter and very good slag removal.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	N
0.06	1.5	0.8	≤0.03	≤0.03	22.0	10.5	0.18

MICROSTRUCTURE - ALL-WELD METAL

Austenitic matrix with a ferrite content of about 6FN according to the DeLong diagram.

CORROSION RESISTANCE - ALL-WELD METAL

Corrosion resistance

Wet corrosion resistance similar to weld metal of the 19Cr 9Ni steel type.

Oxidation resistance

Up to 1150 °C (2102°F) in air.

RECOMMENDED WELDING DATA

Diameter, mm	2.5	3.25	4.0
Current, A	45-70	70-110	100-140

Redrying electrodes when necessary: 300 °C (570°F)/2h

DEPOSITION DATA

Electrode data

Electrode diameter, mm	2.5	3.25	4.0
Length, mm	300	350	350
Weights: kg/100 pcs	2.2	3.6	6.0
kg/box	4.0	4.5	5.1

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Electrode data

Electrode diameter, mm	2.5	3.25	4.0
Electrodes/box	184	124	85
Max deposition rate, kg weld metal/h, approx	1.1	1.6	2.1
Effective value kg weld metal/kg electrodes	0.62	0.62	0.64
Change value Electrodes/kg weld metal	71	42	25
Burn off time per electrode at max current, s	46	51	64

Working data

Welding positions	all except vertical down
Current/polarity	direct current/electrode positive or alternating current at an open circuit voltage of at least 60V

APPLICATIONS

Sandvik 22.12.HTR is intended primarily for welding the high temperature steels Sandvik 253MA®[1)] and Avesta 253MA®[1)], UNS S30815.

It is also suitable for welding other high temperature steels, such as AISI 309 and EN 1.4828.

[1)]253MA® is a trademark owned by Outokumpu Stainless.

Datasheet updated 1/7/2016 11:49:22 AM (supersedes all previous editions)

SANDVIK 22.9.3.LB
COVERED ELECTRODES

DATASHEET

Sandvik 22.9.3.LB (2209-15) is a chromium-nickel-molybdenum-nitrogen covered electrode with basic coating for welding of 22-23%Cr duplex (austenitic-ferritic) stainless steels (e.g. Sandvik SAF 2205).

The basic type of electrode combines good welding properties in all positions and high impact strength at low temperatures. The weld metal is characterized by high strength and very good pitting corrosion resistance as well as very good resistance to stress corrosion cracking in chloride containing media.

Product Standards

- AWS A5.4 E2209-15
- ISO 3581-A 22 9 3 N L B

Product Approvals

- TÜV
- DNV

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N	PRE*
≤0.04	0.5	1.0	≤0.03	≤0.025	23.0	9.0	3.2	0.17	≥35.0

* PRE = % Cr + 3.3 x %Mo + 16 x % N

APPLICATIONS

Sandvik 22.9.3.LB (2209-15) is used for welding of duplex and lean duplex stainless steels in service temperatures up to 280°C (536°F), where good impact strength at temperatures below -40°C is required.

ISO	1.4462, 1.4362, 1.4162, 1.4662, 1.4660, 1.4417
ASTM UNS	S32205, S31803, S32304, S32101, S82441

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14

Datasheet updated 1/27/2016 8:56:09 AM (supersedes all previous editions)

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 22.9.3.LB (2209-15) is austenitic-ferritic with a ferrite content of approximately 45 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Temperature	°C (°F)	20 (68)	-50 (-58)
Proof strength, $R_{P0.2}$	MPa (ksi)	630 (91)	-
Tensile strength, R_m	MPa (ksi)	790 (115)	-
Elongation, A	%	25	-
Impact strength, KV	J	90	60

CORROSION PROPERTIES

Strauss test, ASTM A262 E	Resistant to intergranular corrosion

Pitting corrosion

Sandvik 22.9.3.LR (2209-17) meets pitting resistance of 22°C according to ASTM G48 A, and resistance to intermetallic formation as defined by ASTM A 923 C with weight loss less than 10 mdd.

The PRE value for Sandvik 22.9.3.LB (2209-17) is 35 minimum.

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	50-80
3.25 (~1/8)	75-120
4.00 (~5/32)	120-175

Thermal data

Interpass temperature	Max 250°C (400°F)
Heat input	0.5-2.5 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Welding positions	All positions
Current/polarity	DC+

Redrying of the electrodes when necessary 300°C (570°F)/2h

Electrode and deposition data

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)
Weight			

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kg/100 pcs	1.8	3.2	4.9
lb/100 pcs	4.0	7.0	10.8
Max deposition rate			
kg weld metal/h (approx.)	0.8	1.4	1.9
lb weld metal/h (approx.)	1.8	3.1	4.2
Effective value			
kg weld metal/kg electrodes	0.65	0.68	0.68
lb weld metal/lb electrodes	0.65	0.68	0.68
Change value			
Electrodes/kg weld metal	87	43	28
Electrodes/lb weld metal	40	20	13
Burn off time per electrode at max current, s	38	55	59

SANDVIK 22.9.3.LR
COVERED ELECTRODES

DATASHEET

Sandvik 22.9.3.LR (2209-17) is a chromium-nickel-molybdenum-nitrogen covered electrode with rutile coating for welding of 22-23%Cr duplex (ferritic-austenitic) stainless steels (e.g. Sandvik SAF 2205).

The electrode has excellent arc stability, low spatter, self peeling slag and smooth weld bead finishing. The weld metal is characterized by high strength and very good corrosion resistance pitting in chloride containing media and to stress corrosion cracking.

Product Standards

- AWS A5.4 E2209-17
- ISO 3581-A E 22 9 3 N L R

Product Approvals

- TÜV
- DNV

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N	PRE*
≤0.03	≤0.9	0.8	≤0.03	≤0.025	23.0	9.0	3.0	0.15	≥35.0

* PRE = % Cr + 3.3 x % Mo + 16 x % N

APPLICATIONS

Sandvik 22.9.3.LR (2209-17) is used for welding of duplex and lean duplex stainless steels in service temperatures up to 280°C (536°F).

ISO	1.4462. 1.4362. 1.4162. 1.4662. 1.4460. 1.4417.
ASTM UNS	S32205. S31803. S32304. S32101. S82441.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	350	~3/16	~14

Datasheet updated 1/7/2016 1:53:04 PM (supersedes all previous editions)

The electrodes are delivered in sealed plastic capsules.

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 22.9.3.LR (2209-17) is austenitic-ferritic with a ferrite content of approximately 40 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Temperature,	°C (°F)	20 (68)	-40 (-40)
Proof strength, $R_{p0.2}$	MPa (ksi)	640 (93)	
Tensile strength, R_m	MPa (ksi)	700 (116)	
Elongation, A	%	20	
Impact strength (KV)	J (ft lb)	48 (35)	40 (30)

CORROSION RESISTANCE

Intergranular corrosion

Huey test, ASTM A262 Pr C	$0.25 g/m^2/h$
Strauss test, ASTM A262 Pr E	Resistant to intergranular corrosion

Pitting corrosion

Sandvik 22.9.3.LR (2209-17) meets pitting resistance of 22°C according to ASTM G48 A, and resistance to intermetallic formation as defined by ASTM A 923 C with weight loss less than 10 mdd.

Stress corrosion cracking, NACE TM 0177

Applied stress	Time to fracture
650 MPa	65.6 h
520 MPa	>720 h (no fracture)

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	40–75
3.25 (~1/8)	80–110
4.00 (~5/32)	100–150
5.00 (~3/16)	140-210

Thermal data

Interpass temperature, °C (°F)	Max 250 (400)
Heat input	0.5-2.5 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Working data

Datasheet updated 1/7/2016 1:53:04 PM (supersedes all previous editions)

Welding positions	Diameter ≤3.20 mm (~1/8 in.) All except vertical down Diameter ≥4.00 mm (~5/32 in.) Horizontal
Current/polarity	DC+ or AC
Redrying of the electrodes when necessary	300°C (570°F)/2h

Electrode and deposition data

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx)	≤1.8	≤3.6	≤5.5	≤8.7
lb weld metal/h (approx)	≤4.0	≤7.9	≤12.1	≤19.1
Effective value				
kg weld metal/kg electrodes	0.58	0.58	0.58	0.58
lb weld metal/lb electrodes	0.58	0.58	0.58	0.58
Change value				
Electrodes/kg weld metal	91	47	32	20
Electrodes/lb weld metal	41	21	15	9
Burn off time per electrode at max current, s	38	55	59	64

SANDVIK 23.12.2.LR
COVERED ELECTRODES

DATASHEET

Sandvik23.12.2.LR (309LMo-17) is a high alloyed chromium-nickel-molybdenum covered electrode with rutile coating fo rwelding of dissimilar joints between stainless steel and mild or low alloyed steels. It is also used to create buffer layers with a composition of 18%Cr/8%Ni/2%Mo before overlay alloys are deposited.

The electrode has excellent arc stability, low spatter and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self peeling slag, easy post weld finishing. Sandvik 23.12.2.LR (309LMo-17) gives smooth uniform beads and works in any standard weld position.

STANDARDS

- ISO: E 23 12 2 L R 32
- AWS: E309LMo-17

Product Standards

- AWS A5.4 E309LMo-17
- ISO 3581-A E 23 12 2 L R

Product Approvals

- CE

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.03	0.9	0.8	23.0	12.5	2.6

APPLICATIONS

Sandvik 23.12.2.LR (309LMo-17) is used for:

- Welding of stainless steels to mild or low alloy steels.
- Buffer layers on low alloy steels before overlays of 316 composition
- Welding of medium carbon hardenable steels, e.g. armour plate

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12

Datasheet updated 1/7/2016 2:54:51 PM (supersedes all previous editions)

3.25	350	~1/8	~14
4.00	350 or 450	~5/32	~14 or ~18
5.00	450	~3/16	~18

The electrodes are delivered in hermetically sealed metal cans.

WELD METAL CHARECTERISTICS

The all weld metal for Sandvik 23.12.2.LR (309LMo-17) is austenitic with a ferrite content of approximately 20 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Mechanical properties (nominal)

Temperature,	°C (°F)	20 (68)	-20 (-4)	-60 (-76)
Proof strength, $R_{p0.2}$	MPa (ksi)	560 (81.2)		
Tensile strength, R_m	MPa (ksi)	790 (100)		
Elongation, A	%	30		
Impact toughness (KV)	J (ft lbs)	57 (42)	50 (37)	45 (33)

CORROSION RESISTANCE

Sandvik 23.12.2.LR (309LMo-17) is resistant to intergranular corrosion according to ASTM A262 practice E.

