SCHWEISSEN & SCHNEIDEN 2005
LET’S TALK PRODUCTIVITY

NEW TANDEM-TWIN SAW
50% MORE OUTPUT

ALUMINIUM JOINS MARATHON PAC FAMILY

BORN-AGAIN ROBOTS
Focus on customer solutions

We are committed to helping customers increase their competitiveness through delivering improved productivity solutions. That is why we have chosen productivity as our central theme for this year’s Schweissen & Schneiden, the International Welding and Cutting Fair in Essen, Germany.

Being a truly global manufacturer and supplier, ESAB enjoys the unique ability to combine the benefits of international experience with the most extensive range of equipment and consumables available from a single source. At Essen, we’ll be demonstrating how we combine that product capability with global process development and applications experience to help you lower your costs and increase your profitability.

Profit from Productivity is ESAB’s theme for the fair. So, whether you are an ESAB customer through our network of distributors or a direct customer of one of our advanced automation systems, we are certain there will be plenty to interest you.

During the past year we have been celebrating 100 years of ESAB. This long tradition of technical excellence and service to customers continues to be at the heart of our operations worldwide. Today, that tradition is being continued with extensive new investments in systems and technologies to enhance the quality and efficiency of our services.

We hope you enjoy this edition of Svetsaren and we look forward to welcoming you to the ESAB stand in September.
Focus on customer solutions

Contents

06 Schweissen und Schneiden 2005.
ESAB shows how to profit from productivity.

09 Marathon Pac™.
Improved productivity and quality in MIG/MAG welding.

13 Plasma gouging.
Faster, cleaner, quieter.

14 ESAB welding solutions for windmill tower production.
Processes and equipment for increased productivity.

21 OK Flux 10.72 successful in windmill tower production.
Productivity and weldability united with low-temperature toughness.

25 Trouble-free MAG welding with OK AristoRod™.
Process stability, less maintenance, less post weld labour, lower welding costs.

28 Superior quality aluminium wire for the superior welding fabricator.
Now available in Marathon Pac.

31 A weld that lasts for 100,000 years.
Friction stir welding to seal canisters for nuclear waste.

34 Improved Tandem-MAG process.
New ESAB welding gun avoids limitations of traditional systems.

38 Coreshield 8.
Self-shielded cored wire crucial for construction of new quay in Hamburg.

40 The AristoMig robot package.
Easy to install – easy to use – new robots and retrofit.

43 AristoMIG 400/500 power sources.
Robust, intelligent and user-friendly.

49 Product news.
- EAGLE plasma cutting installation.
- E-Vent plasma cutting machine.
- MiggyTrac 1001
- MiggyTrac 3000
- High performance 300 A MIG/MAG power sources.
- Electric push-pull welding gun.
- New product names for aluminium MIG wires and TIG rods.
- New product names for stainless consumables
Welcome to the new style Svestaren - the ESAB Welding and Cutting Journal. As ESAB enters its second century we felt it appropriate to take a fresh look at this now well-established journal. So we set our designers the task to come up with a fresher, easier to read look that would offer greater clarity and flexibility in the way we present text, images and diagrams.

I hope you like the result. By making the format slightly wider than before, we can take advantage of a three column grid and also allow ourselves greater use of spacing to improve and modernize the overall look and feel of the journal.

Certainly Svestaren has come a long way since the first edition was published in 1936. In those days it was only available in Swedish and appeared more like a newsletter with very limited images. Now it is published as an international journal in English and distributed across the world earning a reputation as being one of the most authoritative journals available in the field of welding and cutting.

As editor, I hope to build on that proud past and to bring you articles and features that are both stimulating and satisfy your demand for information on the applications, processes and new equipments that are helping to drive productivity across our industry.

Svestaren remains an ideal forum for our engineers to share new developments, in this dynamic industry, with our end-user customers across the world. In doing so, I hope that this new styling together with the quality of articles it carries, will bring you even greater enjoyment from an old friend!
ESAB shows how to profit from productivity at Schweissen und Schneiden 2005

Everything on ESAB’s vast stand at the Schweissen und Schneiden Fair 2005 has been selected for its ability to demonstrate measurable productivity improvements, mostly through time and cost savings. Packed with welding and cutting equipment, consumables and accessories, the ESAB stand illustrates the extraordinarily broad product range available from the world’s leading supplier. Customers can purchase virtually everything they need for welding and cutting from this single source and, with such a wide range available, there is no need to compromise on performance, quality or price.

Figure 1. Graphic representation of Marathon Pac Plaza at ESAB’s stand at Schweissen und Schneiden 2005.

ESAB will take the opportunity provided by this year’s premier welding and cutting fair, being held in Essen, Germany, from the 12th to 17th September 2005, to demonstrate a wide range of welding and cutting product and process innovations.

Hall 1, Stand 202
One of the most impressive live demonstrations at the Fair is the submerged arc welding (SAW) of wind turbine tower sections. With ESAB’s Tandem-Twin SAW technology and unalloyed wires and fluxes, productivity in this application can be raised by up to 50 per cent as a result of the higher deposition rate and reduced joint volume. For this application, ESAB can supply everything required; in the demonstration, a CaB column-and-boom is equipped with an A6 Tandem Twin welding head served by TAF 1250 and LAF 1250 power sources, and the workpiece is supported on ESAB roller beds.

Elsewhere on the stand, an EAGLE high-speed plasma cutting machine will be used to show how increased output can be achieved thanks to features such as faster piercing, quicker cutting and rapid accelerations that minimise point-to-point traverse times. Moreover, when used in conjunction with ESAB’s Columbus programming system with advanced nesting, a further 7 per cent saving on raw materials is available.

For those interested in robotic welding, ESAB’s stand features three AristoMig robot packages. Robots from Motoman, Kuka and ABB are married to ESAB AristoMig 500 welding machines to show how such arrangements can be used for fabricating stainless steel and aluminium components.

Also shown with the robots, although equally applicable to other welding processes, are the Marathon Pac bulk packs of welding wire that can reduce the number of stoppages for wire changes by 90 per cent, thereby saving 10 hours in spool changing for every tonne of wire used. This increase in productivity is further enhanced by the remarkable process stability and quality improvements that can be delivered by this packaging technology. New additions to the Marathon Pac family include the Marathon Pac Endless System - which totally eliminates interruptions for wire changes - plus Marathon Pacs with 141 kg of aluminium wire, and smaller Marathon Pacs with 100 kg of stainless steel wire.

Three advanced welding wires will be featured for their ability to raise productivity. The new OK AristoRod bare MAG wires offer higher efficiency for robotic and mechanised welding processes. Advanced Surface Characteristics (ASC) on these wires lead to a lower maintenance requirement, higher deposition rates and an excellent weld finish that reduces the need for post-weld cleaning. ESAB’s latest Matt Stainless Steel MIG Wires offer class-leading feedability, plus consistently high and repeatable weld quality that reduces post-weld cleaning.

Highly innovative, ESAB’s OK 14.11 is a metal-cored welding wire specifically for robotic and mechanised applications. Productivity is enhanced through dependable feeding at high duty cycles, excellent start and stop characteristics, no porosity or spatter, and a flat weld with round penetration and smooth tie-in.

A significant area on the ESAB stand is devoted to products sold through distributors. These range from MIG, TIG and MMA welding equipment through to hand plasma cutting equipment and standard automation products. In addition, visitors to the show will see ESAB’s extensive range of consumables, as well as accessories such as Eye-Tech helmets and protective clothing.

ESAB’s distributors are truly a one-stop-shop, meeting all of a customer’s needs for welding and cutting products and support services - such as servicing and repairs - plus they provide a direct route to technical advice from ESAB’s own experts located around the world.
Marathon Pac™ for improved productivity and quality in MIG/MAG welding

Juha Lukkari, ESAB OY, Helsinki, Finland.

The Marathon Pac family of bulk drums now covers welding wires for non- and low-alloyed steel, stainless steel, aluminium and MIG brazing. The drums, charged with high quality consumables, provide fabricators with substantial savings on downtime for spool exchange and high process stability resulting in improved weld quality and less rejects. Marathon Pac is user-friendly, designed for easy handling and disposal.

The avoidance of downtime is crucial in any welding system, because it leads to substantial loss of efficiency and can be extremely costly - especially in mechanised and robotic applications.

In MIG/MAG welding, downtime is often caused by the need to stop the process to exchange wire spools, and by wire feeding irregularities that necessitate unplanned maintenance. The use of modern bulk packaging containing high volumes of high quality wires, reduces downtime to a minimum, improves process stability, and increases output and quality of the finished product.

Marathon Pac™ – a complete family
ESAB Marathon Pac is the most advanced bulk packaging system available to fabricators. The complete Marathon Pac family offers options containing 100 kg to 475 kg of non- and low-alloyed MAG-solid and cored wires, stainless MAG-solid and cored wires, aluminium MIG-wires and copper-based MIG-brazing wires.

The range of wires is of the highest quality available in the market and includes the recently introduced ESAB advanced wire products; OK AristoRod, matte stainless wires and the new generation of aluminium wires. These provide fabricators with unsurpassed welding properties bringing MIG/MAG productivity and quality to new levels. OK AristoRod and aluminium wires are described in separate articles elsewhere in this issue of Svetsaren.

The Marathon Pac family comprises four product options:
- Standard Marathon Pac
- Jumbo Marathon Pac
- Mini Marathon Pac
- Endless Marathon Pac

Mini Marathon Pac is the latest product. It provides fabricators with an option to reduce capital tied-up in stainless wires, while still benefitting from the advantages of the Marathon Pac system.

Table 1 gives an overview of wire grades and filling content for the various Marathon Pacs.

Enormous savings on downtime
Marathon Pac with 250 kg of solid wire contains the equivalent of fourteen 18 kg spools; the 475 kg option has the equivalent of twenty six 18 kg spools. It brings enormous savings on downtime for spool exchange, leading to increased total arc time and welding output.

The following example calculates the time saving for a company using robotic welding.

- Production time: 5 days, 3 shifts.
- Weight of used wire: 250 kg/week
- Number of spool changes
  - 18 kg spools: 14
  - 250 kg Marathon Pac: 1
- Time consumed for changing one spool: 10 min.
- Total time consumed for changing of spools:
  - 18 kg spools: 140 min (2.33 hours)
  - 250 kg Marathon Pac: 10 min (0.17 hours)

This gives over two hours more effective production time for the company, each week. With a 475 kg Marathon Pac, the company will gain over four hours of valuable production time.
Table 1: The Marathon Pac family – wire grades and filling content.

<table>
<thead>
<tr>
<th>W x H</th>
<th>Standard Marathon Pac</th>
<th>Jumbo Marathon Pac</th>
<th>Mini Marathon Pac</th>
<th>Endless Marathon Pac</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>513 x 830 mm</td>
<td>595 x 935 mm</td>
<td>513 x 500 mm</td>
<td>2 x standard or jumbo</td>
</tr>
<tr>
<td>Non- and low-alloyed MAG-solid wires</td>
<td>250 kg (1) (Ø 0.8 mm; 200 kg)</td>
<td>475 kg (min Ø 1.0 mm)</td>
<td>Not available</td>
<td>2 x 250 kg</td>
</tr>
<tr>
<td>Stainless MAG-solid wires</td>
<td>250 kg (1) (Ø 0.8 mm; 200 kg)</td>
<td>475 kg (min Ø 1.0 mm)</td>
<td>100 kg</td>
<td>2 x 250 kg</td>
</tr>
<tr>
<td>Aluminium MIG-wires</td>
<td>Not available</td>
<td>141 kg</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Copper-based MIG-brazing wires</td>
<td>200 kg</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
</tbody>
</table>

(1) Cored wires: depending on wire type.

Figure 1. The Marathon Pac family. From left to right: Marathon Pac, Jumbo Marathon Pac, Mini Marathon Pac, Endless Marathon Pac

In highly automated production, or in-line manufacturing, even one stop per drum is regarded as being too much. Endless Marathon Pac is an outstanding product development which provides the final step towards total efficiency – no stops at all for wire changing.

The principle is very simple. While the robot continues welding, a second drum is joined to the one in use with a special butt welding machine. The complete joining procedure takes only a few minutes and is easy to learn.

The joining machine is light, transportable and can be used for several robot stations. Endless Marathon Pac is ideal for multi-robot stations. No surprise, then, that the first users of Endless Marathon Pac were in the automotive industry!

**Increased process stability and higher weld quality**

The special coiling technique used in packing Marathon Pac drums ensures trouble-free, low-friction feeding of the wires over long distances, and straight delivery to the contact tip. Welds are always well positioned and perfectly straight. The unwind process from the drum is automatic, so no separate de-coiling equipment is needed and no forces are required to turn a traditional revolving spool. This low-force feeding results in reduced wear of wire feeders, especially when compared with steel jumbo coils.

Low-friction feeding in combination with ESAB’s advanced welding wires, brings unsurpassed process stability and weld finish. This results in more production output and less rejects.

**Efficient handling – easy recycling**

Cost savings, when compared with 18 kg spools, result not just from reduced downtime. Marathon Pacs are designed for efficient handling and recycling. They are supplied on Euro pallets containing four standard Marathon Pacs or two Jumbo Marathon Pacs. A pallet contains around 20% more wire than a pallet with spools, resulting in improved handling efficiency.

Another saving is achieved when unpacking. The plastic foil around the pallet is easily removed and the Marathon Pac is ready for use; 18 kg spools have to be unpacked box by box.

Installation of Marathon Pac is simple and fast. Standard and Mini versions have a re-usable lid with a quick fit connector in the centre to which the wire conduit is attached. The Jumbo version has a re-usable cone with a quick fit connector. Installation at the welding station takes only a few minutes.
They are lifted with a special certified yoke that fits into the straps attached to the drum. Alternatively, using the yoke, drums can be transported to the welding station by overhead gantry.

Installation of Marathon Pac is simple and fast. Standard and Mini versions have a re-usable lid with a quick fit connector in the centre to which the wire conduit is attached. The Jumbo version has a re-usable cone with a quick fit connector. Installation at the welding station takes only a few minutes.

Disposal of the empty drums is very simple. After removal of the straps, the octagonal double-skinned cardboard drums are folded flat for space saving storage and environmentally friendly recycling. What remains is 100% cardboard which will often collect a return fee when sold to a dedicated paper recycler.

When compared with steel jumbo coils, Marathon Pac is easier and safer to handle, the wire is protected against contamination, no de-coiling equipment is needed, and spool return logistics are eliminated.

**About the author:**

**Juha Lukkar** joined ESAB Oy in Finland in 1974, after graduating from the Helsinki University of Technology. He is currently head of the Technical Customer Service Department.

Marathon Pac - the benefits:
- Drastically reduced downtime for spool changing
- Trouble-free, low-force feeding over long distances
- Straight wire delivery at the contact tip provides consistent wire positioning for improves weld quality
- Less force on feed system gives lower wear
- Environmental packing
- Less wire wasted in replacing spools
- Reduced logistic costs and simplified handling

They are lifted with a special certified yoke that fits into the straps attached to the drum. Alternatively, using the yoke, drums can be transported to the welding station by overhead gantry.

Installation of Marathon Pac is simple and fast. Standard and Mini versions have a re-usable lid with a quick fit connector in the centre to which the wire conduit is attached. The Jumbo version has a re-usable cone with a quick fit connector. Installation at the welding station takes only a few minutes.

Disposal of the empty drums is very simple. After removal of the straps, the octagonal double-skinned cardboard drums are folded flat for space saving storage and environmentally friendly recycling. What remains is 100% cardboard which will often collect a return fee when sold to a dedicated paper recycler.

When compared with steel jumbo coils, Marathon Pac is easier and safer to handle, the wire is protected against contamination, no de-coiling equipment is needed, and spool return logistics are eliminated.

**About the author:**

**Juha Lukkar** joined ESAB Oy in Finland in 1974, after graduating from the Helsinki University of Technology. He is currently head of the Technical Customer Service Department.