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	45–85
3.25 (~1/8)	80–120
4.00 (~5/32)	110–160
5.00 (~3/16)	150-220

Thermal data

Interpass temperature, °C (°F)	Max 250 (400)
Heat input	Max 2.0 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Working data

Welding positions	Diameter ≤3.25 mm (~1/8 in.) All except vertical down Diameter ≥4.0 mm (~5/32 in.) Horizontal
Current/polarity	DC+ or AC
Redrying of the electrodes when necessary	300°C (570°F)/2h

Electrode and deposition data

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	450 (~18)	450 (~18)
Deposition rate				
kg weld metal/h (approx.)	≤1.0	≤1.5	≤2.1	≤3.0
lb weld metal/h (approx.)	≤2.2	≤3.3	≤4.6	≤6.6
Effective value				
kg weld metal/kg electrodes	0.62	0.65	0.65	0.67
lb weld metal/lb electrodes	0.62	0.65	0.65	0.67
Change value				
Electrodes/kg weld metal	84	43	25	14
Electrodes/ lb weld metal	38	20	11	6
Burn off time per electrode at max current, s	40	46	72	81

SANDVIK 23.12.2.LR-16
COVERED ELECTRODES

DATASHEET

Sandvik 23.12.2.LR-16 (309LMo-16) is a covered electrode with rutile-basic coating for joining of dissimilar materials and it is commonly used also for first layer deposit in ASTM 316 overlays. The low carbon content reduces the susceptibility to intergranular carbide precipitation and intergranular so.

The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry. The high alloy composition and ferrite level enable the weld metal to tolerate dilution from dissimilar and difficult-to-weld materials without hot cracking or brittle microstructures.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 23.12.2.LR-16 (309LMo-16) gives smooth uniform beads and works in any standard weld position.

Product Standards

- ISO 3581 E 23 12 2 L R
- AWS/ASME A5.4/SFA-5.4 E309LMo-16

Product Approvals

- AWS
- ASME
- ISO 3581

Contact your nearest sales office for full details

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
0.03	0.6	2.0	23.0	12.5	2.6

APPLICATIONS

Sandvik 23.12.2.LR-16 (309LMo-16) is used for welding in all positions of stainless steels to carbon or low alloy steels. It is used for dissimilar joints between stainless and low alloy steels, buffer layers on low alloy steels and interface runs in ASTM 316L clad steels.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14

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4.00	350	~5/32	~14
5.00	350	~3/16	~14

WELD METAL CHARECTERISTICS

The all weld metal for Sandvik 23.12.2.LR-16 (309LMo-16) is austenitic with a ferrite content of about 20 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature,	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	400 (58)
Tensile strength, R_m	MPa (ksi)	690 (100)
Elongation, A	%	40
Hardness	HB	160

CORROSION RESISTANCE

Sandvik 23.12.2.LR-16 (309LMo-16) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	All except vertical down
Current/polarity	DC+ or AC

Diameter, mm (in.)	Current, A
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx.)	≤1	≤1.5	≤2.0	≤2.8
lb weld metal/h (approx.)	≤2.2	≤3.3	≤4.4	≤6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15

Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

Datasheet updated 1/7/2016 3:28:17 PM (supersedes all previous editions)

SANDVIK 24.13.R
COVERED ELECTRODES
DATASHEET

Sandvik 24.13.R (309/309H-16) is a covered chromium-nickel electrode with rutile-basic coating used for first-layer overlay welding of carbon or low-alloy steels. This electrode has the same composition as type 309 except the carbon restriction eliminates carbon content below 0.04%. Carbon content in the range 0.04-0.15 facilitates higher tensile and creep strengths at elevated temperatures. It is also used for joining of dissimilar material. The coating for this electrode is of the American rutile type with a faster freezing rate over -17 type of the same weld deposit chemistry.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 24.13.R (309/309H-16) gives smooth uniform beads and works in any standard weld position.

Product Standard
- ISO 3581 E 23 12 R
- AWS/ASME A5.4/SFA-5.4 E309-16

Product Approvals
- AWS
- ASME
- ISO 3581

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C
0.07

APPLICATIONS
Sandvik 24.13.R (309/309H-16) is used for welding in all positions of stainless steels to carbon or low-alloy steels. Used for buffer layer in overlay welding, Sandvik 24.13.R (309/309H-16) gives a 304 composition in the first layer. These electrodes are suitable for welding of 24Cr 12Ni wrought and cast steels designed for corrosion and oxidation resistance. High carbon castings to ACI's HH grade should be welded with an electrode that is similar to the casting composition.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.

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2.50	300	~3/32	~12
3.25	300	~1/8	~14
4.00	300	~5/32	~14
5.00	300	~3/16	~14

WELD METAL CHARACTERISTICS

The all weld metal for is austenitic with a ferrite content of 8-16 FN according to WRC-92.

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.07	0.6	2.0	24.0	13.0

MECHANICAL PROPERTIES

Temperature,	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$[a]	MPa (ksi)	393 (57)
Tensile strength, R_m	MPa (ksi)	593 (86)
Elongation, A	%	35
Hardness	HB	210
Impact toughness (KV)	J (ft lbs)	55 (41)

[a] $R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE

Due to the higher carbon content, Sandvik 24.13.R (309/309H-16) is not resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	Diameter	All except vertical down
Current/polarity	DC+ or AC	

Diameter, mm (in.)	Current, A
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)

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Deposition rate				
kg weld metal/h (approx.)	≤1	≤1.5	≤2.0	≤2.8
lb weld metal/h (approx.)	≤2.2	≤3.3	≤4.4	≤6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/ lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

SANDVIK 24.13.LR
COVERED ELECTRODES

DATASHEET

Sandvik 24.13.LR (309/309L-17) is a high alloyed chromium-nickel covered electrode with rutile coating for welding of dissimilar joints between stainless steel and mild or low alloyed steels. It is also used to create buffer layers with a composition of 18%Cr/8%Ni before overlay alloys are deposited.

The electrode has excellent arc stability, low spatter and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 24.13.LR (309/309L-17) gives smooth uniform beads and works in any standard weld position.

Product Standards

- AWS A5.4 E309/309L-17
- ISO 3581-A E 23 12 L R

Product Approvals

- CE

Contact your nearest sales office for details

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.02	1.0	0.8	23.0	12.5

APPLICATIONS

Sandvik 24.13.LR (309/309L-17) is used for :

- Welding of stainless steel to low alloyed steels
- Buffer layers on low alloy steels before overlays with 304 composition
- Welding of stainless steels of 23%Cr/12%Ni type
- Joining of ferritic/martensitic stainless steels of 12-18%Cr type

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350 or 450	~5/32	~14 or ~18
5.00	450	~3/16	~18

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The electrodes are delivered in hermetically sealed metal cans.

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 24.13.LR (3097309L-17) is austenitic with a ferrite content of approximately 20 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Mechanical properties (nominal)

Temperature,	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$	MPa (ksi)	480 (70)	
Tensile strength, R_m	MPa (ksi)	570 (83)	
Elongation, A	%	35	
Impact strength (KV)	J (ft lbs)	55 (41)	50 (37)

CORROSON RESISTANCE

Sandvik 24.13.LR (309/309L-17) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	45–80
3.25 (~1/8)	80–120
4.00 (~5/32)	110–160
5.00 (~3/16)	150-220

Thermal data

Interpass temperature, °C (°F)	Max 250 (400)
Heat input	Max 2.0 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Working data

Welding positions	Diameter ≤3.25 mm (~1/8 in.) All except vertical down Diameter ≥4.00 mm (~5/32 in.) Horizontal
Current/polarity	DC+ or AC
Redrying of the electrodes when necessary	300°C (570°F)/2h

Electrode and deposition data

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	450 (~18)	450 (~18)

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Deposition rate				
kg weld metal/h (approx.)	≤0.99	≤1.4	≤2.0	≤2.9
lb weld metal/h (approx.)	≤2.2	≤3.1	≤4.4	≤6.4
Effective value				
kg weld metal/kg electrodes	0.59	0.63	0.61	0.63
lb weld metal/lb electrodes	0.59	0.63	0.61	0.63
Change value				
Electrodes/kg weld metal	85	44	22	15
Electrodes/ lb weld metal	39	20	10	7
Burn off time per electrode at max current, s	41	56	75	84
Weight/1000pcs, kg (lb)	19 (42)	35 (77)	70 (154)	108 (238)

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SANDVIK 24.13.LR-16
COVERED ELECTRODES

DATASHEET

Sandvik 24.13.LR-16 (309/309L-16) is a covered chromium-nickel electrode with rutile-basic coating used for first-layer overlay welding of carbon or low-alloy steels. The low carbon content reduces the susceptibility to intergranular carbide precipitation and intergranular corrosion. It is also used for joining of dissimilar material. The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry.

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 24.13.LR-16 (309/309L-16) gives smooth uniform beads and works in any standard weld position.

Product Standard

- ISO 3581 E 23 12 L R
- AWS/ASME A5.4/SFA-5.4 E308L-16

Product Approvals

- AWS
- ASME
- CWB
- ISO 3581

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.02	0.6	2.0	23.0	12.0

APPLICATIONS

Sandvik 24.13.LR-16 (309/309L-16) is used for welding in all positions of stainless steels to carbon or low-alloy steels. Used for buffer layer in overlay welding, Sandvik 24.13.LR gives a 304 composition in the first layer. Sandvik 24.13.LR-16 (309/309L-16) can also be used for welding of some high-temperature steels, such as 309S. In cases where postweld heat treatment is required, the total welding procedure must be qualified.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12

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3.25	300	~1/8	~14
4.00	300	~5/32	~14
5.00	300	~3/16	~14

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 24.13.LR-16 (309/309L-16)is austenitic with a ferrite content of 9-20 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal

Mechanical properties (nominal)

Temperature,	°C (°F)	20 (68)	-20 (-4)
Proof strength, $R_{p0.2}$[a]	MPa (ksi)	480 (70)	
Tensile strength, R_m	MPa (ksi)	560 (81)	
Elongation, A	%	35	
Hardness	HB	210	
Impact toughness (KV)	J (ft lbs)	55 (41)	50 (37)

[a] $R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE

Sandvik 24.13.LR-16 (309/309L-16) is resistant to intergranular corrosion according to ASTM A262 practice E in the as-welded and quench-annealed condition.

FABRICATION

Welding data

Welding positions	All except vertical down
Current/polarity	DC+ or AC

Diameter, mm (in.)	Current, A
2.50 (~3/32)	60–90
3.25 (~1/8)	75–120
4.00 (~5/32)	100–155
5.00 (~3/16)	130–210

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (12)	350 (14)	350 (14)	350 (14)
Deposition rate				

kg weld metal/h	1.0	1.5	2.0	2.8
lb weld metal/h)	2.2	3.3	4.4	6.2
Effective value				
kg weld metal/kg electrodes	0.62	0.63	0.68	0.64
lb weld metal/lb electrodes	0.62	0.63	0.68	0.64
Change value				
Electrodes/kg weld metal	91	45	31	15
Electrodes/lb weld metal	41	21	14	5
Burn-off time per electrode at max current, s	33	45	55	75
Weight/1000 pcs, kg (lb)	14 (30)	30.4 (67)	45 (100)	65 (143)

SANDVIK 25.10.4.LR
COVERED ELECTRODES

DATASHEET

Sandvik 25.10.4.LR (2594-16) is a covered electrode with rutile-basic coating and about 105% metal recovery used for welding of super-duplex (austenitic-ferritic) stainless steels of UNS S32750/S32760 type (e.g. Sandvik SAF 2507 and Zeron* 100).

The weld metal has especially good properties under severely corrosive conditions. Examples of properties are:

– Excellent stress corrosion cracking resistance in chloride-containing media
– Excellent pitting resistance
– High resistance to general corrosion
– High resistance to erosion corrosion and corrosion fatigue

Spray transfer gives a bead with a finely rippled surface. There is little spatter and very good slag removal. The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing.

* Zeron is a trademark owned by Rolled Alloys

Product Standards

– ISO 3581 E 25 9 4 N L R
– ASME/AWS SFA-5.4: E2594-16

Product Approvals

– AWS
– ASME
– CWB
– DNV
– TÜV

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo	N
0.03	0.5	0.7	25.0	9.5	4.0	0.25

APPLICATIONS

For welding:

Datasheet updated 1/8/2016 9:53:04 AM (supersedes all previous editions)

- High alloy austenitic-ferritic stainless steels such as Sandvik SAF 2507, UNS S32750 (wrought) and UNS J93404 (cast) and other super-duplex steels
- 25% chromium duplex stainless steels with PRE values between 37 and 40
- Dissimiliar joints between duplex and carbon and low-alloy steels
- Sandvik SAF 2205 and corresponding duplex steels where the highest corrosion resistance is required

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 25.10.4.LR (2594-16) is austenitic-ferritic (duplex) with a ferrite content of approximately 40 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-40 (-40)
Yield strength, $R_{p0.2}$	MPa (ksi)	640 (93)	
Tensile strength, R_m	MPa (ksi)	840 (122)	
Elongation, A	%	25	
Hardness	HV10	298	
Impact strength (KV)	J (ft lb)	50 (37)	35 (26)

CORROSION RESISTANCE

The minimum CPT value (Critical Pitting Temperature) in 6% ferric chloride solution is 40°C (105°F).

FABRICATION

Welding data

Welding positions	Diameter <2.50 mm (~3/32 in.)	All except vertical down
	Diameter >3.25 mm (~1/8 in.)	All except vertical down and overhead
Current/polarity	Direct current/electrode positive or alternating current at an open circuit voltage of at least 60V	
Diameter, mm (in.)		Current, A
2.50 (~3/32)		55-85
3.25 (~1/8)		70-110
4.00 (~5/32)		110-150

Redrying electrodes when necessary: 300°C (570°F)/2h

Thermal data

Interpass temperature: 150°C (300°F). A lower interpass temperature may be recommended when welding heavy structures.

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Heat input: 0,2 kJ/mm - 1,5 kJ/mm (5-38 kJ/in.)

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)
Deposition rate			
kg weld metal/h (approx.)	1	1.5	2.0
lb weld metal/h (approx.)	2.2	3.3	4.4
Effective value			
kg weld metal/kg electrodes	0.62	0.64	0.65
lb weld metal/lb electrodes	0.62	0.64	0.65
Change value			
Electrodes/kg weld metal	91	45	31
Electrodes/ lb weld metal	41	21	14
Burn-off time per electrode at max current, s	33	45	55
Weight/1000 pcs, kg (lb)	18 (39)	35 (77)	53 (117)

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SANDVIK 25.10.4.LB COVERED ELECTRODES

DATASHEET

Sandvik 25.10.4.LB (2594-15) is a high alloyed chromium-nickel-molybdenum-nitrogen covered electrode with basic coating for welding of 25%Cr- and superduplex stainless steels (e.g. Sandvik SAF 2507 and Zeron 100).

The basic type of electrode combines good welding properties in all positions with high impact strength at low temperatures. The weld metal is characterized by high strength and very good corrosion resistance. Examples are:

- Excellent stress corrosion cracking resistance
- Excellent pitting resistance in chloride-containing media
- High resistance to general corrosion
- High resistance to erosion corrosion and corrosion fatigue

Product Standards

- AWS A5.4 E2594-15
- ISO 3581-A25 9 4 N L B

Product Approvals

- TÜV
- DNV

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N	PRE*
0.03	0.6	0.8	≤0.03	≤0.025	25.0	10.0	4.0	0.25	≥42.0

* PRE = % Cr + 3.3 x % Mo + 16 x % N

APPLICATIONS

Sandvik 25.10.4.LB 2594-15 is used for welding of super duplex stainless steels in service temperatures up to 280°C (536°F), where good impact strength at temperatures down to -50°C is required.

ISO	1.4410. 1.4501. 1.4507.
ASTM UNS	S32750. S32760. S31260. S32550

Sandvik 25.10.4.LB 2594-15 can also be used as overmatching consumable for 21-23%Cr duplex stainless

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steels.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14

The electrodes are delivered in hermetically sealed metallic cans.

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 25.10.4.LB (2594-15) is ferritic-austenitic with a ferrite content of approximately 45 FN according to WRC-92.

MECHANICAL PROPERTIES

The following data are valid for as welded all-weld metal.

Temperature,	°C (°F)	20 (68)	-50 (-58)
Proof strength, $R_{p0.2}$	MPa (ksi)	765 (110)	
Tensile strength, R_m	MPa (ksi)	913 (132)	
Elongation, A	%	28	
Hardness	HV10	298	
Impact toughness (KV)	J (ft lbs)		40 (30)

CORROSION RESISTANCE

Intergranular corrosion

Strauss test, ASTM A262 Pr E	Resistant to intergranular corrosion

Pitting corrosion

Sandvik 25.10.4.LB (2594-15) meets the required pitting resistance of 40°C according to ASTM G48 A

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	50–80
3.25 (~1/8)	70–100
4.00 (~5/32)	100–150

Thermal data

Interpass temperature, °C (°F)	Max 150 (300)
Heat input	0.5-1.5 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Working data

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Welding positions	All positions
Current/polarity	DC+
Redrying of the electrodes when necessary	300°C (570°F)/2h

Electrode and deposition data

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)
Deposition rate			
kg weld metal/h (approx.)	≤1	≤1.4	≤2.0
lb weld metal/h (approx.)	≤2.2	≤3.1	≤4.4
Effective value			
kg weld metal/kg electrodes	0.71	0.71	0.73
lb weld metal/lb electrodes	0.71	0.71	0.73
Change value			
Electrodes/kg weld metal	79	41	26
Electrodes/ lb weld metal	36	19	12

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SANDVIK 25.22.2.LMNB
COVERED ELECTRODES

DATASHEET

Sandvik 25.22.2.LMnB is a chromium-nickel-molybdenum covered electrode with basic coating for welding of austenitic stainless steels for example, Sandvik 2RE69 and Sandvik 3R60 U.G used in the production of ammonium carbamate, nitric acid and inorganic acids. It is also used for surfacing on low alloyed steels.

The electrode combines good welding properties such as arc stability, low spatter and self peeling slag with very low impurity levels. Together with a high manganese content this fully austenitic weld metal is very resistant to hot cracking.

Product Standards

– AWS A5.4
– ISO 3581-A

Product Approvals

– TÜV

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.04	0.4	4.5	≤0.02	≤0.02	25.0	22.0	2.1	0.15

APPLICATIONS

Sandvik 25.22.2.LMn is used for welding of Sandvik 2RE69 and Sandvik 3R60 U.G. urea grade materials. But it can also be used for the following types:

ISO	1.4466, 1.4335, 1.4435, 1.4436, 1.4577, 1.4578, 1.4585
UNS	S31050, S31002, S31603, S31600

WELD METAL CHARACTERISTICS

The all-weld metal for Sandvik 25.22.2.LMnB is fully austenitic with a maximum ferrite content of 0.6%.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$[a]	MPa (ksi)	420 (61)
Tensile strength, R_m	MPa (ksi)	600 (87)
Elongation, A	%	30

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Temperature	°C (°F)	20 (68)
Impact strength, KV	J (ft lb)	70 (52)

[a] $R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE

General corrosion

0.73 mm/year (0.029 mils/year) in 40% H_2SO_4 at 25°C (75°F)
0.13 mm/year (0.005 mils/year) in 60% boiling H_3PO_4
0.30 mm/year (0.012 mils/year) in 99% HNO_3 at 60°C (140°F)

Intergranular corrosion

Huey test, ASTM A262 Pr C	<0.12 mm/year
Strauss test, ASTM A262 Pr E	Resistant

FABRICATION

Welding data

Diameter, mm (in.)	Current, A
2.50 (~3/32)	60–80
3.25 (~1/8)	80–110
4.00 (~5/32)	110–140
5.00 (~3/16)	160–190

Thermal data

Interpass Temperature	150ºC (300ºF)
Heat input	1.5 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (12)	350 (14)	350 (14)	350 (14)
Deposition rate				
kg weld metal/h		1.3	1.7	2.3
lb weld metal/h		2.9	3.7	5.1
Effective value				
kg weld metal/kg electrodes		0.59	0.64	0.53
lb weld metal/lb electrodes		0.59	0.64	0.53
Change value				
Electrodes/kg weld metal		53	31	15
Electrodes/lb weld metal		24	14	5
Burn-off time per electrode at max current, s		45	55	75
Weight/1000 pcs, kg (lb)	2.2 (4.8)	3.2 (7)	4.9 (10.8)	7.8 (17.1)

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Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

SANDVIK 27.31.4.LCuR-16
COVERED ELECTRODES

DATASHEET

Sandvik 27.31.4.LCuR-16 (383-16) is a covered electrode of AWS 383-16 type with rutile-basic coating and normal metal recovery for welding of high-alloy austenitic stainless steels of UNS S08028 (e.g. Sanicro 28) and Alloy 825 type (e.g. Sanicro 41).