Marathon Pac - the benefits:
- Drastically reduced downtime for spool changing
- Trouble-free, low-force feeding over long distances
- Straight wire delivery at the contact tip provides consistent wire positioning for improves weld quality
- Less force on feed system gives lower wear
- Environmental packing
- Less wire wasted in replacing spools
- Reduced logistic costs and simplified handling

They are lifted with a special certified yoke that fits into the straps attached to the drum. Alternatively, using the yoke, drums can be transported to the welding station by overhead gantry.

Installation of Marathon Pac is simple and fast. Standard and Mini versions have a re-usable lid with a quick fit connector in the centre to which the wire conduit is attached. The Jumbo version has a re-usable cone with a quick fit connector. Installation at the welding station takes only a few minutes.

Disposal of the empty drums is very simple. After removal of the straps, the octagonal double-skinned cardboard drums are folded flat for space saving storage and environmentally friendly recycling. What remains is 100% cardboard which will often collect a return fee when sold to a dedicated paper recycler.

When compared with steel jumbo coils, Marathon Pac is easier and safer to handle, the wire is protected against contamination, no de-coiling equipment is needed, and spool return logistics are eliminated.
Shorty before the last Essen Fair, in 2001, ESAB and the production departments of General Motors Europe, in Bochum, discussed process support for optimising several GME applications in terms of weld quality and productivity. After initial welding tests, triangular cross members of the front axle suspension system of the successful Opel Zafira were welded - on the ESAB stand during the Fair - using OK Tubrod 14.13 metal cored wire delivered from an ESAB Marathon Pac.

The performance of the Marathon Pac – both during the Fair and in follow-up factory tests – led GME to conduct a thorough investigation of all the welding wire spooling and packing systems currently available. The investigation was supervised by GME’s welding expert, Mr. Lambrecht who, with the help of a local University, set up a full test programme to examine the wire surface conditions, feeding behaviour, weld results, and total costs of each individual wire system.

Over several months, different systems - 300 kg drums, 250 kg spiders, carton bulk drums, and 250 kg and 475 kg Marathon Pacs - were tested under the tough conditions of a highly demanding three shift production. ESAB Marathon Pac’s overall performance, consistent quality and environmental friendliness, together with the process support from ESAB technicians, outperformed all of the other systems. Today, ESAB Marathon Pac is specified for use in all GME factories.

To keep a long story short
ESAB Marathon Pac is the leading system used in GME’s OPEL, VAUXHALL and SAAB production facilities. Depending on individual applications, ESAB Marathon Pacs deliver unalloyed wires such as OK Autrod 12.51 for welding applications; copper based wires such as OK Autrod 19.30 for MAG brazing; or OK Autrod 16.11 for high alloyed material.

Generally, the 250 kg Marathon Pac is used because most of the robot cells are not accessible to the bigger 475 kg Jumbo Pacs.
Plasma gouging: a faster, cleaner, and quieter alternative to carbon arc gouging

ESAB system tested for weld removal in windmill fabrication.

Alaaeldin Assal, ESAB Welding & Cutting, Florence, USA.

In today’s competitive production environment, fabricators constantly seek to improve their competitive edge through faster and lower-cost operations. In metal fabrication, one particularly time-consuming operation is carbon arc gouging for the removal of weld defects and weld metal before inspection. It is also widely applied in the manufacture of windmill towers. However, the carbon arc gouging process is known to generate high noise and fumes.

Today, plasma gouging is seen as an excellent alternative to carbon arc gouging - with many advantages. It produces substantially less fumes, is much quieter, requires less surface cleaning after gouging and it can be used for all electrically conductive materials. Above all, plasma gouging is much faster, offering a welcome boost to productivity.

Plasma gouging requires a specially designed plasma system that produces a much higher cutting/gouging arc voltage than a normal plasma system. This places high demands on the system components, especially the plasma power supply.

Recently, ESAB was asked by a windmill tower manufacturer in Portugal to demonstrate plasma gouging as an alternative gouging method in their factory. The demonstration used the ESAB ESP-150/PT-26 manual and mechanized plasma gouging system that is designed specifically for heavy duty cutting and gauging applications. The system, combining performance and reliability in one package, successfully demonstrated its ability in weld removal jobs; quickly and with less fumes and noise.

The well established ESP-150 system has proven performance and reliability in both cutting and gauging applications. Features include:

- Water cooled torches for tough cutting and gouging conditions.
- Built-in water cooler to simplify the installation process.
- Easy set-up and operation.

About the Author

Alaaeldin A. Assal is Export Business Manager for ESAB Welding & Cutting, Florence, USA. In Europe, he is stationed at ESAB Cutting GmbH, Karben, Germany.

For more information contact: aassal@esab.com
ESAB welding solutions for windmill tower production

Processes and equipment for increased productivity.

BJÖRN TORSTENSSON and PER IVARSON, ESAB AUTOMATION, LAXÅ, SWEDEN.

With the steadily increasing share of wind power in the world’s total energy consumption over the last decades, windmill fabrication has matured as an industrial sector. Having originated within industries such as offshore and pressure vessel fabrication, many fabricators have converted to fully-fledged producers of windmills, often operating internationally. Today, the windmill industry exists in an extremely competitive environment where fabricators are constantly forced to reconsider their production facilities in order to remain competitive. In welding, one of the most important elements of fabrication, increased productivity is the number one priority - along with meeting increased weld quality requirements.

ESAB closely follows the progress of the windmill industry, working with fabricators to find solutions for their welding demands. This co-operation has resulted in the most complete and productive range of welding equipment and consumables.

ESAB supplies complete and productive welding solutions for windmill fabrication to give manufacturers the competitive edge needed to remain ahead in one of the world’s most demanding branches of industry. Tandem-Twin SAW is ESAB’s latest high-productivity innovation - to be launched by ESAB during Schweissen & Schneiden 2005.

Tandem-Twin SAW at Sonderjyllands Maskinfabrik, Denmark.
available today - the new Tandem-Twin SAW system being the latest product.

This article discusses the new Tandem-Twin SAW system, along with column and boom installations, roller beads, head and tail stocks and tractors, including the new FrameTrac for the automatic welding of door frames. All this equipment will be presented on the ESAB stand at Schweissen & Schneiden 2005.

Another article in this issue of Svetsaren reviews a completely new flux/wire combination, developed to meet recent weld metal toughness demands at -50°C without sacrificing weldability or productivity.

The welding process – crucial link in the production chain

Welding is just one step in the long process from the iron ore mine to a ready installed wind turbine, but it is crucial to the planning and financial success of wind energy projects. In windmill fabrication, the amount of deposited weld metal is in the range 700 - 1500 kg per tower, while workpieces up to 100 tons have to be handled.

Successful welding in windmill fabrication depends on the right choice and efficient use of various categories of equipment. If any one has limitations in terms of capacity or efficiency, it will limit the output of the complete production chain:

- the welding process equipment and consumables.
- manipulators to accommodate the welding heads.
- The equipment to handle the work piece.

Of primary importance, however, is the technical knowledge and experience of engineers, production managers and welders to produce excellent welds at high productivity.

The welding design of windmill towers is pretty straightforward with long lengths of longitudinal and circumferential welds brought in the downhand position, with plate thicknesses up to 100mm. It is not surprising that submerged arc welding has been the prevailing joining process ever since this industry began - no alternative technique has so far gained ground in production. Innovation has mainly focussed on more productive variants of the process, along with consumables that could meet higher productivity and quality demands. The new weld metal toughness demand at -50°C is, in this respect, the most recent challenge placed on consumables development, coming along with the increasing development of offshore windmill parks.

The use of twin and tandem wire welding heads has brought a major productivity increase in the SAW of windmill towers, and these systems are nowadays well-established. However, in today’s competitive business environment, the windmill industry has to carry productivity far beyond these levels.
Table 1. Comparison of deposition rates for various SAW techniques.

<table>
<thead>
<tr>
<th>SAW process</th>
<th>Wire combination</th>
<th>Deposition rate at 100% duty cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single wire</td>
<td>1 x 4.0 mm</td>
<td>12 kg/h</td>
</tr>
<tr>
<td>Twin-wire</td>
<td>2 x 2.5 mm</td>
<td>15 kg/h</td>
</tr>
<tr>
<td>Tandem wire</td>
<td>2 x 4.0 mm</td>
<td>25 kg/h</td>
</tr>
<tr>
<td>Tandem-Twin</td>
<td>4 x 2.5 mm</td>
<td>38 kg/h</td>
</tr>
</tbody>
</table>

Table 2. Reduction of joint cross section by reduced opening angle.

<table>
<thead>
<tr>
<th>Plate thickness (mm)</th>
<th>Cross section Y- joint 60° 5mm land, no gap (mm²)</th>
<th>Cross section Y- joint 50° 5mm land, no gap (mm²)</th>
<th>Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>231</td>
<td>187</td>
<td>-19</td>
</tr>
<tr>
<td>35</td>
<td>520</td>
<td>420</td>
<td>-19</td>
</tr>
<tr>
<td>45</td>
<td>924</td>
<td>746</td>
<td>-19</td>
</tr>
</tbody>
</table>

Table 3. Arc time per meter weld for 35mm plate thickness at 100% duty cycle (theoretically; based on deposition rates used for filling passes).

**Y-60° (CONVENTIONAL OPENING ANGLE):**

Weight of the joint (kg/m) = Joint volume (mm²/1000mm/m) x overthicknes [20%] x specific weight (g/cm³)/1000²

= 520 x 1000 x 1.2 x 7.87 / 1000² = 4.91 kg/m

Tandem-Twin:

Arc time per m length = weight of joint (kg/m) / deposition rate (kg/h)

= 4.91 / 38 = 0.129 h/m.

Tandem welding (2 x 4.0 mm):

Arc time per m length = 4.91 / 25 = 0.196 h/m

**Y-50° (REDUCED OPENING ANGLE DUE TO SUPERIOR SLAG RELEASE OF OK FLUX 10.72):**

Weight of the joint (kg) = Joint volume (mm²/1000mm/m) x overthicknes [20%] x specific weight (g/cm³)/1000²

= 420 x 1000 x 1.2 x 7.87 / 1000² = 3.97 kg/m

Tandem-Twin:

Arc time per m length = weight of joint (kg/m) / deposition rate (kg/h)

= 3.97 / 38 = 0.104 h/m

Comparing a Y-60° joint welded with Tandem SAW with a Y-50° joint (-19% joint volume) welded with Tandem-Twin the following calculation applies:

Time saving (%) = (h/m₆₀°; Tandem - h/m₅₀°; Tandem Twin) / h/m₆₀°; Tandem

= (0.196 - 0.104) / 0.196 = 46.9 %

This implies that, by changing from Tandem welding (2 x 4.0 mm) and a joint preparation with an opening angle of 60°, to Tandem Twin with an opening angle of 50°, ARC TIME IS ALMOST HALVED.

ESAB has responded by developing the Tandem-Twin process – two twin heads placed in sequence - not only for windmill fabricators, but all industries that deal with the submerged arc welding of big cylindrical objects. The equipment has been tested on the current steel grades for windmill fabrication (see Svetsaren 1/2005 page 13), new consumables have been developed and have gained the necessary approvals, and welding procedures have been established. ESAB will render all application support needed to help fabricators implement this technique, aided by the facilities of the new Process Centre in Gothenburg. Tandem-Twin SAW is already successfully used in wind tower production at Sonderjyllands Maskinfabrik (cover photo) and DSSN, in Denmark.

Research and development at ESAB does not stop at Tandem-Twin welding however. Four-wire set-ups for windmill fabrication have been researched and tested.

**Tandem-Twin SAW – a major step forward**

The Tandem-Twin SAW technique brings welding productivity to new levels. It can be used for all welds with the accessibility to accommodate the equipment - most importantly the circumferential welds that make up the majority of weldments in windmill fabrication.

The development of the process coincided with the development of a new flux, OK Flux 10.72, that satisfies recent low-temperature toughness requirements, while using a non-alloyed wire electrode OK Autrod 12.22. In terms of weldability, this flux/wire combination must accommodate the high deposition rates of the Tandem-Twin process and, more specifically, provide good slag detachability in narrow joints. The flux is suited for all SAW variants, from single wire to twin-tandem and other multi-wire procedures.

The obtainable deposition rates with Tandem-Twin SAW in windmill fabrication are shown in Table 1, in conjunction with common single and multi-wire techniques. The deposition rates are obtained from actual windmill fabrication at welding currents in the range of 800 – 1000 A. Tandem-Twin is used for the filler layers exclusively. The
One very important component in all automated welding solutions is the manipulator, carrying and transporting the welding head. In wind tower production, the most commonly used manipulator is a column and boom. ESAB supplies a comprehensive product range of CaB’s, from small (3 x 3 m) for light duty applications, up to heavy duty types covering 10 x 8 m.

For wind tower applications, the ESAB CaB 460 is most commonly used. Working range is from 4 x 4 up to 6 x 6 m. It is a robust, fully modularised product that can be exactly tailored to customer demands. Fabricators have a choice in, for example, size, type of foundation, type of drive units, camera systems and flux handling systems. An example of a tailor-made solution, with GMD joint tracking and closed circuit video and

**Arc time almost halved with Tandem-Twin**

During Schweissen & Schneiden 2005, ESAB will demonstrate the welding of windmill tower shells with the Tandem-Twin technique at deposition rates up to 40 kg/h. This will be performed in a V-joint with an included angle of 50°, whereas 60° is common in windmill fabrication. The reduced joint volume accounts for another major productivity advantage over and above the extremely high deposition rate (Table 2 and 3). Slag detachability and weld appearance are excellent, brought about by the new welding flux OK Flux 10.72, whereas the weld metal meets the low-temperature toughness requirements.
A special handle being used to disengage the gear, so that it can easily be pushed to another location.

ESAB’s recently introduced FrameTrac is a solution for the mechanised welding of door frames in windmill towers. These are commonly welded with the manual MMA or FCAW processes. With FrameTrac, fabricators can increase the productivity of the welding of door frames, while at the same time obtaining a more consistent weld quality (Figure 6).

FrameTrac uses the doorframe to travel along, so no rails need to be positioned before welding. To start welding, it is simply connected to an ESAB feed wire feeder. Travel speed and direction, and weaving speed and width, are set with a control box. Wire feed speed and voltage can be adapted by remote control. FrameTrac is equipped with Automatic Current Control to ensure that the stick-out length is always correct.

**Handling Equipment**

The most common types of handling equipment are roller beds and head and tailstocks.

Very suitable for windmill production are the HTLM product range, 50 alt. 80 tons. This equipment operates with work pieces from Ø1500 mm up to Ø6000 mm. AC servo motors with self-locking gears are used to obtain the necessary precision during welding.

The head and tailstock carries and controls the total work piece. Suitable products for wind tower welding production are the HTLM product range, 50 alt. 80 tons. This equipment operates with work pieces from Ø1500 mm up to Ø6000 mm.

The head and tailstock, carries and controls the total work piece. Suitable products for wind tower welding production are the HTLM product range, 50 alt. 80 tons. This equipment operates with work pieces from Ø1500 mm up to Ø6000 mm. AC servo motors with self-locking gears are used to obtain the necessary precision during welding.
Wind energy production rapidly expanding

The global consumption of electricity is constantly increasing. Over the coming decades, an annual 5% increase is expected. Historically, oil, coal, gas, nuclear and hydro power have been the energy sources for electricity production - responsible for roughly 90% of the world electricity in 2003.

But, as we all know, oil, coal and gas are not renewable fuels, and have a negative impact on the environment. Nuclear power on the other hand, providing 17% of the current total global energy demand, is increasingly disregarded as a feasible alternative because it is surrounded by serious environmental and political risks.

It is therefore easy to see why the contribution of wind energy is increasing. In 2003, around 2.5% of Europe's electricity consumption was produced by wind energy, with an installed cumulated power capacity of almost 29,000 MW, generating 60 TWh. Those figures are for most of us a bit obscure, but it is sufficient to provide 14 million European households with electricity.

In the rest of the world, wind energy production has changed dramatically, installed power increasing, on average, by 30% per annum over past years, as shown in Figures 1 and 2.