Product Standards

- ISO 3581 E 27 31 4 Cu L R
- AWS, ASME, ISO 1600, TÜV

Product Approvals

- AWS
- ASME
- ISO 1600
- TÜV

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo	Cu
≤0.025	0.8	1.0	27.0	31.0	3.5	1.5

APPLICATIONS

Sandvik 27.31.4.LCuR-16 (383-16) is suitable for joining highly alloyed fully austenitic stainless steels, such as EN 1.4563 (Sanicro 28) and Alloy 825 (Sanicro 41), which have high corrosion resistance in sulfuric and phosphoric acids and excellent pitting resistance in acid solutions containing chlorides and fluorides, such as sea water.

This electrode can be used for surfacing mild and low alloy steels to give protection against pitting corrosion in chloride-containing solutions.

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14

WELD METAL CHARACTERISTICS

Fully austenitic.

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MECHANICAL PROPERTIES

Temperature,	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	350 (51)
Tensile strength, R_m	MPa (ksi)	550 (80)
Elongation, A	%	35
Hardness	HV10	160
Impact strength (KV)	J (ft lb)	90 (66)

CORROSION RESISTANCE

Typical corrosion rate in a solution of 70% H_3PO_4 + 4% H_2SO_4 + 0.45% Fe^{3+} + 60 ppm Cl^- + 0.4% F^- at 100°C (210°F) is 0.3 mm/year.

Intergranular corrosion

Resistant to intergranular corrosion in tests according to ASTM A262 Pr C, ASTM A262 Pr E.

FABRICATION

Welding data

Welding positions	Diameter <3.25 mm (~1/8 in.)	All except vertical down
	Diameter >3.25 mm (~1/8 in.)	Preferably flat position
Current/polarity	Direct current/electrode positive or alternating current at an open circuit voltage of at least 70V	
Diameter, mm (in.)		Current, A
2.50 (~3/32)		60-70
3.25 (~1/8)		90-110
4.00 (~5/32)		130-140

Redrying electrodes when necessary: 300°C (570°F)/2h

Thermal data

Interpass Temperature: 150°C (300°F).

Heat input: 1.0 kJ/mm (25 kJ/in.) max

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)
Deposition rate			
kg weld metal/h (approx.)	0.9	1.2	1.5
lb weld metal/h (approx.)	2.0	2.6	3.3
Effective value			
kg weld metal/kg electrodes	0.57	0.58	0.63
lb weld metal/lb electrodes	0.57	0.58	0.63
Change value,			

Electrodes/kg weld metal	82	50	33
Electrodes/lb weld metal	37	23	15
Burn-off time per electrode at max current, s	53	63	72
Weight/1000 pcs, kg (lb)	21 (46)	31 (68)	47 (103)

SANDVIK 29.9.R
COVERED ELECTRODES

DATASHEET

Sandvik 29.9.R (312-16) is a covered electrode with rutile-basic coating and about 110% metal recovery giving a duplex (ferritic-austenitic) all weld metal. It is used for welding of dissimilar materials, high carbon and manganese steels like tool steels as well as surfacing. Sandvik 29.9.R (312-16) is also used for overlays on hot forming steels and as a universal electrode for repair and maintenance work. The coating for this electrode is of the American rutile type with a faster freezing rate over -17 Type of the same weld deposit chemistry,

The electrode has excellent arc stability and fast burn off rate with minimal stub loss. It is also characterized by improved moisture resistance, self-peeling slag, high resistance to porosity and easy post weld finishing. Sandvik 29.9.R (312-16) gives smooth uniform beads and works in any standard weld position.

Scaling resistant up to 1150°C (2100°F). Spray transfer gives a bead with a finely rippled surface, little spatter and very good slag removal.

Product Standards

- ISO 1600 E 29 9 R
- AWS/ASME A5.4/SFA-5.4 E312-16

Product Approvals

- AWS
- ASME
- ISO 1600

Contact your nearest sales office for full details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni
0.1	0.8	1.5	28.5	10.0

APPLICATIONS

Sandvik 29.9.R (312-16) is maintenance and repair alloy used for welding of dissimiliar materials, high carbon and manganese steels as well as surfacing and is used for universal repair and maintenece work. Even with high dilution by austenitizers such as nickel and manganese, the weld metal remains highly resistant to cracking. To avoid embrittlement by formation of secondary phases, the service temperature should be limited to a maximum of 420 °C (800°F)

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.

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2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14

WELD METAL CHARACTERISTICS

The all weld metal for Sandvik 29.9.R (312-16) is austenitic with a ferrite content of 50 FN according to WRC-92.

MECHANICAL PROPERTIES

Temperature,	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$[a]	MPa (ksi)	600 (87)
Tensile strength, R_m	MPa (ksi)	720 (104)
Elongation, A	%	25
Hardness	HB	220
Impact toughness (KV)	J (ft lbs)	50 (37)

[a] $R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE

High oxidation resistance in air up to 1100°C (2012°F).

FABRICATION

Welding data

Welding positions	Diameter ≤3.25 mm (~1/8 in.)	All except vertical down
	Diameter ≥4.00 mm (~5/32 in.)	Preferably flat position
Current/polarity	DC+ or AC (50 V min open circuit voltage	

Diameter, mm (in.)	Current, A
2.50 (~3/32)	50–85
3.25 (~1/8)	80–125
4.00 (~5/32)	110–175

Thermal data

Interpass Temperature	150°C (300°F)
Heat input	As low as practical to limit distortion

PRODUCTIVITY DATA

Electrode diameter mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)
Deposition rate			
kg weld metal/h (approx.) lb weld metal/h (approx.)	≤0.9 ≤2.0	≤1.3 ≤2.9	≤2.0 ≤4.4

Effective value, kg weld metal/kg electrodes lb weld metal/lb electrodes	 0.62 0.62	 0.64 0.64	 0.65 0.65
Change value, Electrodes/kg weld metal Electrodes/ lb weld metal	 78 35	 48.5 22	 26 12
Burn-off time per electrode at max current, s	48	56	66
Weight/1000 pcs, kg (lb)	20 (44)	40 (88)	59 (130)

SANICRO 60
COVERED ELECTRODES

DATASHEET

Sanicro 60 is a nickel-chromium-molybdenum covered electrode for welding of Ni/Cr/Mo nickel alloys, high-alloy stainless steels and 5-9%Ni steels in cryogenic applications. It can used in many variants of dissimilar joining of nickel alloys, stainless steels and low alloyed steels. Sanicro 60 can also be used for overlay welding on low alloyed steels.

The electrode combines good welding properties in all positions with very low impurity levels, high impact strength and excellent corrosion resistance to pitting in chloride containing media and stress corrosion cracking.

Product Standards

- EN ISO 14172 E Ni Cr 22 Mo 9 Nb / Ni6625
- AWS A5.11 ENiCrMo-3

Contact your nearest sales office for details.

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	Nb	Fe
≤0.05	0.4	≤1.0	≤0.015	≤0.01	21.0	60.0	9.0	3.4	≤2.0

APPLICATIONS

Sanicro 60 is in components in the chemical and petrochemical industries and often in connection with sea-water cooling where pitting corrosion and stress corrosion cracking are a risk. Typical components are pressure vessels, heat exchangers etc. It is also used in sour gas service where it is approved by ISO 15156/NACE MR0175.

ISO	1.4547, 2.4856, 2.4858, 2.4660
ASTM UNS	S31254, N06625, N08825, N08020

FORMS OF SUPPLY

Diameter mm	Length mm	Diameter in.	Length in.
2.50	300	~3/32	~12
3.25	350	~1/8	~14
4.00	350	~5/32	~14
5.00	450	~3/16	~14

WELD METAL CHARACTERISTICS

Datasheet updated 2/18/2016 4:05:17 PM (supersedes all previous editions)

The following data is valid for non heat treated all-weld metal.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)	-196 (-321)
Proof strength, $R_{p0.2}$	MPa (ksi)	530 (77)	-
Tensile strength, R_m	MPa (ksi)	770 (112)	-
Elongation, A	%	30	-
Impact strength (KV)	J (ft lb)	65 (48)	45 (33)

CORROSION RESISTANCE

Resistant to intergranular corrosion according to ASTM G28 A. Highly resistant to pitting, crevice and stress corrosion cracking in chloride-bearing media.

FABRICATION

Welding data

Welding positions	Diameter ≤3.25 mm (~1/8 in.)	All except vertical down
	Diameter ≥4.00 mm (~5/32 in.)	Horizontal
Current/polarity	DC+	

Diameter, mm (in.)	Current, A
2.50 (~3/32)	50-60
3.25 (~1/8)	70–95
4.00 (~5/32)	90-120
5.00 (~3/16)	120-160

Thermal Data

Interpass temperature	≤100°C (212°F)
Heat input	≤1.5 kJ/mm
Post weld heat treatment	None

PRODUCTIVITY DATA

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	350 (~14)
Deposition rate				
kg weld metal/h (approx.)	≤0.9	≤1.4	≤2.2	≤2.4
lb weld metal/h (approx.)	≤2.0	≤3.1	≤4.9	≤5.3
Effective value				
kg weld metal/kg electrodes	0.66	0.69	0.67	0.72
lb weld metal/lb electrodes	0.66	0.69	0.67	0.72
Change value				
Electrodes/kg weld metal	103	49	30	15
Electrodes/ lb weld metal	47	22	14	7
Burn-off time per electrode at max current, s	41	52	71	99

AQUASAN NI50
COVERED ELECTRODES

DATASHEET

AquaSan Ni50 is a specially formulated, nickel based covered electrode with a waterproof coating for the welding of high strength steels with a Carbon Equivalent (CE) >0.4.

AquaSan Ni50 is specified for welding base materials with a CE >0.4, which are susceptible to hydrogen embrittlement. Nickel has a high affinity for hydrogen and this composition allows hydrogen to diffuse into the weld metal and away from the high strength steel.

STANDARDS

– AWS: A5.35 (pending initial publication).

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	Cr	Ni	Mo
≤0.08	0.3	2.4	12.0	64.0	6.5

APPLICATIONS

AquaSan Ni50 has been qualified for underwater welding of the following steel types to a maximum depth of 50 ft (15m):

Grades: HY 80, HY 100, 204B, A36, 300 series stainless steels

FORMS OF SUPPLY

Electrodes are packaged in 4.5kg (10 lb) unit plastic containers. 3 containers per carton. Each unit contains 5x 0.9kg (2lb) plastic bags.

WELD METAL CHARACTERISTICS

Microstructure

The all weld metal for AquaSan Ni50 has a fully Austenitic matrix.

MECHANICAL PROPERTIES

Temperature	°C (°F)	20 (68)
Proof strength, $R_{p0.2}$	MPa (ksi)	524 (76)
Tensile strength, R_m	MPa (ksi)	648 (101)
Elongation, A	%	14

FABRICATION

Welding data

Datasheet updated 1/25/2016 11:16:09 AM (supersedes all previous editions)

Welding positions	Diameter 2.4 mm (0.093 in.)	All
Current/polarity	DC/-	
Diameter, mm (in.)	2.4 mm (0.093)	
Current, A	90-110 (105 typical)	

Datasheet updated 1/25/2016 11:16:09 AM (supersedes all previous editions)

SANICRO 69
COVERED ELECTRODES

DATASHEET

Sanicro 69 is a covered electrode with basic coating for corrosion-resistant overlays on most low-alloy and stainless steels. It is also used for welding of alloys of Alloy 690 type (e.g. Sanicro 69) and dissimilar joints.

The electrode has good welding properties and is well suited to joint welding, as well as overlay welding.

STANDARDS

- AWS: ENiCrFe-7
- EN Number: Ni 6152

Product Standards

- EN ISO 14172
- AWS A5.11

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	Nb	Fe	Co	Cu
0.03	0.4	2.0	≤0.02	≤0.015	30.0	≥50.0	≤0.3	1.5	9.0	≤0.05	≤0.2

WELD METAL CHARACTERISTICS

The following data is valid for non heat treated all-weld metal.

MICROSTRUCTURE - ALL-WELD METAL

Fully austenitic

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature	°C	20[b]	360*
Proof strength, $R_{p0.2}$[a]	MPa	420	330
Tensile strength, R_m	MPa	650	520
Elongation, A	%	43	39
Impact strength, Charpy V	J	115	-

[a] $R_{p0.2}$ corresponds to 0.2% offset yield strength

[b] After post-weld heat treatment at 610°C for 16 hours.

CORROSION RESISTANCE - ALL-WELD METAL

Datasheet updated 1/8/2016 10:23:55 AM (supersedes all previous editions)

Resistant to intergranular stress corrosion cracking.

RECOMMENDED WELDING DATA

Diameter, mm	2.5	3.25	4.0
Current, A	50-70	70-100	105-145

Redrying electrodes when necessary: 250°C (480 °F)/2h

SANDVIK

SANICRO 71
COVERED ELECTRODES

DATASHEET

Sanicro 71 is a covered electrode with basic coating and normal metal recovery for welding of NiCrFe alloys, 9% Ni steels as well as nickel-alloyed steels for low temperature use. It is also used for dissimilar joints, such as stainless steel and NiCu alloys to carbon steel and nickel alloys. Sanicro 71 is characterized by little spatter and very good slag removal.

STANDARDS

– ISO: Ni Cr 15 Fe 6
– AWS: ENiCrFe-3

Product Standards

– EN ISO 14172
– ASME/AWS SFA5.11

Product Approvals

– TÜV

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	Nb	Fe	Cu
≤0.05	≤1.0	6.5	≤0.015	≤0.01	16.0	67.0	≤1.5	2.5	≤10.0	≤0.5

WELD METAL CHARACTERISTICS

The following data is valid for non heat treated all-weld metal.

Chemical composition, wt%

C	Si	Mn	P	S	Cr	Ni	Mo	Nb	Fe	Cu
≤0.05	≤1.0	6.5	≤0.015	≤0.010	16	67	≤1.5	2.5	≤10	≤0.5

MICROSTRUCTURE ALL-WELD METAL

Fully austenitic.

MECHANICAL PROPERTIES - ALL-WELD METAL

Temperature	°C	20	-196
Proof strength, $R_{p0.2}$[a]	MPa	>360	-
Tensile strength, R_m	MPa	>620	-
Elongation, A	%	>30	-

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Temperature	°C	20	-196
Impact strength, Charpy V	J	>60	>45

[a] $R_{p0.2}$ corresponds to 0.2% offset yield strength

CORROSION RESISTANCE - ALL-WELD METAL

Resistant to intergranular corrosion according to ASTM A262 practice E in the 'as-welded', stress relieved and solution annealed condition.

RECOMMENDED WELDING DATA

Diameter, mm	2.5	3.25	4.0	5.0
Current, A	45-60	70-95	90-120	120-150

Redrying electrodes when necessary: 200 °C (390 °F)/2h

DEPOSITION DATA

Electrode diameter, mm (in.)	2.50 (~3/32)	3.25 (~1/8)	4.00 (~5/32)	5.00 (~3/16)
Length, mm (in.)	300 (~12)	350 (~14)	350 (~14)	400 (~16)
Weights				
kg (lb)/100 pcs	1.7 (3.7)	2.9 (6.4)	5.0 (11)	8.7 (19.1)
kg (lb)/box	4.5 (9.9)	4.6 (10.1)	5.3 (11.7)	5.2 (2.4)
Electrodes/box	260	160	105	58
Effective value				
kg weld metal/kg electrodes	0.61	0.71	0.68	0.67
lb weld metal/lb electrodes	0.61	0.71	0.68	0.67
Change value				
Electrodes/kg weld metal	94	49	29	16
Electrodes/lb weld metal	43	23	13	7
Burn-off time per electrode at max current, s	46	59	76	101

Working data

Welding positions,	all except vertical down
Current/polarity	direct current/electrode positive.

THERMAL SPRAY WIRE

Thermal spray wire in a wide range of alloys for high-temperature corrosion protection, bonding layers, build-up coating and sealing.

OUR SPRAY WIRE ALLOYS

Grade	Type of alloy	Bond coating	Protective coating	Build-up coating
Kanthal SW 010	FeCrAl	✔	✔	-
Kanthal SW 030	FeCrAl	✔	✔	-
Kanthal SW 100	FeCrAlY	✔	✔	-
Kanthal SW 200	NiCr	-	✔	-
Kanthal SW 210	NiCrFe	-	✔	-
Kanthal SW 230	NiCrFe	-	✔	-
Kanthal SW 806	NiAl	✔	✔	✔
Kanthal SW 782	NiFe	-	-	✔
Kanthal SW 821	CuNi	-	✔ 1)	-

1) In particular in marine and chemical applications

FORMS OF SUPPLY

Standard sizes are 1.20, 1.60 and 2.00 mm (0.0472, 0.0693 and 0.0787 inch). Other sizes can be offered on request. The standard delivery form is tight wound on SD 300K spools.

TYPICAL APPLICATIONS

Kanthal thermal spraying wire is used in a variety of applications, such as:

- High-temperature oxidation protection used, for example, to resist gases in boiler atmospheres
- Coatings to resist heat and prevent scaling of conventional low alloy steels
- Bond coats for improving the adhesion of top coatings
- Coatings on moulds in the glass industry

SANDVIK SW 010
SPRAY WIRE

DATASHEET

Sandvik SW 010 (Kanthal A1) is a ferritic iron-chromium-aluminum alloy (FeCrAl alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings, resistant to high-temperature oxidation and corrosion.

APPLICATIONS

Typical applications for Sandvik SW 010 are bond coats in high-temperature coating systems, protective coatings in high-temperature atmospheres containing sulphur or carbon and protective coatings against scaling of conventional low alloy steels.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	62-78
Hardness HV (300g)	165-280
Surface roughness (μm)	11-16
Porosity (%)	1-6*
Oxides (%)	5-20*

*) These results are obtained when using air as spraying gas. Also nitrogen has been used, resulting in lower rates of porosity and oxides.

Chemical composition (nominal), %

	C %	Si %	Mn %	Cr %	Al %	Fe %
Min	-	-	-	20.5	5.3	Balance
Max	0.08	0.7	0.4	23.5	6.3	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	830 (120)
Tensile strength, R_m	MPa (ksi)	930 (135)
Elongation, A	%	5
Young's Modulus	GPa	220

Datasheet updated 10/10/2015 2:36:44 PM (supersedes all previous editions)

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	7.10
Electrical resistivity at 20°C Ω mm^2/m	1.45
Melting point, °C (°F)	1500 (2732)
Magnetic Properties	The material is magnetic up to approximately 600°C (1112°F), the Curie point.
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/10/2015 2:36:44 PM (supersedes all previous editions)

![SANDVIK]

SANDVIK SW 030
SPRAY WIRE

DATASHEET

Sandvik SW 030 (Kanthal D) is a ferritic iron-chromium-aluminum alloy (FeCrAl alloy) for use in arc and flame spray systems. The alloy produces dense, well bonded coatings, resistant to high-temperature oxidation and corrosion.

APPLICATIONS

Typical applications for Sandvik SW 030 are bond coats in high-temperature coating systems, protective coatings against sulphur-containing atmospheres and protective coatings against scaling of conventional low alloy steels.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	65-75
Hardness HV (300g)	160-270
Surface roughness (μm)	12-17
Porosity (%)	1-6*
Oxides (%)	5-15*

*) These results were obtained when using air as spraying gas. Also nitrogen has been used, resulting in lower rates of porosity and oxides.

Chemical composition (nominal), %

	C %	Si %	Mn %	Cr %	Al %	Fe %
Min	-	-	-	20.5	4.3	Balance
Max	0.08	0.7	0.5	23.5	5.2	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	720 (104)
Tensile strength, R_m	MPa (ksi)	840 (122)
Elongation, A	%	6
Young's Modulus	GPa	220

Datasheet updated 10/11/2015 1:03:48 PM (supersedes all previous editions)

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	7.25
Electrical resistivity at 20°C Ω mm^2/m	1.35
Melting point, °C (°F)	1500 (2732)
Magnetic Properties	The material is magnetic up to approximately 600°C (1112°F), the Curie point.
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/11/2015 1:03:48 PM (supersedes all previous editions)

SANDVIK SW 100
SPRAY WIRE

DATASHEET

Sandvik SW 100 (Kanthal AF) is a ferritic iron-chromium-aluminum alloy with the addition of Yttrium (FeCrAlY alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings, resistant to high-temperature oxidation and corrosion.