The production costs of wind energy have been hotly debated over the past years but, with an increasing number of wind energy projects, economics of scale have resulted in a great improvement. Over the last decade, increased technical performance, more efficient production methods, offshore wind tower concepts, etc. have constantly reduced the cost per kWh (Figure 3), whereas the cost of conventionally produced electricity has dramatically increased.

The operation of the motors is synchronised between the head and tailstock.

ESAB – The complete welding house for windmill fabricators
ESAB is a complete, one-stop-shop supplier to the windmill fabrication industry. Continuing development, in co-operation with the industry and based on a thorough knowledge of the industry's welding requirements, has resulted in the introduction of innovative and productive welding products - both equipment and consumables. All products discussed in this article will be presented during Schweissen & Schneiden 2005. We hope to welcome you at our stand in Hall 1 and discuss how you can raise your company's welding performance to a higher level.

**About the authors:**

**Björn Torstensson** looks back on a long career within ESAB in various positions within R&D, marketing and business development. Björn has a background in electronic engineering, with a degree in marketing.

**Per Ivarson** joined ESAB more than 20 years ago and has, ever since, operated within the marketing department for welding automation. Today he concentrates on applied automation for the Nordic and West European markets.

---

**Figure 1.** Global wind power capacity development (source: WWEA)

**Figure 2.** Installed capacity per continent 2004 (source WWEA)

**Figure 3.** Cost of wind generated electricity, cents/kWh (source: American Wind Energy Association).
Success of OK Flux 10.72 in wind tower production spreads to other industries.

ESAB’s new SAW flux unites productivity and weldability with excellent low-temperature toughness.

**Acknowledgement**

We thank the following customers for their valuable contributions to this article: SAM Stahlturm – und Apparatebau GmbH, DSD Noell, Hitachi Canadian Industries, Leucci Construzioni and TEGOPI. We thank our ESAB colleagues Rolf Paschold, John D. Tinline, Ferruccio Mariani, Jorge Lima and Jose-Luis Sastre for their support.

**Low-temperature toughness without compromising weldability or productivity.**

The increasing output of wind turbines has lead to higher and stronger windmill towers. Additionally the requirements on toughness have been raised.

Today, fabricators specify Charpy-V toughness requirements of min. 27J at –50°C for all foundation parts, both for on- and offshore windmill towers. The wind towers mounted on top of the foundation parts are specified according to customer demands, satisfying –20, –40 or –50ºC.

In development, ESAB incorporated use with Tandem-Twin SAW - a technique not yet applied by any of the fabricators reviewed in this article - but bound to gain ground in the industry because of its extremely high productivity. The results of successful tests were published in issue 1/2005 of Svetsaren, again satisfying –50ºC weld metal toughness, despite the high heat inputs involved.

Another approach explored by ESAB is the use of OK Flux 10.72 with four wires of diameter 4.0 mm, each having its own power source. The tests confirm excellent welding characteristics in this procedure. The results are very promising.
Knowing a good horse when you see one.
Good news spreads fast in an industry that is constantly on the lookout for increased productivity to improve competitive edge. ESAB approached windmill fabricators across the globe with its new product - which was well received.

Within a year, OK Flux 10.72 has been accepted, or is under test, by many fabricators – not only within the windmill fabrication industry. The benefits of the flux are recognised by all industries that deal with low-temperature requirements, especially in multi pass SAW welding, as testified by the case references described below. SAM (Germany, penstocks), Hitachi (Canada, pressure vessels & windmills), Leucci Construzioni (Italy, windmills) and TEGOPI (Portugal, windmills) are well known names that have adopted OK Flux 10.72 in production and enjoy improved productivity while satisfying low-temperature toughness demands.

SAM, Germany - splendid in narrow joints.
SAM Stahlturm – und Apparatebau GmbH (SAM), in Magdeburg, is an all-round construction company that began activities in the windmill industry in 1997 - but was soon involved in the construction of large infra-structural projects. A landmark in the history of this young enterprise was, undoubtedly, the Mittelland Canal Aqueduct that crosses the River Elbe over steel bridges. The company was responsible for the complete project from design to erection.

By the end of 2004, SAM had started the fabrication of two penstocks for the Karahnjukar project in Iceland (Figure 1), where six Francis turbines will produce 690 MW for the energy needs of a new aluminium production plant to be in service by the end of 2006. Here, SAM acted as a sub-contractor to DSD Noell in Würzburg. The project involves the creation of three reservoirs, totalling 57 km³, and the construction of 72 km of tunnels. Two parallel tunnels are placed vertically to accommodate the two 410m long penstocks.

The penstocks are in S355ML, S420ML and S460ML and have an inner diameter of 3400 mm and a wall thickness of 35 to 58 mm, depending on the location of the pipe segment. The penstocks were produced in transportable 9 m sections, each section consisting of three plates. SAM uses single and tandem SAW. Although the toughness requirement for the penstock was set at -20°C, they decided to qualify their WPQ’s for -50°C to be prepared for future demands. OK Flux 10.72 was used with OK Autrod 12.24, diameter 4.0 mm, a combination that meets the required strength level. The joint configuration was a Y-joint with a reduced included angle of 50°, to save on joint volume, and a land of 10 mm. The low-temperature toughness demand was satisfied by a convenient margin.

Dipl.-Ing. Dieter Ohms, SAM Welding & QA Engineer, expressed his satisfaction with OK Flux 10.72, saying, “The good weld metal toughness is remarkable, but what strikes me even more is the behaviour in narrow joint preparations. Simply splendid.”

Hitachi – the flux that does it all.
Hitachi Canadian Industries is located in Saskatoon, Canada. Three years ago, after the decline of conventional power generation business, for which the company fabricated gas and steam turbine components, it expanded into the production of wind towers. Although these are now a major product, the company handles a diverse range of projects, that includes pressure vessels. In wind tower production, Hitachi experienced some limitations with the flux wire combination OK Flux 10.71/ Spoolarc 81 (S2Si / EM12K), mainly in connection with low-temperature impact requirements. Changing to OK Flux 10.62 solved the problem but, with this high-basic flux, they had to compromise on welding productivity.

In May 2004, the windmill business really took-off for Hitachi. They invested in additional production capacity, partnering with ESAB who suggested a different approach to subarc welding. This involved the move of the operator from the boom to the base of the manipulator - while controlling the process remotely. Hitachi first purchased one longitudinal welding station based on this technology, and are now using four complete ESAB welding stations with automatic GMD joint tracking, as well as closed circuit video and targeting optics (crosshair and laser optics). These investments have greatly improved the duty cycle and dramatically reduced the defect rate.

The limitations on productivity in combination with low-temperature toughness have been overcome by the introduction of OK Flux 10.72, used in combination with Spoolarc 81 (Ø 4 mm). Weld metal toughness requirements at -40°C, for wind towers with a diameter up to 3650 mm and plate thicknesses from 12 to 38 mm, were dependently met in I-, Y- and DY – joints at welding currents up to 780A. The same flux-wire combination was successfully used on a recent large pressure vessel project, where the requirements were met in the stress relieved condition.

Warren Becker, Assistant Manager Fabrication Services, reviews the fruitful co-operation with ESAB: “The fact that ESAB supplies completely integrated welding solutions results in a higher level of user-friendliness. ESAB’s solution has really brought us more arc time and less defects. The new flux is one of the contributing factors. It meets our impact toughness demands comfortably. We apply it universally. It’s the flux that does it all.”

Leucci Construzioni – excellent toughness at minus fifty.
Leucci Construzioni in Brindisi, Italy, has manufactured wind towers since 1998. The introduction of OK 10.72 has provided them with a versatile and productive flux for both single wire and tandem welding, while satisfying increased low-temperature weld toughness demands.

Figure 2. Production of windmill towers by remote control at Hitachi.
After having produced more than 200 towers with a weight of 55 tonnes and a height of 55 m each, the company now builds 1.5 MW windmills with a weight of 150 tonnes and a height of 67 m.

Their production facilities previously consisted of ten subarc welding stations but, recently, they have invested in three new ESAB tandem stations (Figure 3), as well as an ESAB Suprarex SXE cutting machine.

The towers are fabricated in three segments. The lowest section has a diameter of 4000 mm and a wall thickness of 38 mm; the top-side segment is 2300 mm in diameter with a thickness of 14 mm. The joint preparation is a 60° Y-joint with a land of 5-8 mm. Welding is done with single wire or tandem SAW, depending on the segment.

To meet the universal toughness requirement of 27 J at -50°C, ESAB's flux/wire combination OK Flux 10.72/OK Autrod 12.22 is used for all submerged arc welding, both single wire and tandem heads. For wind tower production, all WPQs above 15 mm are approved down to -50°C, using the flux/wire combination OK Flux 10.72/OK Autrod 12.22. The joint preparation is a 60° Y-joint. The root run is deposited with FCAW with OK Tubrod 14.13 – diameter 1.2 mm. Filling and capping is done with single wire (1 x 4.0 mm), twin-arc (2 x 2.5 mm) or tandem SAW (2 x 4.0 mm, DC+/AC).

TEGOPI, TEGOPI of Porto, Portugal, conveniently located at only 20 km from the seaport of Leixões, is a versatile fabricator of windmill towers (from 1996), civil constructions, and lifting and moving equipment.

The company uses several ESAB column & boom SAW welding units with single wire, twin arc or tandem heads. For wind tower production, all WPQs above 15 mm are approved down to -50°C, using the flux/wire combination OK Flux 10.72/OK Autrod 12.22. The joint preparation is a 60° Y-joint. Welding is done with single wire or tandem SAW, depending on the segment.

Giuseppe Goffredo, Technical Director of Leucci Construzioni: “The new ESAB equipment and consumables have made a significant contribution to our objective of manufacturing three complete towers every week.”

**TEGOPI**

TEGOPI of Porto, Portugal, conveniently located at only 20 km from the seaport of Leixões, is a versatile fabricator of windmill towers (from 1996), civil constructions, and lifting and moving equipment.

The company uses several ESAB column & boom SAW welding units with single wire, twin arc or tandem heads. For wind tower production, all WPQs above 15 mm are approved down to -50°C, using the flux/wire combination OK Flux 10.72/OK Autrod 12.22. The joint preparation is a 60° Y-joint. The root run is deposited with FCAW with OK Tubrod 14.13 – diameter 1.2 mm. Filling and capping is done with single wire (1 x 4.0 mm), twin-arc (2 x 2.5 mm) or tandem SAW (2 x 4.0 mm, DC+/AC).

**Established!**

Within one year of its introduction to the market, ESAB’s OK Flux 10.72 has become established in the windmill industry as a universal flux with good productivity, excellent weldability and a superior weld metal toughness. It suits all common SAW variations - single wire, twin-arc and tandem - and offers a tempting potential for fabricators to increase productivity further with four-wire and tandem twin-arc welding.

---

**About the Author**

**Martin Gehring**, Dipl.-Ing. FH, EWE, is Global Group Product Manager for non- and low-alloyed SAW wires and fluxes at ESAB in Gothenburg. He joined ESAB, in Germany, in 1994 as Product Manager SAW and GMAW wires. He took up his current position in 2001.

For more information contact: Martin.Gehring@esab.de

---

**OK Flux 10.72**

**EN 760: SA AB 1 57 AC**

Agglomerated aluminate-basic flux with an extremely high current-carrying capacity, for applications with toughness requirements down to -50°C. Excellent slag removal, also in narrow V-joints. For structural steels, fine grained steels and low temperature steels. Especially designed for windmill tower fabrication. For single and multi-wire procedures. Suits for both DC and AC welding. Single layer and multi layer welding of unlimited plate thickness.

<table>
<thead>
<tr>
<th>Re  (MPa)</th>
<th>Rm  (MPa)</th>
<th>Charpy-V (°C/ J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>415</td>
<td>500</td>
<td>-30/120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-40/100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-50/70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-62/50</td>
</tr>
</tbody>
</table>
Trouble-free MAG-welding with OK AristoRod™ bare welding wire

Frank Tessin and Bruno Schwarz, ESAB GmbH, Solingen, Germany

OK AristoRod bare MAG wires with ASC technology bring process stability, reduced maintenance downtime, and less post weld labour, all adding up to increased productivity and lower welding costs.

Use of copper-coated solid wires has been standard in MAG-welding for decades. Many users know, however, that considerable quality differences exist between MAG-welding wires from various suppliers. In mechanised and robotic applications in particular, the properties of individual wires can have an enormous effect on the welding costs. A high quality wire must have a very stable arc, low spatter level and, above all, excellent feeding properties.

Feeding quality is a weak point with many copper-coated wires. During welding, copper particles break free from the wire surface due to the action of the wire feeder rollers and the friction in the liner. These accumulate and lead to feeding irregularities and downtime when the wire feeding system is not cleaned regularly. The adhesion of the copper layer to the surface is, therefore, the primary feature that determines the quality of a copper-coated wire.

To avoid the problem, during the 1980s and 1990s, many welding suppliers introduced copper-free welding wires. However, they never gained acceptance in the market because of other disadvantages, such as increased sensitivity to corrosion and a high contact tip wear especially at high wire feed speeds.

AristoRod wires produced with ASC technology feature:

- very stable current transfer from tip to wire. The result is a very stable arc with a very regular droplet transfer and an extremely low level of spatter, both in short arc and spray arc, and also at high welding currents. Figure 1 shows the current transfer of AristoRod with ASC technology, compared with a conventional bare wire and a high quality copper-coated wire. ASC brings the current transfer to the level of copper-coated wire - but with a lower fluctuation and voltage drop. This also has a positive effect on the starting properties which is extremely important in MAG welding with many start–stop cycles, for example, robotic welding (Figure 2).

- reduced friction in the feeding system. This results in consistent, trouble-free feeding with no clogging of liners and guns. Contact tip wear is reduced to a level equal to the very best copper-coated wires, as shown in Figure 3.

- no accumulation of copper in the feeding system. Reduced downtime for cleaning.

- wire surface protected against corrosion (Fig. 4).

AristoRod wires with ASC technology will increase the duty cycle of MAG welding installations and reduce the need for spatter removal after welding, resulting in lower welding costs. They are suitable for manual, mechanised and robotic welding. Their advantages become even more apparent at higher wire feeding speeds, when the accumulation of copper particles in the feeding system increases with copper-coated wires and leads to a higher sensitivity to feeding problems.
A wide range of wire grades
The AristoRod MAG wire range includes the standard G3Si1 and G4Si1 types, and also wires for high strength steels and for steels for use at high temperatures. The advantages of AristoRod with ASC technology are particularly advantageous for Mo-containing wires where a good copper-coating is hard to achieve. Table 1 shows the complete range of AristoRod wires with classifications and approvals.

AristoRod and MarathonPac – a perfect team for increased productivity.
AristoRod wires can be supplied on adapter-free 18 kg wire baskets (BS 300, EN 759) or in MarathonPac bulk drums charged with 250 or 475 kg. For many ESAB customers, Marathon Pac is crucial in maximising production output– cutting downtime on spool changes by almost 95%.

The special coiling technique used when packing the drums ensures that the welding wire is never twisted or warped - or causes arc wander. This results in consistently well-positioned, high quality welds. MarathonPac drums can be folded flat after use and are fully recyclable.

Putzmeister successful with AristoRod wires
The German machine manufacturer, Putzmeister, produces pump installations for the handling of concrete and other fluid building materials. Established in 1958, Putzmeister now comprises 14 companies worldwide with 2000 employees.

Putzmeister in Gründau, produces the beams for the pumps (Figure 5), in lengths from 16 to 62 meters. Customers increasingly require larger and lighter beams, calling for the use of high strength steel such as the S 690 Q grade that Putzmeister has been using for over 10 years.

For the MAG welding of S 690 Q, Putzmeister uses OK AristoRod 13.29 (EN 12534: G 69 3 Mn3Ni1CrMo). The copper-coated wires previously used had an inconsistent quality of the copper-coating, resulting in the accumulation of debris in the feeding system and a high level of spatter. AristoRod 13.29 overcomes these problems.