APPLICATIONS

Typical applications for Sandvik SW 100 are bond coats in high-temperature coating systems, protective coatings against sulphur or carbon containing atmospheres and protective coatings against scaling of conventional low alloy steels. The trace elements added in this alloy improve the coating protective properties.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	70-80
Hardness HV (300g)	170-200
Surface roughness (μm)	8-18
Porosity (%)	1-6*
Oxides (%)	3-14*

*) These results were obtained when using air as spraying gas. Also nitrogen has been used, resulting in lower rates of porosity and oxides.

Chemical composition (nominal), %

	C %	Si %	Mn %	Cr %	Al %	Trace Elements	Fe %
Min	-	-	-	20.5	4.7	-	Balance
Max	0.08	0.7	0.4	23.5	5.7	-	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	800 (116)
Tensile strength, R_m	MPa (ksi)	880 (128)
Elongation, A	%	5
Young's Modulus	GPa	220

Datasheet updated 10/11/2015 3:39:05 AM (supersedes all previous editions)

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	7.15
Electrical resistivity at 20°C $\Omega\ mm^2/m$	1.39
Melting point, °C (°F)	1500 (2732)
Magnetic Properties	The material is magnetic up to approximately 600°C (1112°F), the Curie point.
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/11/2015 3:39:05 AM (supersedes all previous editions)

SANDVIK SW 200
SPRAY WIRE

DATASHEET

Sandvik SW 200 (Nikrothal 80) is an austenitic nickel-chromium alloy (NiCr alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings resistant to high-temperature oxidation and corrosion.

APPLICATIONS

Typical applications for Sandvik SW 200 are protective coatings against corrosive gases, protection against scaling of conventional low alloy steels and build-up coatings for dimensional restoration.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	65-75
Hardness HV (300g)	170-280
Surface roughness (μm)	5-15
Porosity (%)	2-5
Oxides (%)	8-30

Chemical composition (nominal), %

	C %	Si %	Mn %	Cr %	Fe %	Ni %
Min	-	1.0	-	19.0	-	Balance
Max	0.10	1.7	1.0	21.0	2.0	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	950 (138)
Tensile strength, R_m	MPa (ksi)	1030 (149)
Elongation, A	%	6

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended.

Datasheet updated 10/10/2015 1:25:26 PM (supersedes all previous editions)

Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	8.30
Electrical resistivity at 20°C Ω mm^2/m	1.09
Melting point, °C (°F)	1400 (2552)
Magnetic Properties	Non-magnetic
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/10/2015 1:25:26 PM (supersedes all previous editions)

SANDVIK SW 210
SPRAY WIRE

DATASHEET

Sandvik SW 210 (Nikrothal 60) is an austenitic nickel-iron-chromium alloy (NiFeCr alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings resistant to high-temperature oxidation and corrosion.

APPLICATIONS

Typical applications for Sandvik SW 210 are protective coatings against corrosive gases, protection against scaling of conventional low alloy steels and build up coatings for dimensional restoration.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	60-70
Hardness HV (300g)	160-230
Surface roughness (µm)	10-15
Porosity (%)	2-5
Oxides (%)	10-23

Chemical composition (nominal), %

	C %	Si %	Mn %	Cr %	Ni %	Fe %
Min	-	1.0	-	14.0	57	Balance
Max	0.10	1.7	1.0	18.0	60	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	830 (120)
Tensile strength, R_m	MPa (ksi)	930 (135)
Elongation, A	%	5

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended.

Datasheet updated 10/12/2015 2:55:04 PM (supersedes all previous editions)

Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	8.20
Electrical resistivity at 20°C Ω mm^2/m	1.11
Melting point, °C (°F)	1390 (2534)
Magnetic Properties	Slightly magnetic
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/12/2015 2:55:04 PM (supersedes all previous editions)

SANDVIK SW 230
SPRAY WIRE

DATASHEET

Sandvik SW 230 (Nikrothal 40) is an austenitic iron-nickel-chromium alloy (FeNiCr alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings resistant to high-temperature oxidation.

APPLICATIONS

Typical applications for Sandvik SW 230 are protective coatings against corrosive gases, protection against scaling of conventional low alloy steels and build-up coatings for dimensional restoration.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	60-70
Hardness HV (300g)	160-240
Surface roughness (µm)	10-15
Porosity (%)	2-5
Oxides (%)	10-20

Chemical composition (nominal), %

	C %	Si %	Mn %	Cr %	Ni %	Fe %
Min	-	1.6	-	18.0	34	Balance
Max	0.10	2.5	1.0	21.0	37	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	860 (125)
Tensile strength, R_m	MPa (ksi)	950 (138)
Elongation, A	%	6

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

Datasheet updated 10/10/2015 1:25:18 PM (supersedes all previous editions)

PHYSICAL PROPERTIES

Density g/cm^3	7.90
Electrical resistivity at 20°C Ω mm^2/m	1.04
Melting point, °C (°F)	1390 (2534)
Magnetic Properties	Non-magnetic
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/10/2015 1:25:18 PM (supersedes all previous editions)

SANDVIK SW 782
SPRAY WIRE

DATASHEET

Sandvik SW 782 is an austenitic iron-nickel alloy (FeNi alloy) alloy for use in arc and flame spray systems. The alloy has low resistivity and a high-temperature coefficient of resistance.

APPLICATIONS

Typical applications for Sandvik SW 782 are mold coatings in the glass industry or build-up coatings for dimensional restoration.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	65-78
Hardness HV (300g)	130-215
Surface roughness (µm)	7-13
Porosity (%)	1-5
Oxides (%)	15-22

Chemical composition (nominal), %

Ni %	Fe %
52.0	Bal.

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	670 (97)
Tensile strength, R_m	MPa (ksi)	730 (106)
Elongation, A	%	7

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

Datasheet updated 10/10/2015 1:25:12 PM (supersedes all previous editions)

PHYSICAL PROPERTIES

Density g/cm³	8.20
Electrical resistivity at 20°C Ω mm²/m	0.37
Melting point, °C (°F)	1435 (2615)
Magnetic Properties	Magnetic up to approx. 530°C (986°F), the Curie point
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/10/2015 1:25:12 PM (supersedes all previous editions)

SANDVIK SW 806
SPRAY WIRE

DATASHEET

Sandvik SW 806 is an austenitic nickel-aluminium alloy (NiAl 95-5 alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings.

APPLICATIONS

Typical applications for Sandvik SW 806 are bond coats, as protective coatings against high-temperature oxidation, protective coatings against scaling of conventional iron base alloys and as build-up coatings for dimensional restoration.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Summary of results obtained when spraying with a conventional arc spray gun, using varying spraying parameters.

Deposition Efficiency (%)	60-70
Hardness HV (300g)	180-250
Surface roughness (μm)	15-28
Porosity (%)	3-7*
Oxides (%)	10-25*

*) These results are obtained when using air as spraying gas. Also nitrogen has been used, resulting in lower rates of porosity and oxides.

Chemical composition (nominal), %

Al %	Ni %
≥4.5	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	780 (113)
Tensile strength, R_m	MPa (ksi)	850 (123)
Elongation, A	%	7

FABRICATION

Machining

Datasheet updated 10/11/2015 1:01:42 PM (supersedes all previous editions)

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	8.20
Electrical resistivity at 20°C Ω mm^2/m	0.42
Melting point, °C (°F)	1430 (2606)
Magnetic Properties	Non-magnetic
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/11/2015 1:01:42 PM (supersedes all previous editions)

SANDVIK SW 821
SPRAY WIRE

DATASHEET

Sandvik SW 821 is an austenitic copper-nickel alloy (CuNi alloy) for use in arc and flame spray systems. The alloy produces dense, well bonding coatings which are resistant to corrosion.

APPLICATIONS

Sandvik SW 821 is typically used in marine applications and in certain chemical applications.

FORMS OF SUPPLY

Contact your local Sandvik office for information on forms of supply.

TYPICAL COATING PROPERTIES

Properly sprayed the wire produces dense, well bonding coatings for oxidation and corrosion protection.

Chemical composition (nominal), %

	Si	Mn	Fe	Ni	Cu
Min	-	-	-	63	Balance
Max	0.5	1.25	2.50	-	Balance

MECHANICAL PROPERTIES

Wire Diameter 1.6 mm (0.063 in.) at 20°C (68°F)

Yield strength, $R_{p0.2}$	MPa (ksi)	577 (84)
Tensile strength, R_m	MPa (ksi)	626 (91)
Elongation, A	%	8
Young's modulus	GPa	178

FABRICATION

Machining

Depending on the surface finish requirements, the coating may be machined by turning or grinding. For rougher surfaces, turning using carbide tools, light cuts and efficient cooling to avoid overheating is recommended. Grinding in fine steps using cooling, light pressure and clean wheels gives a smoother finish.

PHYSICAL PROPERTIES

Density g/cm^3	8.8
Melting point, °C (°F)	1350 (2462)
Magnetic Properties	The material is slightly magnetic at room temperature
Dimension tolerance mm (in.)	+ 0/-0.05 (0.002)

Datasheet updated 10/12/2015 2:06:47 PM (supersedes all previous editions)

SAFETY

Personnel working with thermal spraying should be aware of the hazards connected to the process. They should be familiar with the use of equipment regarding, i.e. eyes, skin, hearing and respiratory protection.

Personnel should be familiar with safety regulations regarding the complete process, including spraying and the spray equipment used. This product contains elements, which in certain combinations may be dangerous for your health. Safety Information Sheets are provided by Sandvik for this product, and should be read and understood before using the material.

Not following these instructions may endanger your health.