Herr Roman Riebenstahl, general manager of the Gründau Putzmeister factory, confirms this: “My welders prefer AristoRod because they don’t have to spend much time on cleaning the wire feeding system and removing spatter on the workpiece.”

OK AristoRod 12.50 - A steady force for robotic production processes.
OK AristoRod™ productivity features highly at the Komatsu facility in Padua, Italy and one of four Komatsu Group production units in Europe. They produce a wide range of earth moving equipment including mini-excavators, back hoe loaders and skid steer loaders. The main equipment structures and chassis are
fabricated in-house on three highly automated production lines comprised of a multitude of robotic welding cells.

A high speed welding process is applied universally and with very demanding parameters. Welding currents reach in excess of 400 A at wire feed speeds of over 20 m/min., with frequent start-stop cycling. The weld wire is guided to the welding head through 20 m long liners. In addition, they use a relatively long stick-out length imposing high demands on wire straightness. OK AristoRod™ 12.50 – 1.2 mm is used throughout the production process and has already earned a good reputation at the Komatsu plant.

Claudio Gallana, Production Manager at Komatsu, states “The most important requirement for us is the consistency of the welding consumables. ESAB’s OK AristoRod™ wire gives the same high performance time and again. It is a steady factor in our high efficiency welding. We’ve experienced no feeding problems at all and the welds are always nice and clean and well positioned”.

**Table 1. The complete range of OK AristoRod wires.**

<table>
<thead>
<tr>
<th>AWS and EN classifications Wire</th>
<th>Classification Weld Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK AristoRod™ AWS A5.19</td>
<td>EN 440</td>
</tr>
<tr>
<td>12.50</td>
<td>ER70S-6</td>
</tr>
<tr>
<td>12.57</td>
<td>ER70S-3</td>
</tr>
<tr>
<td>12.62</td>
<td>ER70S-3</td>
</tr>
<tr>
<td>12.63</td>
<td>ER70S-6</td>
</tr>
<tr>
<td>12.65</td>
<td>ER70S-6</td>
</tr>
<tr>
<td>13.08</td>
<td>ER70S-3</td>
</tr>
<tr>
<td>13.09</td>
<td>ER70S-6</td>
</tr>
<tr>
<td>13.12</td>
<td>EN108-3</td>
</tr>
<tr>
<td>13.13</td>
<td>EN108-3</td>
</tr>
<tr>
<td>13.27</td>
<td>EN108-3</td>
</tr>
<tr>
<td>13.29</td>
<td>ER108S-3</td>
</tr>
<tr>
<td>13.31</td>
<td>ER108S-3</td>
</tr>
</tbody>
</table>

**About the Authors**

Frank Tessin M.Sc. is Product Manager Cored Wires and Key Account Manager and Bruno Schwarz EWE is Product Manager Solid Wires, at ESAB GmbH, Solingen, Germany.

For more information contact: bruno.schwarz@esab.de
Superior quality aluminium filler wire for the superior welding fabricator

TONY ANDERSON, ESAB NORTH AMERICA.

Experienced manufacturers of aluminium-welded structures will be the first to agree that there are aluminium welding wires and that there are superior quality aluminium welding wires. The distinction between these two products can be like night and day. It can often mean the difference between problem-free welding and major difficulties associated with feedability, process down time and costly welding repairs. To meet the requirements of the most demanding industrial applications, ESAB’s new range of premium quality aluminium MIG-wires has excellent welding characteristics and superior feedability. This new family of wires is available...
under its own consumables range product identification; OK Autrod followed by the 4-digit AWS/EN-ISO filler metal number for easy selection. This also applies to the complementary OK Tigrod range of TIG-rods.

Aluminium welding wire is a relatively soft material with poor column strength and is extremely susceptible to hydrogen solubility when molten. Because of these unique properties, its ability to perform successfully in a production environment is very dependent on the methods and controls used during its manufacturing operations. The characteristics that can most seriously affect the performance of aluminium MIG welding wire weldability and weld metal strength. The physical quality of this rod is extremely important. Impurities or discontinuities in this product can be transferred throughout the entire manufacturing process and result in an end product of a seriously inferior quality. ESAB applies a unique shaving technology that produces a smooth and absolutely clean surface for enhanced feedability and x-ray quality welds. The shaving operation effectively removes surface discontinuities and provides an end-product free from surface abnormalities that can trap contaminants and cause porosity (Figure 1).

Extremely controlled die maintenance is vital for the production of consistently high quality aluminium welding wire. To ensure the continuous surface quality on the wire throughout the draw reduction process, only the finest quality drawing dies and specialized lubricants are used. Because of the work hardening characteristics of the various aluminium alloys there are often intermediate heat treatment operations performed during manufacturing. These heating operations are necessary and designed to ensure the optimum mechanical properties that assist feedability of the completed product. After final drawing to the desired size, the aluminium wire must be cleaned. This is an extremely important process that will essentially determine if the completed product will meet welding standard requirements in terms of x-ray quality weldments. Monitoring of the cleaning operation is essential and ESAB performs very stringent tests on all their wire during manufacturing to make certain the cleaning process is continually effective. Weld testing is routinely conducted upon completion of the final drawing, cleaning and spooling of the wire. Test samples are welded on a regular basis, followed by radiographic inspection of the completed weld to verify the wire integrity. The ESAB product proves to be significantly superior when graded against the AWS Specification minimum requirements for deposited weld metal quality.

Surface finish and cleanliness
The surface finish of an aluminium welding wire begins with the quality of the raw material used for producing the wire - the characteristic with probably the greatest effect on the wire's performance. Typically, aluminium welding wire is manufactured from a re-draw rod of around 9 mm diameter. The American Welding Society largely controls the chemistry of this rod by specification. However, the wire manufacturer may hold itself to even tighter limits within prescribed areas that assist in such characteristics as manufacturability, durability and weld metal strength. The physical quality of this rod is extremely important. Impurities or discontinuities in this product can be transferred throughout the entire manufacturing process and result in an end product of a seriously inferior quality. ESAB applies a unique shaving technology that produces a smooth and absolutely clean surface for enhanced feedability and x-ray quality welds. The shaving operation effectively removes surface discontinuities and provides an end-product free from surface abnormalities that can trap contaminants and cause porosity (Figure 1).

Extremely controlled die maintenance is vital for the production of consistently high quality aluminium welding wire. To ensure the continuous surface quality on the wire throughout the draw reduction process, only the finest quality drawing dies and specialized lubricants are used. Because of the work hardening characteristics of the various aluminium alloys there are often intermediate heat treatment operations performed during manufacturing. These heating operations are necessary and designed to ensure the optimum mechanical properties that assist feedability of the completed product. After final drawing to the desired size, the aluminium wire must be cleaned. This is an extremely important process that will essentially determine if the completed product will meet welding standard requirements in terms of x-ray quality weldments. Monitoring of the cleaning operation is essential and ESAB performs very stringent tests on all their wire during manufacturing to make certain the cleaning process is continually effective. Weld testing is routinely conducted upon completion of the final drawing, cleaning and spooling of the wire. Test samples are welded on a regular basis, followed by radiographic inspection of the completed weld to verify the wire integrity. The ESAB product proves to be significantly superior when graded against the AWS Specification minimum requirements for deposited weld metal quality.

Wire diameter control
In addition to the surface quality characteristics, drawing die quality and maintenance are both critical in maintaining accurate and consistent wire diameter control. ESAB manufactures aluminium wire within far stricter tolerances than the requirements of the American Welding Society. This very tight and consistent wire diameter control benefits the end-user in the form of consistent arc characteristics. Small variations in aluminium welding wire will reflect major variations in arc performance. Just a small increase or decrease in a wire diameter significantly changes the cross-sectional area of the wire. The area change will display itself in the form of too high current density or too low current density, both of which are conducive to the creation of various types of welding discontinuities. The tightly controlled wire diameters maintained by ESAB ensure that the welding parameters remain constant from spool to spool. This is a critical factor in automatic welding applications where the welding process, and not the welder, controls the parameters.

Cast and helix.
Consistent cast and helix of the spooled wire (Figure 3) ensures continuous electrical contact, smoother arc characteristics and more consistent penetration. The AWS specifications require that cast and helix of wire on spools be suitable for feeding in an uninterrupted manner using both automatic and semi-automatic welding equipment.
and verify the quality of the product throughout its production.

Overall quality control for the manufacture of aluminium welding wire. This system complements the conformance to the American Welding Society National Standard AWS A5.10 – Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.

In addition, product quality and QA system are audited annually, by a number of approval societies such as Lloyd’s Register of Shipping, TÜV Rheinland, DB, Det Norske Veritas and Germanischer Lloyd’s. They require physical performance testing of the welding wire through the production of test samples, which are destructively and non-destructively tested.

Conclusion
For the serious aluminium welding fabricator concerned with optimum quality welds, reduction in repair rates and improved productivity, it is essential to use a superior quality aluminium welding wire. Even small inconsistencies in aluminium wire quality, cleanliness, wire diameter or surface condition can cause major problems when attempting to produce continually acceptable aluminium welded structures.

The benefits in a nutshell
- Trouble-free wire feeding.
- A very clean wire surface for X-ray quality welds.
- An exceptionally stable arc with minimal burnback
- Filler metal compositions for all common aluminium grades.
- Available in Marathon Pac bulk drums for dramatically reduced spool change downtime.

A complete range of MIG-wires and TIG-rods

Your best solution for manual, mechanised and robotic MIG-welding of aluminium.

ESAB

ESAB Description | AWS A5.10 | EN ISO 18273 Alloy symbol Numerical | Chemical |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Autrod 1070</td>
<td>Al 1070</td>
<td>Al 1070/A</td>
<td>A63.7</td>
</tr>
<tr>
<td>OK Autrod 1100</td>
<td>Al 1100</td>
<td>Al 1100/A</td>
<td>A60.0 Cu</td>
</tr>
<tr>
<td>OK Autrod 1450</td>
<td>Al 1450</td>
<td>Al 1450/A</td>
<td>A60.5 Ti</td>
</tr>
<tr>
<td>OK Autrod 4043</td>
<td>Al 4043/A</td>
<td>Al 4043/A</td>
<td>A53.55 Si</td>
</tr>
</tbody>
</table>
| OK Autrod 4047 | Al 4047/A | Al 4047/A        | A53.55 Si 
| OK Autrod 5087 | Al 5087   | Al 5087/A        | A51.5 Ti  |
| OK Autrod 5153 | Al 5153/A | Al 5153/A        | A40.4 Si  |
| OK Autrod 5356 | Al 5356/A | Al 5356/A        | A40.4 Si  |
| OK Autrod 5554 | Al 5554/A | Al 5554/A        | A40.4 Si  |
| OK Autrod 5754 | Al 5754/A | Al 5754/A        | A40.4 Si  |

Approvals

<table>
<thead>
<tr>
<th>TÜV</th>
<th>DB</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

ESAB

ESAB Description | AWS A5.10 | EN ISO 18273 Alloy symbol Numerical | Chemical |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Tigrod 1070</td>
<td>Al 1070</td>
<td>Al 1070/A</td>
<td>A63.7</td>
</tr>
<tr>
<td>OK Tigrod 1100</td>
<td>Al 1100</td>
<td>Al 1100/A</td>
<td>A60.0 Cu</td>
</tr>
<tr>
<td>OK Tigrod 1450</td>
<td>Al 1450</td>
<td>Al 1450/A</td>
<td>A60.5 Ti</td>
</tr>
<tr>
<td>OK Tigrod 4043</td>
<td>Al 4043/A</td>
<td>Al 4043/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrod 4047</td>
<td>Al 4047/A</td>
<td>Al 4047/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrod 5087</td>
<td>Al 5087</td>
<td>Al 5087/A</td>
<td>A51.5 Ti</td>
</tr>
<tr>
<td>OK Tigrod 5153</td>
<td>Al 5153/A</td>
<td>Al 5153/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrod 5356</td>
<td>Al 5356/A</td>
<td>Al 5356/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrod 5554</td>
<td>Al 5554/A</td>
<td>Al 5554/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrod 5754</td>
<td>Al 5754/A</td>
<td>Al 5754/A</td>
<td>A40.4 Si</td>
</tr>
</tbody>
</table>

Approvals

<table>
<thead>
<tr>
<th>TÜV</th>
<th>DB</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

ESAB

ESAB Description | AWS A5.10 | EN ISO 18273 Alloy symbol Numerical | Chemical |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Tigrad 1070</td>
<td>Al 1070</td>
<td>Al 1070/A</td>
<td>A63.7</td>
</tr>
<tr>
<td>OK Tigrad 1100</td>
<td>Al 1100</td>
<td>Al 1100/A</td>
<td>A60.0 Cu</td>
</tr>
<tr>
<td>OK Tigrad 1450</td>
<td>Al 1450</td>
<td>Al 1450/A</td>
<td>A60.5 Ti</td>
</tr>
<tr>
<td>OK Tigrad 4043</td>
<td>Al 4043/A</td>
<td>Al 4043/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrad 4047</td>
<td>Al 4047/A</td>
<td>Al 4047/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrad 5087</td>
<td>Al 5087</td>
<td>Al 5087/A</td>
<td>A51.5 Ti</td>
</tr>
<tr>
<td>OK Tigrad 5153</td>
<td>Al 5153/A</td>
<td>Al 5153/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5356</td>
<td>Al 5356/A</td>
<td>Al 5356/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5554</td>
<td>Al 5554/A</td>
<td>Al 5554/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5754</td>
<td>Al 5754/A</td>
<td>Al 5754/A</td>
<td>A40.4 Si</td>
</tr>
</tbody>
</table>

Approvals

<table>
<thead>
<tr>
<th>TÜV</th>
<th>DB</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

ESAB

ESAB Description | AWS A5.10 | EN ISO 18273 Alloy symbol Numerical | Chemical |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Tigrad 1070</td>
<td>Al 1070</td>
<td>Al 1070/A</td>
<td>A63.7</td>
</tr>
<tr>
<td>OK Tigrad 1100</td>
<td>Al 1100</td>
<td>Al 1100/A</td>
<td>A60.0 Cu</td>
</tr>
<tr>
<td>OK Tigrad 1450</td>
<td>Al 1450</td>
<td>Al 1450/A</td>
<td>A60.5 Ti</td>
</tr>
<tr>
<td>OK Tigrad 4043</td>
<td>Al 4043/A</td>
<td>Al 4043/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrad 4047</td>
<td>Al 4047/A</td>
<td>Al 4047/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrad 5087</td>
<td>Al 5087</td>
<td>Al 5087/A</td>
<td>A51.5 Ti</td>
</tr>
<tr>
<td>OK Tigrad 5153</td>
<td>Al 5153/A</td>
<td>Al 5153/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5356</td>
<td>Al 5356/A</td>
<td>Al 5356/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5554</td>
<td>Al 5554/A</td>
<td>Al 5554/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5754</td>
<td>Al 5754/A</td>
<td>Al 5754/A</td>
<td>A40.4 Si</td>
</tr>
</tbody>
</table>

Approvals

<table>
<thead>
<tr>
<th>TÜV</th>
<th>DB</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

ESAB

ESAB Description | AWS A5.10 | EN ISO 18273 Alloy symbol Numerical | Chemical |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Tigrad 1070</td>
<td>Al 1070</td>
<td>Al 1070/A</td>
<td>A63.7</td>
</tr>
<tr>
<td>OK Tigrad 1100</td>
<td>Al 1100</td>
<td>Al 1100/A</td>
<td>A60.0 Cu</td>
</tr>
<tr>
<td>OK Tigrad 1450</td>
<td>Al 1450</td>
<td>Al 1450/A</td>
<td>A60.5 Ti</td>
</tr>
<tr>
<td>OK Tigrad 4043</td>
<td>Al 4043/A</td>
<td>Al 4043/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrad 4047</td>
<td>Al 4047/A</td>
<td>Al 4047/A</td>
<td>A53.55 Si</td>
</tr>
<tr>
<td>OK Tigrad 5087</td>
<td>Al 5087</td>
<td>Al 5087/A</td>
<td>A51.5 Ti</td>
</tr>
<tr>
<td>OK Tigrad 5153</td>
<td>Al 5153/A</td>
<td>Al 5153/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5356</td>
<td>Al 5356/A</td>
<td>Al 5356/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5554</td>
<td>Al 5554/A</td>
<td>Al 5554/A</td>
<td>A40.4 Si</td>
</tr>
<tr>
<td>OK Tigrad 5754</td>
<td>Al 5754/A</td>
<td>Al 5754/A</td>
<td>A40.4 Si</td>
</tr>
</tbody>
</table>

Approvals

<table>
<thead>
<tr>
<th>TÜV</th>
<th>DB</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
A weld that lasts for 100,000 years
Friction Stir Welding to seal 5 cm thick copper canisters containing Sweden’s nuclear waste

Lars Cedervist, Swedish Nuclear Fuel and Waste Management Co (SKB), Oskarshamn, Sweden.