Datasheet updated 10/12/2015 2:06:47 PM (supersedes all previous editions)

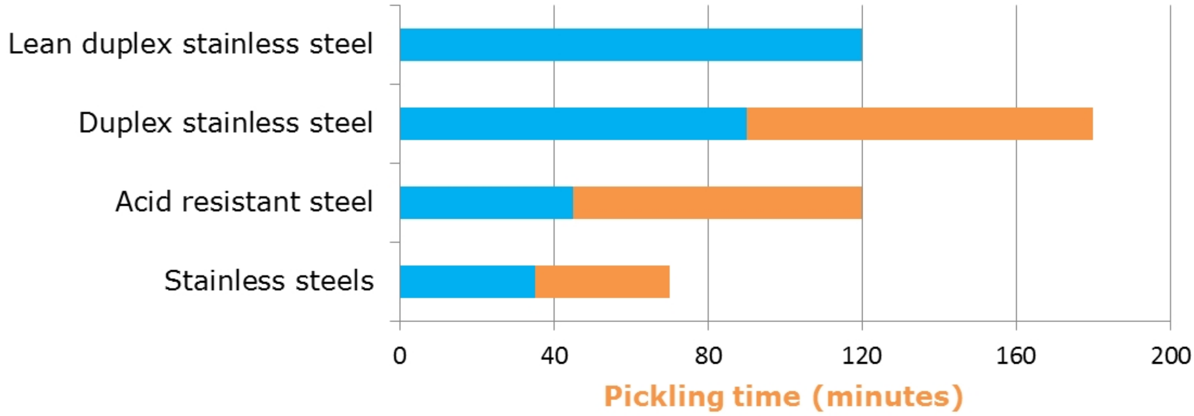
SANDVIK FORMULA 1
WELD FINISHING

DATASHEET

Sandvik Formula 1 is an effective multipurpose pickling paste used for post-weld treatment of stainless steel welds. Stainless steels are pickled in order to refurbish the welds surface finish by removing welding oxide, heat tint or scale, formed during fabrication. Sandvik Formula 1 effectively removes these oxides and the chromium depleted area that will reduce the corrosion resistance of the stainless steel surface.

Sandvik Forumla 1 is rapid and economical to use, as only a thin film of the pickling paste is required for a perfect result. The pickling paste has excellent adhesion and can be applied on vertical surfaces and ceilings without any risk of running or drying.

APPLICATIONS



FORMS OF SUPPLY

Sandvik Formula 1 is supplied in a 1 kg or 2 kg polyethylene container supplied in a 4-pack fiberboard box, including 4 pickling brushes.

STORAGE

Sandvik Formula 1 should be stored indoors at room temperature. The packages should be kept upright and closed and stored with no access for unauthorized personnel.
The shelf life of unopened pickling paste is 3 years. The shelf life of an opened package is 1 year, on condition that the package is carefully closed after use.

INSTRUCTIONS FOR USE

1. Remove as much slag, oxide and weld defects as possible. A stainless steel wire brush is recommended. If necessary, wash off dirt, oil, grease and paint which could impede the pickling process
2. Working temperature between +5 to +40°C (+41 to +104°F)
3. Shake Sandvik Formula 1 pickling paste well before use
4. Apply a relatively thick layer of paste with the accompanying brush. Longer pickling times apply for higher alloy steels.

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5. Remove the pickling paste (pickling residue must be neutralised to pH 7 (Sandvik Neutralisation paste). Carefully brush underlying oxides away with a damp stainless steel wire brush
6. Flush with a generous amount of water. No pickling paste or pickling paste residue must be left after flushing
7. Leave the pickled structure to air dry, to allow the passivated layer to be re-formed on the welded (pickled) areas

Local regulations apply to the use of flushing water. The flushing water contains acid remnants and heavy metals

PHYSICAL PROPERTIES

Form	Viscous, colorless, gel-like solution
Density	1.30 kg/l
Consumption	1 kg (2.2 lbs) of pickling paste is enough for approximately 120 m (393 ft) of weld bead or a surface of approximately 6 m^2 (64.58 ft^2)

SANDVIK FORMULA GREEN

WELD FINISHING

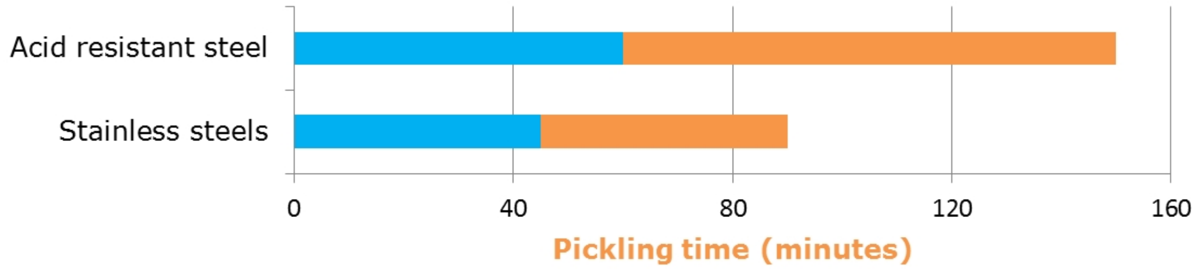
DATASHEET

Sandvik Formula Green is an effective multipurpose pickling paste, virtually free from formation of toxic nitric gases, used for post-weld treatment of stainless steel welds. Stainless steels are pickled in order to refurbish the weld's surface finish by removing welding oxide, heat tint or scale formed during fabrication.

Compared with conventional pickling pastes, Sandvik Formula Green gives 85% less discharge of dangerous nitrate and nitrite ions to waste water. This pickling paste releases 80–85% less toxic, nitric fumes during the pickling process and is therefore more operator friendly than other pickling pastes that generate fairly evil-smelling nitrous compounds.

Sandvik Forumla Green is rapid and economical to use, as only a thin film of the pickling paste is required for a perfect result. The pickling paste has excellent adhesion and can be applied on vertical surfaces and ceilings without any risk of running or drying.

APPLICATIONS



FORMS OF SUPPLY

Sandvik Formula Green is supplied in a 1 kg or 2 kg polyethylene container supplied in a 4-pack fiberboard box, including 4 pickling brushes.

STORAGE

Sandvik Formula Green should be stored indoors at room temperature. The packages should be kept upright and closed and stored with no access for unauthorized personnel.
The shelf life of unopened pickling paste is 3 years. The shelf life of an opened package is 1 year, on condition that the package is carefully closed after use.

INSTRUCTIONS FOR USE

1. Remove as much slag, oxide and weld defects as possible. A stainless steel wire brush is recommended. If necessary, wash off dirt, oil, grease and paint which could impede the pickling process
2. Working temperature between +5 to +40°C (+41 to +104°F)
3. Shake Sandvik Formula Green pickling paste well before use
4. Apply a relatively thick layer of paste with the accompanying brush. Longer pickling times apply for higher alloy steels.

Datasheet updated 9/18/2015 6:19:03 AM (supersedes all previous editions)

5. Remove the pickling paste (pickling residue must be neutralised to pH 7 (Sandvik Neutralisation paste). Carefully brush underlying oxides away with a damp stainless steel wire brush
6. Flush with a generous amount of water. No pickling paste or pickling paste residue must be left after flushing
7. Leave the pickled structure to air dry, to allow the passivated layer to be re-formed on the welded (pickled) areas

Local regulations apply to the use of flushing water. The flushing water contains acid remnants and heavy metals

PHYSICAL PROPERTIES

Form	Viscous, green, gel-like solution with weak odour
Density	1.30 kg/l
Consumption	1 kg (2.2 lbs) of pickling paste is enough for approximately 120 m (393 ft) of weld bead or a surface of approximately 6 m^2 (64.58 ft^2)

SANDVIK ROOT FLUX
WELD FINISHING

DATASHEET

Sandvik Root Flux is applied to the root side before welding and protects against oxidation, which occurs during welding. The root flux has been specially developed for use with GTAW welding of low-alloy and stainless steel with a maximum 25% nickel content but is also suitable for other welding methods.

APPLICATIONS

Sandvik Root Flux is used for root protection when joining tubes and pipes where it is impractical to use a shielding gas, tape or ceramic backing. The use of root flux reduces the risk of porosity, surface oxides and burn-through and the welding speed can also be increased. However, it should not be seen as a substitute for protective gas, but is instead used where protective gases cannot be used. Sandvik Root Flux provides a much better weld than where no root protector is used, but does not achieve quite the same corrosion resistance properties as an argon-protected weld.

FORMS OF SUPPLY

Sandvik Root Flux is supplied in 0.5 kg polyethylene containers supplied in a 4-pack fiberboard box.

STORAGE

Sandvik Root Fl should be stored indoors at room temperature. The packages should be kept upright and closed and stored with no access for unauthorized personnel. The shelf life of unopened pickling paste is 3 years. The shelf life of an opened package is 1 year, on condition that the package is carefully closed after use.

CORROSION RESISTANCE

Testing (ASTM G48) revealed the following technical data:

– Loss of weight with argon-protection = 100% (100% = the loss of weight which occurs with argon protection)
– Loss of weight with Sandvik Root Flux = 180%
– Loss of weight without weld-protection = 318%

INSTRUCTIONS FOR USE

Sandvik Root Flux is brushed on to the root side, about 20 mm (0.787 in.) on each side of the joint. During welding the paste reacts with the heat of welding, forming a thin protective slag.

The slag will be washed away by the process medium when the pipe is taken into service.

PHYSICAL PROPERTIES

Form	Powder form, mixed with denatured ethanol before welding
Consumption	1 kg (2.2 lbs), sufficient for about 100 m (328 ft) of root weld

Datasheet updated 10/2/2015 8:05:31 AM (supersedes all previous editions)

Disclaimer: Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.

Datasheet updated 10/2/2015 8:05:31 AM (supersedes all previous editions)

SANDVIK NEUTRALIZATION PASTE
WELD FINISHING

DATASHEET

Sandvik Neutralization Paste is used on steel and nickel alloy surfaces to neutralize and inhibit pickling paste after use. It has excellent adhesion and can be applied on vertical surfaces and ceilings without any risk of running or drying.

After treatment, the pickling acid residue has a pH value of >8 and the poisonous hydrofluoric acid is chemically converted into harmless fluorspar (CaF_2). The neutralisation paste is mildly alkaline and does not have any poisonous constituents.

APPLICATIONS

Apply Sandvik Neutralization Paste on pickling residues after pickling with Sandvik Formula 1 or Sandvik Formula Green.

FORMS OF SUPPLY

Sandvik Neutralization Paste is supplied in a 2.5 kg polyethylene container supplied in a 4-pack fiberboard box, including 4 pickling brushes.

STORAGE

Sandvik Neutralization Paste should be stored indoors at room temperature. The packages should be kept upright and closed and stored with no access for unauthorized personnel.
The shelf life of unopened pickling paste is 3 years. The shelf life of an opened package is 1 year, on condition that the package is carefully closed after use.