In 1983, SKB proposed that Sweden’s high-level nuclear waste should be deposited in copper canisters at a depth of 500 metres in the Swedish bedrock – the so-called KBS 3 method. High power electron beam welding was the only viable method available at that time for welding thick section copper. In 1997, SKB started to investigate friction stir welding (FSW) as a possible joining method. The results to date, 12 years before the first canister will be sealed and disposed of in the deep repository, show that FSW is a stable and tolerant process that can repeatedly produce defect-free welds.

The barriers
The copper canister is one of the barriers in the Swedish method for final disposal of spent nuclear fuel (Figure 1). The canister (length 5 m, diameter 1 m) containing the nuclear waste needs to remain intact for 100,000 years and a corrosion barrier of 5 cm thick copper and a cast iron insert for mechanical strength are used to meet this requirement. The 5 cm thick cylindrical body with an outer diameter of 105 cm can be produced in seamless form by extrusion, forging or the pierce and draw technique.

The canister manufacturing process requires that a bottom and a lid are sealed using a method that produces extremely high joint integrity. Two methods, FSW and electron beam welding, are being developed at SKB’s Canister Laboratory in Oskarshamn. In May 2005 SKB chose FSW, due to the robustness and reliability of the process.
make the plunge sequence possible without probe wear. Frictional heat is generated between the wear-resistant tool shoulder and the material, causing the material to soften without reaching the melting point, and allowing the tool to traverse the joint line (Figure 2).

Due to the high welding temperature (up to 900°C), the high welding forces and the duration of the weld cycle (up to 1 hour), the requirements on the tool (Figure 3) are rigorous when welding 5 cm thick copper canisters. Currently, the nickel-based superalloy, Nimonic 105, and the sintered tungsten alloy, Densimet, are used as probe and shoulder material, respectively. The welding temperature is measured using a thermocouple inside the tool probe which gives an excellent indication of the state of the process. Currently, this temperature has to be restricted in order to protect the tool probe.

The welding machine
In order to develop a full-scale welding process, SKB ordered a purpose-built machine (Figure 4) from ESAB, in January 2002, that was commissioned at the Canister Laboratory in April 2003. The welding head on the machine rotates up to 425°, while the canister is clamped with 3,200 kN and the lid pressed down with 400 kN. The machine has a maximum capacity of 110 kW, which makes it one of the most powerful welding machines in the world. However, in order to control the heat input, only 40 kW is used. The machine automatically keeps the welding temperature constant throughout a weld cycle by controlling the heat generation. Other advantages include:

- Ability to adjust all process parameters during welding excluding tool angle.
- Facility to automatically accelerate to the steady-state welding speed as a function of the welding temperature.
- Facility to start and park above the joint line.

Weld cycle
The pilot hole is drilled 75 mm above the joint line in order to eliminate the risk of defect formation at the joint line. In addition, no overlap region to remove possible start defects is needed and consistent weld microstructure, resulting from steady state welding conditions, will be present at the joint line. The start sequence could also be aborted if it does not converge towards a stable process. A new pilot hole could then be made and the weld could be started again and completed without rejecting the canister or the lid. After the start sequence the tool is moved downwards to the joint line at a specified angle and at the steady-state welding...
speed (Figure 5). At the joint line, welding conditions are kept constant for process stability and reproducibility. After 360° of steady-state joint line welding, the tool is moved upward 75 mm to a position where the exit hole will be machined away when the canister is machined to its final dimensions (Figure 5).

Non-destructive testing
Two methods are currently being developed and evaluated at the Canister Laboratory.

Radiographic inspection is performed by a digital X-ray system with 60 times the power of medical diagnostic X-ray. The radiographic testing method will find volumetric flaws but has limited sensitivity for non-volumetric flaws.

For ultrasonic testing of FSW, SKB use the phased array technique. Ultrasonic inspection is a more suitable method than X-ray inspection for the detection of non-volumetric flaws.

Welding results
After 48 lid welds at the Canister Laboratory, the process can be summarized as being robust and stable, but not fully automated. Despite this limitation, the welds are made with excellent repeatability and reliability, since the parameter windows are relatively large.

An important milestone was reached in May 2004 when a complete full size canister with a cast iron insert was sealed (Figure 6). No defect indications except deflection of the joint line were found in the bottom weld and the lid weld.

Another milestone was reached, in January 2005, when a series of 20 lid welds was completed in production-like forms. The series demonstrated that the process and the machine are reliable and feasible for production.

In addition to non-destructive testing, various destructive testing methods are carried out to assess the long-term properties of the welds. The welds show similar properties to the base metal in tensile, creep and corrosion tests.

The excellent properties of the welds derive from the fact that FSW is a solid-state welding process that produces a fine grained microstructure.

Summary
The results from the lid welds at the Canister Laboratory show that FSW can be used to seal 5 cm thick copper canisters with repeated production of high integrity joints.

Future work will focus on developing a fully automated weld cycle to minimize the human factor, and to satisfy SKB’s quality requirements regarding rejected canisters - less than 1 in a 100 - and to support the Encapsulation Plant application.

REFERENCES
THEGERSTRÖM C., DOWN TO EARTH…and below - SWEDEN’S PLANS FOR NUCLEAR WASTE. IAEA BULLETIN JUNE 2004. HTTP://WWW.IAEA.ORG/PUBLICATIONS/MAGAZINES/BULLETIN/BULL461/ARTICLE13.PDF

CEDERQVIST L. FSW TO SEAL 50 MM THICK COPPER CANISTERS - A WELD THAT LASTS FOR 100,000 YEARS. 5TH INTERNATIONAL SYMPOSIUM ON FSW, METZ, FRANCE, SEPTEMBER 2004.

ABOUT THE AUTHOR
LARS CEDERQVIST, MSc., developed FSW LAP JOINTS UNDER A NASA CONTRACT AT UNIVERSITY OF SOUTH CAROLINA FOR TWO YEARS, THEN IMPLEMENTED FSW ON THE ECLIPSE 500 JET AT MTS SYSTEMS CORP., BEFORE JOINING SKB IN 2002 AS PROJECT MANAGER AND DEVELOPMENT ENGINEER FOR FSW IN THE ENCAPSULATION TECHNOLOGY GROUP.

FOR MORE INFORMATION, CONTACT LARS. CEDERQVIST@SKB.SE OR VISIT WWW.SKB.SE.
Improved quality, productivity and versatility for Tandem-MAG process.

New ESAB MTT1200 welding gun with large electrode inter-distance avoids limitations of traditional synchronised arc systems.

Acknowledgements

Finance for this project was provided by companies within the KIMAB Joining Technology Centre: ESAB, AGA / Linde Gas, Outokumpu Stainless, Sandvik Materials Technology, Sapa Technology, SCANIA CV, SSAB Tunnplåt, Gestamp Hardtech, The Swedish Welding Commission, Jernkontoret, Volvo Cars and Volvo Trucks. Grateful thanks are given to these companies and their representatives and also to ESAB and AGA / Linde Gas for their co-operation in the trials.

Tandem-MAG welding systems have been available for some time and have proven their capacity for increasing productivity. European countries, such as Germany, France, England, and Italy have successfully implemented this technology, however, others have been less successful. A plausible explanation, for Tandem-MAG not being implemented in the anticipated high number of manufacturing plants in Europe, may be the complexity of process control.

Tandem-MAG welding systems without synchronised pulsed welding, providing a wider process window, a higher flexibility in process settings and a reduced sensitivity for arc disturbances and spatter. More arc types can be combined and parameters can be set for each wire individually. This opens up new options for welding both thin and thick materials. Welding equipment can be less sophisticated and less costly.

A wider electrode inter-distance allows Tandem-MAG welding without synchronised pulsed welding, providing a wider process window, a higher flexibility in process settings and a reduced sensitivity for arc disturbances and spatter. More arc types can be combined and parameters can be set for each wire individually. This opens up new options for welding both thin and thick materials. Welding equipment can be less sophisticated and less costly.

Improved quality, productivity and versatility for Tandem-MAG process.

New ESAB MTT1200 welding gun with large electrode inter-distance avoids limitations of traditional synchronised arc systems.

Acknowledgements

Finance for this project was provided by companies within the KIMAB Joining Technology Centre: ESAB, AGA / Linde Gas, Outokumpu Stainless, Sandvik Materials Technology, Sapa Technology, SCANIA CV, SSAB Tunnplåt, Gestamp Hardtech, The Swedish Welding Commission, Jernkontoret, Volvo Cars and Volvo Trucks. Grateful thanks are given to these companies and their representatives and also to ESAB and AGA / Linde Gas for their co-operation in the trials.

Tandem-MAG welding systems have been available for some time and have proven their capacity for increasing productivity. European countries, such as Germany, France, England, and Italy have successfully implemented this technology, however, others have been less successful. A plausible explanation, for Tandem-MAG not being implemented in the anticipated high number of manufacturing plants in Europe, may be the complexity of process control.

Tandem-MAG welding systems have been available for some time and have proven their capacity for increasing productivity. European countries, such as Germany, France, England, and Italy have successfully implemented this technology, however, others have been less successful. A plausible explanation, for Tandem-MAG not being implemented in the anticipated high number of manufacturing plants in Europe, may be the complexity of process control.

Two variants of Tandem-MAG welding

Traditional Tandem-MAG welding uses synchronised pulsed welding with the arcs close in the welding gun, i.e. electrode inter-distance is short. The type of current pulse synchronisation can differ depending on control possibilities in the equipment and preferences.

As an alternative, non-pulsed welding can be used. Here, there are less parameters to set, but the main problem is finding a stable process (avoiding arc disturbances).

These two types are discussed in detail below, and an improved way of using non-pulsed welding is described.

Short electrode inter-distance with synchronised pulsed welding

There are three main types of arc synchronisation; a time delay between the current pulse peaks (phase-displacement) for each arc, or the arcs working in-phase or anti-phase in the peak current timing. Apart from deciding which type of synchronisation to use for optimal performance, some limitations must be considered:
Synchronised pulsed welding reduces the possibility of using different welding currents and arc types which can be beneficial when optimising the weld penetration and weld geometry.

Synchronised pulsed welding may limit productivity. The wires can not be fed with high speed and full anti-phase synchronisation, since each current pulse will need to have sufficient time to melt the material. Within the available time span, pulses will start to overlap which can result in increasing stability or spatter problems.

Synchronised pulsed welding can of course give good weld geometry and joint properties but the development of weld data can be time consuming and problems with arc deflection and spatter are not uncommon, especially at higher welding currents and travel speeds.

Benefits for systems with larger electrode inter-distance

For Tandem welding systems with larger electrode inter-distance, synchronisation between the arcs becomes unnecessary. New process options become available:

- **Short arc welding on thin sheet material**
  Trials have shown that short arc welding can be used with good results when the electrodes are separated sufficiently (configuration A in Figure 1). Lap joints of 2.5 mm lap joints were produced with a welding speed of 2 m/min with short arc on both electrodes. This created a narrower weld bead than with pulsed welding, which in turn could reduce the overlapping length in the joint. The weld data was established by just using the synergistic settings in the ESAB AristoMig power source: selecting wire, shielding gas and wire feed speed as for a single wire application. This was done with identical data selected in each of the two power sources. The data corresponded to a typical single wire welding speed of 1 m/min. Since this data was used on both welding machines, the welding speed setting was doubled to 2 m/min. The weld data could be fine-tuned, but this simple method of setting the process resulted directly in a good process.

Larger electrode inter-distance with non-synchronised welding

With non-synchronised welding – and, in this case, preferably also combined with a larger electrode inter-distance to avoid arc disturbances - the process brings interesting results:

- **Stable process settings are easier to find** (one wire can be set independently of the other since the arcs have limited interference).

- **Spatter problems and arc deflection tendencies are reduced.**

- **More arc type combinations are possible** (short arc + short arc becomes possible on thinner sheets for instance - this will be unstable if the arcs are too close).

- **Deeper penetration can be achieved when the process is set in a manner only possible for larger electrode-interdistances.**

With non-synchronised welding - and, in this case, preferably also combined with a larger electrode inter-distance to avoid arc disturbances - the process brings interesting results:

- **Stable process settings are easier to find** (one wire can be set independently of the other since the arcs have limited interference).

- **Spatter problems and arc deflection tendencies are reduced.**

- **More arc type combinations are possible** (short arc + short arc becomes possible on thinner sheets for instance - this will be unstable if the arcs are too close).

- **Deeper penetration can be achieved when the process is set in a manner only possible for larger electrode-interdistances.**

**Benefits for systems with larger electrode inter-distance**

For Tandem welding systems with larger electrode inter-distance, synchronisation between the arcs becomes unnecessary. New process options become available:

- **Short arc welding on thin sheet material**
  Trials have shown that short arc welding can be used with good results when the electrodes are separated sufficiently (configuration A in Figure 1). Lap joints of 2.5 mm lap joints were produced with a welding speed of 2 m/min with short arc on both electrodes. This created a narrower weld bead than with pulsed welding, which in turn could reduce the overlapping length in the joint. The weld data was established by just using the synergistic settings in the ESAB AristoMig power source: selecting wire, shielding gas and wire feed speed as for a single wire application. This was done with identical data selected in each of the two power sources. The data corresponded to a typical single wire welding speed of 1 m/min. Since this data was used on both welding machines, the welding speed setting was doubled to 2 m/min. The weld data could be fine-tuned, but this simple method of setting the process resulted directly in a good process.

Figure 1. Evaluated welding gun configurations for the adjustable ESAB MTT1200 welding gun. Electrode inter-distances are illustrated at a contact tip to plate distance of 20 mm.

Figure 2. A 2.5 mm lap joint welded with double short arc (top and middle), and a 2 mm lap joint with zinc-coated steels also welded with double short arc, 7 µm Zn-coating on each side and zero gap between the plates (bottom).
Deep penetration for tandem welding of thicker components

Unexpected penetration levels can be reached for some process combinations when larger electrode inter-distance is used:

The same weld data settings were used for the bead on plate welds (Figure 3), only the electrode inter-distance was changed. Configuration A gave a much deeper weld penetration, (Figure 3a) compared to configuration C (Figure 3b). Figure 3c shows another bead on plate weld made with configuration A, where a full penetration of 10 mm C-Mn steel was achieved - an unusual penetration capacity for a MAG-welding process.

Another penetration example.

A 6 + 6 mm T-joint with full penetration (welds on both sides) can be achieved with 1 - 1.2 m/min travel speed and crossing weld penetrations inside the weld. No joint preparation was used. Note: Larger plate thicknesses can be welded with full penetration, 6 mm is not the maximum thickness.

Discussion and conclusions

Tandem-MAG welding is a viable process. For larger electrode inter-distances, approximately 20 mm, the process becomes quite flexible and robust. Here, all normally used arc types can be used – in many combinations and without synchronisation. Testing and finding of suitable data is easy and arc deviation and spatter problems are greatly reduced. With freedom in wire and arc type selection, there is more than one solution for a welding task, but the time for developing a welding procedure is reduced when all aspects and parameters for synchronised pulsing can be omitted. (There may be cases where synchronised pulsing can make a final improvement but there is no obligatory use of this solution to achieve process stability.)