INSTRUCTIONS FOR USE

1. The paste is mixed in with the pickling paste using a brush when pickling has been completed, while the pickling paste is still in place on the structure
2. A reaction starts and mild blistering occurs. When blistering ceases the reaction has ceased and neutralization is complete
3. Flush with a generous amount of water. No pickling paste or pickling paste residue must be left after flushing
4. Leave the pickled structure to air dry, to allow the passivated layer to be re-formed on the welded (pickled) areas

Local regulations apply to the use of flushing water. The flushing water contains acid remnants and heavy metals.

PHYSICAL PROPERTIES

Form	Viscous, white, creamy
Consumption	Packages contain 2.5 kg. One package can neutralise 240 linear metres of pickled weld or 12 m^2 of pickled steel surface.

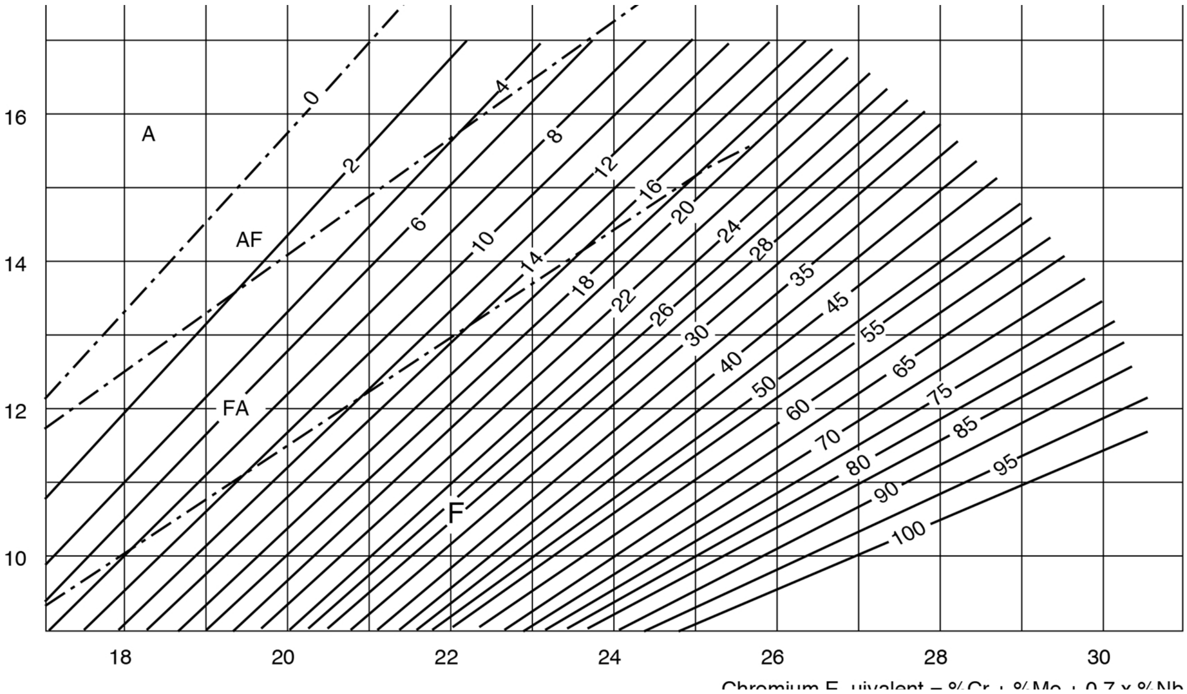
Datasheet updated 9/18/2015 5:25:35 AM (supersedes all previous editions)

FERRITE CONTENT DIAGRAMS

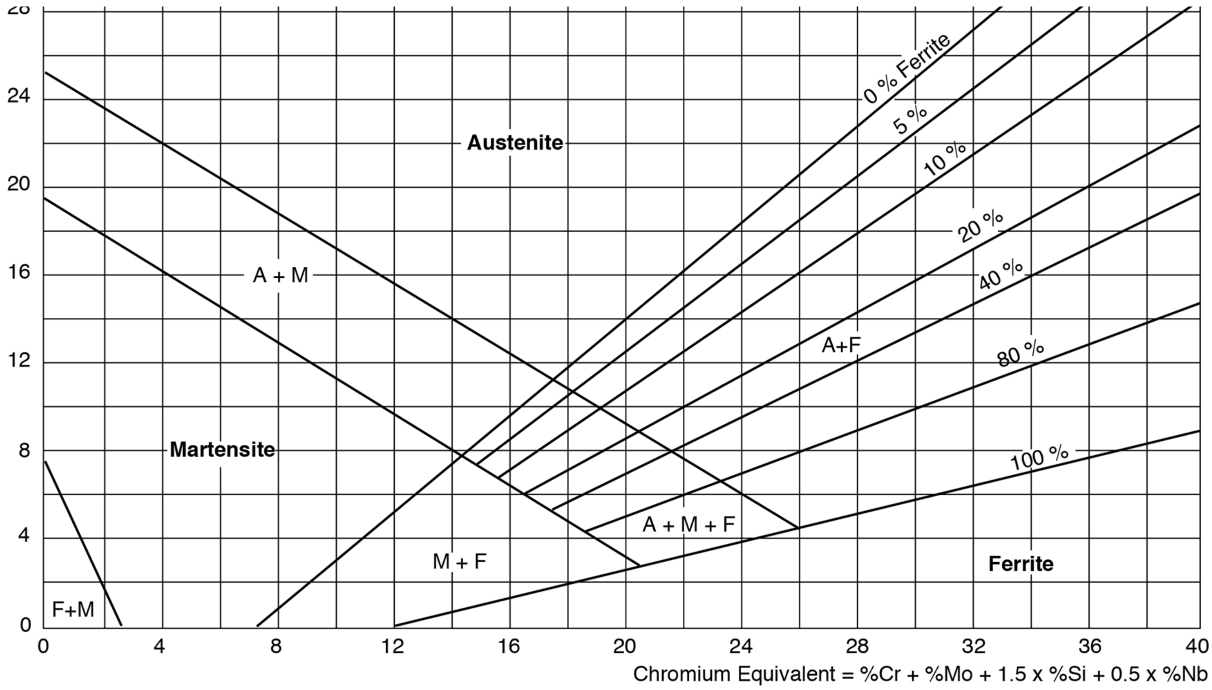
Ferrite content is important for avoiding hot cracking during welding of austenitic stainless steels. Ferrite is also an important constituent in duplex stainless steels. Ferrite diagrams, also referred to as Constitution diagrams, are used to predict ferrite levels from the composition of austenite and ferrite stabilizing elements. Today, the WRC-92 diagram is widely used for duplex and austenitic stainless steels. The Schaeffler and Delong diagrams are the original methods for predicting the phase balances in austenitic stainless steel welds.

A 'nickel equivalent' is calculated for the austenite stabilizing elements and a 'chromium equivalent' for the ferrite stabilizing elements. These are used as the axes for the diagrams. The nickel and chromium equivalent calculations are different for the three ferrite diagrams. The ferrite content in ferrite diagrams is based on thermodynamic stability and should therefore be seen as a guide, as differences to the actual ferrite in welds occur.

WRC-92



SCHAEFFLER


28
24
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4
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20
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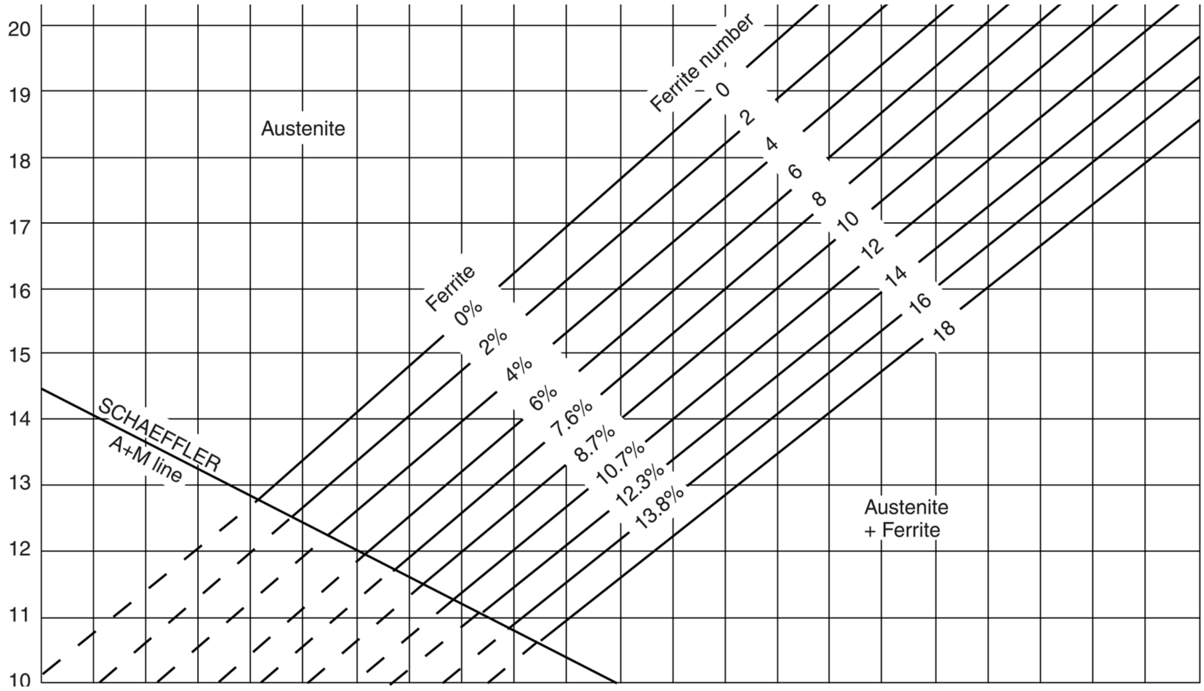
28
32
36
40
Chromium Equivalent = %Cr + %Mo + 1.5 x %Si + 0.5 x %Nb
Austenite
A + M
Martensite
F+M
M + F
A + M + F
A+F
Ferrite
0 % Ferrite
5 %
10 %
20 %
40 %
80 %
100 %

DELONG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17
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15
14
13
12
11
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Austenite
Ferrite number
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2
4
6
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12
14
16
18
Ferrite
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2%
4%
6%
7.6%
8.7%
10.7%
12.3%
13.8%
SCHAEFFLER
A+M line
Austenite
+ Ferrite

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