One or two weld pools?

At larger electrode inter-distances, unwanted partial solidification of the weld pool could be expected between the arcs (i.e. two arcs and two weld pools). This will be the case when the arcs are separated more and more. When this happens, the beneficial effect on weld penetration may disappear. During welding trials, this aspect was studied with gun configuration A, the largest electrode inter-distance with the MTT1200 welding gun. A number of cross-sections of weldments were examined. It was evident that for these welding combinations, the arcs were burning in one weld pool (Figure 5).

Weld start and weld stop problems that could be expected with a larger electrode inter-distance could be solved by using the creep-start and crater-fill functions for beam and panel welding (straight weld runs). For robotic welding on products that demand gun rotation around corners, there is a limit on how large the electrode
inter-distance can be. This limit depends on the application and the equipment used. A recommendation for these situations is to use as large an electrode inter-distance as possible - up to 20 mm.

In summary:
- Tandem MAG shows a high potential in terms of both weld penetration and productivity.
- With increased electrode inter-distance, enhanced process performance is achieved: wider process window / higher flexibility in process settings, and a reduced sensitivity for arc disturbances and spatter. Both thinner and thicker joints can be optimised.
- With the equipment used in these evaluations, all common arc types can be used in different combinations. This, in turn, reduces the need for synchronised pulsing and makes the equipment less costly.
- As a recommendation, a large gas cup and a high shielding gas flow will ensure a good gas shielding at high welding speeds.

References

About the authors
Joakim Hedegård
MSc, Lic Tech, IWE, has been working in welding research and education for more than fifteen years. Presently working as researcher and program manager of the KIMAB Joining Technology Centre (KIMAB = Corrosion and Metals Research Institute).

Johan Andersson, MSc, IWE and Erik Tolf, MSc, are welding research engineers at KIMAB.

Klas Weman, MSc, has extensive experience in the development of arc equipment, power sources and welding processes at ESAB Welding Equipment AB in Laxå, Sweden and, previously, as an associate professor at the Welding Technology Department at the Royal Institute of Technology in Stockholm.

For more information contact: joakim. hedegard@kimab.com

Kjellberg medal for Bertil Pekkari

The Kjellberg medal - the Swedish Welding Commission's highest honour - was awarded to Bertil Pekkari, on 19 May, 2005, for his valuable contribution to welding in Swedish industry. Bertil is the 8th person to receive this honour since its institution in 1941. He retired from ESAB as Technical Director and Vice President in 2004. He is now Chairman of the Swedish Welding Commission and also Chairman of the Welding Institute (TWI).

Bertil Pekkari (left) receives the Kjellberg medal presented by Dr. Nils Stenbacka, Vice Chairman of the Swedish Welding Commission.
Coreshield 8 – self-shielded cored wire applied in the Hamburg harbour.

Suitability under windy outdoor conditions and high deposition rate crucial for construction of new quay.

FRANK TESSIN, ESAB GMBH, GERMANY.

The extension of the Predöhl Quay required the construction of a new quay, which is built-up in the harbour basin directly in front of the old quayside. The necessary welding work took six weeks and required the welding of 408 type S 355 J2G3 steel plates with a wall thickness of 25 mm to the framework of the quay to secure the so called hinged anchors. The hinged anchor piles structurally reinforce the quayside.

The plates were joined to the framework with a=6 fillet welds in the positions PB, PF, and PD. The total weld length was approximately 730 m. The preheat temperature of the steel was 120°C and the joints were randomly ultrasonic tested. Traditionally, manual stick electrode welding is used for such welding work. More productive MAG welding was impossible due to expected winds, welding directly at the water

Building contractors AUG. PRIEN GmbH & Co KG of Hamburg, Germany, carried out the welding work for the extension of the Predöhl Quay in the port of Hamburg, being contracted by the Department for Economy and Labour, Energy and Harbour Construction of the city of Hamburg. ESAB’s Coreshield 8 self-shielded cored wire was crucial to meeting the construction schedules.

Building site at the Predöhl quay.
level, and restricted space that did not allow wind protection by a welding tent. These limitations do not apply to welding with self-shielded wires.

Prien GmbH showed great interest in a proposal from ESAB GmbH Solingen to carry out the project with self-shielded cored wire.

A presentation on the application of Coreshield 8 convinced the construction company of the versatility and productivity advantages of the process. Without delay, the welding qualification procedure to EN 288-3 was successfully passed at SLV Nord so that the work could commence at the earliest possible date.

Along with Coreshield 8, Prien used ESAB process package no. 114 which consists of the special MT 300 GL torch and the digital inverter power source AristoMig 400. The all-position suitability of Coreshield 8 -1.6 mm significantly simplified the attachment of the plates to the framework. At a fixed welding current of 200-220 A in all positions, a deposition rate of 3kg/h (100% duty cycle) was obtained, shortening the welding time substantially compared with MMA.

For future projects, Prien plans to include Coreshield 8 in its selection of preferred welding consumables.

### Coreshield 8

Coreshield 8 is a self-shielded cored wire with a fast-freezing slag to support the weld metal during welding, giving it all-position capabilities. It is ideal for outdoor welding in structural fabrication and other heavy-duty applications where good toughness is required.

### Classification

SFA/AWS A5.20 E71T-8

<p>| Typical all-weld metal composition (%) |</p>
<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Ni</th>
<th>Cu</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.18</td>
<td>0.14</td>
<td>0.6</td>
<td>&lt;0.1</td>
<td>&lt;0.5</td>
<td>&lt;0.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

| Typical mechanical properties |
| Yield strength (MPa) | 457 |
| Tensile strength (MPa) | 552 |
| Elongation (%) | 29 |
| Charpy-V, -40C (J) | 43 |

<p>| Welding parameters |</p>
<table>
<thead>
<tr>
<th>Diameter, mm</th>
<th>Welding current, A</th>
<th>Arc voltage, V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>155-240</td>
<td>21-25</td>
</tr>
</tbody>
</table>

**About the Author**

**Frank Tessin** M.Sc. is Product Manager Cored Wires and Key Account Manager at ESAB GmbH, Solingen, Germany.

For more information contact: Frank.tessin@esab.de

Figure 1. Welding of a support plate in the overhead position with Coreshield 8. Power source: AristoMig 400 with MA4 panel and ESABFeed 48 wire feed unit.

A presentation on the application of Coreshield 8 convinced the construction company of the versatility and productivity advantages of the process. Without delay, the welding qualification procedure to EN 288-3 was successfully passed at SLV Nord so that the work could commence at the earliest possible date.

Along with Coreshield 8, Prien used ESAB process package no. 114 which consists of the special MT 300 GL torch and the digital inverter power source AristoMig 400. The all-position suitability of Coreshield 8 -1.6 mm significantly simplified the attachment of the plates to the framework. At a fixed welding current of 200-220 A in all positions, a deposition rate of 3kg/h (100% duty cycle) was obtained, shortening the welding time substantially compared with MMA.

For future projects, Prien plans to include Coreshield 8 in its selection of preferred welding consumables.

### Coreshield 8

Coreshield 8 is a self-shielded cored wire with a fast-freezing slag to support the weld metal during welding, giving it all-position capabilities. It is ideal for outdoor welding in structural fabrication and other heavy-duty applications where good toughness is required.

### Classification

SFA/AWS A5.20 E71T-8

<p>| Typical all-weld metal composition (%) |</p>
<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Ni</th>
<th>Cu</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.18</td>
<td>0.14</td>
<td>0.6</td>
<td>&lt;0.1</td>
<td>&lt;0.5</td>
<td>&lt;0.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

| Typical mechanical properties |
| Yield strength (MPa) | 457 |
| Tensile strength (MPa) | 552 |
| Elongation (%) | 29 |
| Charpy-V, -40C (J) | 43 |

<p>| Welding parameters |</p>
<table>
<thead>
<tr>
<th>Diameter, mm</th>
<th>Welding current, A</th>
<th>Arc voltage, V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>155-240</td>
<td>21-25</td>
</tr>
</tbody>
</table>

**About the Author**

**Frank Tessin** M.Sc. is Product Manager Cored Wires and Key Account Manager at ESAB GmbH, Solingen, Germany.

For more information contact: Frank.tessin@esab.de
The AristoMig robot package – high tech welding equipment for any robot.

Easy to install - easy to use - new robots and retrofit.

**Alex Jiroflé, ESAB European Sales and Marketing, Belgium.**

With the introduction of the AristoMig robot package, ESAB can now provide robot suppliers and integrators with superior welding technology that is easy to install and use, both for new welding robots and for retrofitting.

**Use of welding robots shows steady growth**

The use of arc welding robots in the industrialised world shows a steady increase. Figure 1 shows the yearly installation and forecast for industrial robots until 2007. Nearly 25% of all industrial robots are used in welding applications. Figure 2 shows the estimated operational stock of industrial robots [1]. It is not only new robots that require the latest welding equipment and technology. Increasingly, fabricators use this option when retrofitting their existing installations.

The ESAB AristoMig process package is available through robot suppliers and integrators and can be used for almost all robotic applications. It can be connected to different type of robots and includes standard configurations for new Motoman and ABB robots and for the retrofitting of existing Motoman and ABB robot installations.

**High tech welding equipment**

The AristoMig process package (with ESAB Can-bus technology) offers a choice of AristoMig inverter-based power sources, encapsulated and non-encapsulated, robot-mounted wire feeders, interfaces and the AristoPendant U8 control box.

The interface with the robot controller can be achieved with analogue/digital I/O communication or via CAN-bus. The package includes high quality welding wires supplied in ESAB MarathonPac bulk drums.

Figure 3 shows two different standard process packages. The first is with a RoboFeed 30 encapsulated wire feeder mounted on the robot arm. The second shows the MEM 30-4 or MEL 48-4 open wire feeders.

The package features several different components. The heart and brain of the installation is the AristoPendant U8. The excellent man – machine – communication (MMC) with language option, allows the operator or welding...
engineer to access and/or set the process parameters while welding. Quality control, parameter-setting, error handling, storing of the parameters, remote choice (= robot in control), external communication - is all achieved with the AristoPendant U8 – the only non-standard component in the package.

There are U8 configurations for:
- Digital/analogue I/O connection
- Profibus
- Device Net
- CAN open.

The 2nd important component is the powersource. Here ESAB offers the choice of four different power sources - the AristoMig 320, 400, 450 and 500. Each can be equipped with a built-in water cooler.

In wire feeders, there is choice between enclosed and open versions. All include important process functions for robotic welding such as manual wire feed, manual wire retract, gas test, gas sensor, air test and transport of the anti-collision status. All wire feeders have a EURO connector for the welding torch.

The Interface or Bussplitter (depending of the method of communication) is another important component. All new robots are normally equipped with bus communication such as Profibus, Device Net, CAN-open etc. The bus splitter connects to the robot bus and splits the equipment’s internal bus from that of the robot. For conventional communication, there is a digital/analogue solution which can also be used to retrofit older robot installations that have no bus communication.

Components are connected by cables and cable assemblies, available in lengths from 2 to 35m, with or without water cooling. ESAB’s internal CAN-bus communication enables these to be thinner and more flexible, because only two wires are needed for all signals instead of one wire per signal with a conventional system.

The AristoMig process package includes robot quality MIG/MAG wires packed in MarathonPac bulk drums. MarathonPac reduces downtime for spool exchange by almost 95%, drastically increasing the duty cycle and output of a robot installation.

Benefits
Both the integrator or robot supplier and the end-user enjoy clear benefits from the AristoMig process package.

Benefits to the integrator (robot supplier):
- The process package is easy to install and connect. In addition, the AristoPendant U8 provides an unbeaten combination of easy handling and full functionality enhancing the efficiency of integrators.
- Features and functions are indicated in plain text: no need for symbol tables to identify functions. Example: 15 languages are included in the standard software and can be changed in the configuration menu. The integrator can set up the equipment in the language of the end-user without additional tools.
- Standard components are well proven and easily exchangeable. For example, the exchange of an AristoMig 400 with an AristoMig 500 takes only a few minutes.
- The use of CAN-bus technology gives access to information such as measured values of voltage, current and power.

Benefits to the end-user:
- Superior weld quality: The weld quality that can be obtained with the AristoMig process package, helped by the excellent MMC of the U8 Pendant, is unsurpassed. Quality functions is a standard feature in the AristoPendant U8.
- Less rejects - resulting in higher production.
- Special functions such as SuperPulse for challenging applications.
- Support from ESAB weld specialists to get the best out of the equipment.
- The use of CAN-technology reduces the risk of cable failure. The "error log" function helps to analyse faults efficiently and to limit downtime.


About the author

Alex Jirofle is Robotics Applications Manager within ESAB Sales and Marketing Europe. He is located at ESAB Belgium, in Brussels.

For more information contact: alex.jirofle@esab.be
The AristoMig 400/500 range of power sources.
As versatile and intelligent as you want it to be – always easy to operate.

Acknowledgement
This article is based on information obtained from my ESAB colleagues Hans Wolters, Peter Budai, Per Åberg, Michael Setterberg, Hannes Löfgren, Arvo Köster, Michael Persson, Johann Katic, Franz Josef Maus and Arne Skovro.

Strong and reliable machines
All AristoMig machines have design features that provide clear advantages for fabricators. The revolutionary Alutech™ aluminium chassis is strong, corrosion-proof, easy to clean, and designed for long service life under tough working conditions (Figure 1). The machines are ergonomically designed with a slanted front, and feature two large handles integrated into the chassis - certified to facilitate lifting of the machine by crane.

Although compact by design, AristoMig power sources have air and water-cooling units built-in to facilitate long and trouble-free service under the most demanding conditions. Air-cooling is a “fan-on-demand system”, which means that it is only activated during welding and shuts-off automatically. This saves energy and reduces wear and maintenance.

The integrated dust and metal-particles filter is easily reached for cleaning. AristoMig is the only machine with air-cooling separated from electronics. The design enables three minute service - unique in the market.

Water cooling is activated by means of ELP (ESAB Logic Pump) as soon as a water-cooled torch is connected. The ELP switch cannot be activated with an air-cooled torch. The water-cooling unit is connected to the power source's sleep mode. This extends the lifecycle of the power source and pump, saves on electricity consumption and reduces workshop noise.

The unique True-Arc Voltage, in combination with an ESAB PSF welding torch, guarantees welding with the selected arc voltage, independent of the torch and return cable length. You get what you see.

AristoMig power sources use CAN-bus communication, optimising the flexibility of the equipment (Figure 1). CAN-bus is a digital communication and control system that enables all “intelligent” components of the machine to communicate with one another, both inside and outside the power source. The system needs fewer cables than a conventional system and is therefore easy to operate, reliable and insensitive to disturbances.
Modular design provides fabricators with the following options to ‘build’ their AristoMig power source:

- **Capacity**
  1. 400A
  2. 500A

- **Type of power source**
  1. Air cooled
  2. With water-cooling
  3. With multi-voltage unit
  4. With water-cooling and multi-voltage unit

- **Type of wire feeder**
  1. AristoFeed 30 – 4 open bobin or encapsulated bobin
  2. AristoFeed 48 – 4 open bobin or encapsulated bobin

- **Accessories such as torch, cable assembly, trolley, remote control, kit for multiple wire feeders and counterbalance device.**

AristoMig – the panel does it

The various panel versions, incorporated in the wire feeder, contain most of the software that determines the level of functionality and intelligence of the machine to meet the welding requirements of individual fabricators.

Table 1 shows the increasing level of processes, machine functions and intelligence of AristoMig 400 or 500 machines equipped with respectively MA4, MA6, U6 panels and the AristoPendant U8 control unit.

In the first column, under “processes”, the welding processes are listed for the individual AristoMig/panel combinations. The second column shows the process functions that can be operated with the individual panels. The third column shows the intelligence of the machine. It reflects ESAB’s knowledge and experience in the form of synergic lines and smart functions that enable full control over the welding process.

In all columns, the functionality increases from top to bottom, from an inverter with conventional options and no synergic settings added (AristoMig with MA4 panel), to a truly multi-process machine with the highest level of intelligence available (AristoMig Universal with U8 control box).

- **AristoMig with MA4 panel**
  Equipped with an MA4 panel, AristoMig machines can be used for non-pulse MIG/MAG welding and MMA. It has all the modern process functions of a conventional machine. User benefits, in comparison with a conventional MIG/MAG rectifier, are:

  - lighter weight (compared with rectifier and thyristor technology).
  - stepless inductance - enabling parameters to be set precisely and maximising the potential of the consumable.
  - inverter process dynamics - providing better (start) performance.
  - remote control option.
  - standard high quality MMA welding with stick electrodes and arc gouging.

AristoMig machines with MA4 panel can basically be used wherever conventional rectifiers are applied. For welders used to a conventional machine, this combination can be the first step towards benefitting from digital technology without having to use any menus. The control panel has a display and push buttons, functions being clearly indicated by symbols.

The application field of this non-pulsing unit is limited to the welding of non- and low-alloyed steel, stainless steel and aluminium in short arc or spray arc. It has the ease of use of conventional equipment - but better characteristics.

- **AristoMig with MA6 panel – a truly all-round machine**
  The AristoMig with MA6 panel is basically still a two-process machine, but advanced in the sense that synergic MIG/MAG and synergic pulse MIG/MAG are added. A powerful arc gouging option is included, running at speeds which normally require a much higher output current.
Along with these extra process variants, are a number of related process functions that are added to the process functions of MA4 - making it a truly all-round machine for MIG/MAG and MMA welding. It is also the first panel to have ESAB intelligence added in the form of a considerable number of synergic lines for the MIG/MAG welding of steel, stainless steel, aluminium, and for rutile and basic cored wires, covering the most common applications. Synergic lines for MMA are also included. An interesting option is the ability to change the library of synergic lines. For example, if a fabricator wants a machine that is specialised for aluminium welding, the standard library of synergic lines can be changed.

Figure 2. Processes, process functions and intelligence of AristoMig power sources.

<table>
<thead>
<tr>
<th>Process functions MA4</th>
<th>Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage setting</td>
<td></td>
</tr>
<tr>
<td>Wire feed speed</td>
<td></td>
</tr>
<tr>
<td>V/A display</td>
<td></td>
</tr>
<tr>
<td>Virtually stepless inductance</td>
<td></td>
</tr>
<tr>
<td>Gas pre/post flow</td>
<td></td>
</tr>
<tr>
<td>Creepstart</td>
<td></td>
</tr>
<tr>
<td>Crater filling</td>
<td></td>
</tr>
<tr>
<td>Burnback time</td>
<td></td>
</tr>
<tr>
<td>2/4 stroke</td>
<td></td>
</tr>
<tr>
<td>MMA: Arc force, hotstart</td>
<td></td>
</tr>
<tr>
<td>Remote control</td>
<td></td>
</tr>
</tbody>
</table>

| Process functions MA6 = MA4 + : Flexible synergy | Intelligence |
| Synergy supported hotstart | 29 commonly used synergic lines in memory |
| Synergy supported crater fill | Alternative group of synergic lines upgradable with ESAT |
| Trigger data mode | 15 languages display |
| Trigger data mode remote control | Lock parameter function with ESAT |
| Settable limits | Auto save mode |
| 10 memory positions | Off-the-arc-wire feeder |
| Choice of electrode type | Alternative 4 stroke modes with ESAT |
| Hot start MIG | Panel enable mode with ESAT |
| Gas purge |              |
| Wire inching |              |
| Spot weld |              |

| Process functions U6 = MA6 + : HiF lift arc | Intelligence U6 = MA6 |
| Up/downslope | Library of >200 synergic lines |
| Gas pre-/postflow | Create and store personal synergic lines |
| 2/4 stroke TIG | Lock parameter without ESAT |

| Process functions U8 = U6 + : 99 memory positions | Intelligence U8 = U6 + : |
| Memory card | Library of >200 synergic lines |
|              | Create and store personal synergic lines |

<table>
<thead>
<tr>
<th>Explanation of key words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 4-stroke: choice of three different 4-stroke modes.</td>
</tr>
<tr>
<td>Auto save mode: last used parameters are saved in the memory position when switching to another setting.</td>
</tr>
<tr>
<td>Crater filling: less risk of end-crater cracks.</td>
</tr>
<tr>
<td>Creepstart: lower start wire speed for smooth starting; ideal for aluminium and stainless steel.</td>
</tr>
<tr>
<td>Error log: log of all machine and communication errors for fault analyses and service.</td>
</tr>
<tr>
<td>ESAT: ESAB Software Administration Tool.</td>
</tr>
<tr>
<td>Fast mode: four buttons for quick selection of settings.</td>
</tr>
<tr>
<td>Gas purge: clean gas hoses by purging; important for aluminium welding.</td>
</tr>
<tr>
<td>Hot start: higher start current to avoid start defects; trigger controlled in one of the three 4-stroke modes.</td>
</tr>
<tr>
<td>Lock parameter function: blocking of parameter setting by PIN-code.</td>
</tr>
<tr>
<td>Memory card: external memory for storing welding data.</td>
</tr>
<tr>
<td>Memory position: location to store a complete set of welding parameters.</td>
</tr>
<tr>
<td>MMA arc force: for better weld pool control.</td>
</tr>
<tr>
<td>Multiple wire feeder control: allows connection of up to four wire feeders.</td>
</tr>
<tr>
<td>Off-the-arc-wire feeder: Function for connecting an arc voltage feeder.</td>
</tr>
<tr>
<td>Panel enable mode: panel active when using remote control.</td>
</tr>
<tr>
<td>Settable limits: process parameters can be limited between two levels.</td>
</tr>
<tr>
<td>Virtually stepless inductance: variable inductance.</td>
</tr>
<tr>
<td>Synergic: one knob setting of all parameters.</td>
</tr>
<tr>
<td>Synergic line: a complete envelope of parameters for a wire/gas combination - one knob use.</td>
</tr>
<tr>
<td>Trigger data mode: switching between memory position with torch trigger.</td>
</tr>
<tr>
<td>Wire inching: current free wire transport.</td>
</tr>
<tr>
<td>Q-log: logging of used parameters for quality control.</td>
</tr>
</tbody>
</table>
AristoMig with MA6 panel - a truly all-round machine

The panel can be operated in 15 languages - a great advantage in today’s multi-cultural workshops.

“Parameter limit” is a smart function that locks welding parameters within a range allowed by the welding procedure specification, so that welders can not go beyond heat-input limits and stay within specified weld quality. A PIN code can be installed with ESAT. The parameter lock is ideal for fabricators required to testify that WPS’s are fulfilled (eg, in shipbuilding, pressure vessel fabrication and offshore fabrication). It can also be used to control the heat input when welding high strength and creep resistant steel and ferritic and duplex stainless steels.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

Due to the limited amount of memory positions, it is basically a machine intended for manual and mechanised welding. Robotic welding normally requires the availability of more memory positions and, moreover, the right interface (as available with AristoPendant U8 control unit). AristoMig with MA6 panel is well suited for mechanised welding with Miggytrack or Railtrack equipment, typically for use in shipyards, truck and train fabrication, and pressure vessel fabrication.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.

AristoMig with MA6 panel is a machine that will suit the majority of fabricators. Steel, stainless steel and aluminium, from thicknesses of around 1.5 mm, can be welded. The pulsing facility makes it suitable for welding thin plates and for positional welding.
Intelligence at your fingertips

AristoMig panels are very easy to operate due to a logical and user-friendly set-up. All AristoMig panels use a menu structure, very much like a mobile phone - not a tree structure as is still very common. As a result, users never have to click deeper than a few levels to reach any information. An example of user-friendly operation with the MA6 panel - the most commonly used panel with AristoMig machines – is shown in Figure 3 and illustrates how the machine settings are changed from solid wire MAG welding in spray arc to synergic pulse welding of stainless steel. Operation is very straightforward, using just two buttons to change all settings.

The U6 panel and U8 Pendant control box work in the same user-friendly way. The amount of information stored in U8, however, is much larger and, initially, it may take some time to locate the required settings using the menus.

1. Settings for MAG welding with 1.0 mm solid wire: Push menu to go to process selection.

2. Present process setting. Push 1st button to select process.

3. Push Next until pulse MIG/MAG appears. This is automatically synergic pulse welding.

4. Use 1st button to scroll down to “wire type”.

5. Push Next button until stainless steel wire appears.

6. Use 1st button to scroll down to “gas”. Standard gas selection for stainless steel already given.

7. Use 1st button to scroll down to “wire diameter”.

8. Push Next button until 1.2mm appears.

9. Selection ready: Push Menu to go to welding display.

10. Display for synergic pulse MIG welding of stainless steel with 1.2mm wire in Ar/2% CO₂ shielding gas. Crater fill and hot start active by pushing button 2 and 3.
**Unique Aristo SuperPulse™ technology,** included in the U8 Pendant control box, is attractive for fabricators handling very thin to very thick aluminum and stainless steel. SuperPulse is ESAB’s latest innovation in digital welding. It has the capacity to pair all arc types in one setting, offering full control over heat-input and weld penetration, and providing great potential for quality and productivity improvement.

By combining short arc with pulse arc, material below 1mm can be welded with excellent weld quality. Positional welding of thicker material can be performed at a high productivity and excellent weld quality by combining spray arc with pulse arc. Other areas for the use of SuperPulse are root runs or applications where it provides a faster alternative to TIG-welding. Aristo SuperPulse can be combined with all AristoMig power sources, but optimal results are achieved with AristoMig 500 because of superior welding characteristics in the low-current area.

**Process packages**
Described above are the options ESAB offers to fabricators to ‘build’ their standard AristoMig machine. ESAB can also build AristoMig process packages for customers’ specific applications.

The AristoMig robot package is a standard system developed for robot suppliers and integrators. It uses robot mounted wire feeders and the AristoPendant U8 control unit is loaded with the configuration needed to communicate with the BUS-system of the robot. The package is used for both new and used robots. The AristoMig robot package is described elsewhere in this issue of Svetsaren.

Non-standard packages can be built on request, eg, an AristoMig aluminium welding package. As described earlier, it can be loaded with a special library of synergic lines for aluminium and is, typically, equipped with a push-pull gun, special feeder rolls, teflon liner, etc.

Another example of a non-standard package is for shipyards, where the standard wire feeder is replaced by the light-weight ESAB Yardfeeder™.
E-Vent is a new, compact, single-source solution that includes a CNC control system and software. With E-Vent, operators can make full use of the advantages of tried and tested plasma technology.

ESAB Cutting Systems’ innovative E-Vent plasma cutting system is especially suited to applications in the heating, ventilation, air conditioning and building insulation industries (HVAC), as it is extremely compact in design.

The size of the cutting area varies, depending on the model. The machine is available with cutting areas of 1,500 x 3,000 mm, 1,500 x 6,000 mm, 2,000 x 3,000 mm, 2,000 x 4,000 mm or 2,000 x 8,000 mm. Maximum cutting thickness is 8 mm.

Modular machine design allows flexible configurations that can be individually adjusted to suit the specific requirements of different industries. Compact design simplifies integration into any workshop.

Advanced cutting technology
In developing E-Vent, special attention has been focused on issues such as quiet running, accurate positioning and a high machine speed. Extremely dynamic AC drives cater for a cutting speed of 20,000 mm per minute (depending on the material) - an impressive speed for this specific class of machine. Torsion-resistant design with a low-lying cross rail, allows the ESP 50 plasma torch to be brought very close to the work piece, ensuring ideal positioning and guidance of the cutting beam.

The unit is controlled via the user-friendly Vision LE CNC. All machine functions and processing steps are centrally monitored, controlled and co-ordinated.

Pen Marking
This process is mainly used on ESAB’s smaller machines or for stainless steel operation. A classic felt tip pen is used with the plate rider system, ensuring a constant distance and pressure on the felt. The pen is clamped onto its bracket via a magnetic device. Marking speed can be up to 3,000 mm/min. This is an ideal solution for marking draw folding lines, assembling lines and parts numbers.

Unfolding
The software includes a range of industry-specific features such as workplace preparation and parts management functions.

Pattern libraries: The most extensive libraries of rectangular, round and oval fittings are available. All patterns are suitable for welding or seaming and can have metric or imperial dimensions. The patterns have configurable options such as seam positions; nominal, OD/ID, notches, stitching and double skinned isolation.

Fitting data entry: Allows the user to select a fitting and then detail for manufacturing. Gauge, connectors, seams and stiffeners are Pressure Class driven.

Software is a very user-friendly, 32-bit application running under Windows on PCs and networks comprising:

- Full specification database.
- Extensive, flexible Pattern Libraries.
- CAD drawing program imports DXF files.
- Auto-Interactive slice and assemble for oversize fittings.
- Powerful label and report generator.

ESAB Cutting Systems GmbH Product Manager Carl M. Bandhauer, is delighted to again serve a market segment in which ESAB has an excellent reputation:

"Our customers appreciate the design and compactness of the E-Vent, as well as the fast and simple assembly, high process speed and easy machine handling."
AUSTRIAN METAL BUILDING COMPANY RELIES ON EAGLE PLASMA CUTTING INSTALLATION FOR FLEXIBILITY AND SPEED.

Innovative cutting concept from ESAB Cutting Systems helps Kranawetter & Heiss save time and money.

Rationalization is not only of importance to large companies, small and medium-sized enterprises also have to optimize operating and fabrication processes. A recent visit to Kranawetter & Heiß Metallbau showed how the use of state-of-the-art cutting technology contributes to increased efficiency.

Based in St. Pölten Unterradlberg in Lower Austria, Kranawetter & Heiß has developed from a small locksmith’s shop to a modern metal fabrication company with 12 employees and is renowned in the region for a wide range of services and supplies. Throughout Kranawetter & Heiß, craftsmanship and state-of-the-art technology combine with commitment and quality control.

Stephan Kranawetter, son of the company’s founder, says, “Our clients, customers and partners simply expect perfection. Thus, we constantly face new challenges. Whether parts for steel and facade construction, windows, doors or railings, it is the right technology that enables us to perform to customer expectations. Some 6 months ago, we decided to buy a new cutting system and discussed individual concepts from several suppliers. We favoured the concept presented by ESAB Cutting Systems and, today, we know we made the right decision”.

Planning, customer-specific configuration and assembly of the system was carried out by ESAB Cutting Systems in Karben near Frankfurt am Main, local project supervision being carried out by ESAB GesmbH, Vienna.

The heart of the machine is the ESAB EPP 200 system with integrated gas and high frequency console that supplies 5 to 200 A, features an automatic switch-over from PT-24 to PT-600 and enables record-beating cutting speeds of up to 3750 mm per minute. One common power source for two plasma cutting heads means potential savings of approximately 25,000 Euros compared to traditional solutions.

“This alone was worth the investment in this machine” says Stephan Kranawetter who, at the same time, praises the flexibility of the concept: “With the EAGLE guiding machine, the two plasma torches and the EPP 200, we can manufacture even small batch sizes of 100 to 200 pieces quickly, accurately and economically. Even when it comes to custom-built products, we rely on the quality and speed of plasma”.

The company has now integrated 90% of all previously out-sourced cutting services into their own operations. And what is the customer’s final comment on the assembly, commissioning and operator training services? “From the very beginning, ESAB’s specialists have given first-class advice. The equipment was installed in just two weeks, the programming software COLUMBUS runs on a standard PC and all processes can be easily adapted to the task required. We are very satisfied.”

### Technical Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAGLE 2500 with CNC contouring control VISION - PC</td>
<td></td>
</tr>
<tr>
<td>Overall width of machine</td>
<td>3,660 mm</td>
</tr>
<tr>
<td>cutting width with 1 torch</td>
<td>2,000 mm</td>
</tr>
<tr>
<td>cutting length</td>
<td>4,000 mm</td>
</tr>
<tr>
<td>length of running path</td>
<td>6,000 mm</td>
</tr>
<tr>
<td>cutting thickness</td>
<td>1 to 50 mm</td>
</tr>
<tr>
<td>cutting speed</td>
<td>max. 30 m/min</td>
</tr>
<tr>
<td>mains voltage</td>
<td>220 V, 50 Hz</td>
</tr>
<tr>
<td>CNC contouring control</td>
<td>VISION - PC</td>
</tr>
</tbody>
</table>

### Description:

The EAGLE is specially designed for high-precision plasma applications. It combines high productivity, extraordinary precision and state-of-the-art process control at maximum quality and the best price possible.

With the cutting parameters which can be programmed by the NCE controller, ESAB Cutting Systems achieves fully automatic set-up of all machine and cutting parameters such as gas pressure, current, voltage, gas type, speed, ignition height, deceleration and acceleration times.
Miggytrac 1001

THE PERFECT COMPLEMENT TO YOUR MIG/MAG POWER SOURCE

Replacing the well-known Miggytrac 1000, the Miggytrac 1001 is a small, compact, motor powered tractor to which a standard ESAB welding torch can be quickly attached. Four driving wheels, together with the permanent magnet fitted onto the tractor, guarantee even, stable movement. The magnet holds the tractor in the correct position on the workpiece - even if it is bent or angled - and follows the joint using guide wheels.

The tractor functions as a straightforward remote control for the feed unit; the operator decides the travel direction, and start and stop welding functions from the panel. The panel features additional functions such as travel speed settings (150-1200 mm/min), wire feed speed, voltage and welding on/off.

Pipe mill installation

ESAB AB Welding Equipment has delivered four installations to the Chelyabinsk Pipe Mill, in Russia, for continuous tack welding of pipes.

Each installation comprises a type LAF 1600 power source with a continuous welding current of 1600 A, and a special process control system built around ESAB's PEH arc welding controller.

The welding head, based on components from the A6-system, is designed for gas-shielded welding with argonmix and CO₂-gas.

A laser joint tracking system is used for path compensation.

For further information, please contact: krister.skog@esab.se

Miggytrac 3000

THE COMPLETE EQUIPMENT FOR MIG/MAG WELDING

The Miggytrac range has been extended with the introduction of the new generation Miggytrac 3000 to complement the Miggytrac 1001 and Miggytrac 2000. The Miggytrac 3000 is a small, compact 4-wheel driven tractor for horizontal welding of for example beams and stiffeners. Welding and travelling parameters are controlled by push buttons and indicated on displays. Intermittent welding is easily achieved.

If the MIG/MAG power source used does not feature a crater fill function, the tractor can be programmed with this function.

Weight of the Miggytrac 3000 is 17 kg, without consumables, and it is designed for a 20 kg bobbin.
NEW HIGH PERFORMANCE MIG FOR UP TO 300A APPLICATIONS.

High performance MIG usually means high power, limited choice, and for use on thinner material - a premium price. But, in response to customer demands for flexible, high performance MIG equipment up to 300A, ESAB now introduce a totally new range of high performance machines for medium duty applications. Presented on the ESAB stand at the 2005 Essen fair, these machines represent exceptional value for money.

**ESABMig C300i/300i**
Fully featured, compact and versatile packages, the all new ESABMig C300i and 300i are designed for use on a wide range of applications requiring up to 300A, have a power to weight ratio that is unique in the market and offer outstanding weld characteristics in both the MIG and MMA processes. Both of these competitively priced, with respect their performance, inverter based units are equipped with ESAB’s new and unique function for the setting of short arc parameters. With this simple, one knob control, you set the wire feed speed and the equipment automatically selects the correct welding parameters irrespective of wire and gas combination without using synergic lines.

The ESABMig 300i uses the ESABFeed 30L-4 wire feed unit, which can be fitted with 15m connection cables to provide a wide working radius, while the compact ESABMig C300i comes with a built in wire feed system.

Correct arc voltage is guaranteed independent of any voltage drop in the welding cables by ESAB’s TrueArcVoltage system. This means that welding with 3m leads or the optional 15m extension leads will make no difference to the arc voltage at the torch and consequently the weld result.

**ESAB AristoMig C300/300**
Designed to produce quality weld results in high alloy materials up to 5mm in thickness, these price competitive machines with their impressive power to weight ratio, are the perfect partners for a wide range of production and prefabrication applications. Inverter based and equipped with the same technology as the market leading ESAB AristoMig 500, these machines are unrivalled for thin plate welding and spatter reduction. The AristoMig C300/300 are equipped with the CAN-Bus communication and control system and the MA6 control panel, one of the easiest to operate control units on the market, providing access to quality and productivity improvement functions in the MIG/MAG, Pulse MIG and MMA welding processes. In addition the user-friendly control panels provide the ESAB AristoMig with a full bank of Synergic lines.

The ESAB AristoMig 300 uses the AristoFeed 30L-4 wire feed unit, which can be fitted with 15m connection cables to provide a wide working radius, while the compact ESAB AristoMig C300 comes with a built in wire feed system.

As with the ESABMig C300i/300i correct arc voltage is guaranteed independent of any voltage drop in the welding cables by ESAB’s “TrueArcVoltage” system.
**Product News**

**MXH 400w PP - Electric push-pull welding gun**

The MXH 400w PP is a water-cooled, electric push-pull welding gun for feeding aluminium wires and small diameter wires (0.8 – 1.2mm) over long distances. The gun can be used with ESABFeed or AristoFeed wire feeders and with the ESABMig C420 compact power source. The wire feed speed is controlled by a potentiometer located in the gun handle.

When connected to an AristoMig U 500 power source, with AristoPendant U8 control unit and AristoFeed 30-4 wire feeder, ESAB’s unique SuperPulse technology can be used for advanced aluminium welding.

The gun is supplied, as standard, with a straight neck. A 45 degrees swan neck is available as an option, allowing 360 degrees rotation for any welding position. Cable lengths of 6 m or 10 m are available, standard delivery including a Teflon liner, feed roll and a contact-tip for 1.2 mm wires.

Co-ordination between the front feeder (pull) and the main feeder (push) is controlled by the main feeder’s printed circuit board. The motor and gear ratios of both the MXH PP gun and the push feeder are optimised to ensure an accurate push-pull feeding system.

Use with the CAN-bus operated AristoFeed feeder requires a connection kit or a combined connection and wire feed control kit assembled to the feed unit. ESABFeed M12, M13 and M13i feeders feature a standard 23-pole Burndy socket for direct connection. A connection kit is also required for use with the ESABMig C420 compact power source.

**NEW PRODUCT NAMES FOR ALUMINIUM MIG/TIG WIRES**

ESAB aluminium MIG and TIG wires have, recently, been given new product designations to simplify selection. The new designations are: OK Autrod or OK Tigrod - followed by the numeric 4-digit AWS filler metal code. This allows ESAB to use the same product designations, worldwide – an obvious advantage for international fabricators. All existing approvals have been transferred to the new product designations.

<table>
<thead>
<tr>
<th>Old product name</th>
<th>New name</th>
<th>AWS A5.10</th>
<th>New EN-ISO 18273 Numerical Class.</th>
<th>Chemical Class.</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Autrod 18.01</td>
<td>OK Autrod 1070</td>
<td>S Al 1070</td>
<td>A99.7</td>
<td></td>
</tr>
<tr>
<td>OK Tigrod 18.01</td>
<td>OK Tigrod 1070</td>
<td>S Al 1070</td>
<td>A99.7</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 18.04</td>
<td>OK Autrod 4043</td>
<td>ER4043</td>
<td>S Al 4043/S Al 4043A</td>
<td>AIS5/AlSi6(A)</td>
</tr>
<tr>
<td>OK Tigrod 18.04</td>
<td>OK Tigrod 4043</td>
<td>R4043</td>
<td>S Al 4043/S Al 4043A</td>
<td>AIS5/AlSi6(A)</td>
</tr>
<tr>
<td>OK Autrod 18.05</td>
<td>OK Autrod 4047</td>
<td>ER4047</td>
<td>S Al 4047/S Al 4047A</td>
<td>AIS12/AlSi12(A)</td>
</tr>
<tr>
<td>OK Tigrod 18.05</td>
<td>OK Tigrod 4047</td>
<td>R4047</td>
<td>S Al 4047/S Al 4047A</td>
<td>AIS12/AlSi12(A)</td>
</tr>
<tr>
<td>OK Autrod 18.11</td>
<td>OK Autrod 1450</td>
<td>S Al 1450</td>
<td>A99.5Ti</td>
<td></td>
</tr>
<tr>
<td>OK Tigrod 18.11</td>
<td>OK Tigrod 1450</td>
<td>S Al 1450</td>
<td>A99.5Ti</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 18.13</td>
<td>OK Autrod 5754</td>
<td>S Al 5754</td>
<td>AlMg3</td>
<td></td>
</tr>
<tr>
<td>OK Tigrod 18.13</td>
<td>OK Tigrod 5754</td>
<td>S Al 5754</td>
<td>AlMg3</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 18.15</td>
<td>OK Autrod 5356</td>
<td>ER5356</td>
<td>S Al 5356/S Al 5356(A)</td>
<td>AlMg5Cr(A)</td>
</tr>
<tr>
<td>OK Tigrod 18.15</td>
<td>OK Tigrod 5356</td>
<td>RS356</td>
<td>S Al 5356/S Al 5356(A)</td>
<td>AlMg5Cr(A)</td>
</tr>
<tr>
<td>OK Autrod 18.16</td>
<td>OK Autrod 5183</td>
<td>ER5183</td>
<td>S Al 5183/S Al 5183(A)</td>
<td>AlMg4.5Mn0.7(A)</td>
</tr>
<tr>
<td>OK Tigrod 18.16</td>
<td>OK Tigrod 5183</td>
<td>RS183</td>
<td>S Al 5183/S Al 5183(A)</td>
<td>AlMg4.5Mn0.7(A)</td>
</tr>
<tr>
<td>OK Autrod 18.17</td>
<td>OK Autrod 5087</td>
<td>S Al 5087</td>
<td>AlMg4.5Mn2r</td>
<td></td>
</tr>
<tr>
<td>OK Tigrod 18.17</td>
<td>OK Tigrod 5087</td>
<td>S Al 5087</td>
<td>AlMg4.5Mn2r</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 18.20</td>
<td>OK Autrod 5556</td>
<td>ER5556</td>
<td>S Al 5556A</td>
<td>AlMg5Mn</td>
</tr>
<tr>
<td>OK Tigrod 18.20</td>
<td>OK Tigrod 5556</td>
<td>RS556</td>
<td>S Al 5556A</td>
<td>AlMg5Mn</td>
</tr>
<tr>
<td>OK Autrod 18.22</td>
<td>OK Autrod 18.22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Tigrod 18.22</td>
<td>OK Tigrod 18.22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NEW PRODUCT NAMES FOR STAINLESS CONSUMABLES

With effect from autumn 2005, ESAB stainless steel MIG and TIG wires, SAW wires and strip, will have new product designations to simplify selection. Depending on product, the new designations will be: OK Autrod, OK Tigrod or OK Band - followed by the AWS filler metal code. This allows ESAB to use the same product designations, worldwide – an obvious advantage for international fabricators. All existing approvals transfer to the new product designations.

<table>
<thead>
<tr>
<th>Solid MIG wires:</th>
<th>Present name</th>
<th>New name</th>
<th>EN 12072</th>
<th>AWS A5.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Autrod 16.11</td>
<td>OK Autrod 347Si</td>
<td>G 19 9 NbSi</td>
<td>ER347Si</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.12</td>
<td>OK Autrod 308LSi</td>
<td>G 19 9 LSi</td>
<td>ER308LSi</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.31</td>
<td>OK Autrod 318Si</td>
<td>G 19 12 3 NbSi</td>
<td>ER318Si</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.32</td>
<td>OK Autrod 316LSi</td>
<td>G 19 12 3 LSi</td>
<td>ER316LSi</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.34</td>
<td>OK Autrod 317L</td>
<td>G 18 15 3 L</td>
<td>ER317L</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.51</td>
<td>OK Autrod 309LSi</td>
<td>G 23 12 LSi</td>
<td>ER309LSi</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.54</td>
<td>OK Autrod 309MoL</td>
<td>G 23 12 2 L</td>
<td>(ER309LMo)</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.70</td>
<td>OK Autrod 310</td>
<td>G 25 20</td>
<td>ER310</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.76</td>
<td>OK Autrod 310Nb</td>
<td>G 25 17</td>
<td>ER310</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.79</td>
<td>OK Autrod 410NiMo</td>
<td>G 13 4</td>
<td>(ER410NiMo)</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.81</td>
<td>OK Autrod 430Ti</td>
<td>G Z 17 Ti</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.86</td>
<td>OK Autrod 2209</td>
<td>G 22 9 3 N L</td>
<td>ER2209</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.95</td>
<td>OK Autrod 16.95</td>
<td>G 18 8 Mn</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAW wires:</th>
<th>Present name</th>
<th>New name</th>
<th>EN 12072</th>
<th>AWS A5.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Autrod 16.10</td>
<td>OK Autrod 308L</td>
<td>S 19 9 L</td>
<td>ER308L</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.21</td>
<td>OK Autrod 347</td>
<td>S 19 9 Nb</td>
<td>ER347</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.30</td>
<td>OK Autrod 316L</td>
<td>S 19 12 3 L</td>
<td>ER316L</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.34</td>
<td>OK Autrod 317L</td>
<td>S 18 15 3 L</td>
<td>ER317L</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.41</td>
<td>OK Autrod 318</td>
<td>S 19 12 3 Nb</td>
<td>ER318</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.43</td>
<td>OK Autrod 309L</td>
<td>S 23 12 2 L</td>
<td>(ER309LMo)</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.54</td>
<td>OK Autrod 309MoL</td>
<td>S 23 12 2 L</td>
<td>(ER309LMo)</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.70</td>
<td>OK Autrod 310</td>
<td>S 25 20</td>
<td>ER310</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.86</td>
<td>OK Autrod 2209</td>
<td>S 22 9 3 N L</td>
<td>ER2209</td>
<td></td>
</tr>
<tr>
<td>OK Autrod 16.88</td>
<td>OK Autrod 2509</td>
<td>S 25 9 4 N L</td>
<td>ER2509</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strip for SAW and ES cladding</th>
<th>Present name</th>
<th>New name</th>
<th>EN 12072</th>
<th>AWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK Band 11.61</td>
<td>OK Band 308L</td>
<td>S 19 9 L</td>
<td>EQ308L</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.62</td>
<td>OK Band 347</td>
<td>S 19 9 Nb</td>
<td>EQ347</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.63</td>
<td>OK Band 316L</td>
<td>S 19 12 3 L</td>
<td>EQ316L</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.64</td>
<td>OK Band 2209</td>
<td>S 22 9 3 N L</td>
<td>EQ2209</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.65</td>
<td>OK Band 309L</td>
<td>S 23 12 L</td>
<td>EQ309L</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.66</td>
<td>OK Band 309L</td>
<td>S 23 12 L Nb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Band 11.67</td>
<td>OK Band 309Mo</td>
<td>S 23 12 L Nb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Band 11.68</td>
<td>OK Band 310MoL</td>
<td>S 25 22 2 N L</td>
<td>(EQ310MoL)</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.69</td>
<td>OK Band 310MoL</td>
<td>S 25 22 2 N L</td>
<td>(EQ310MoL)</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.71</td>
<td>OK Band 309LESW</td>
<td>(EQ 309L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Band 11.72</td>
<td>OK Band 309LESW</td>
<td>(EQ 309L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Band 11.73</td>
<td>OK Band 309LESW</td>
<td>(EQ 309L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Band 11.82</td>
<td>OK Band 430</td>
<td>S 17</td>
<td>EQ430</td>
<td></td>
</tr>
<tr>
<td>OK Band 11.92</td>
<td>OK Band NiCrMo3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OK Band 11.95</td>
<td>OK Band NiCr3</td>
<td>UP-NiCr20Nb</td>
<td>ENiCr-3</td>
<td></td>
</tr>
</tbody>
</table>